THE ADVENT OF COBLENDING HARVESTING THE ETBE ETOH SYNERGY

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Biofuels 2011 - 6th Annual meeting
Amsterdam – The Netherlands 13 Oct 2011

EFOA The European Fuel Oxygenates Association

FEDERCHIMICA AISPEC GRUPPO FONTI RINNOVABILI

BIOFUELS ITALIA

BioFuels: 3 Key Entities

FEDERCHIMICA

Italian Chemical Industry Federation

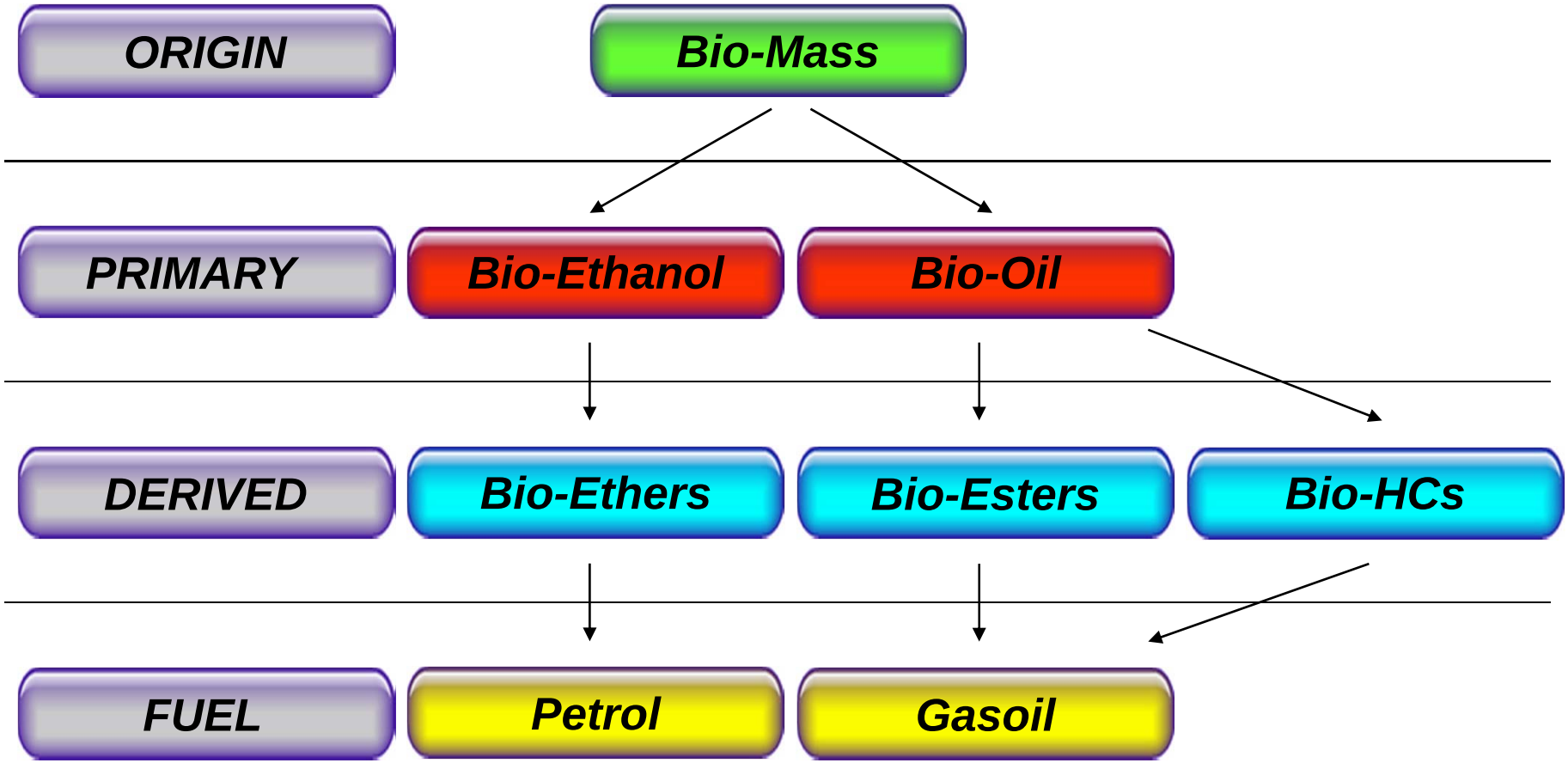
EFOA

European Fuel Oxygenates Association

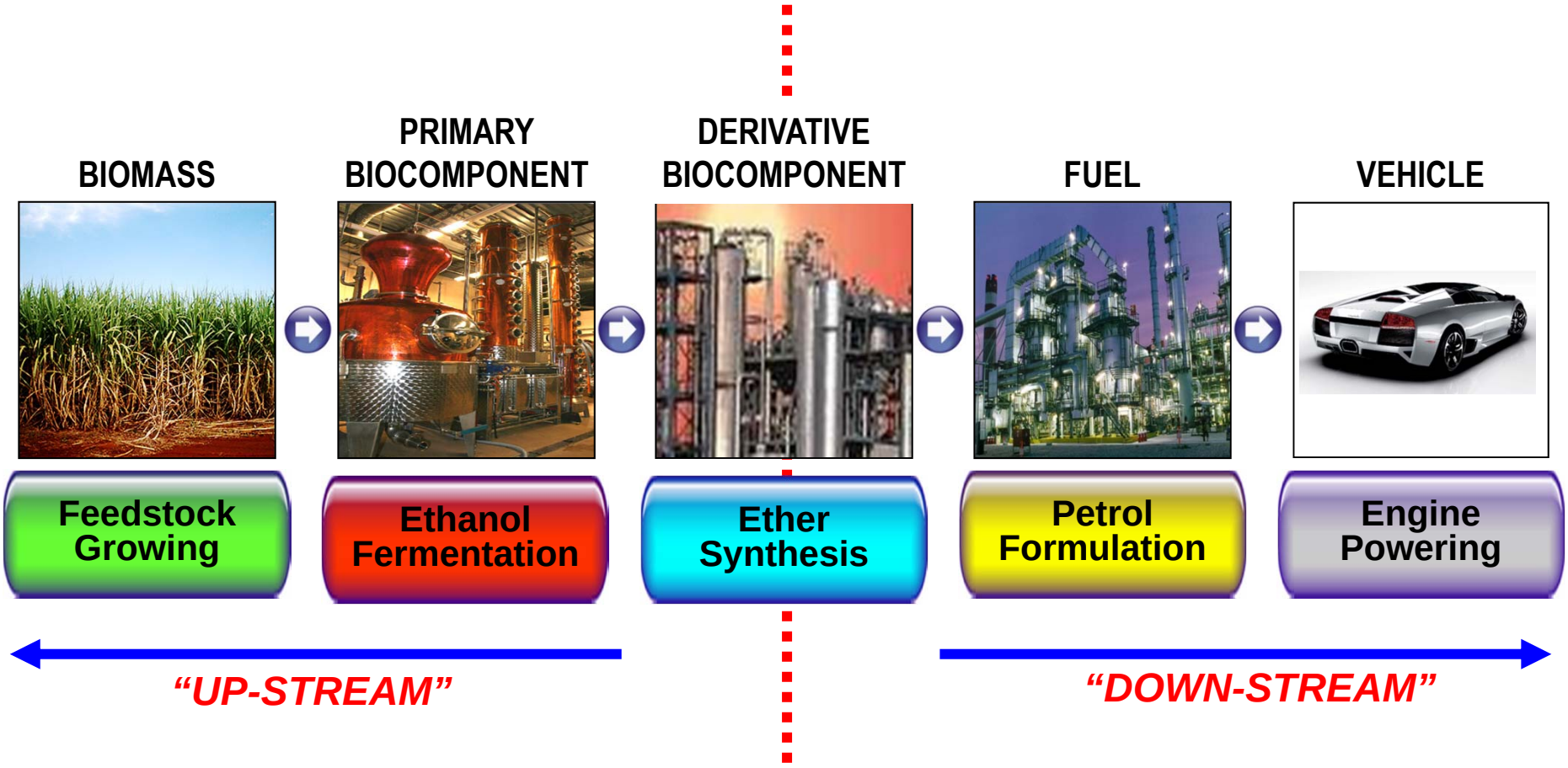
BIOFUELS ITALIA

Italian Biofuels Technology Platform

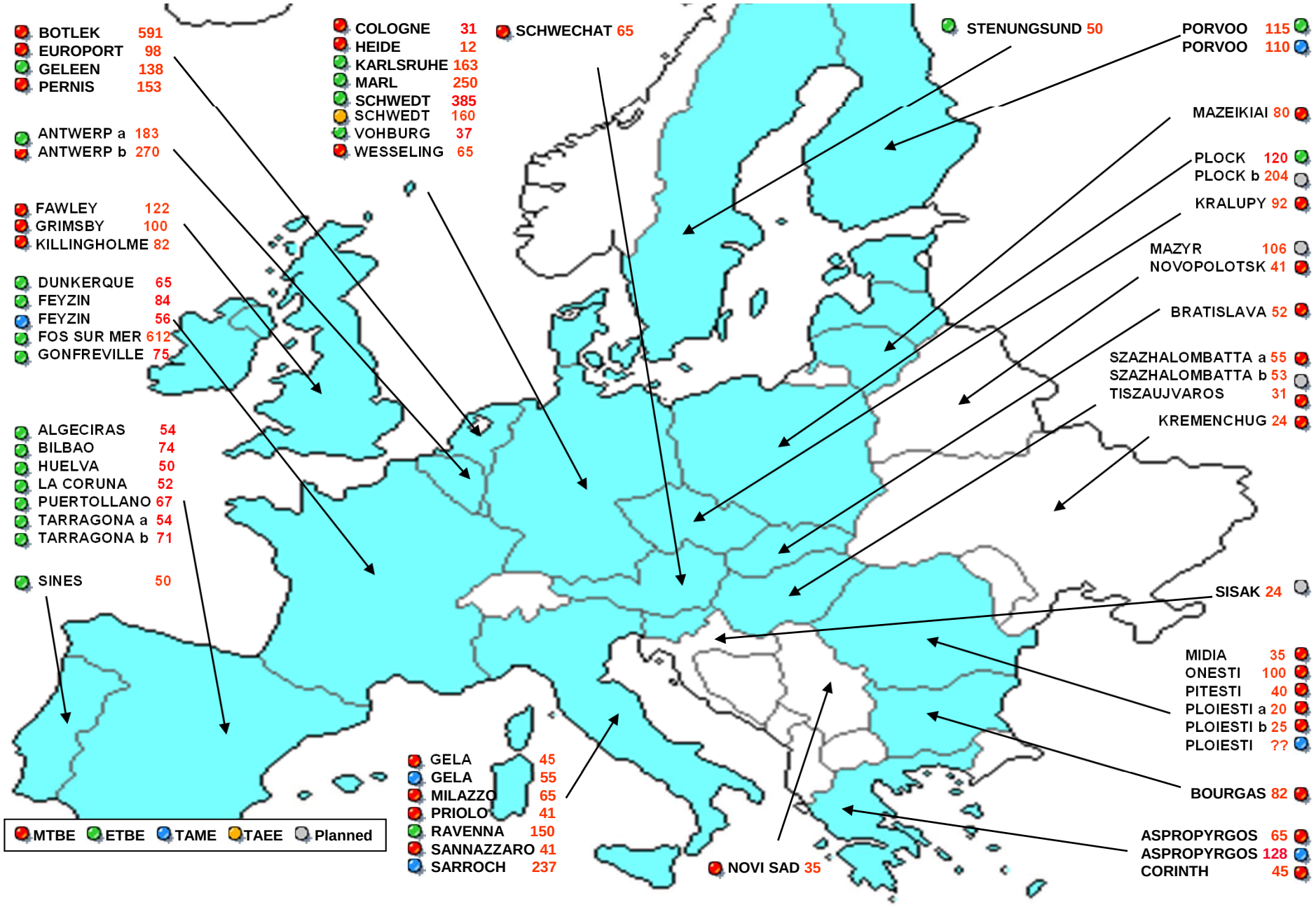
Bio-Ether (ETBE) is for Petrol
what Bio-Ester (FAME) is for Gasoil



Bio-Petrol Supply Chain: Ethers in Central Position



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



Addressing RED & FQD EU Directives Challenge

What	**10% Bio-energy in Fuels (RED)**
	6% CO_2 Saving (FQD)
Challenge	**Sustainability: a Broader Concept**
	Full Obligation but Partial "Control" ?
	Petrol/Gasoil - Supply/Demand Unbalance
