

Ethanol and Ether Derivatives in Gasoline Pool



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Agenda

- **Market and Spec Development: Requirements for Oxygenates Octane Boosters**
- **Ether/ETBE as Oxygenate of Choice**
- **Bio-ETBE Already a Reality with Axens Technology**

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What is the situation in 2017 in India?



New motor fuel specifications BS IV and VI

AAGR for MTBE consumption expected at 5%/yr in India 2016-2021

India is a leader for the production of sugar → raw material for 1G ethanol is available

Several 2G Ethanol projects from ligno-cellulosic biomass announced in 2017

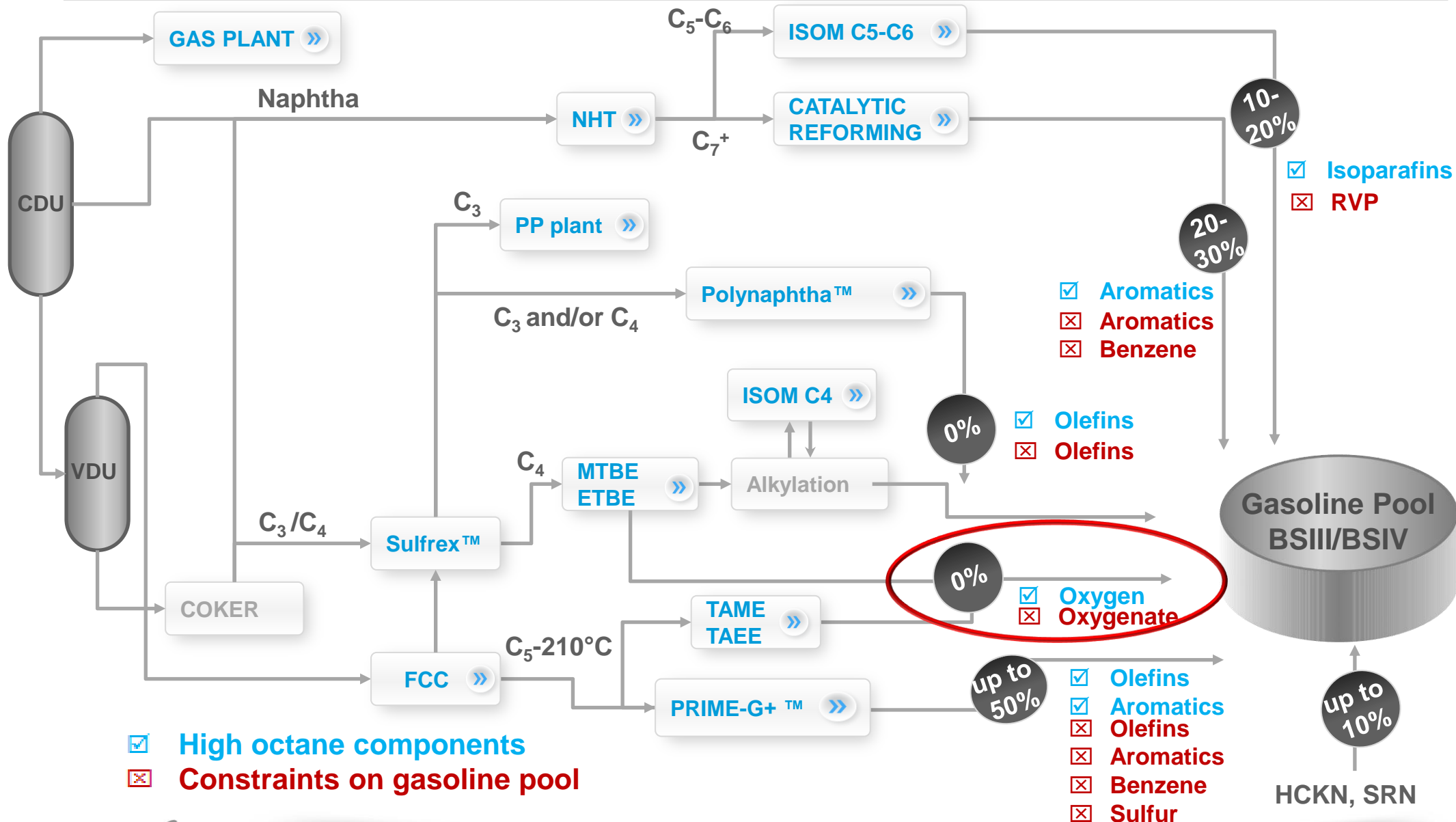
Upgrade Gasoline to Euro V/VI or BS VI: Same Hard Challenge

	Euro IV	Euro V Euro VI 	BS IV	BS VI 
RON, min.	95	95 (1)	91-95	91-95
MON, min.	85	85 (1)	81-85	81-85
Aromatics, vol%, max.	35	35	35	35
Olefins , vol%, max.	18	18	18-21	18-21
Benzene, vol%, max.	1.0	1.0	1.0	1.0
Oxygen, wt%, max.	2.7	2.7/3.7	2.7	2.7
Sulfur, ppm, max.	50	10	50	10
RVP, kPa	60 / 70	60 / 70	60	60

