EXPLOITING THE FULL GHG REDUCTION POTENTIAL OF BIOFUELS THE KEY FORGOTTEN FACTOR

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European Fuel Oxygenates Association

- Founded in 1985
- 8 members; representing the majority of European ether capacity
- Non-profit, technical organisation

- The European Fuel Oxygenates Association (EFOA) is a sector group of CEFIC, the European Chemical Industry Council
- Its role is to represent the European Fuel Ether industry in a wide variety of technical and government initiatives
- EFOA is recognised by the European Commission as a stakeholder on fuel quality and biofuels

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Presentation's Key Messages

- Treating all bio-fuels on consistent basis
- Capturing the entire GHG saving potential
- The whole is more than the sum of its parts
- Environmental contribution beyond GHG

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Biofuels Categories

"**Total**": Molecules produced starting exclusively from renewable raw materials (no fossil parts in their structure).

"**Partial**": Molecules synthetized from at least one, but not all, renewable raw materials (some of the atoms in the structure are from bio origin while others from fossil one).

"**Primary**": Molecules directly originated from bio-mass, normally via biological (i.e. fermentation) and/or mechanical (i.e. distillation) processes .

"**Derivatives**": Molecules synthetized starting from "primary" bio-fuel ones, by chemical processes (i.e. etherification, esterification, hydro-de-oxygenation).

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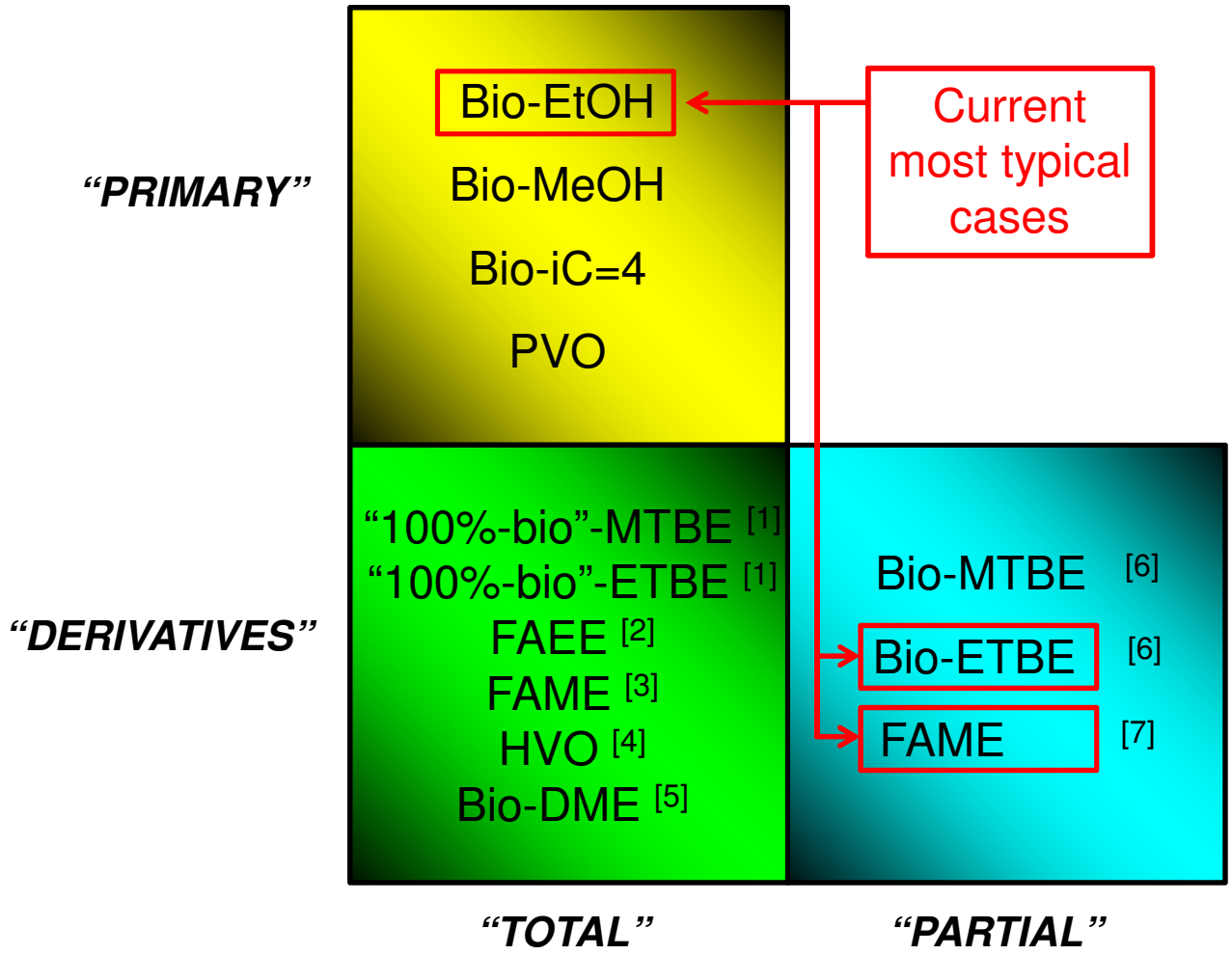
Bio-Fuels Type Examples



[1] From both olefin and alcohol of bio-origin
[2] From PVO and bio-ethanol
[3] From PVO and bio-methanol
[4] Where Hydrogenation H_2 either bio or neglected
[5] From bio-methanol
[6] From either olefin or alcohol of bio-origin and the other reagent fossil
[7] From PVO and fossil methanol

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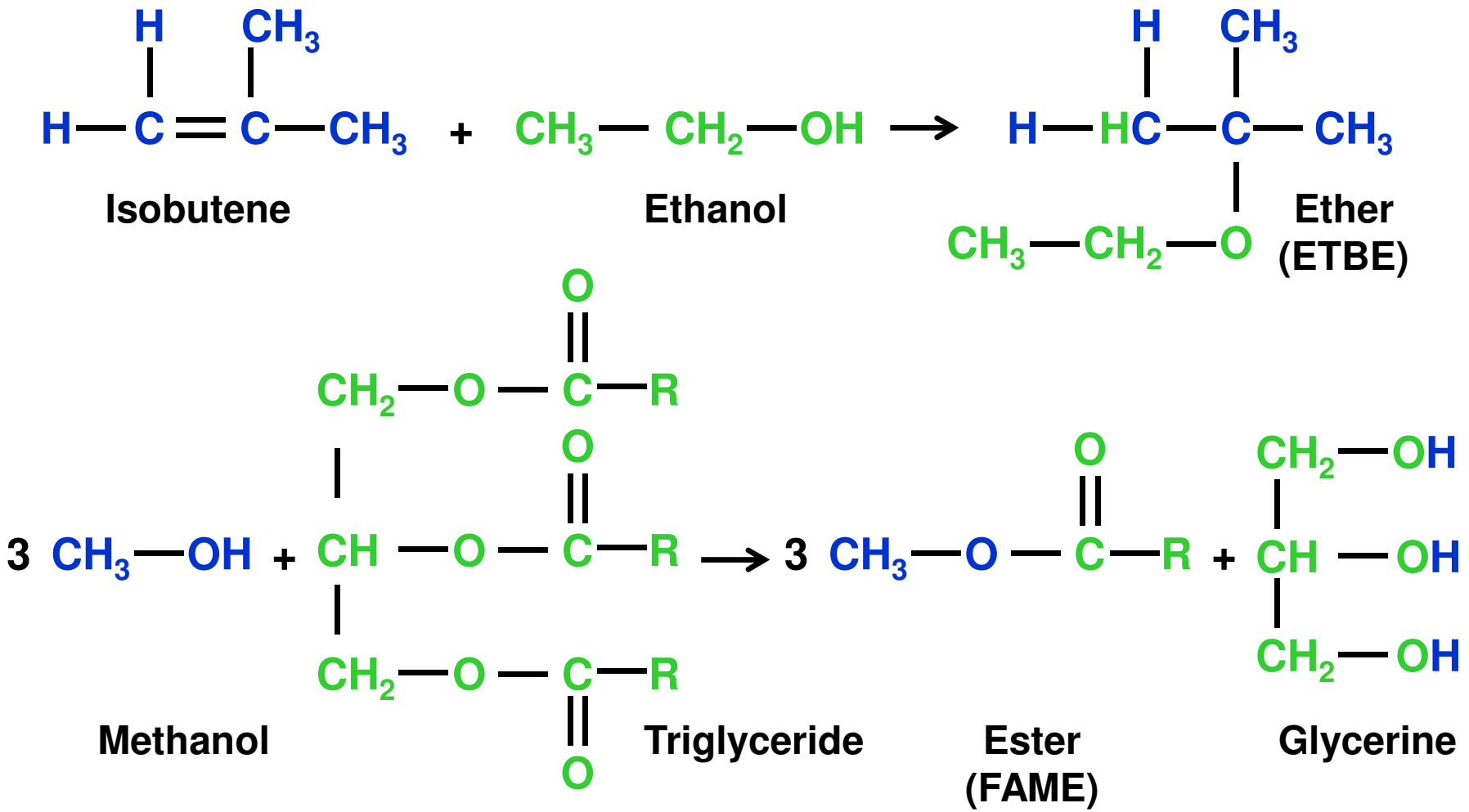
Example: ETBE and FAME both "Partial"



C, H, O *Fossil*

C, H, O *Renewable*

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Current Inconsistency to be Addressed: Also Ethers Should be Treated as Bio-fuels "per-se"

Directive 2009/28/EC (RED) - ANNEX III: "**Energy content of bio-fuels**" (excerpt)		
	by weight *(MJ/kg)*	by volume *(MJ/l)*
MTBE (produced from bio-Methanol)	35 (**of which** 22% from ren.)	26 (**of which** 22% from ren.)
ETBE (produced from bio-Ethanol)	36 (**of which** 37% from ren.)	27 (**of which** 37% from ren.)
TAEE (produced from bio-Ethanol)	38 (**of which** 29% from ren.)	29 (**of which** 29% from ren.)
FAME *(transesterification with fossil methanol)*	37	33
HVO (hydrotreated vegetable oil)	44	34