	Balkanization of Implementation Rules in 27 EU Member States
	Consumers Resistance to "High-Bio" Grades (E10)
	Vehicle/Engines Compatibility/Operability
	Fuel Specifications Limits (Oxygenates/Oxygen/FAME)
How	**CO_2 Reduction Effectiveness of Bio-components**
	High Bio-components Blending Percentage
	Exploitation "best seller" Petrol Grade (Protection Grade)
Solution	**Adopting Immediately Available Consolidated Solutions**
	Maximizing Actual Bio-energy Blending within E5
	Optimizing Logistics: ETBE "Dual-BBEB" [*]
	Capturing Bio-components' Well-to-Wheels CO_2 Saving Potential
	Harvesting Bio-components' Synergetic "Non-linear" Effects

*[*] **B**lend-stock **B**efore **E**thanol **B**lending*

Two “Interactive” EU Directives

FUEL QUALITY Directive *2009/30/EC*

RENEWABLE ENERGY Directive *2009/28/EC*

GHG Emissions Reducton

6% (+2%+2%)

Renewable Energy Transport

10%

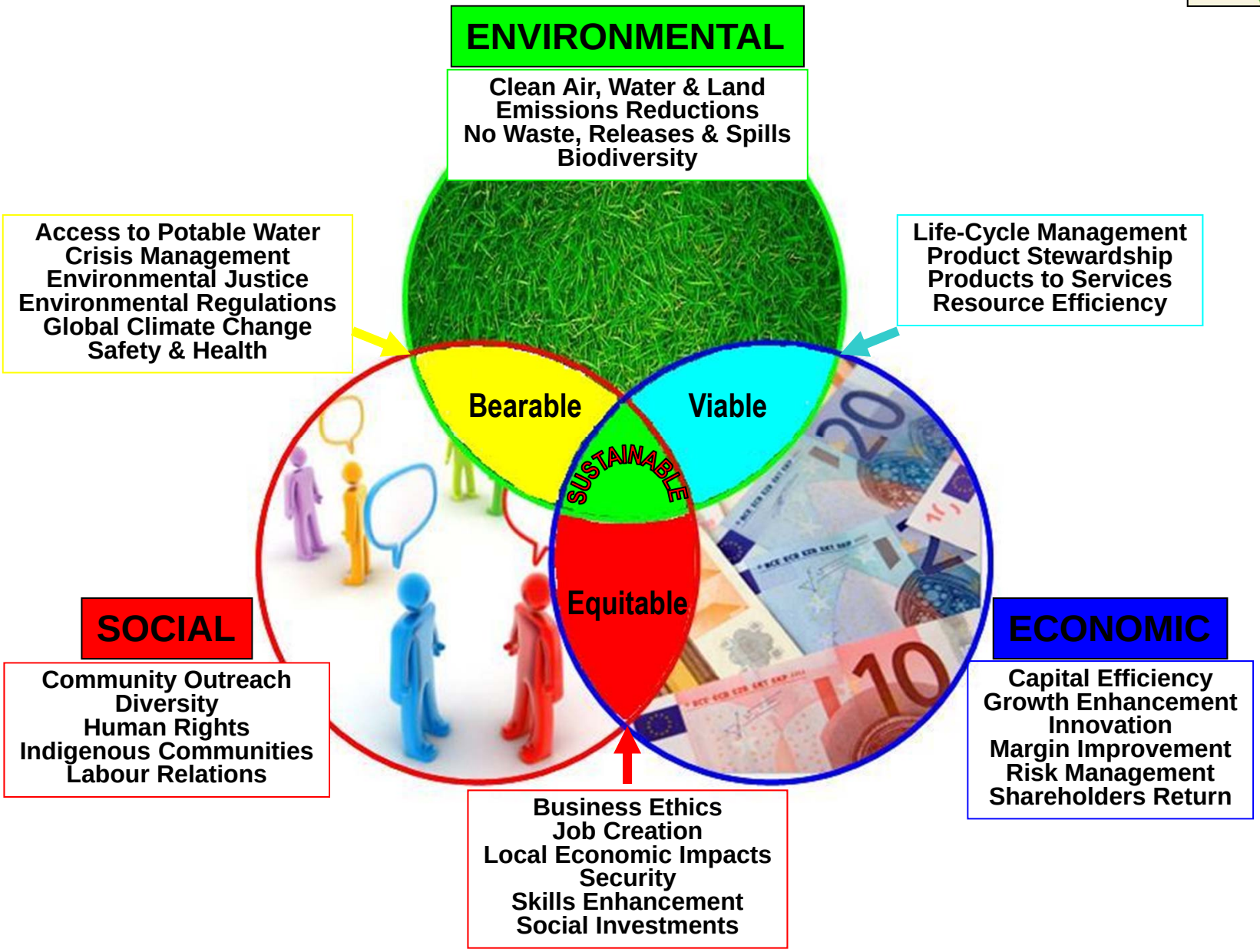
Sustainability Threshold

-35% (2010)

-50% (2017)

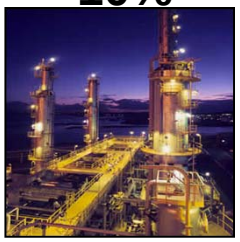
-60% (2018)