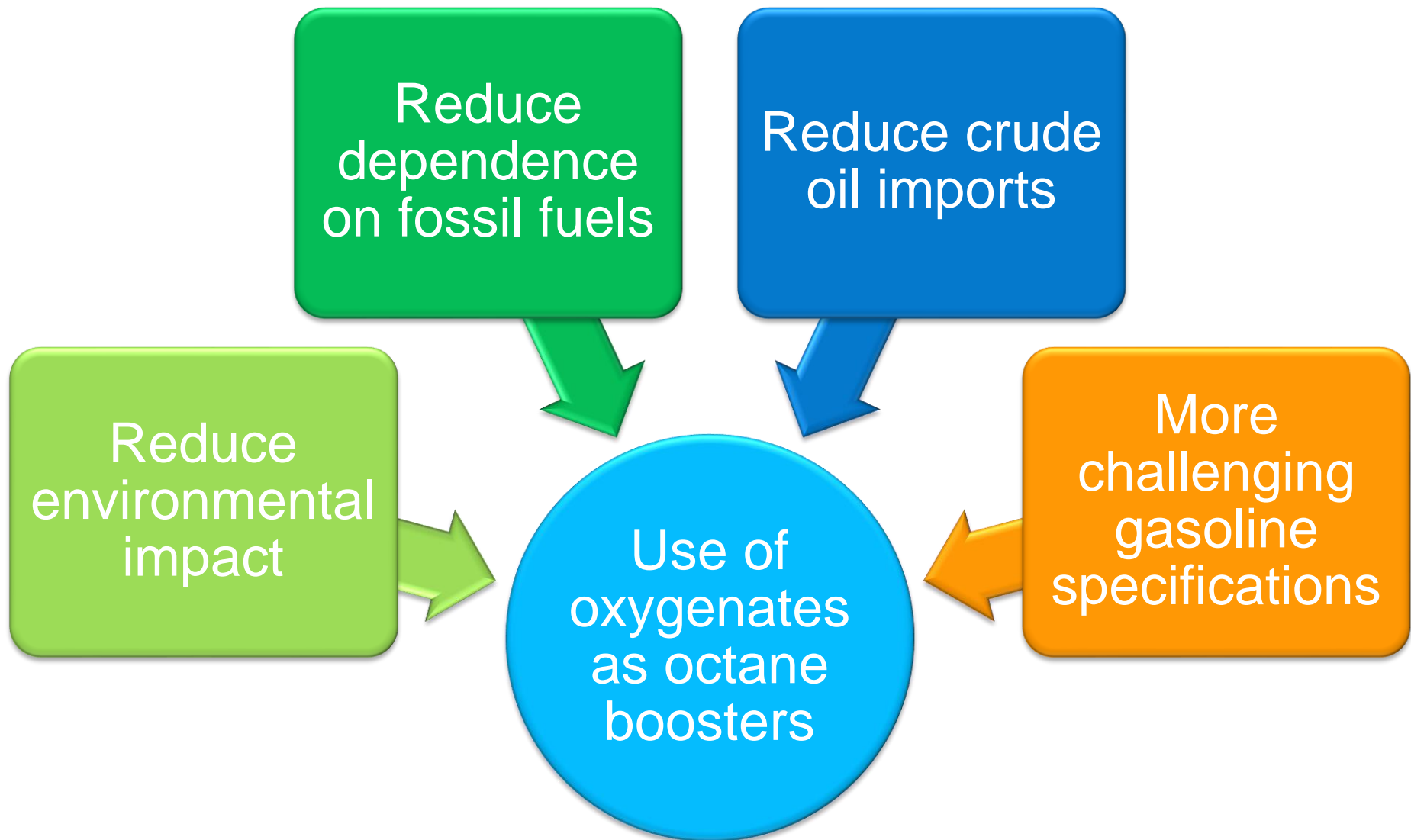
(1) Member States may decide to continue to permit the marketing of petrol with a minimum motor octane number (MON) of 81 and a minimum research octane number (RON) of 91