Directive 2009/28/EC (RED) - ANNEX V - Directive 2009/30/EC (FQD) - ANNEX IV: "**GHG Emission Saving from biofuels**" (excerpt)		
	(Typical)	*(Default)*
MTBE (The part from renewable sources of)	**Equal to that of** Methanol production pathway used	
ETBE (The part from renewable sources of)	**Equal to that of** Ethanol production pathway used	
TAEE (The part from renewable sources of)		
FAME (Biodiesel from rape-seed)	45%	38%
HVO (Hydrotreated vegetable oil from rape-seed)	51%	47%

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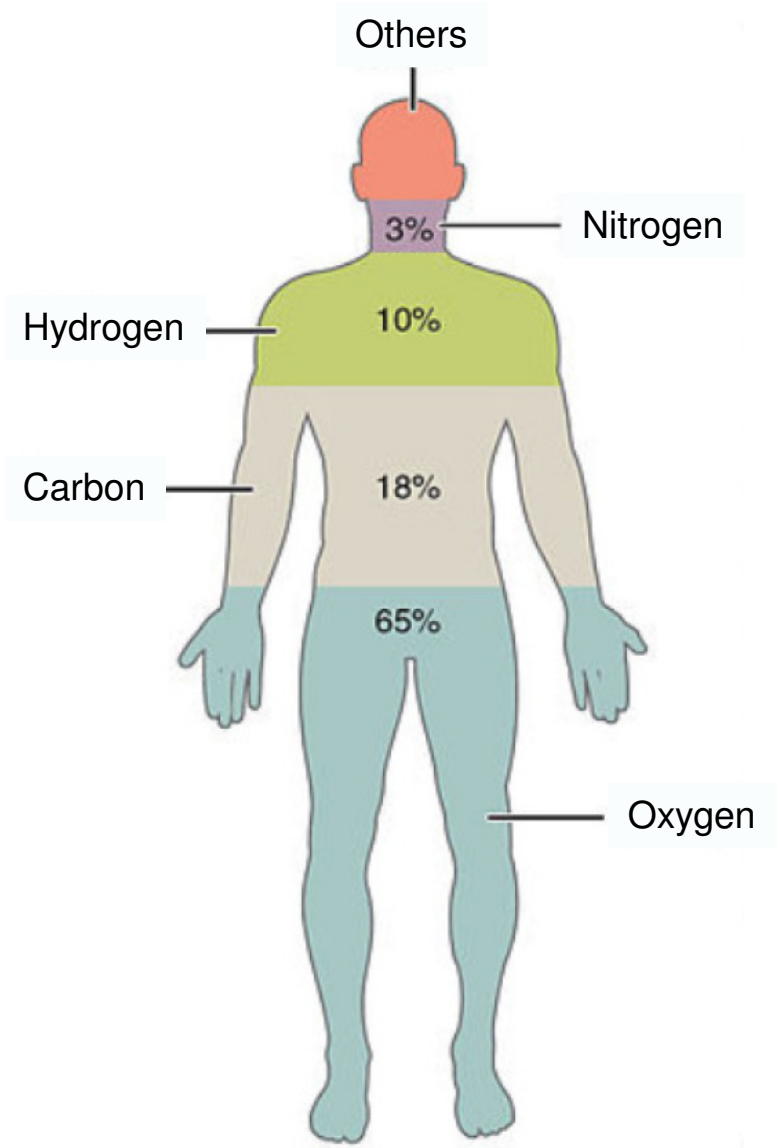
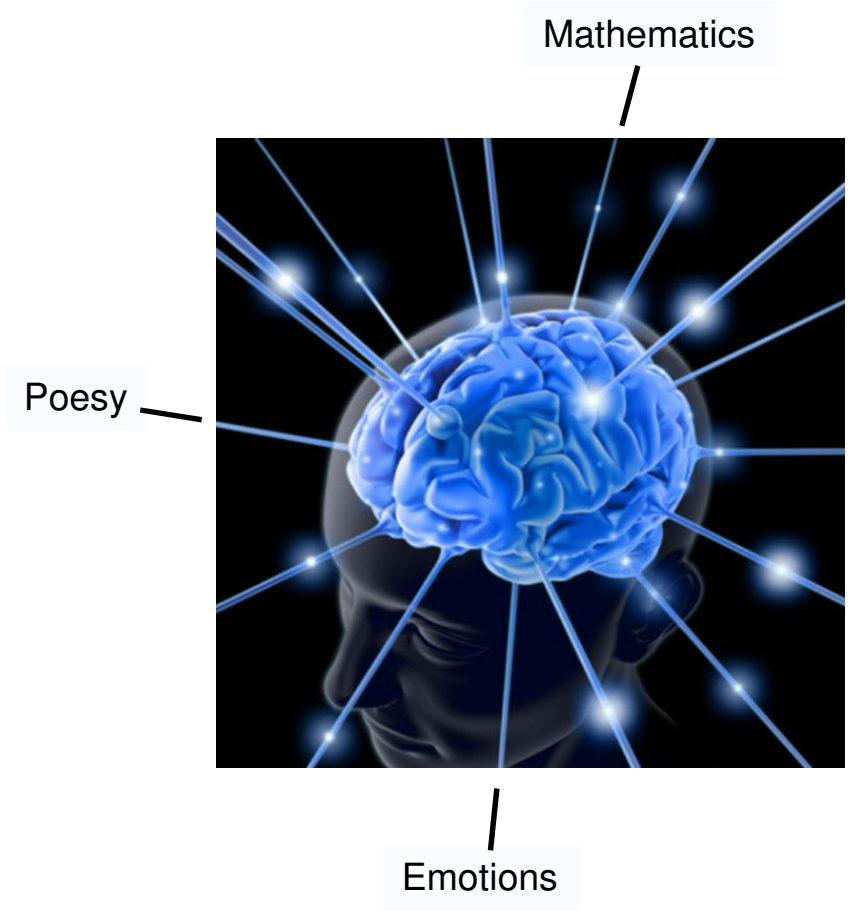
The whole is more than the sum of its parts

Aristotle, Metaphysica





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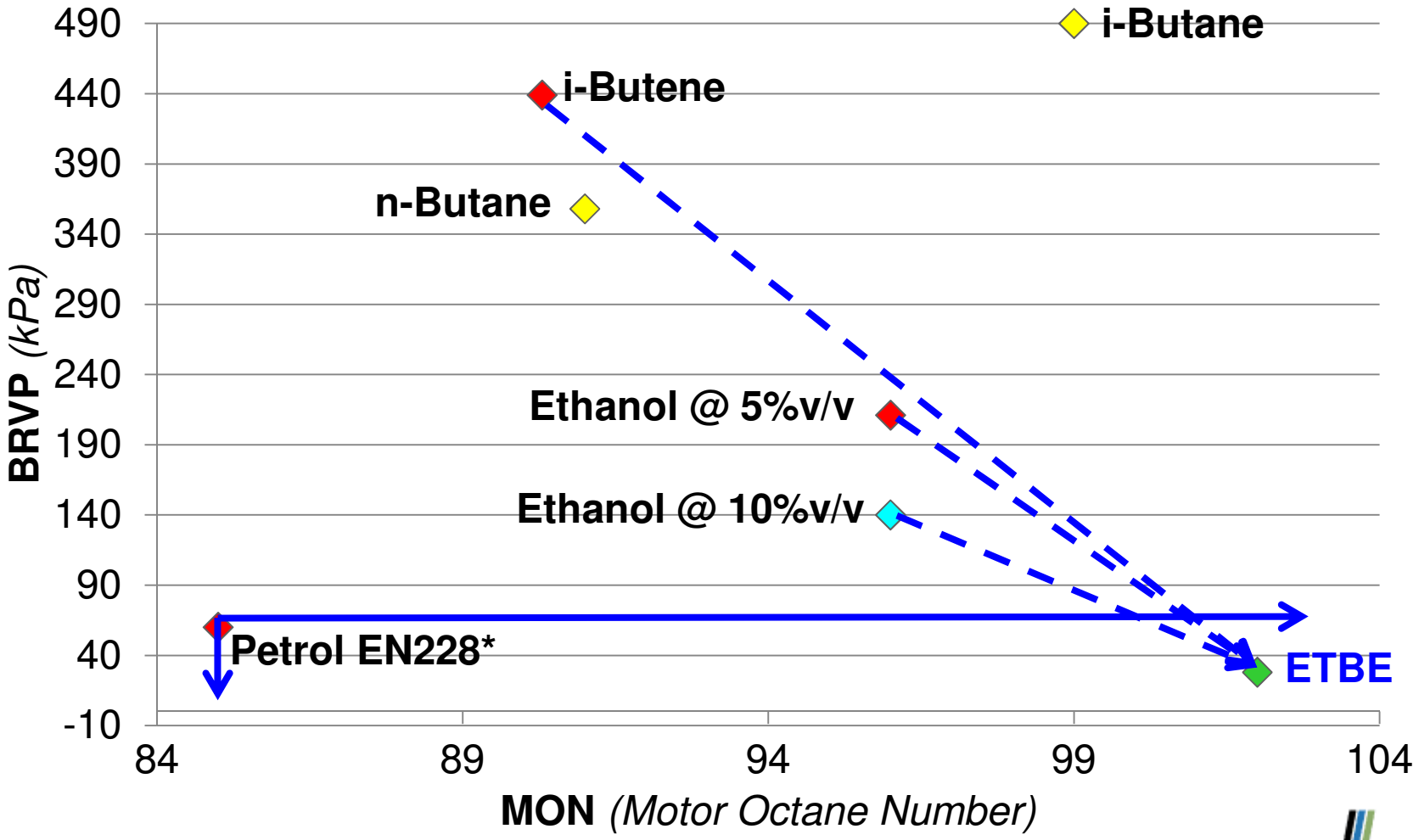
ETBE much more than the sum of its constituents:

Higher octane and Lower volatility than Ethanol + iC=4



*EN228 Petrol Summer Grade Specifications

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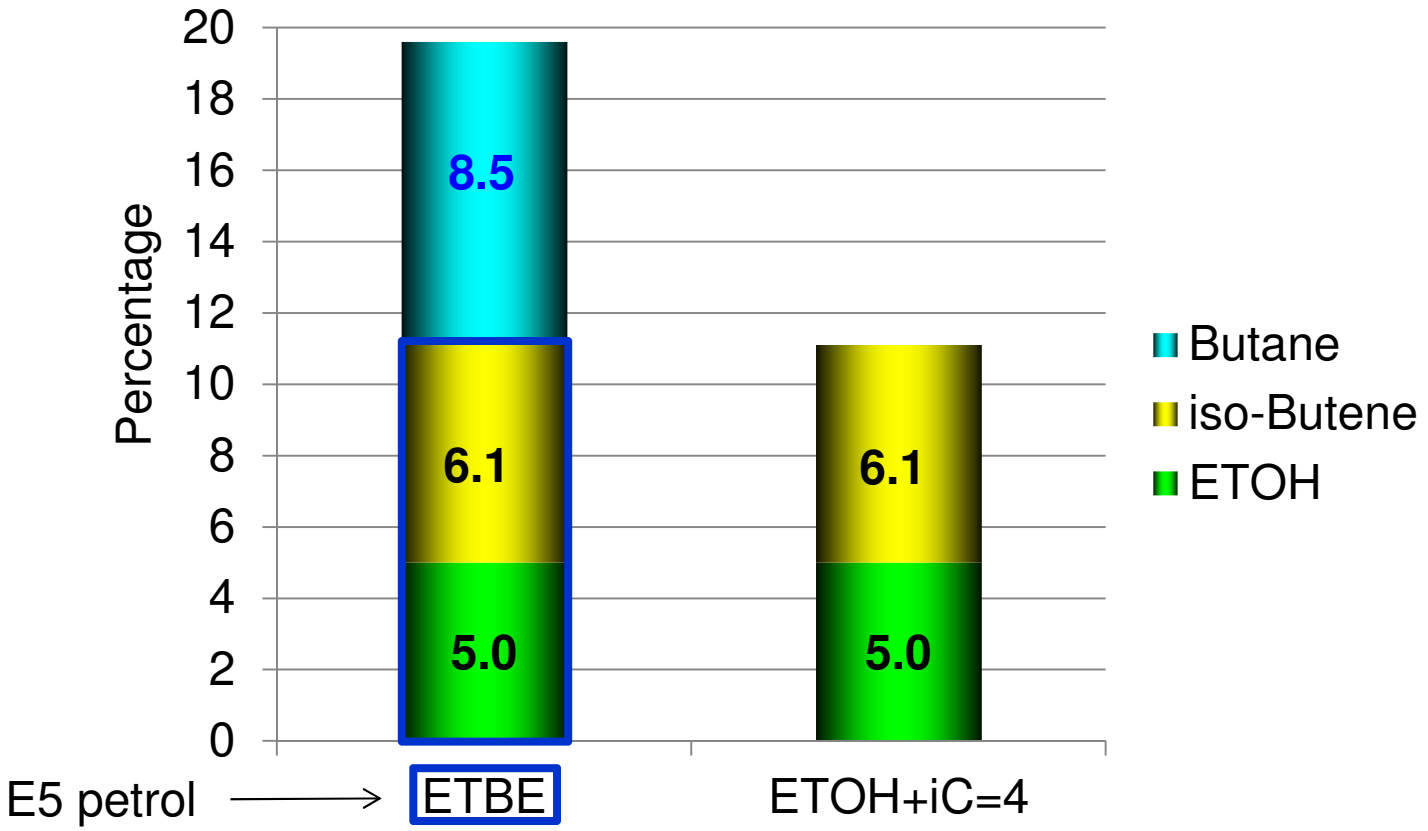
ETBE: much more than the sum of its constituents:

Butane Allowance: With ETBE significant butane room vs. Ethanol + iC=4



..and Butane = very good: { H/C ratio; Octane contribution } → CO_2 Emissions reduction

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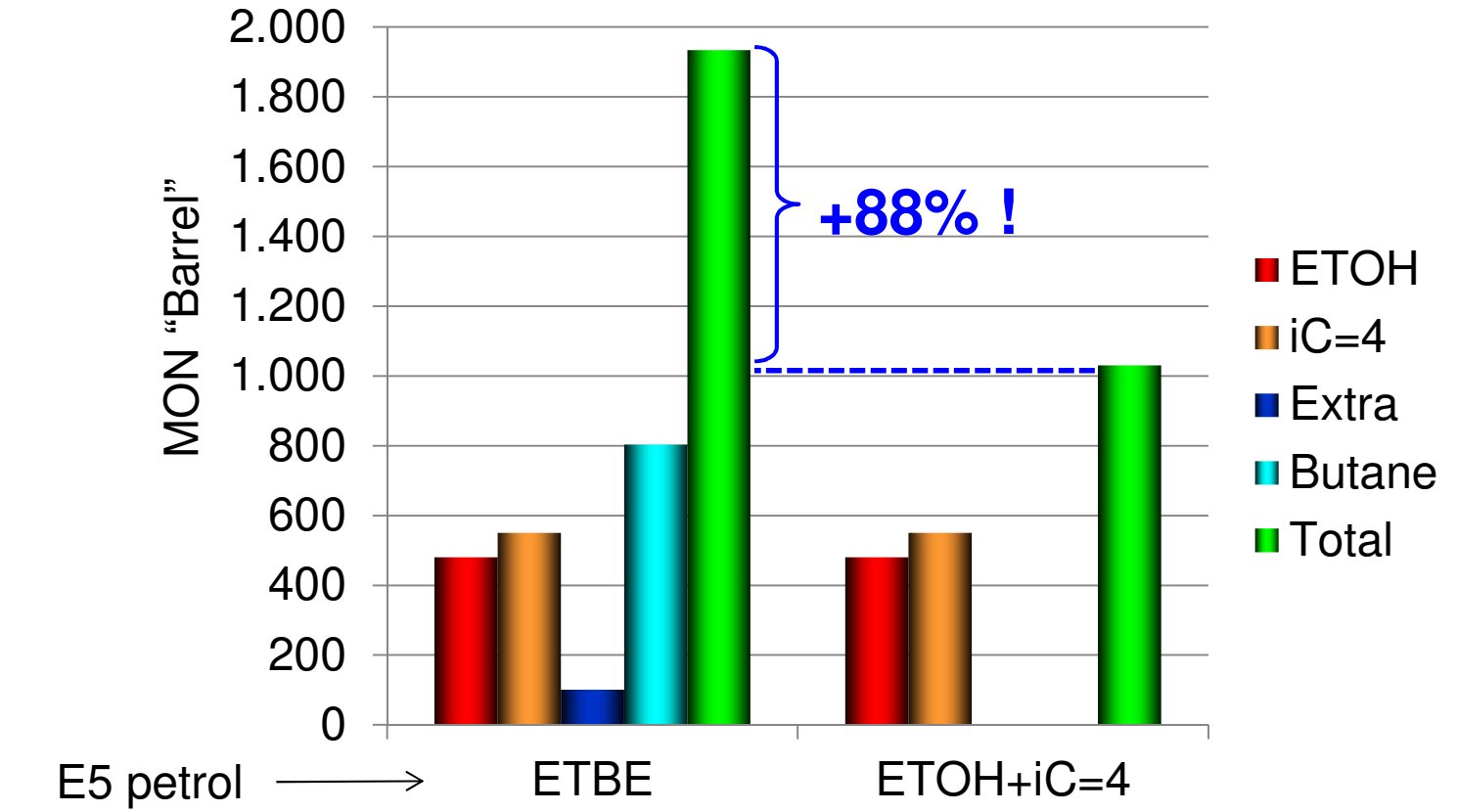
ETBE much more than the sum of its constituents:

Net Octane Contribution. With ETBE twice octane vs. (Ethanol + iC=4)



..and Octane enables { Higher Compression Ratio; Improved Engine Efficiency } → CO_2 Emissions reduction