Bio-component to Address Broader Sustainability



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

100%

4%	10%	1%	85%
			
Crude Production	**Fuel Refining**	**Distribution Retail**	**Engine Combustion**

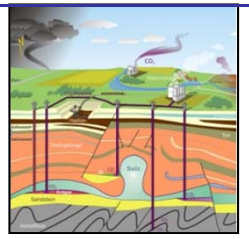
15% — **Oil Ind.**

85% — **Automotive Ind.**

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

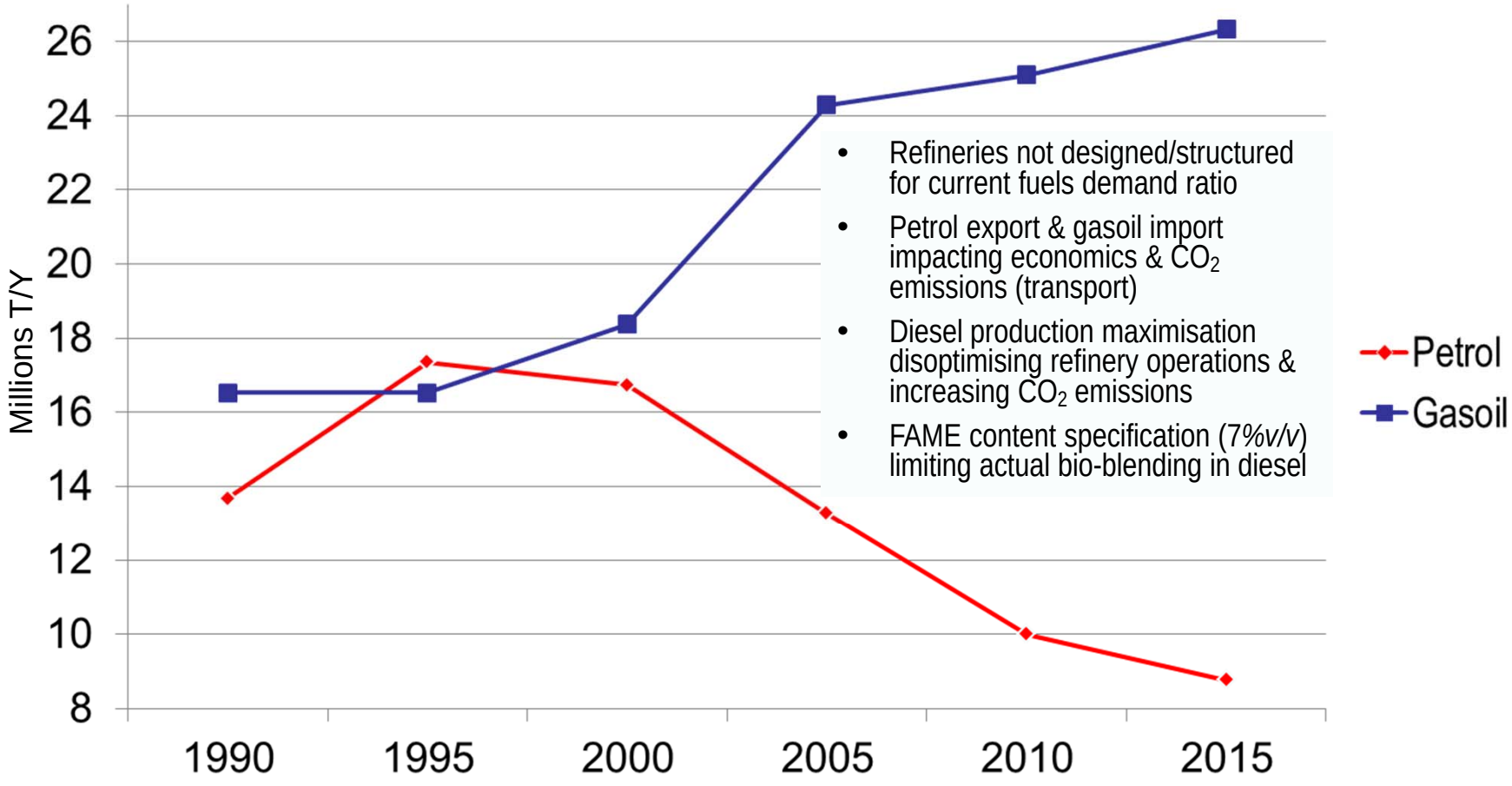
Operations Energy Efficiency

Bio-Fuels Blending



Carbon Capturing & Storage

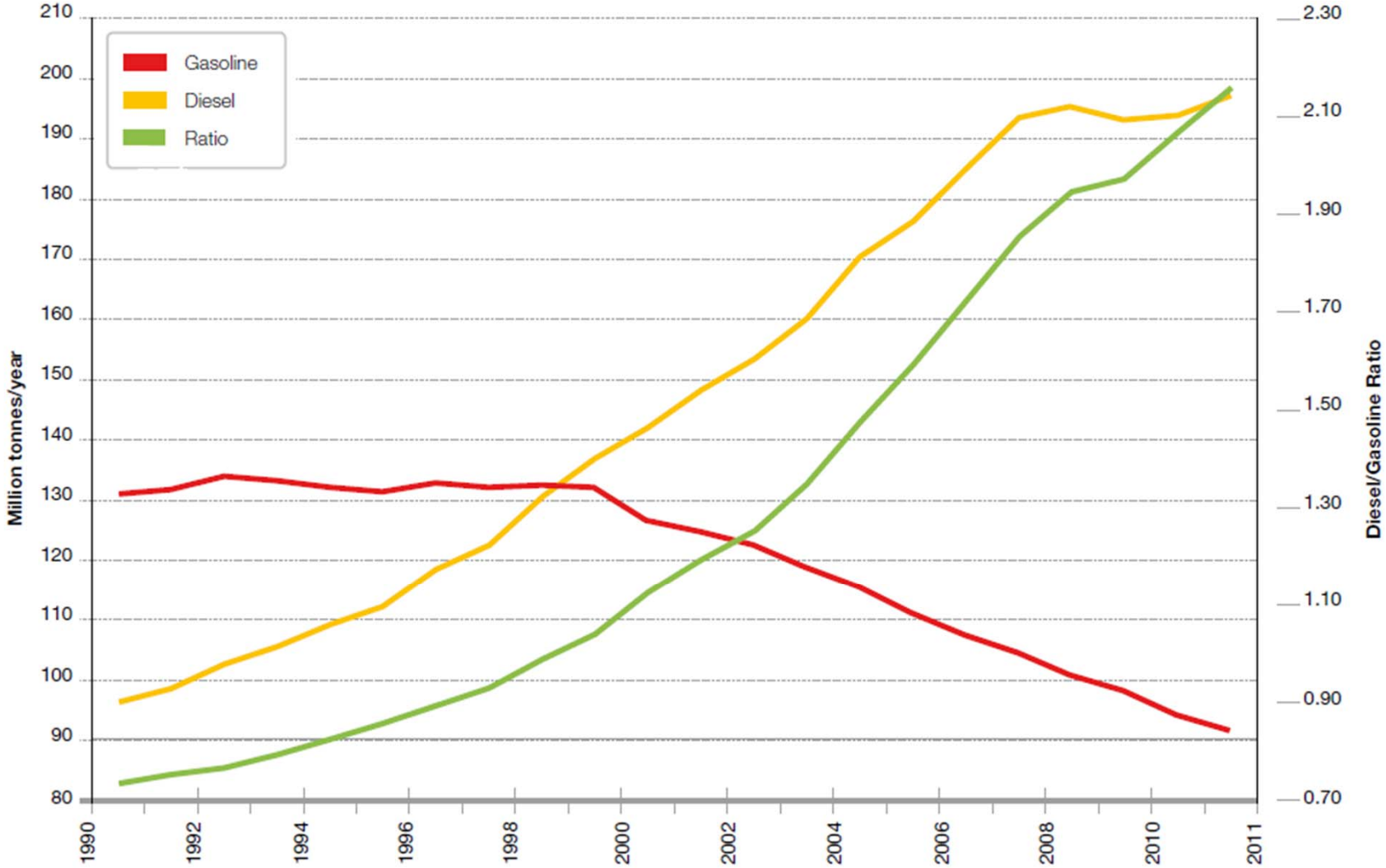
Petrol/Gasoil - Supply/Demand Unbalance: Petrol & Gasoil Domestic Demand Italy



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

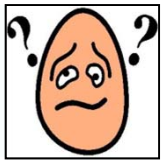
Source: Elaboration from UP (Italian Oil Industry Association)

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



Source: Wood Mackenzie, 2011

Balkanization of National Bio-Blending Obligations



IRELAND
4,0%(v/v)

NORWAY
3,5%(v/v)
Parallel Targets
Pertrol & Gasoil

SWEDEN
5,75%(e/e)
Indicative

FINLANDI
4.0(e/e)

UNITED KINGDOM
3,5%(v/v)

NETHERLANDS
4,0%(e/e)
Parallel Targets
Pertrol & Gasoil

POLAND
5,75%(e/e)
Indicative

FRANCE
7,0%(e/e)
Parallel Targets
Pertrol & Gasoil

GERMANY
Gasoil **4,4%**(e/e)
Pertrol **2,8%**(e/e)

CZECH REPUBLIC
Gasoil **4,5%**(v/v)
Pertrol **3,5%**(v/v)

SPAIN
3,9%(e/e) Ind.
5.83% (e/e) Cum.