Source: Stratas Advisors

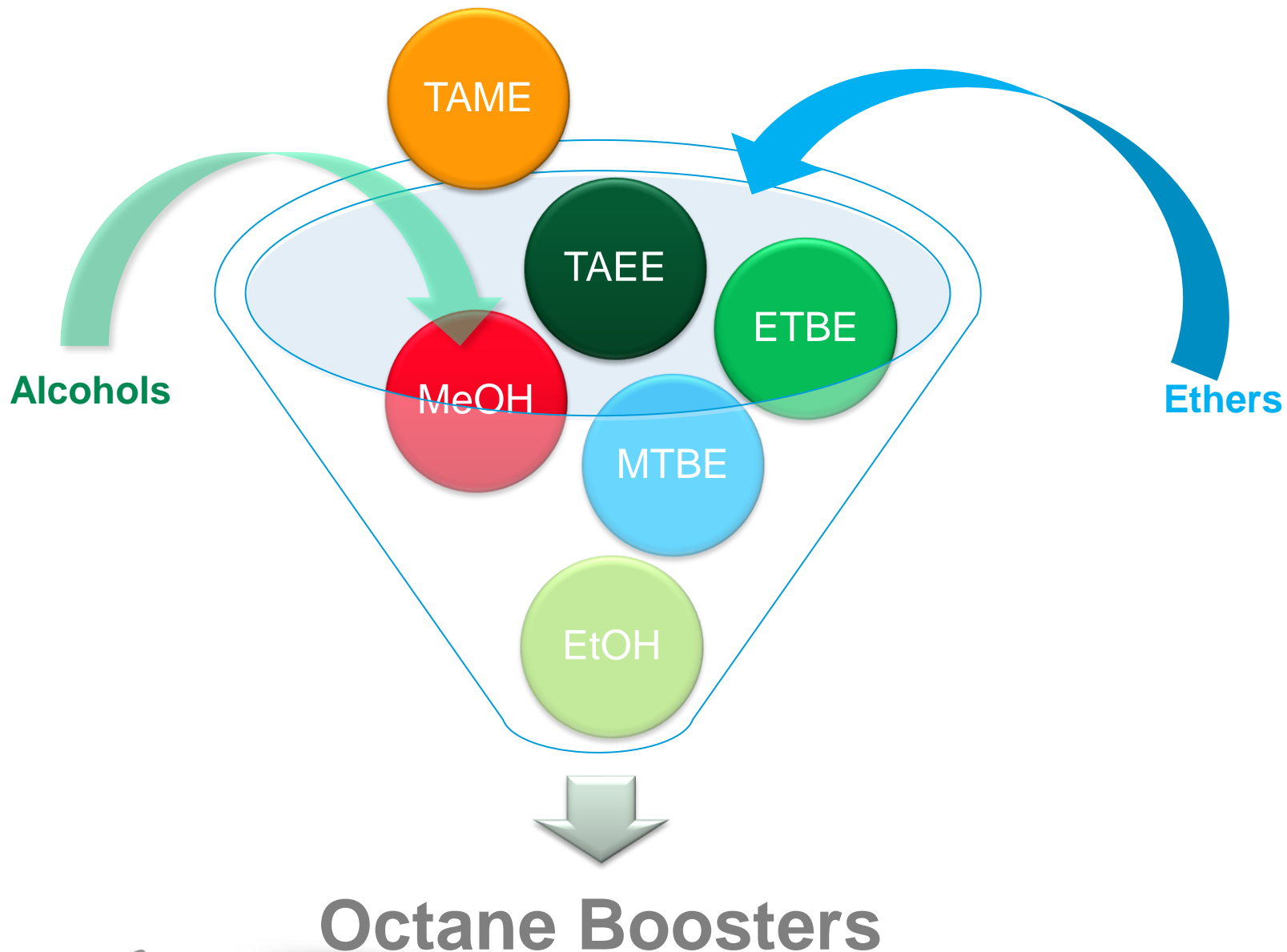
Typical BS III / BS IV Gasoline Pool



Market and Environmental Challenges



Oxygenates: Which One to Choose ?



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Why Ethers are so Attractive?

Iso-Olefin	Alcohol	Ether
i-C4 =	Methanol	MTBE
	Ethanol	ETBE
i-C5 =	Methanol	TAME
	Ethanol	TAAE

+ →

Octane booster production

up to
RON = 118
MON = 98

Olefins converted in ethers

Olefins reduction in gasoline pool

Valorization of alcohols in gasoline pool

Increase gasoline yield

Olefins-to-ethers shift

Gasoline RVP decrease

Direct bio-EtOH Blending vs bio-ETBE

Direct
Ethanol
Blending

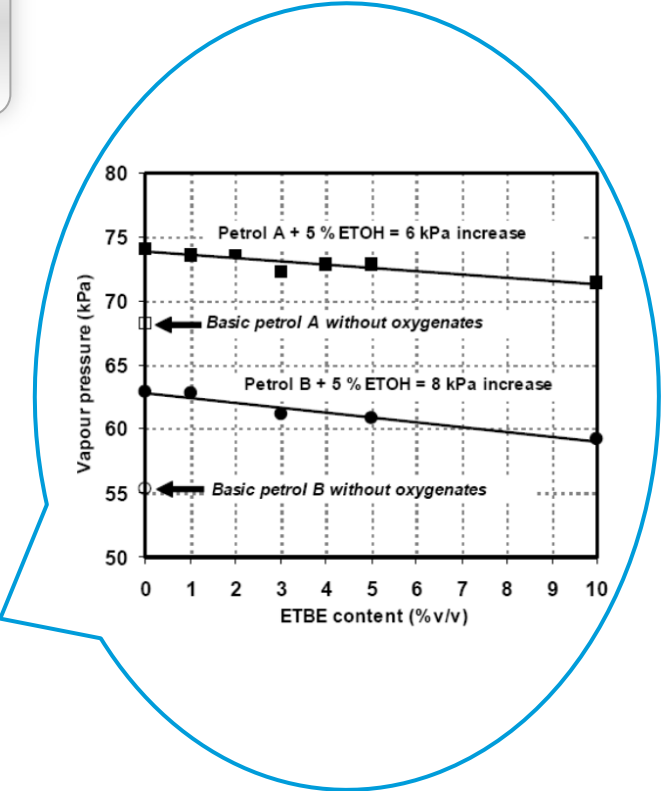
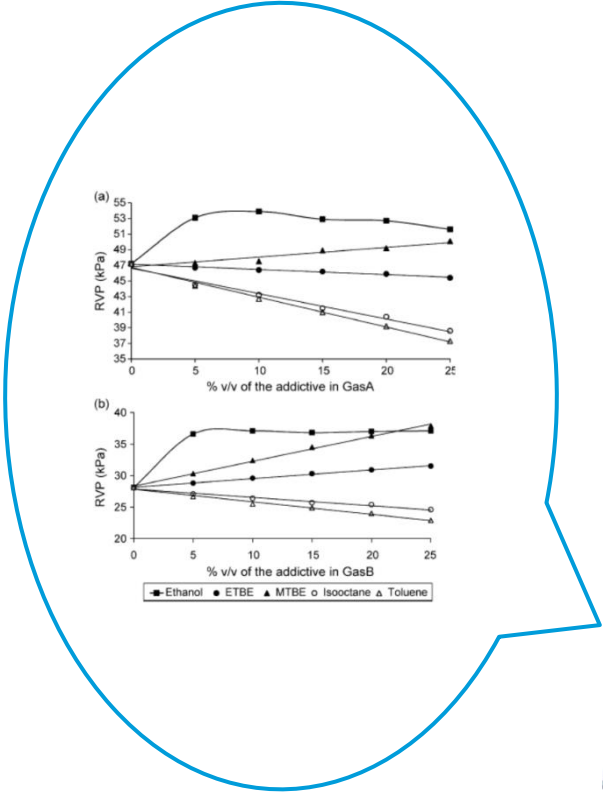
ETBE



Direct bio-EtOH Blending vs bio-ETBE

Direct Ethanol Blending

ETBE



RVP Constraints

RVP Decrease



Direct bio-EtOH Blending vs bio-ETBE

Direct
Ethanol
Blending

ETBE

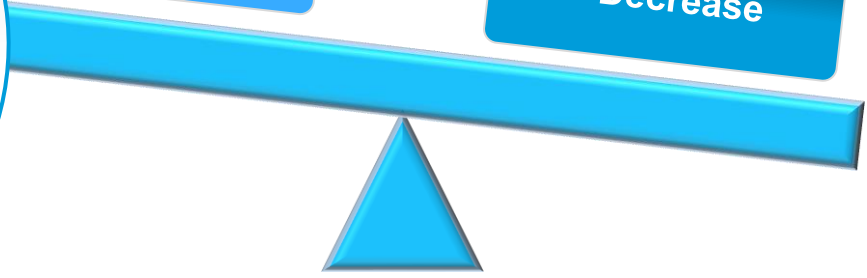
Water
compatibility -
Logistically
challenging