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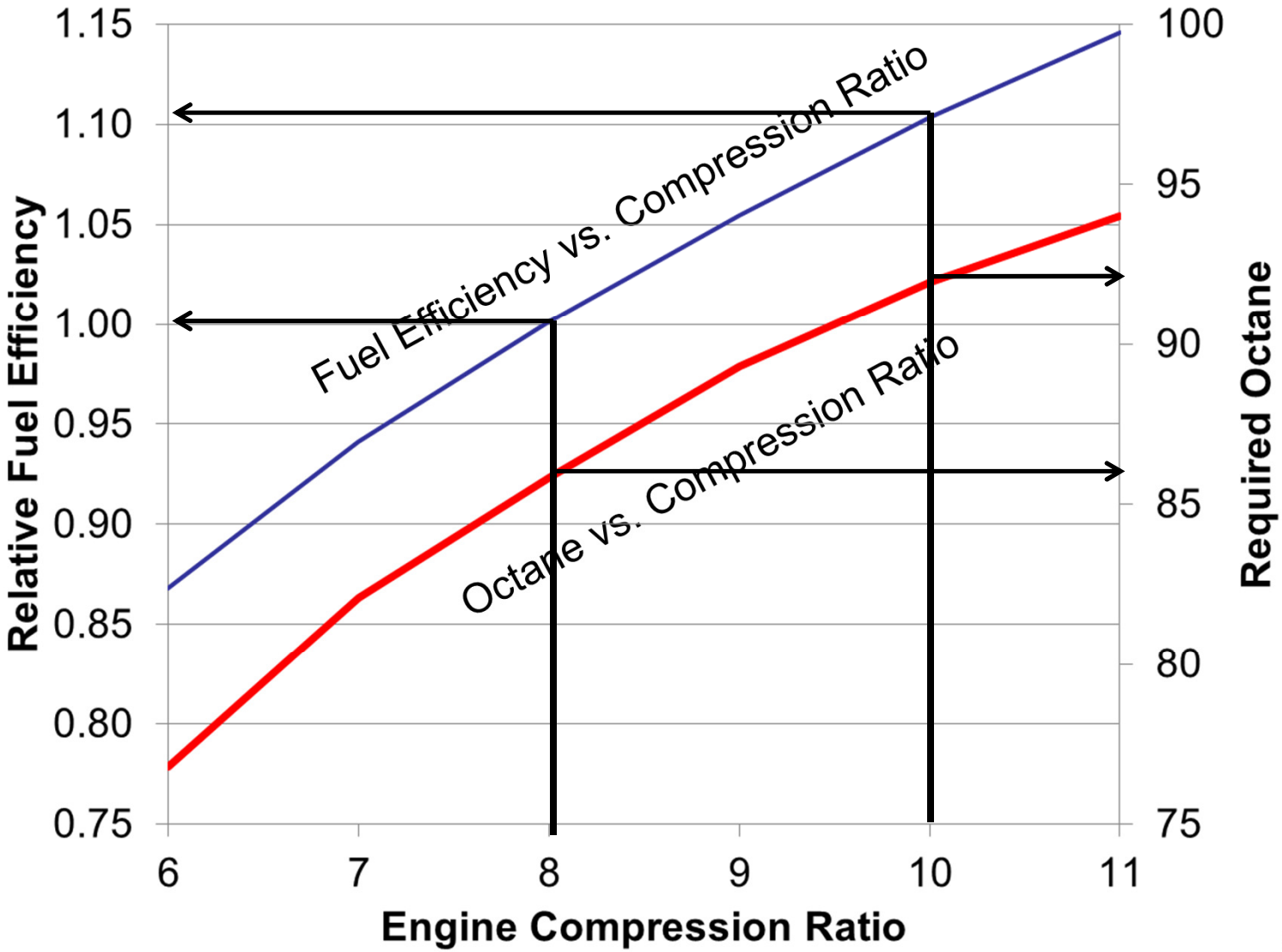
Octane Allows Improved Fuel Efficiency



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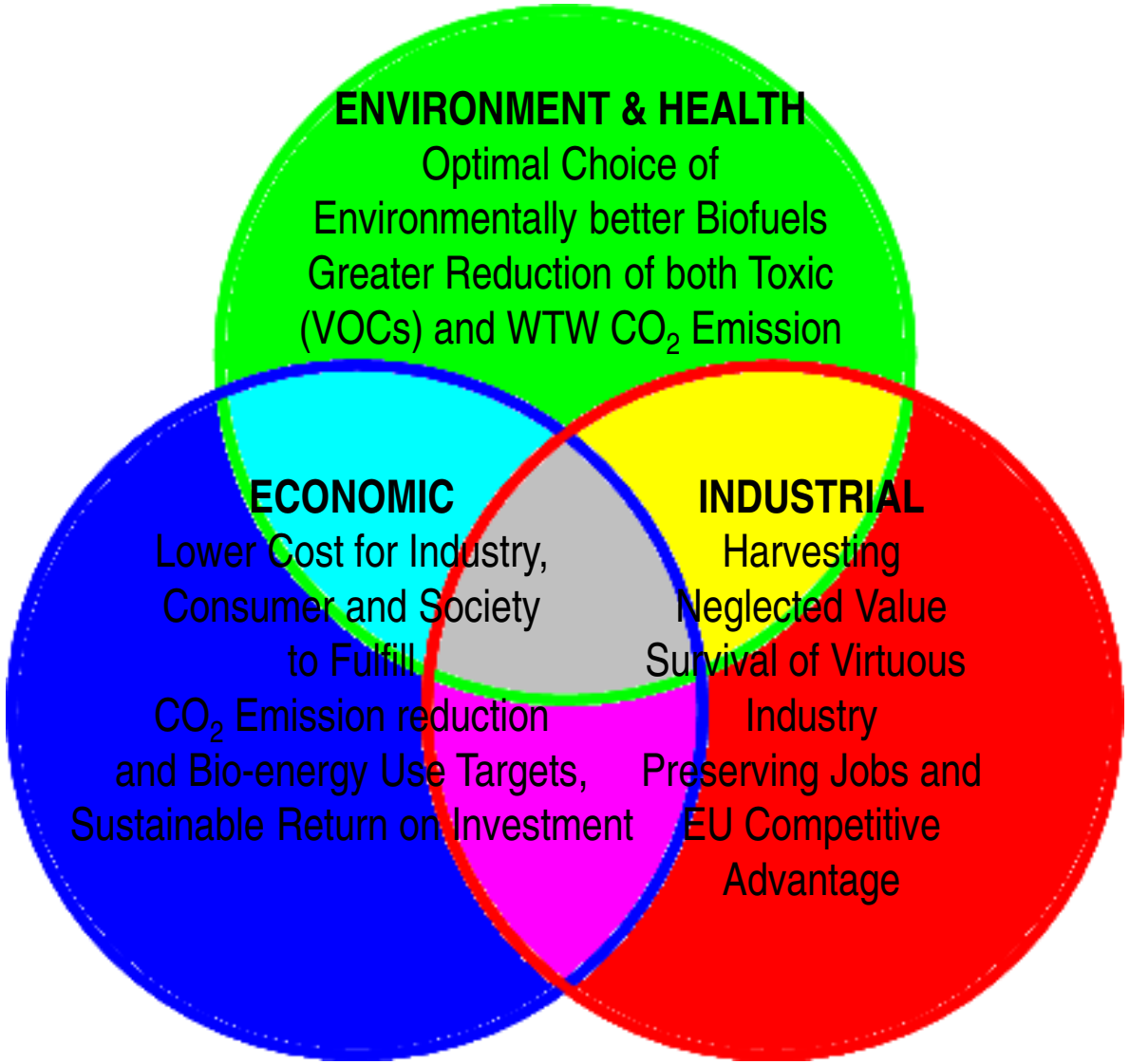
Full Biofuels Contribution Valorization is Needed



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RED: "*GHG emissions from the Production and Use of biofuels shall be calculated as…*"

$$E = e_{ec} + e_l + \mathbf{e_p} + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

Emissions from Processing

$\mathbf{e_p}$ =

- $\mathbf{e_{pc}}$ Energy used (CO_2 emitted) by "*upstream*" processes
- $\mathbf{e_{ps}}$ Energy saved (CO_2 avoided) by "*downstream*" processes

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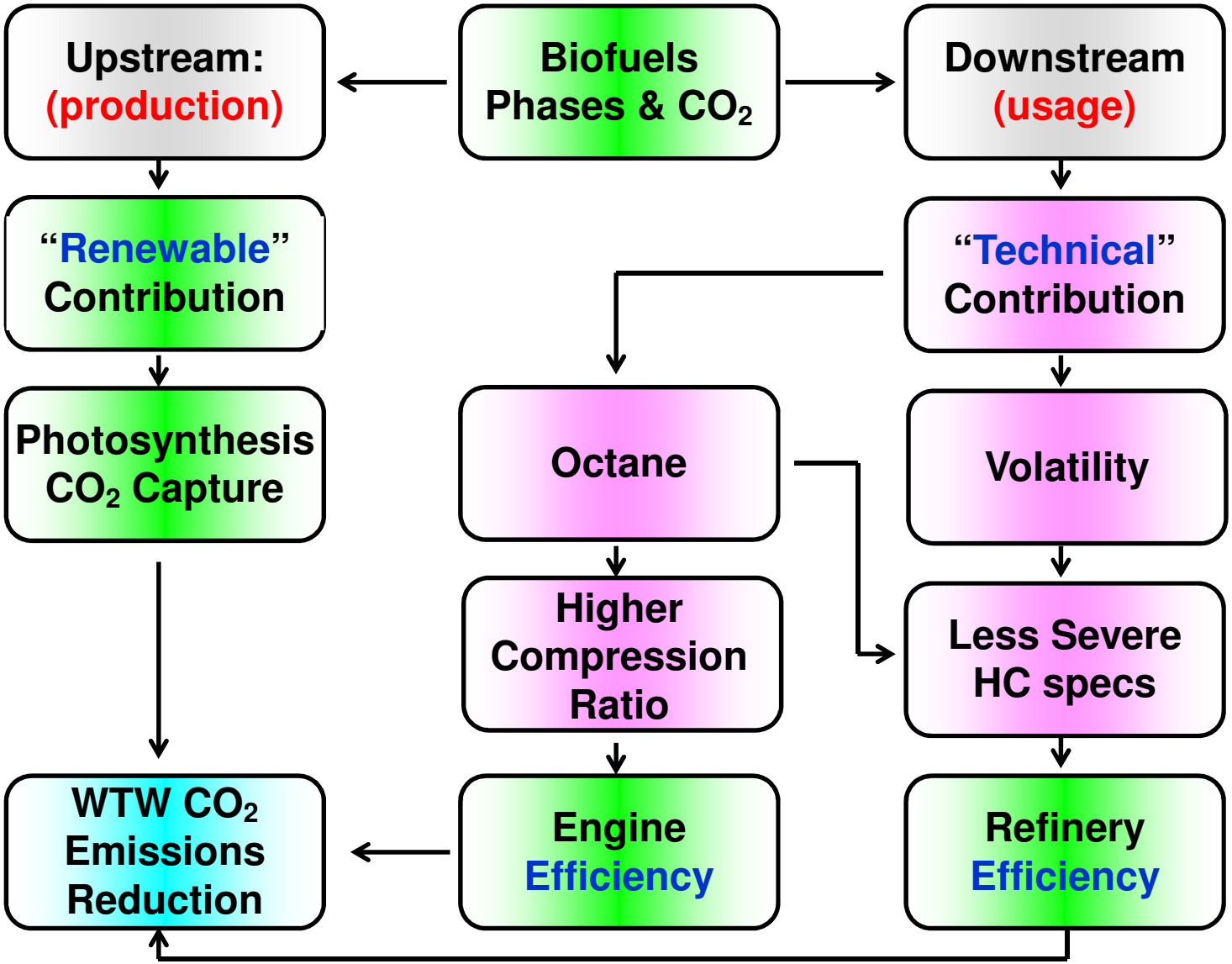
Field-To-Wheels GHG Contribution of Biofuels