ITALY
4.0%(e/e)
Obiettivo cumulativo
Pertrol + Gasoil

AUSTRIA
Gasoil **6,3%**(e/e)
Pertrol **3,4%**(e/e)

SLOVAKIA
5,75%(e/e)
Indicative

PORTUGAL
Gasoil **7,0%**(v/v)

Consumers Resistance to “High-Bio” Grades (E10)

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”

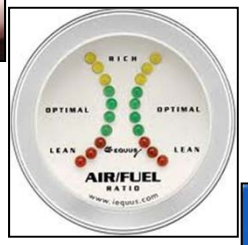
“High bio compete with food and feed”

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

Vehicle/Engines Compatibility/Operability

Fuel filter blockage

Galvanic corrosion



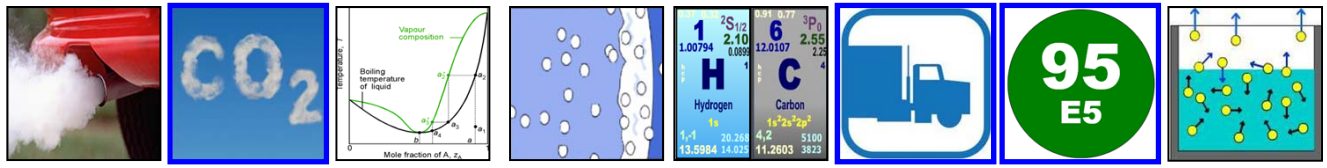
Enleanment

Drivability

Deposit formation

Material compatibility

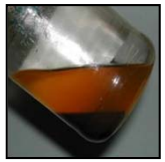
ETBE: A Multifaceted Benefits Carrier



VOCs | CO_2 | AZEOTROPE | PERMEATION | H/C RATIO | LOGISTICS | BIO-ENERGY | VOLATILITY

COMINGLING

DISTILLATION

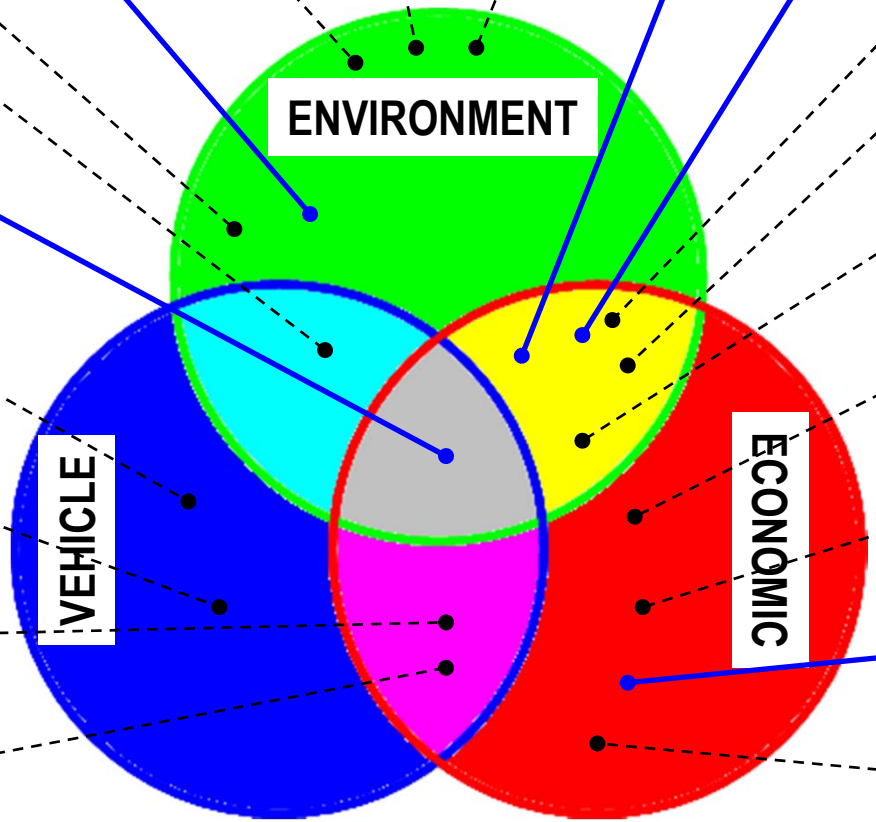


WATER TOLER.

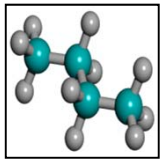
DRIVEABILITY

MATER. COMP.

HYGROSCOPY



ENER. EFFIC.



C4 UPTAKE

OCTANE BARR.

BLENDSTOCK

REF. FLEXIBILITY

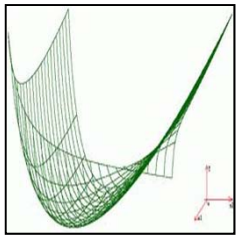
INVEST. SAVING

..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

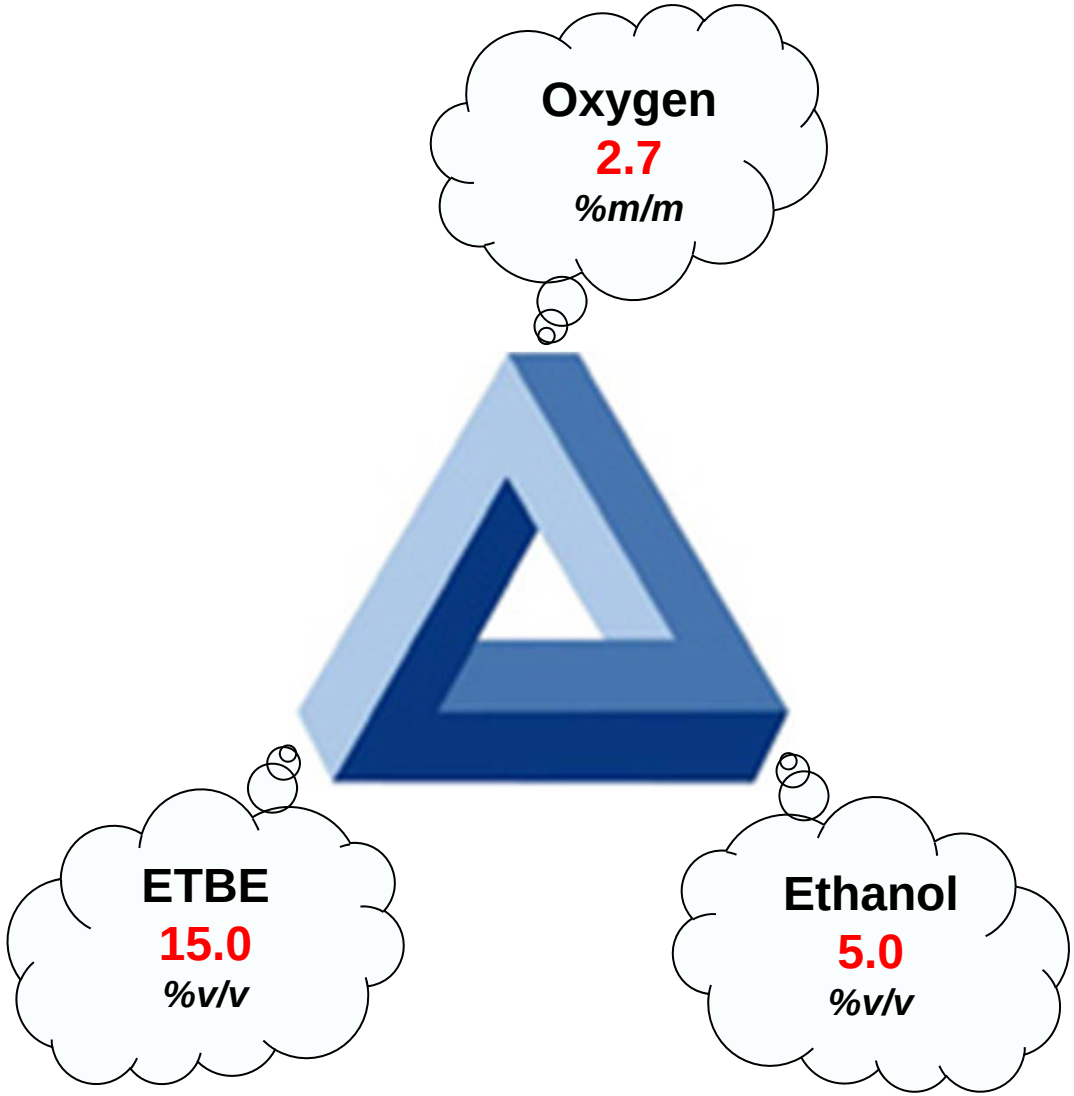
Minimizing Quality “Give-away” and fossil base-stock cost, via ETBE-containing “Dual BBEB”[*] for E5/E10