RVP Constraints

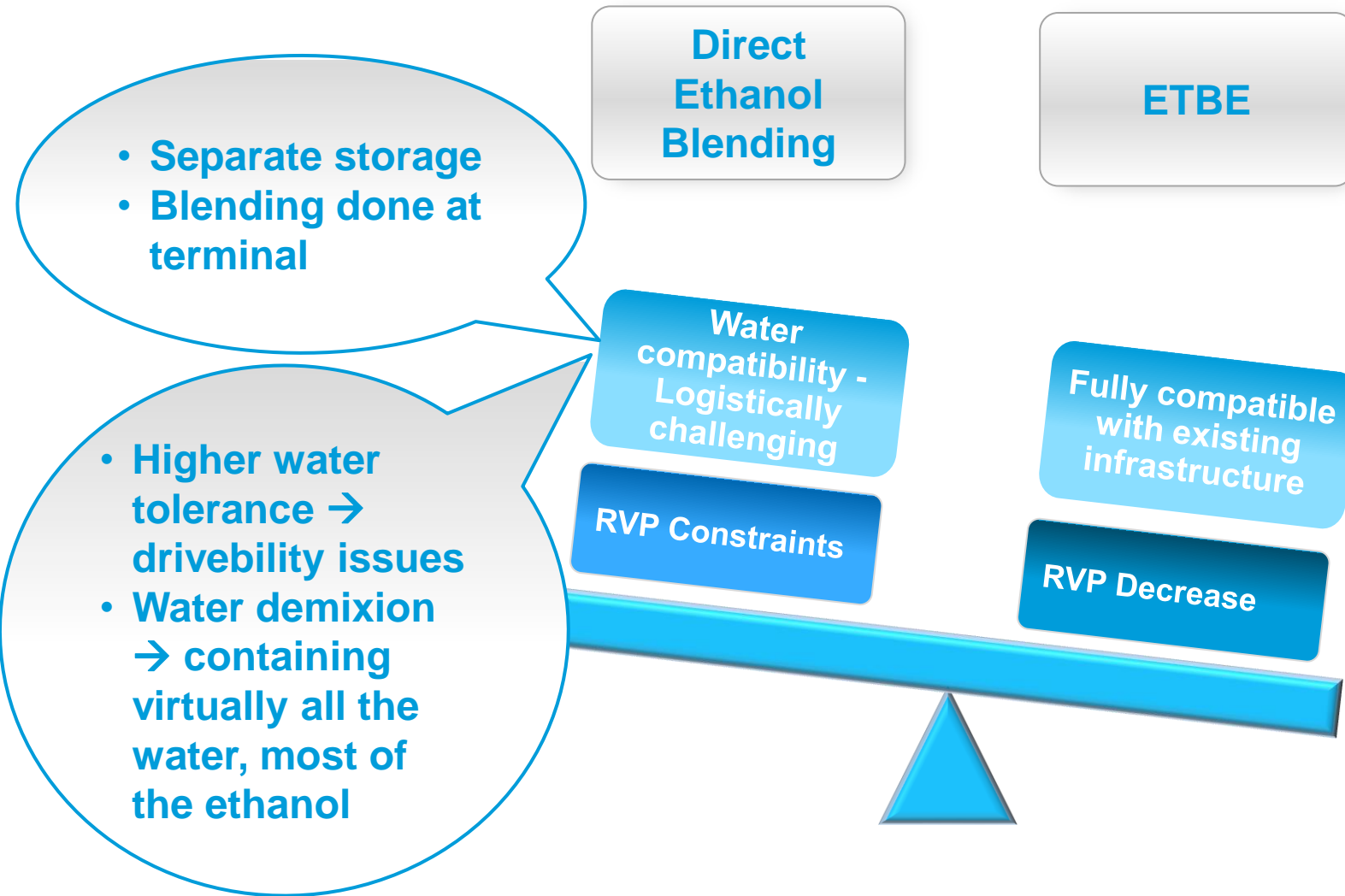
Fully compatible
with existing
infrastructure