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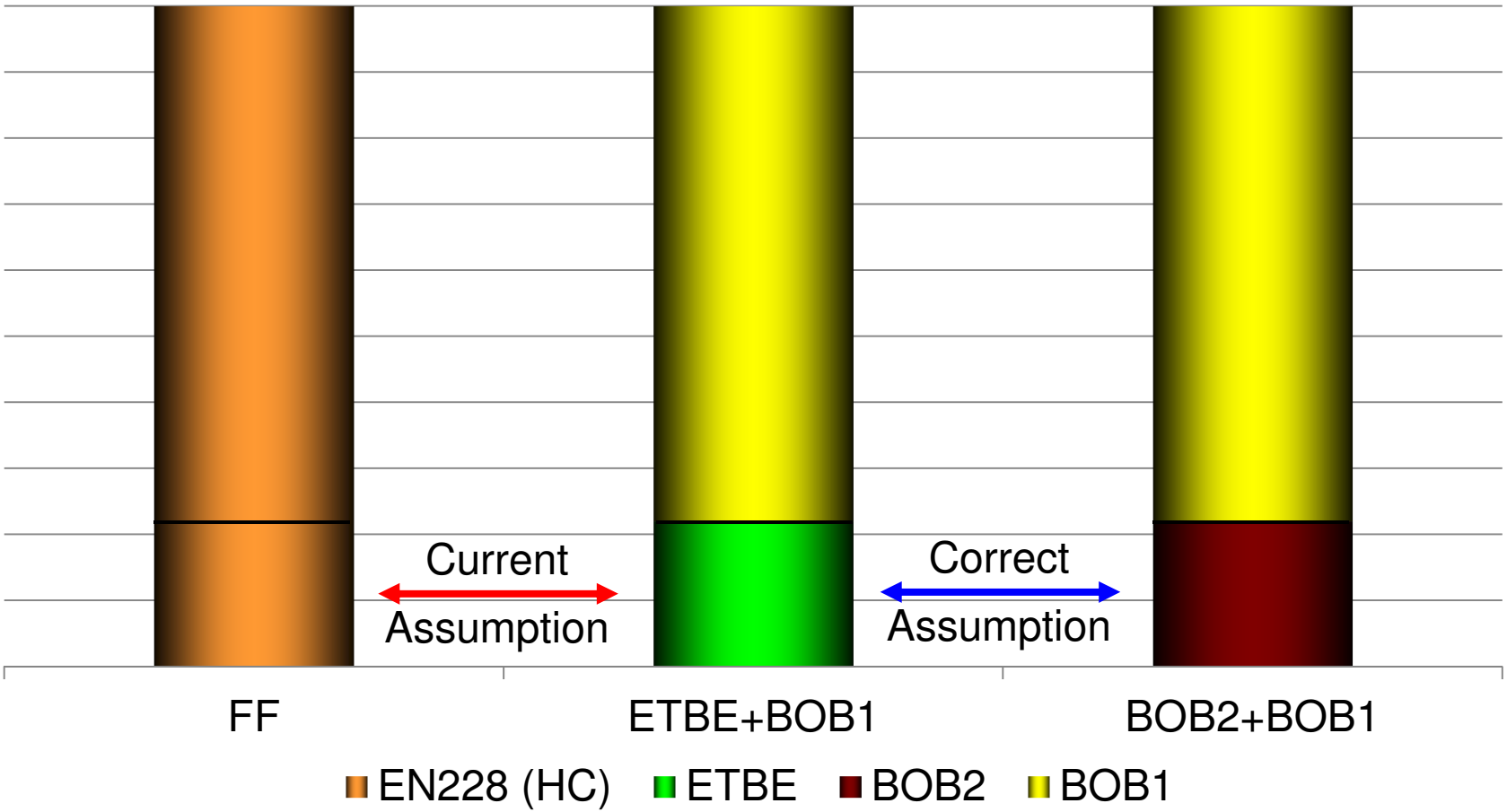
Bio-ethers Replace CO_2-intensive Blend-stocks

(ETBE example for EN228 petrol)



Finished Fuel

Low Octane / High RVP / Low CO_2 HC Blend stock

High Octane / Low RVP / Low CO_2 Bio-Oxygenate

High Octane / Low RVP / High CO_2 HC Blend stock

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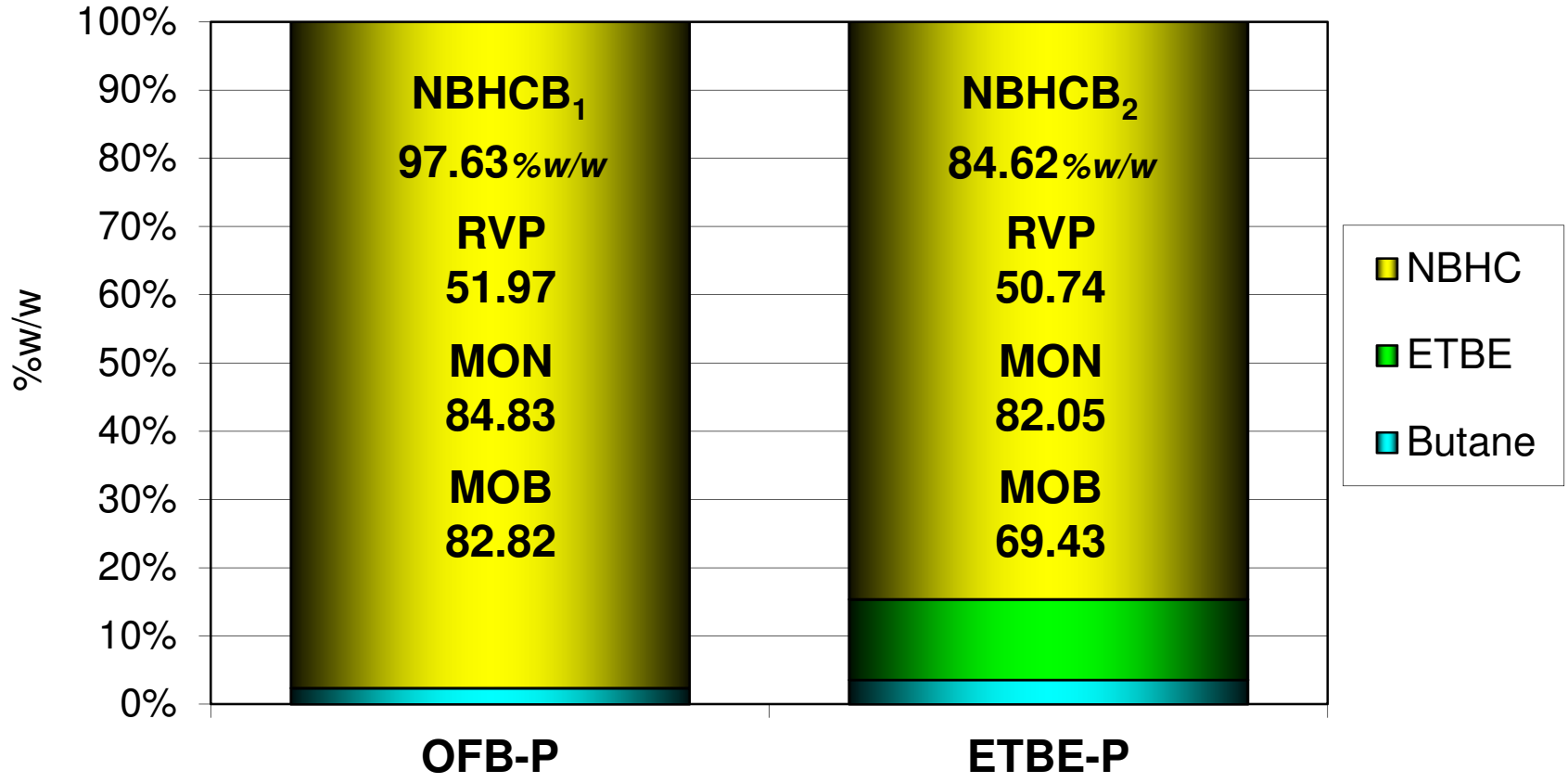
Bio-ethers Reduce HC Blend-stocks CO_2 Intensity

(ETBE example for EN228 petrol)



NBHC = Non-Butane Hydro-Carbon Blend-stock
OFB-P = Oxygenated-Free Base Petrol
ETBE-P = ETBE-containing Petrol
MON = Motor Octane Number (Octane "Intensity")
MOB = Motor Octane Barrel (Octane "Quantity")