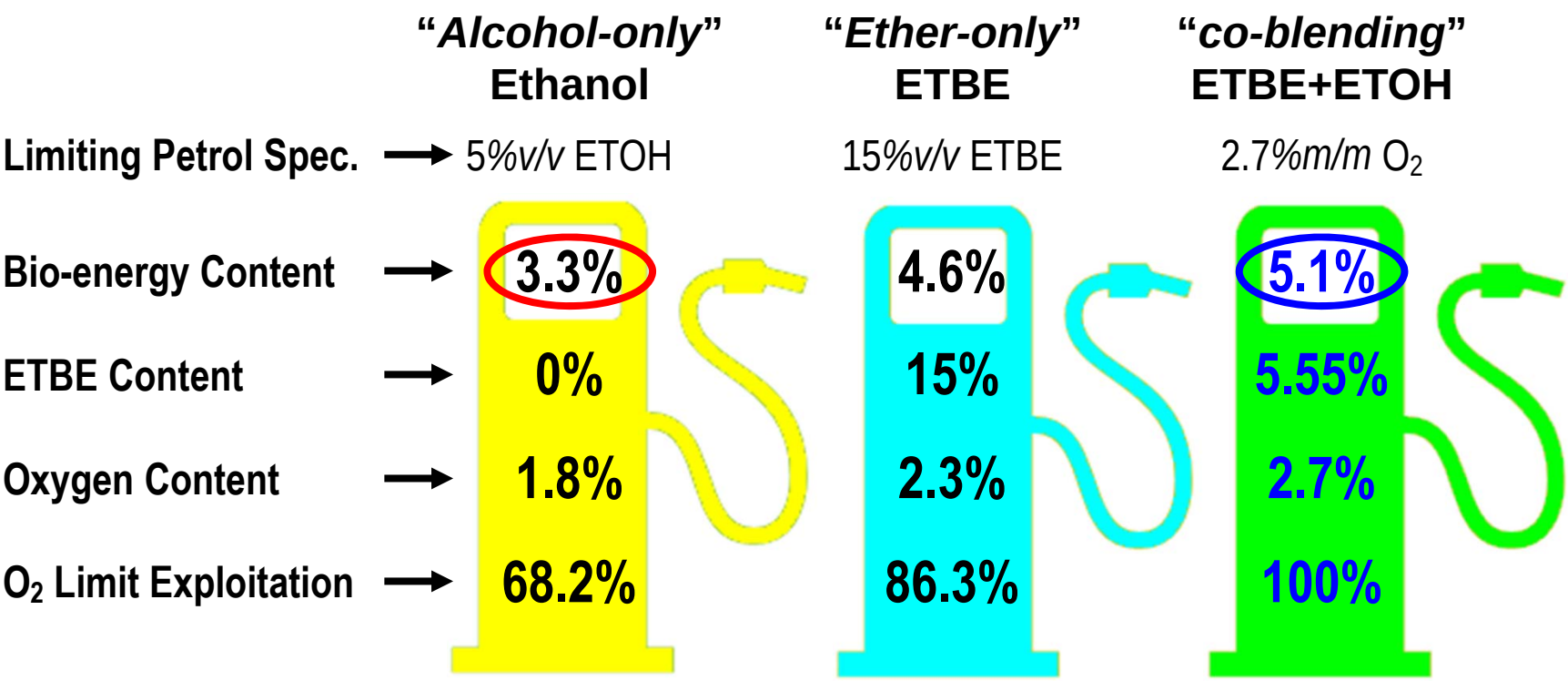
Harvesting Synergetic "Non-linear" Effects of Bio-components

*[*] **B**lend-stock **B**efore **E**thanol **B**lending*

Exploiting Bio-related Petrol Specifications Limits (E5)

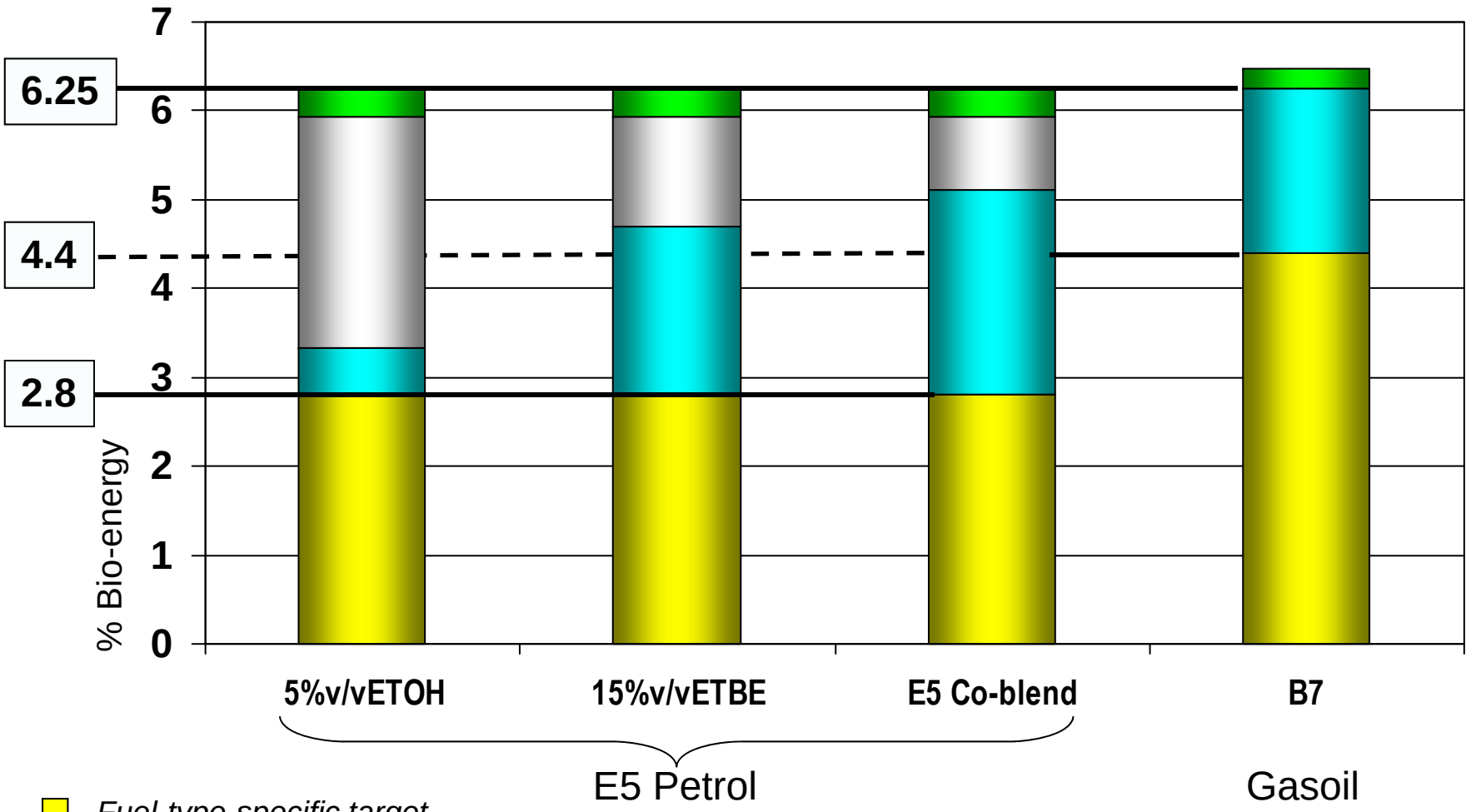


53% more bio-energy into E5 via “Co-blending”



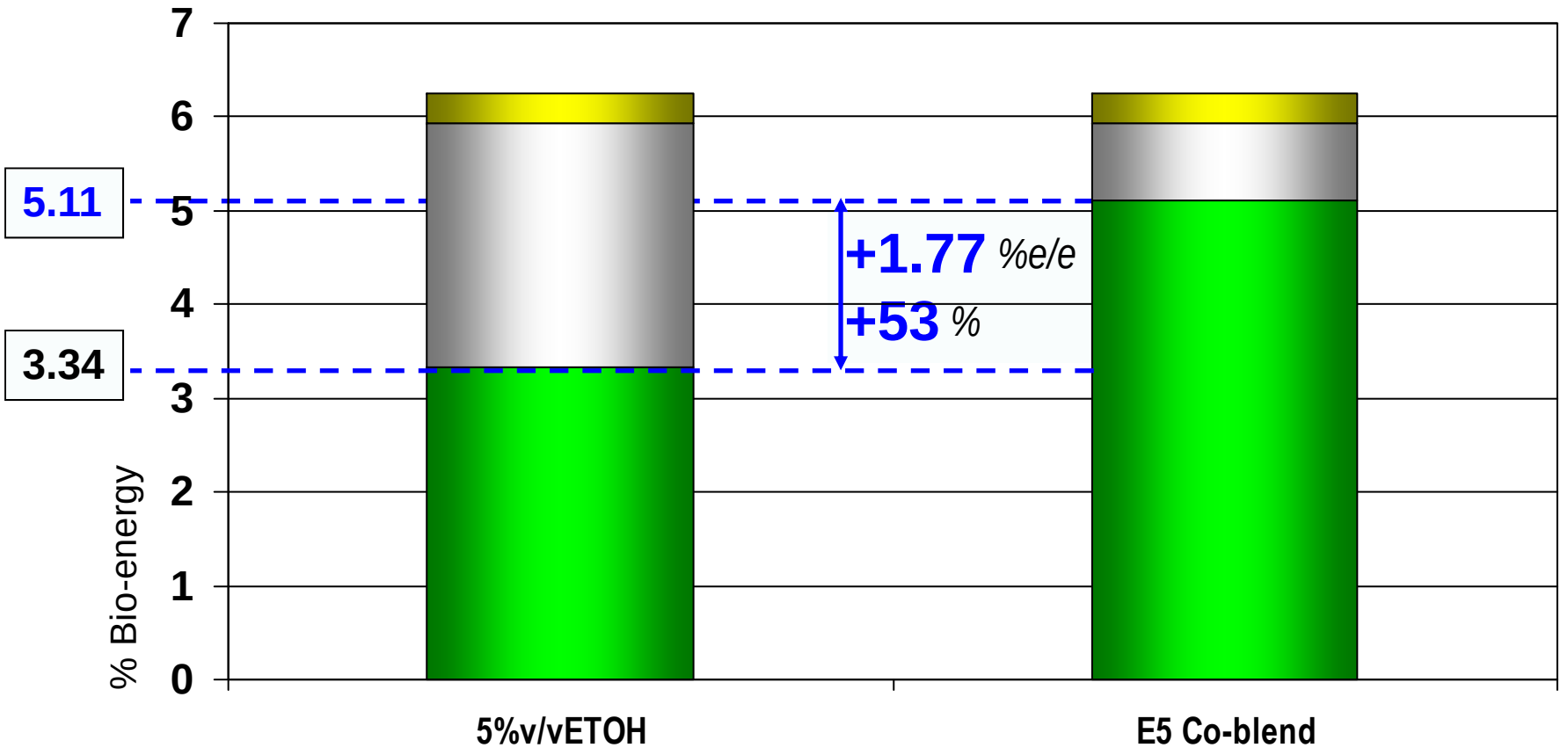
German Example *(1)*:

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)*

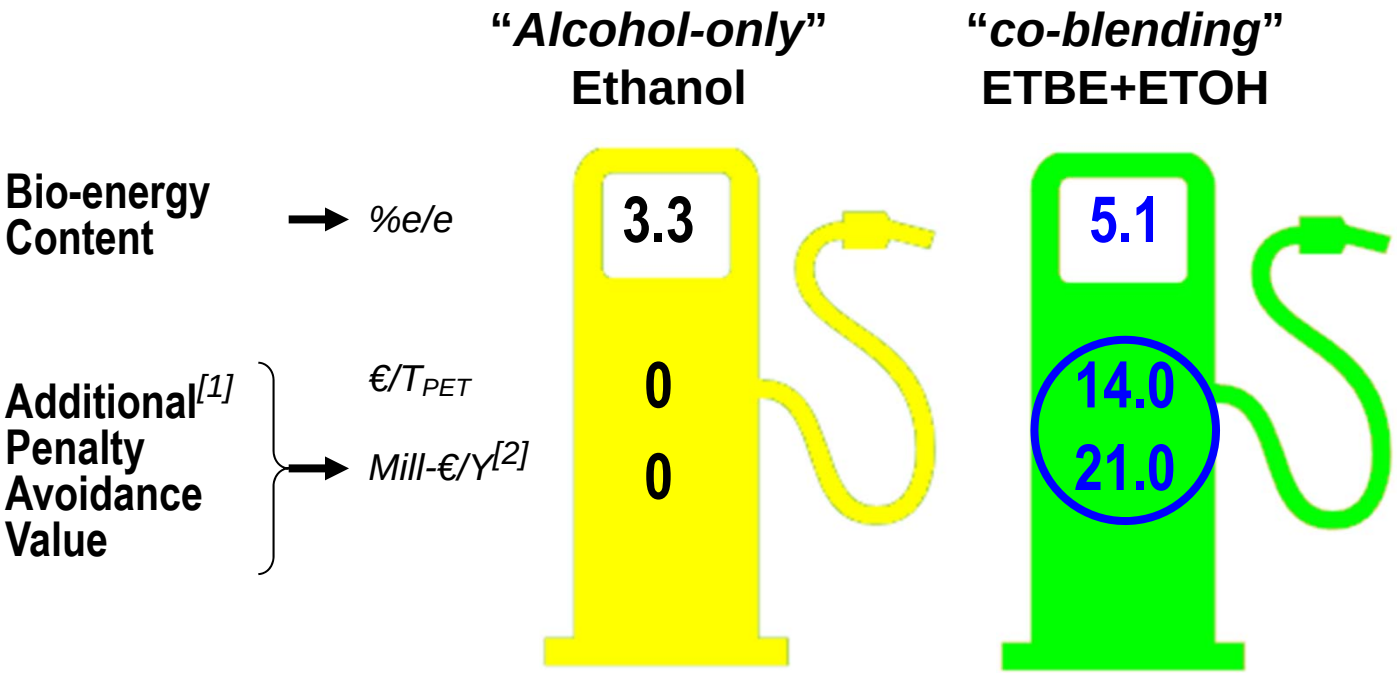
German Example *(2)*:
53% more bio-energy into E5 via “Co-blending”



- *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)*

German Example *(3)*:

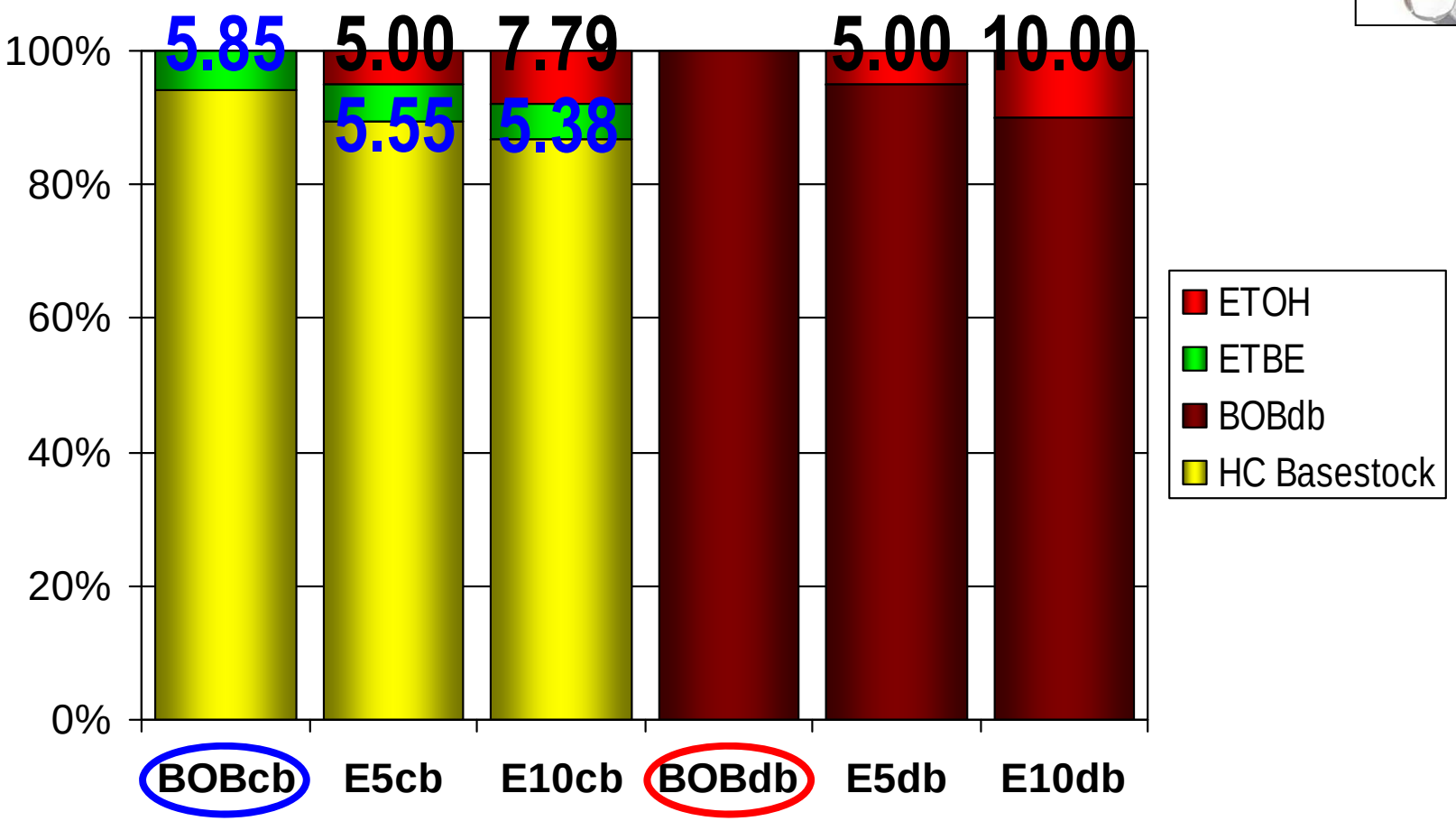
E5: “Co-blending” Enables Significant Non-compliance Penalty Saving



[1] On top of what achievable with 5%v/v ETOH directly blended into E5 “Protection Grade”