RVP Decrease

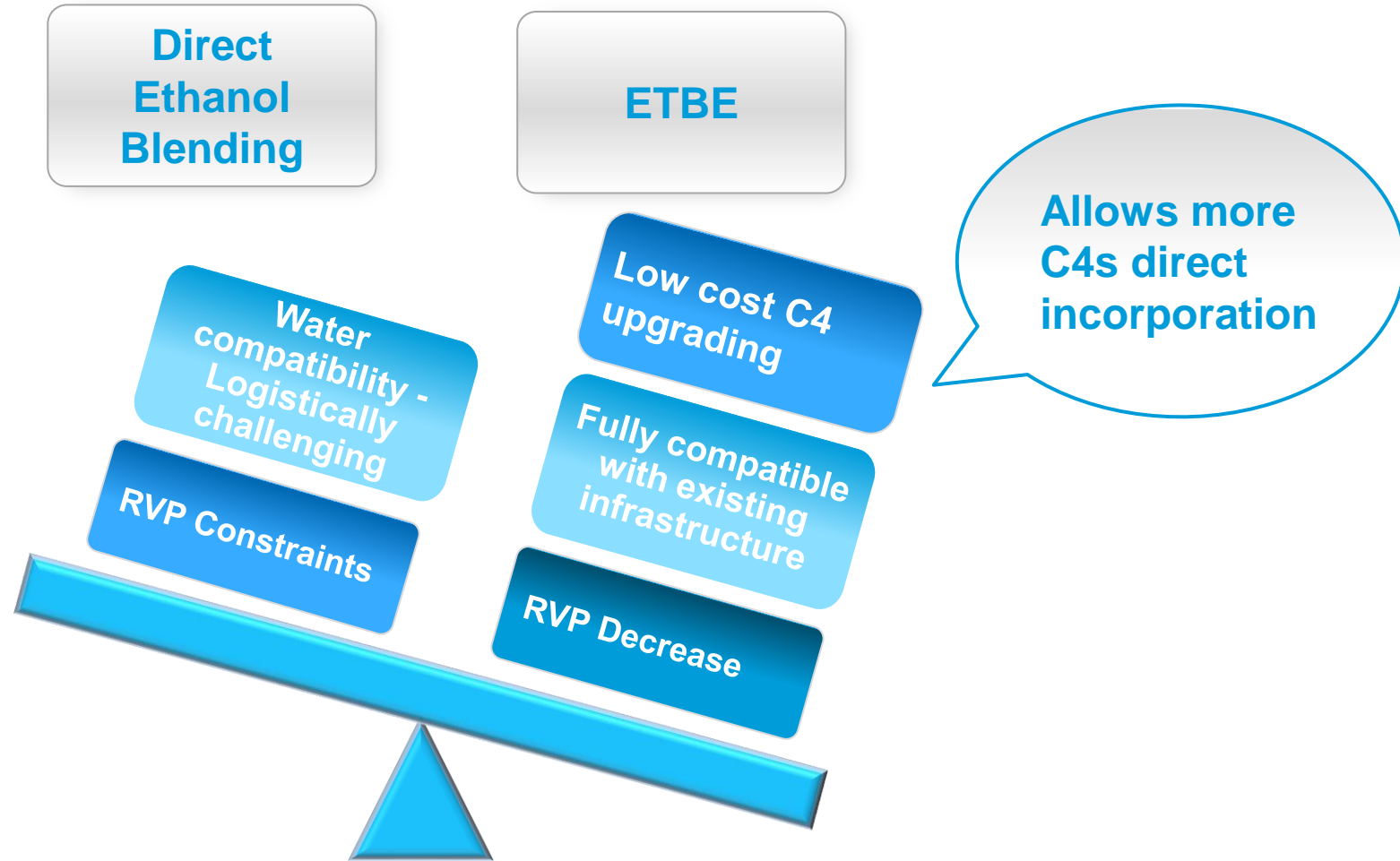
- Higher water tolerance → driveability issues
- Water demixion → containing virtually all the water, most of the ethanol



Direct bio-EtOH Blending vs bio-ETBE

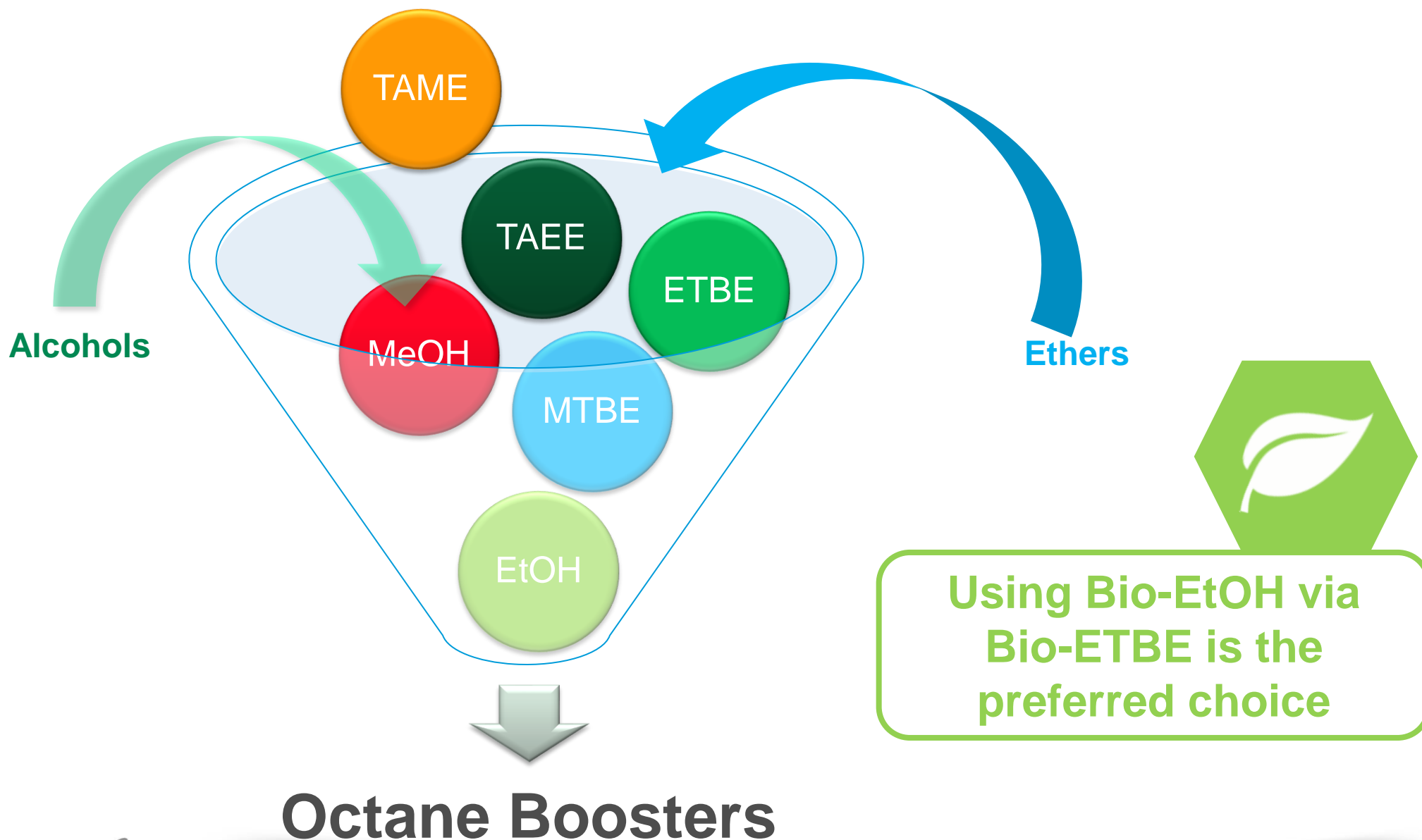


Direct bio-EtOH Blending vs bio-ETBE



Bio-ETBE is usually preferred thanks to better compatibility in gasoline pool

Oxygenates: Which One to Choose?