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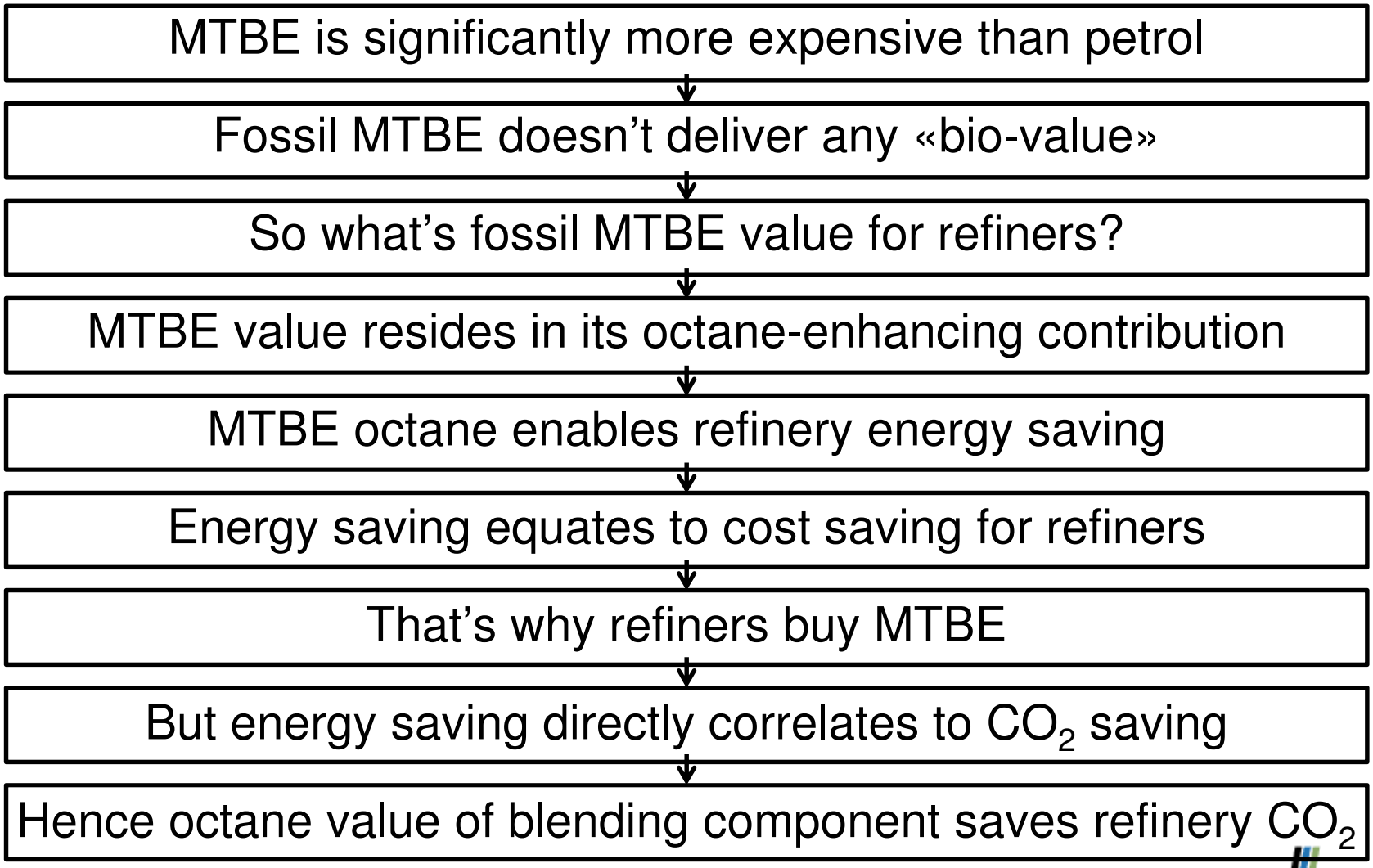
MTBE sales prove octane-related refinery CO_2 saving



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"Downstream" Contribution also Anticipated by EU Standardization Body

CEN/TC 383: EN 16214-4

5. Biofuels and bioliquids production and transport chain

5.1 Main steps:

"***GHG emissions changes arising from blending or formulation of biofuels and fossil fuels may be significant but are not taken into account in this standard at this stage***".

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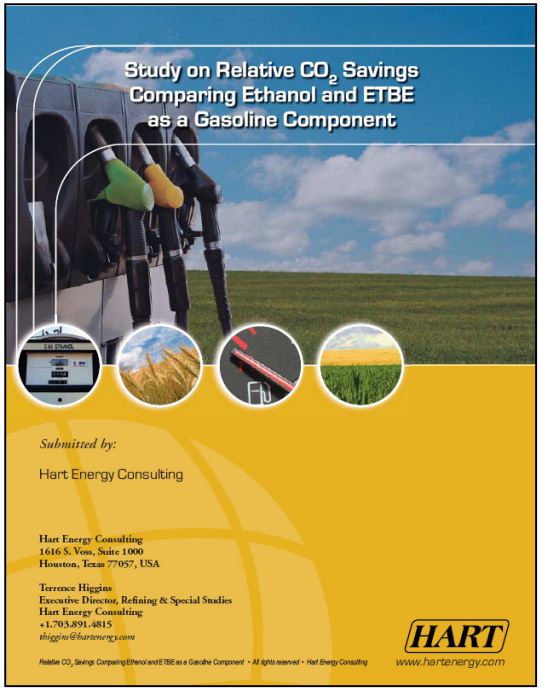
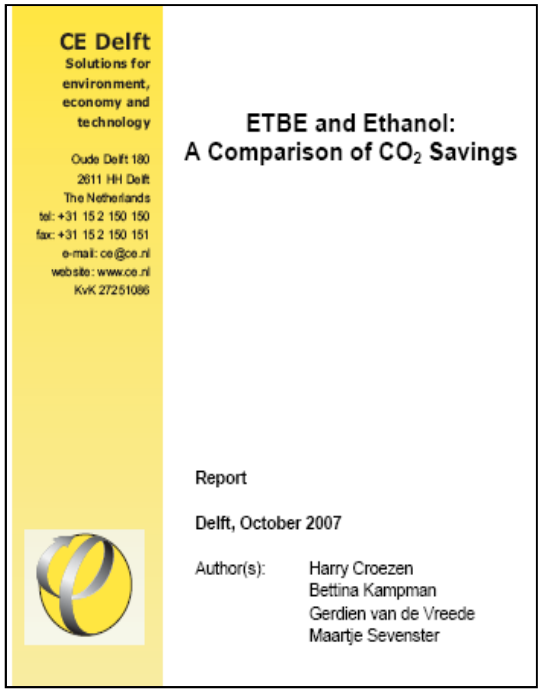
International Studies Confirmed Downstream CO_2 Emissions Reduction

HART July 2007



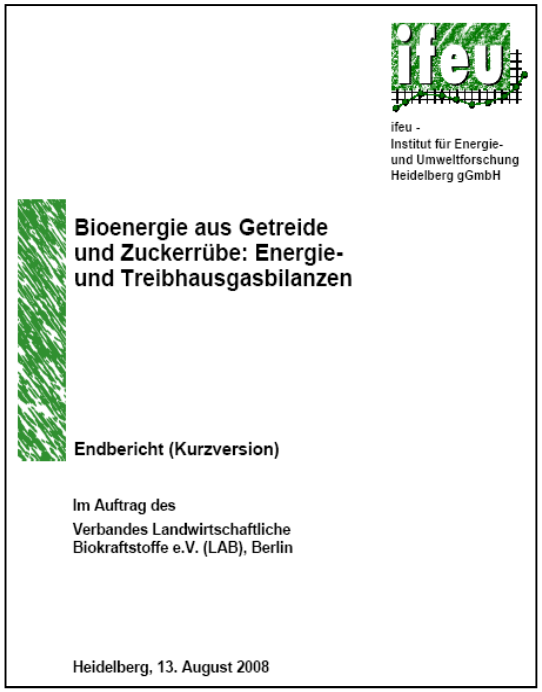
"The use of bio-ETBE reduces refining crude-oil need and processing intensity, requires less fuel and, implying relevant petrol composition changes, allows the reduction of carbon factor and lesser CO_2 emissions"

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"

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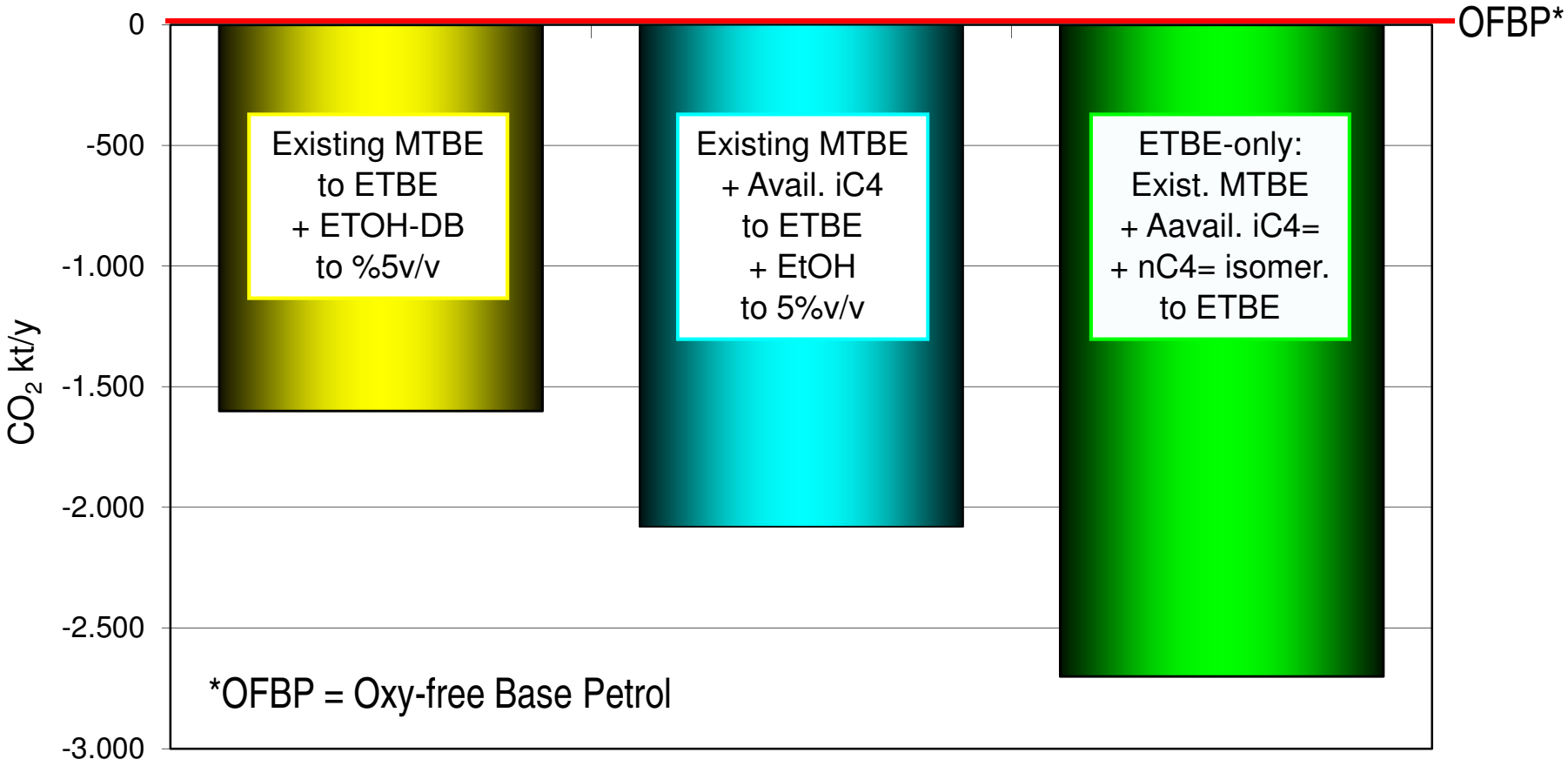
ETBE Downstream CO_2-Saving Contribution