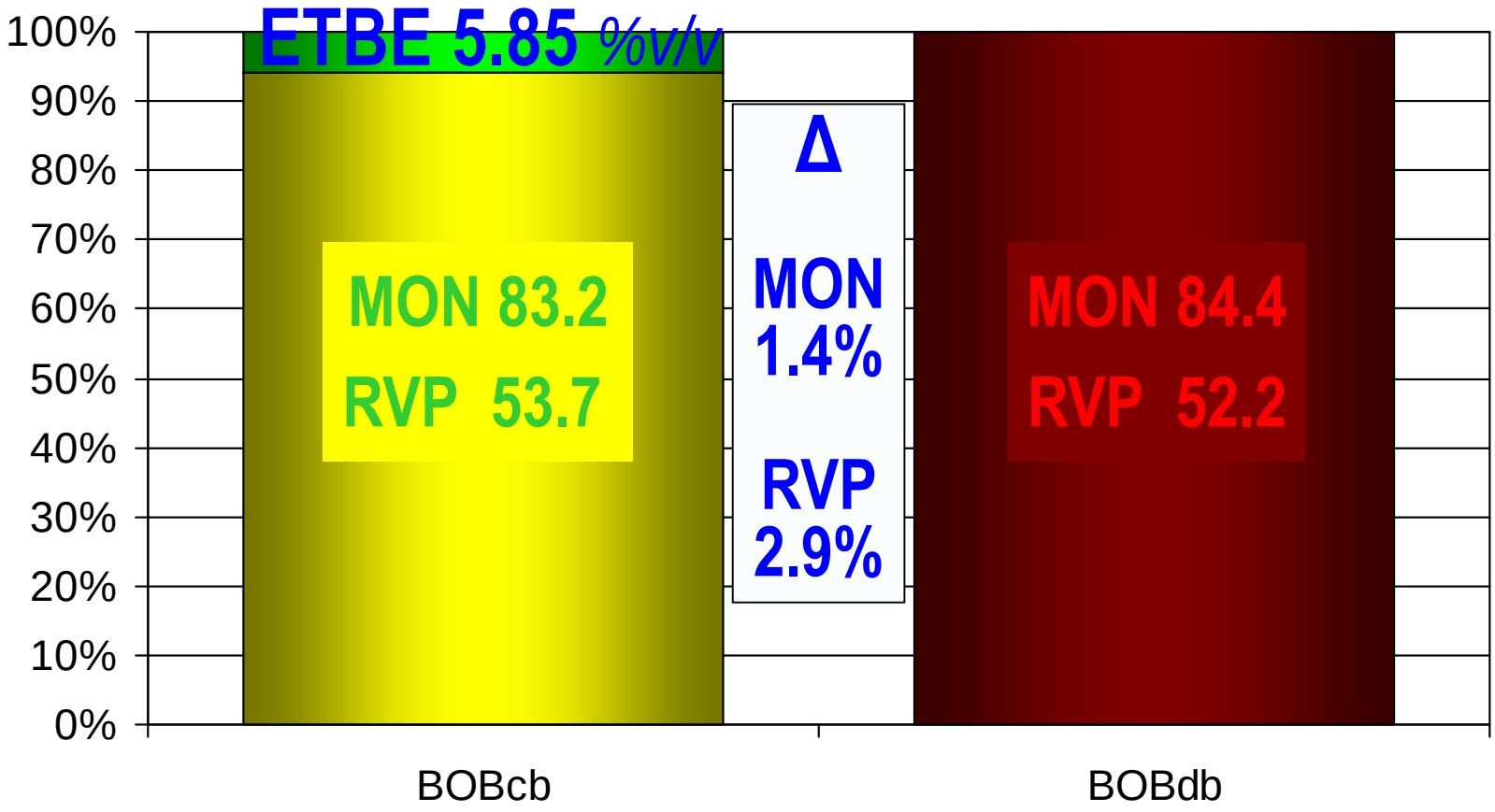
[2] Example based on an average refinery petrol production of 1.5 million tons per year

“Dual” BOBs for E5 and E10



BOBcb = ETBE-containing E5/E10-dual-BBEB that, when blended with 5%v/v ETOH, yields E5 @ 2.7%m/m O_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



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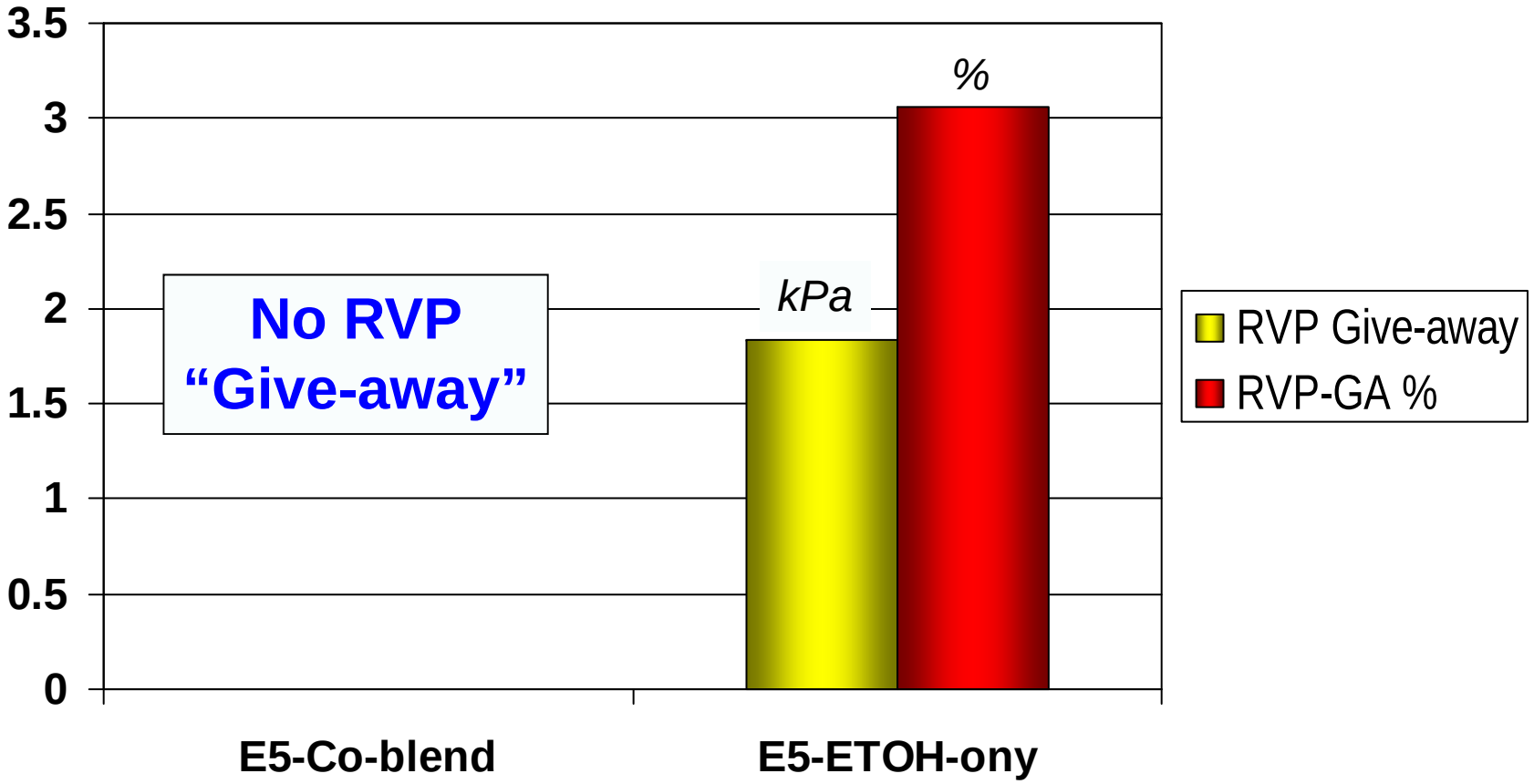
BOBdb = Oxy-free E5/E10-dual-BOB, yielding E5 with 5%v/v ETOH, and E10 with 10%v/v ETOH

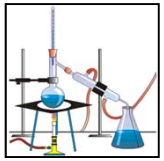
Conservatively neglecting positive non-linear "co-solvency" effects of ETBE

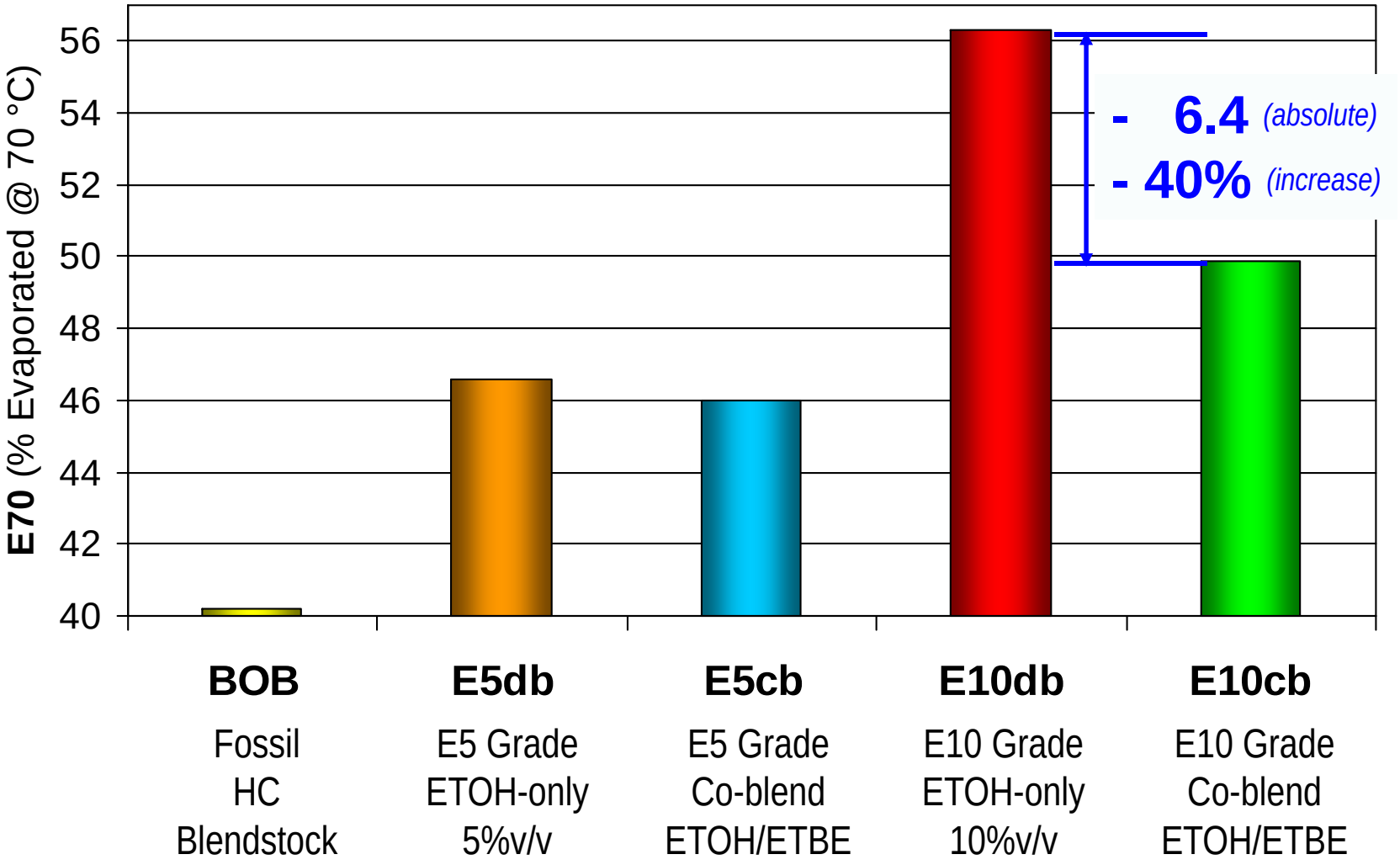
Co-blending avoids RVP “give-away” on E5