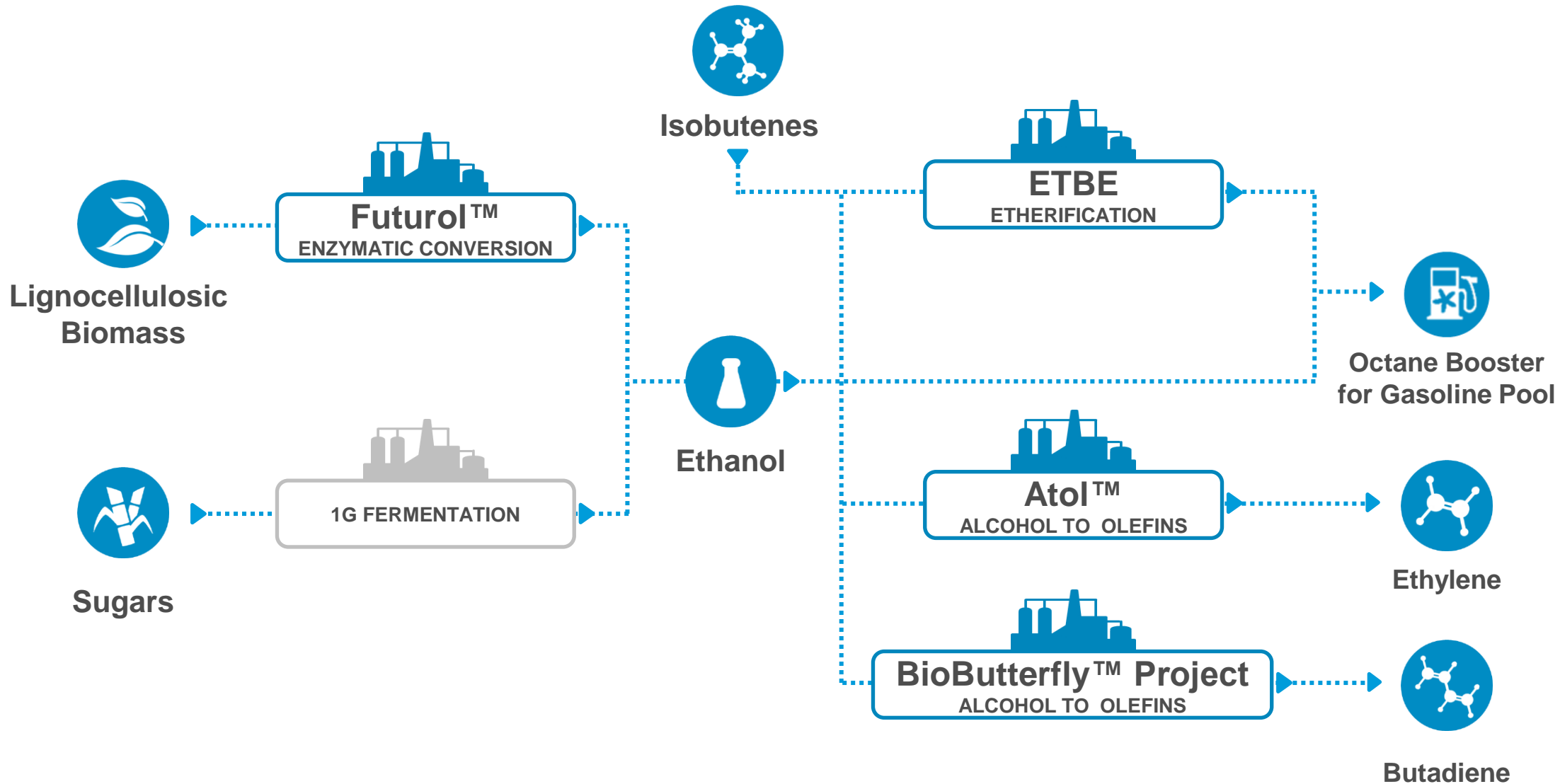
Ether Ban – Something to Fear?



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Ethanol Value Chain – Axens' Portfolio



Axens' ETBE Experience

- Axens/IFPEN pioneered bio-ETBE production
 - First pilot testing of MTBE production in late 60s
 - First pilot testing of bio-ETBE production in early 80s
 - First industrial production of bio-ETBE and bio-TAEE in **1990** in France
 - First basic design reference in **1993**

Axens' ETBE Experience

- Accumulated **know-how**
 - Kinetic & thermodynamic equilibrium simulation tools
 - Analytical expertise and analysis methods
 - Database of analyses of Ethanols
 - › Feedstock type (sugar cane, wheat, ...), region of sourcing, 1G vs 2G...

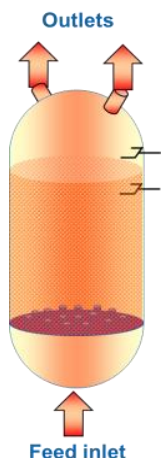
Axens' ETBE Experience

- Axens has a **strong expertise in bio-ETBE**:
 - Grass Root references :
 - › 1 ETBE
 - › 4 MTBE/ETBE (dual modes)
 - Revamp references :
 - › 3 MTBE adapted to ETBE
 - › 3 ETBE revamped (capacity increase, feed quality change)

- Axens **can design etherification** unit in order to be ready for switching between MTBE and ETBE modes:
 - Face **market demand**
 - Anticipate **new legislations**

Axens' ETBE Key Features

Robust and Simple design ...