Source: HART: «Study on Relative CO_2 Savings Comparing Ethanol and ETBE as a Gasoline Component»

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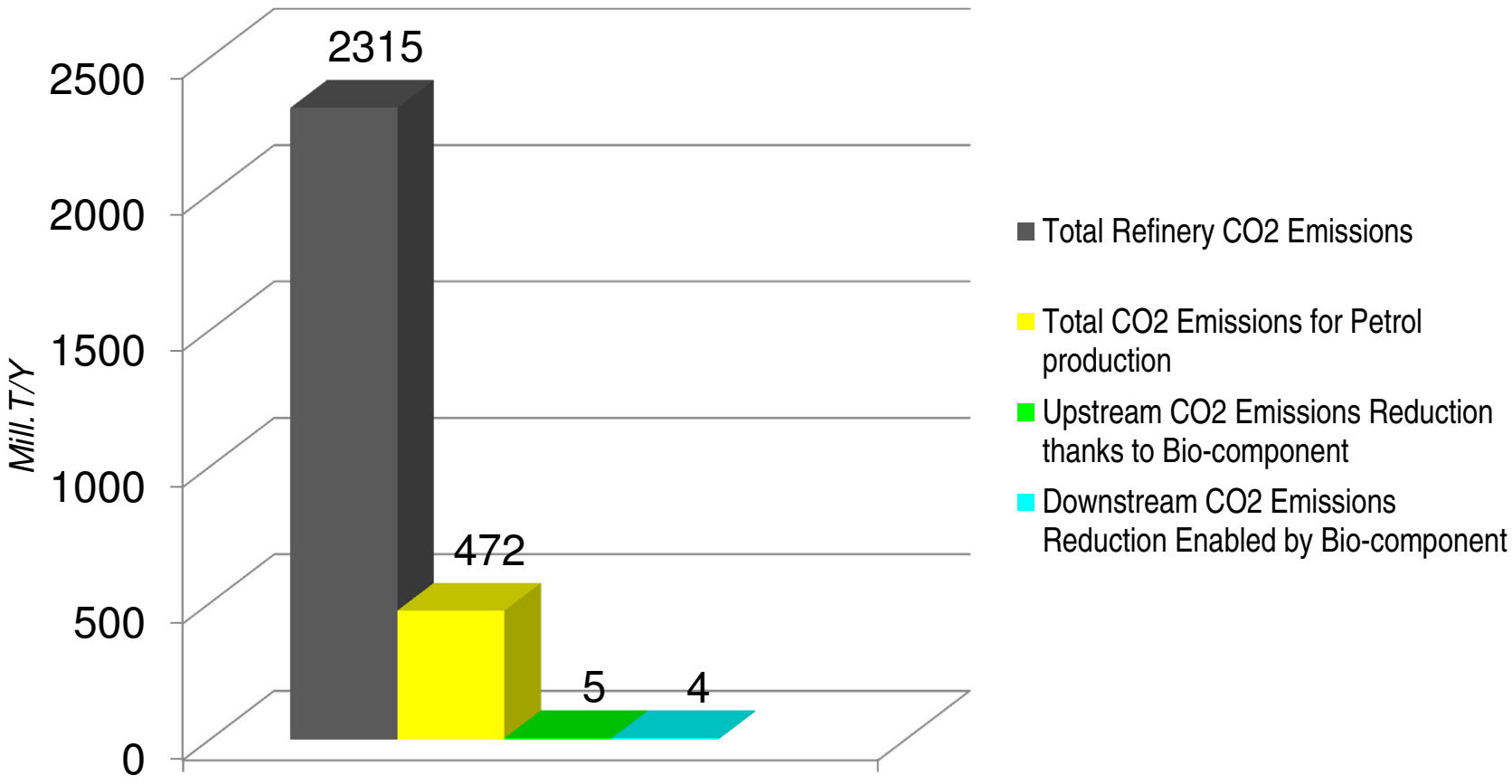
Biofuel CO_2 Emissions Reduction: Although Small in Absolute terms …



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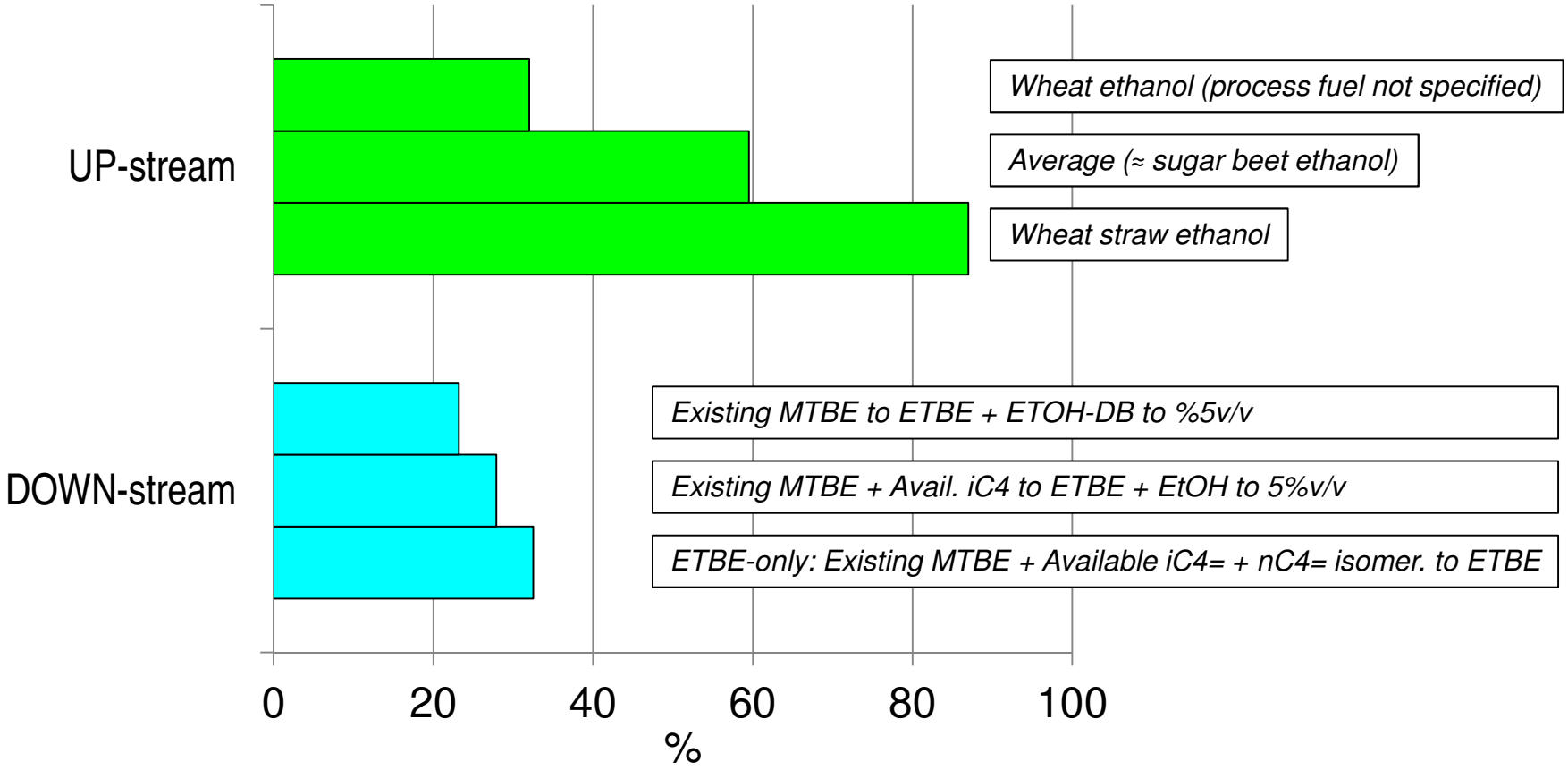
...Still CO_2 Emissions Reduction Very Relevant in Relative Terms



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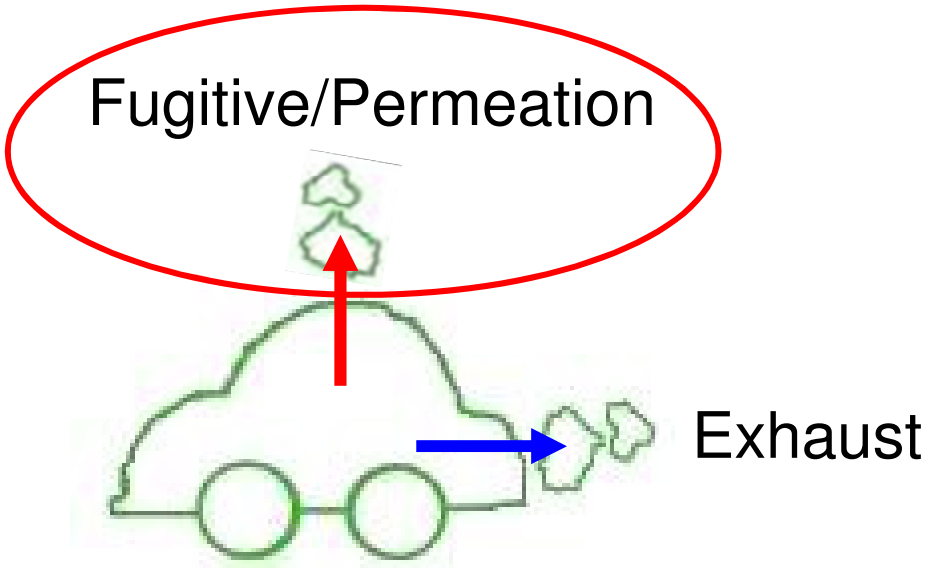
Converting ETOH into Ethanol-Ethers Avoids Vehicle Permeation Emissions, PM & Secondary CO_2 Formation

$$E = e_{ec} + e_l + e_p + e_{td} + \underbrace{e_u} - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