[*]
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 BBEB.

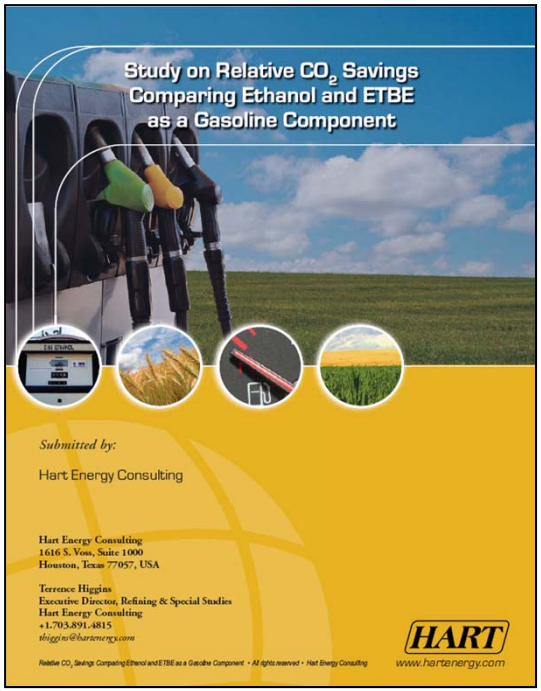
Co-blending Addresses ETOH E70 Boost





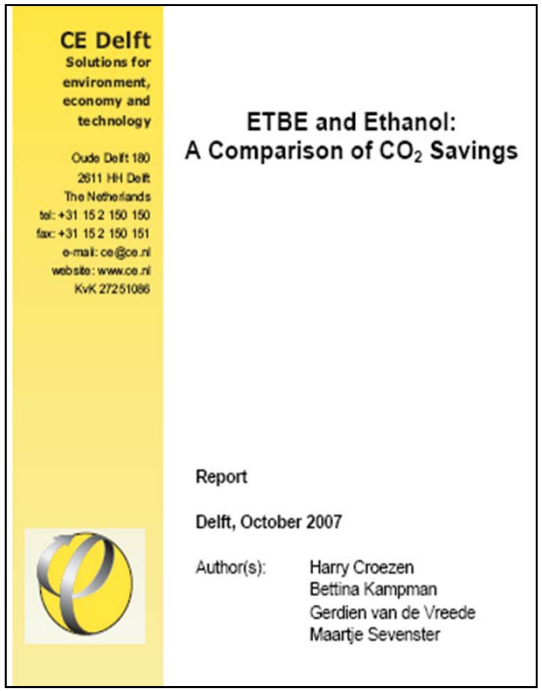
ETBE Further Reduces CO_2 Emissions

HART July 2007



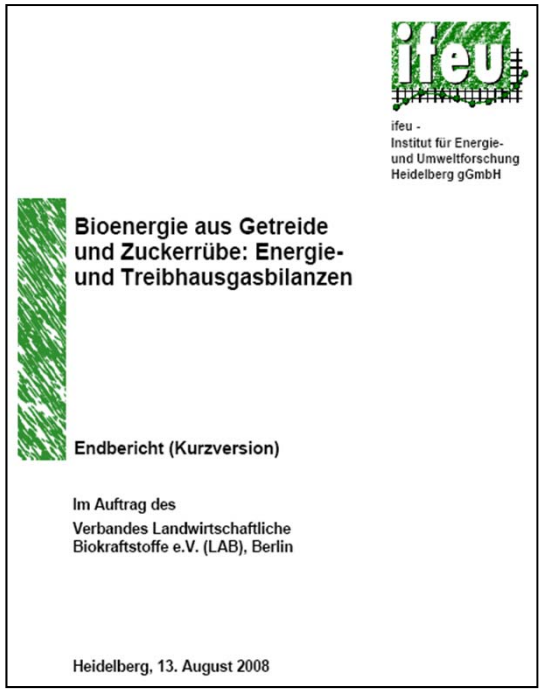
"The use of bio-ETBE reduces refining crude-oil need and processing intensity, requires less fuel and, implying relevant petrol composition changes, allows the reduction of carbon factor and lesser CO_2 emissions"

CE-Delft October 2007



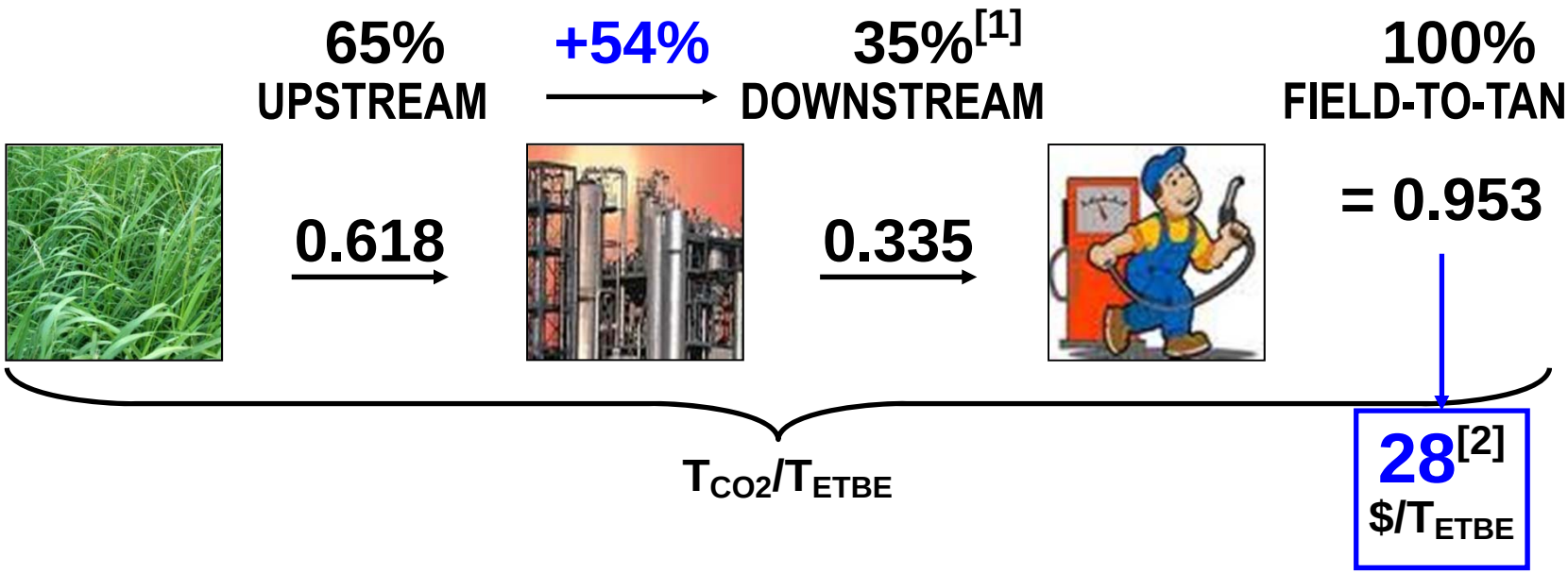
"This study indicated that, when bio-ETBE is used, the resulting modification of refinery operations determine a significant reduction of greenhouse gases emissions"

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"

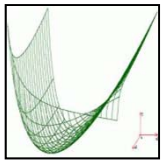
ETBE: Two Relevant CO_2 Saving Contributions



[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.

[2]
Based on CO_2 cost at current ETS value of 20 €/T_{CO2}

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.

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