Expanded bed technology

- Flexibility,
- no hot spot,
- high selectivity

Easy to operate

- Liquid phase reaction section,
- Easy loading/unloading

Intrinsic flexibility

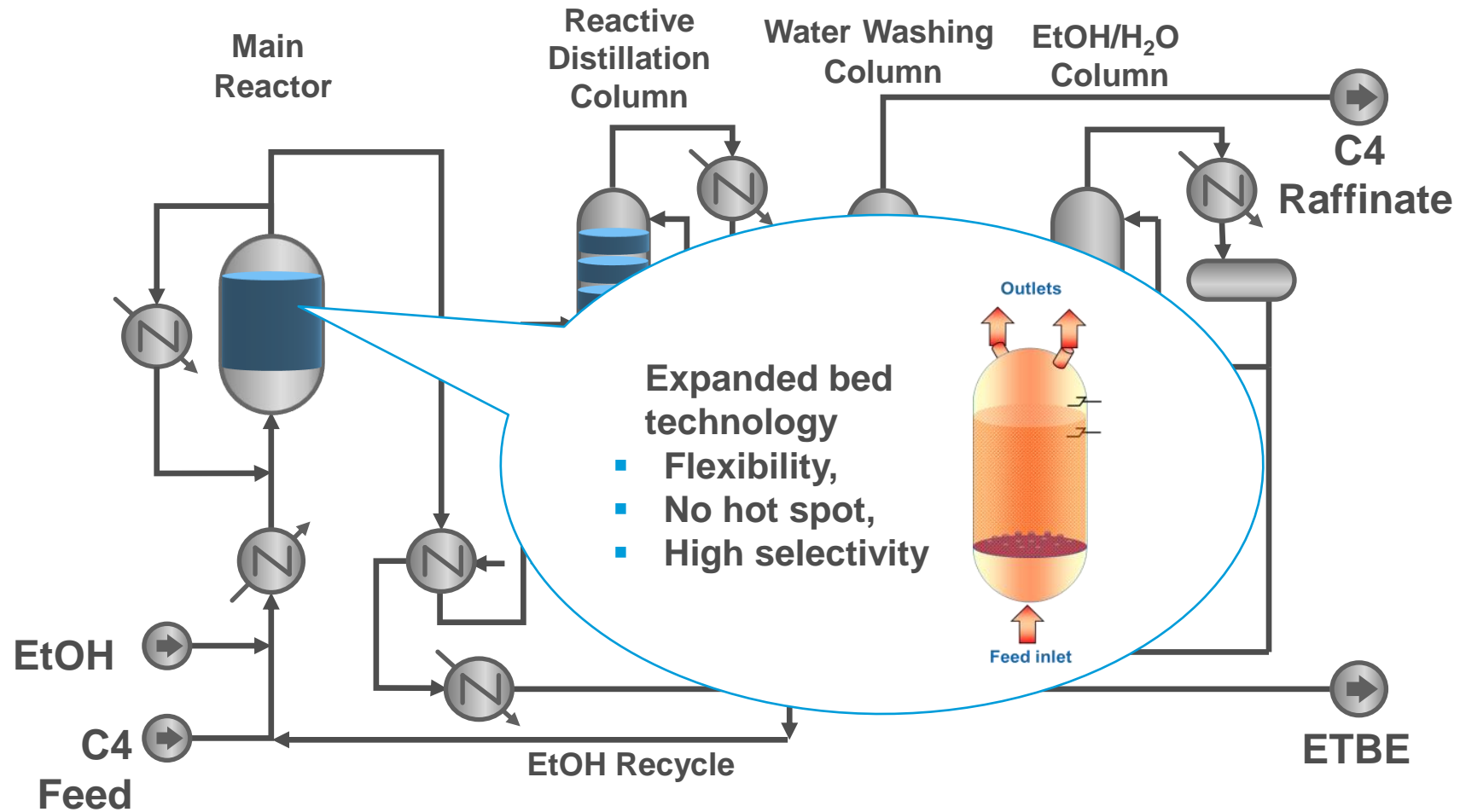
Catalytic Distillation

- Axens in-house **Catacol™**
- Conversion > 99% if required (petro compatible)