Emissions from the **Fuel in Use**



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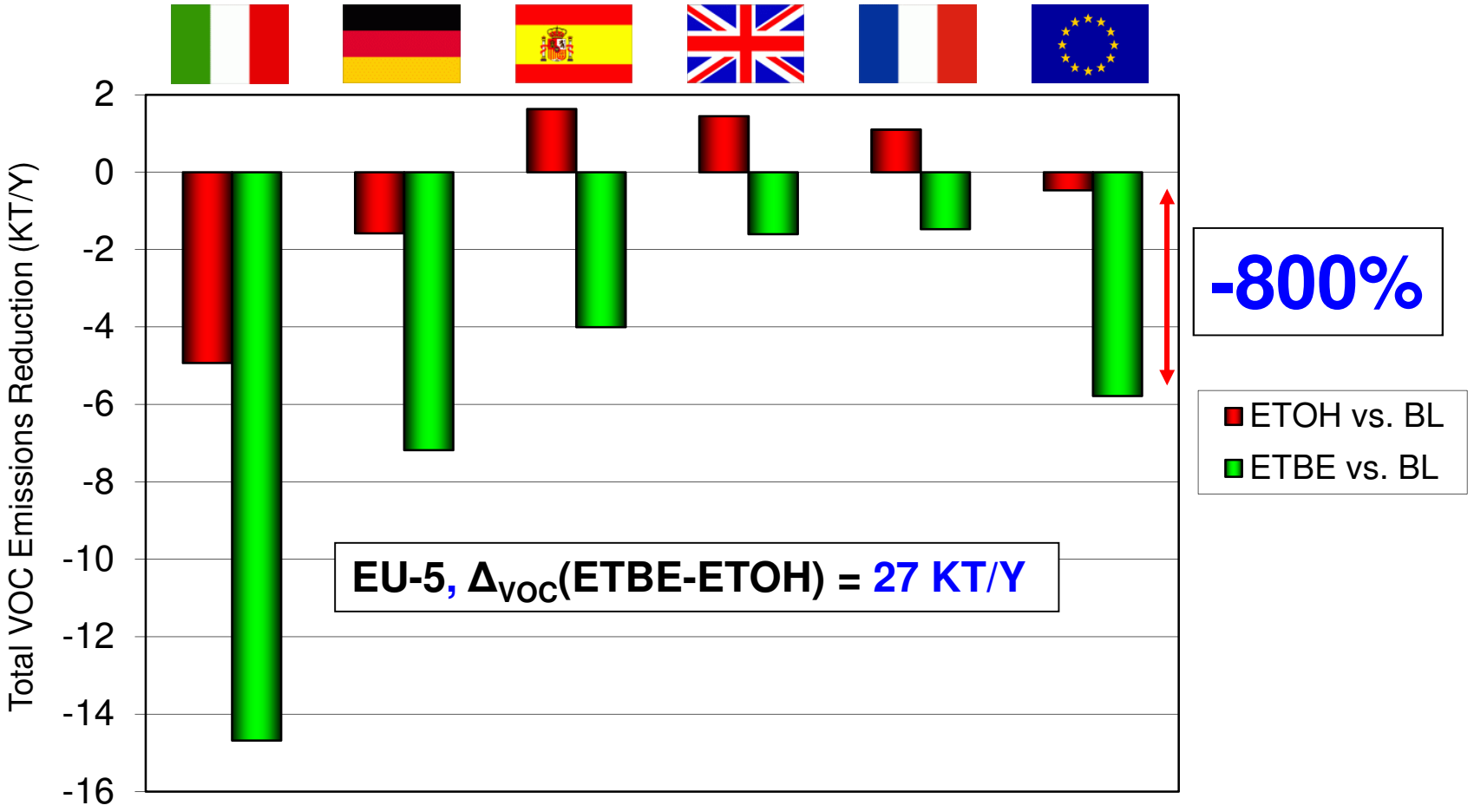
Significantly Lower NMVOC Emissions with Ethers



Source: Emissions and Health Unit - Institute of Environment and Sustainability - EC-JRC Ispra

"An assessment of the impact of ethanol-blended petrol on the total NMVOC emissions from road transport in selected countries"

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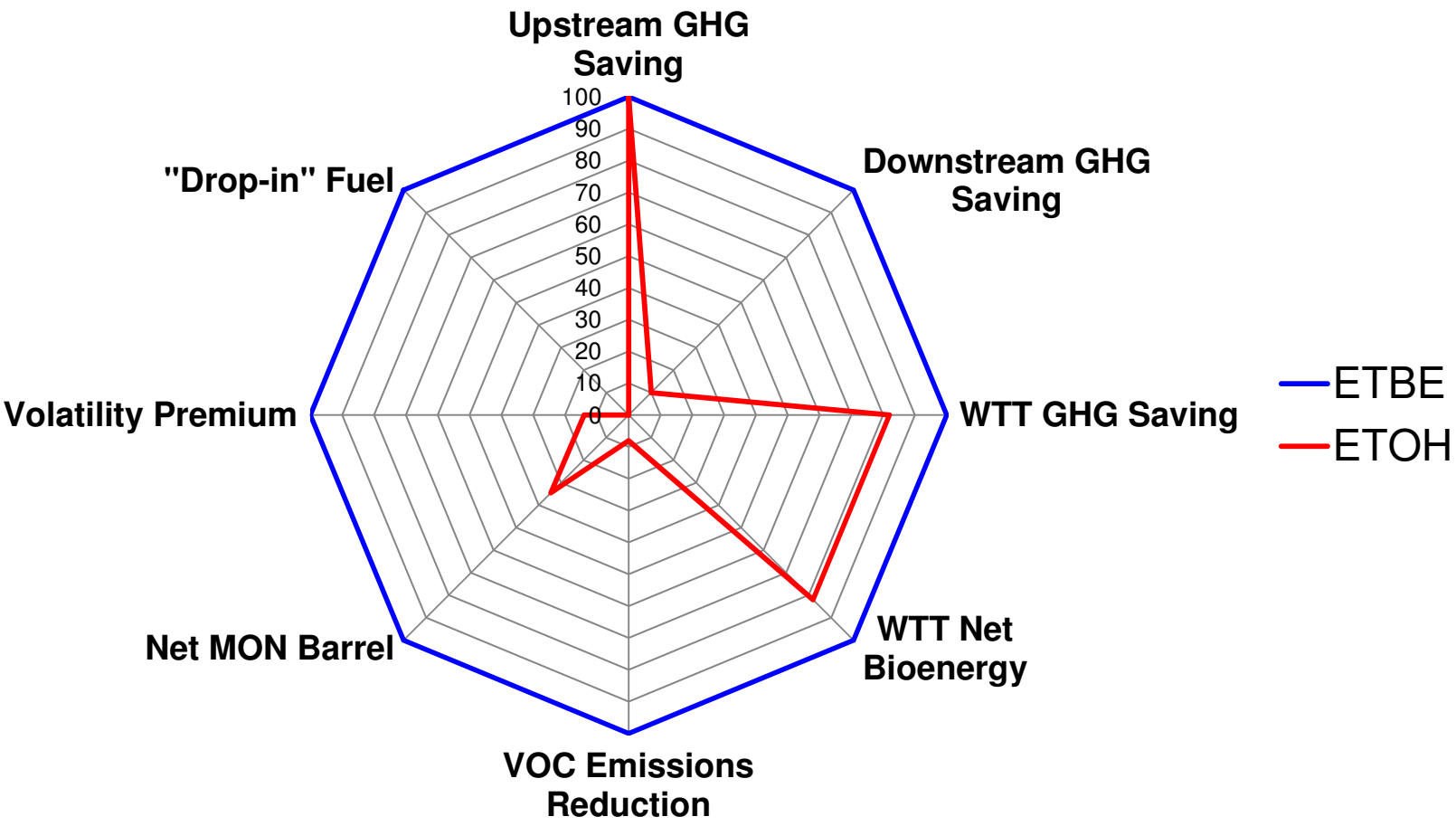
Etherification Improves Key Performances



Relative % Figures @ Same Ethanol-Equivalent

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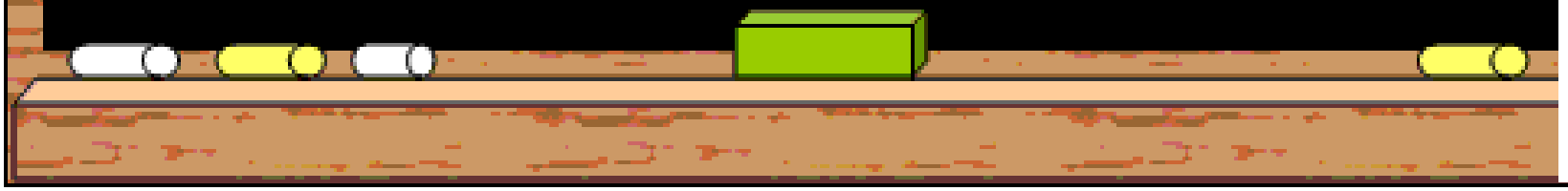
Conclusion

If all bio-fuels will be treated on consistent basis, and their entire GHG saving potential will be valorized, the cost to society will decrease, while significant positive environmental effects will be harvested, well beyond CO_2 emissions reduction



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