... for high performances and very long on-stream time

Axens ETBE Key Features: Simple and Robust

- Standard refinery need configuration



Catacol™ Catalyst Loading

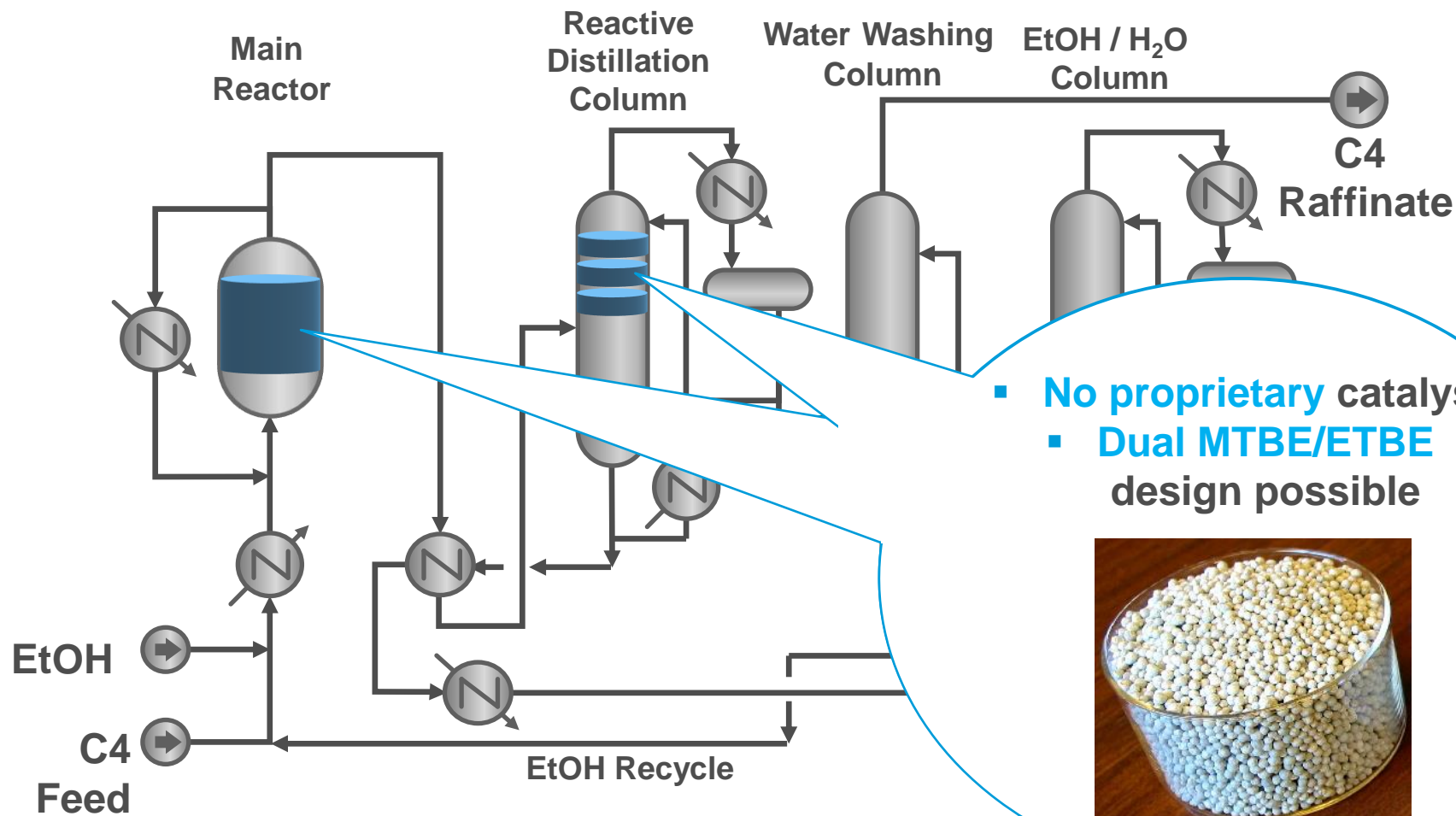


- Lift and pour
 - Simplicity
 - Rapidity
- No proprietary catalyst packing system



Axens ETBE Key Features: Simple and Robust

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Ethers Success with Axens

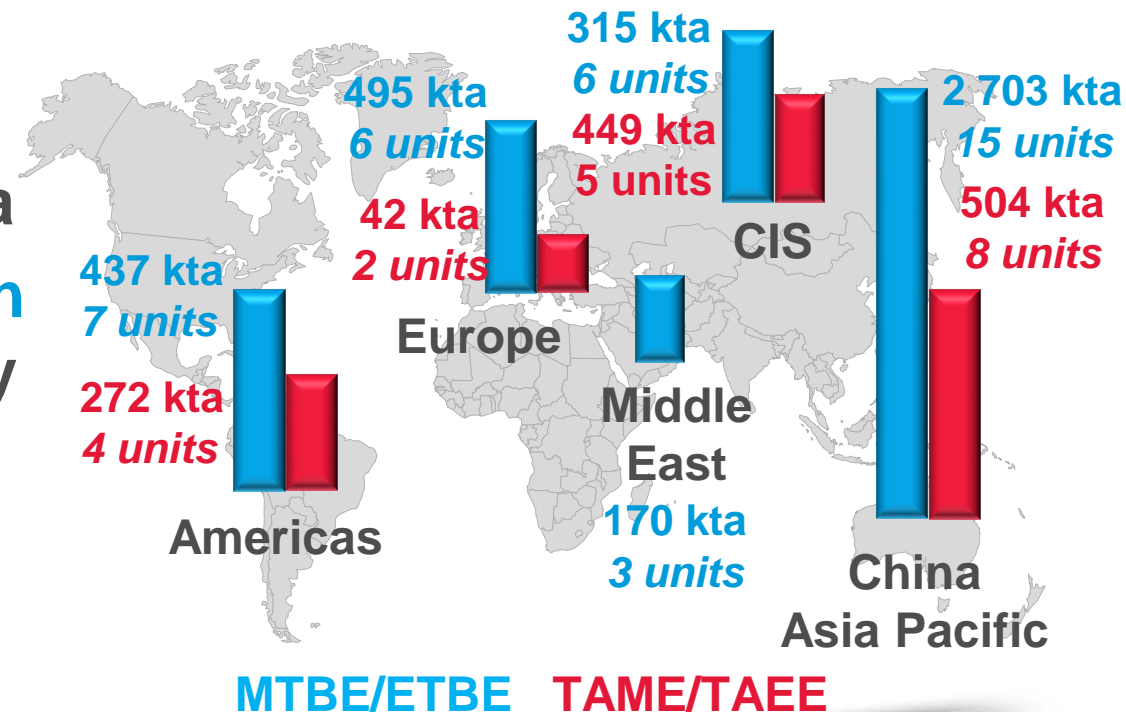
61 Etherification **References**
16 references **in 5** last years

Last Ethers licence award

- MTBE/Butene-1 Complex in India
 - Award after open competition between all major technology providers
- Revamp of TAME into TAEE in Kazakhstan

Last MTBE Start-Ups

- Dec 2015 and July 2016
- All guarantees met
- Smooth start-ups



Conclusions

- India is at a cross-road with new motor fuel specifications and Booming Bio-Ethanol supply
- Using Bio-EtOH via Bio-ETBE is the preferred choice 



Axens as a Global Technology Licensor for gasoline pool solution is ready to bring ETBE and Ethanol technologies in India

Thank you! And see you on Axens' Blog axens.net/blog

