

The role of sustainable oxyfuels in high-octane petrol to improve air quality while addressing biofuels ambition

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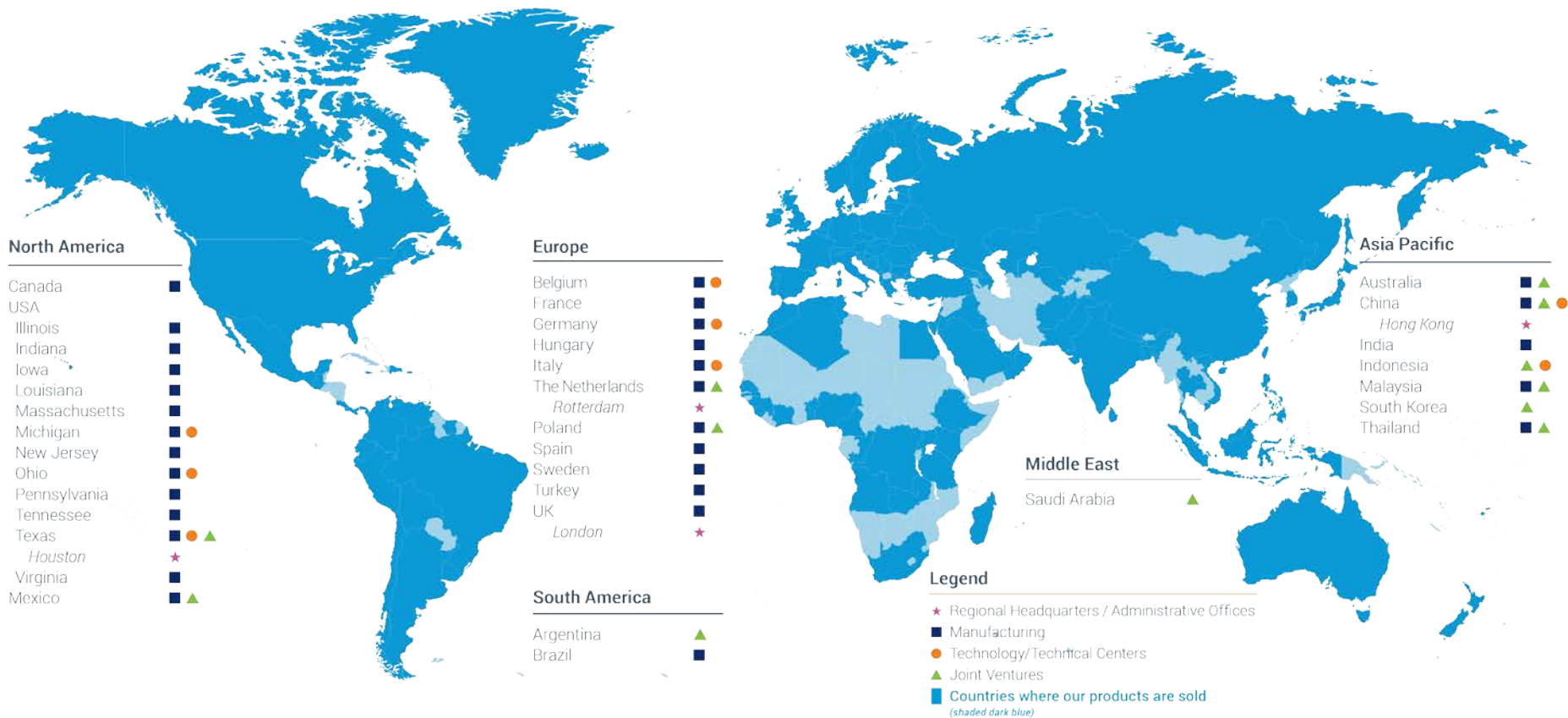
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LyondellBasell is a strong, global company delivering outstanding performance



LyondellBasell has the scope and scale to serve global markets
We manufacture and have joint ventures in 24 countries (including India)
Our products are sold in more than 100 countries

Note: Map is as of December 2018

Our products are advancing a range of solutions in nearly every geography and sector of the economy



Cleaner air & fuel efficiency

Stronger, lighter plastics, and high-octane fuel components contribute to higher fuel efficiency and cleaner air



Clean water

Stronger, longer-lasting pipes used in municipal water systems and key elements used in water filtration systems



Quality healthcare

Improved medical supplies such as synthetic latex gloves, hand sanitizers, biohazard bags and pill coatings



Food safety & access

Food packaging and films that improve freshness, portability and extend shelf-life



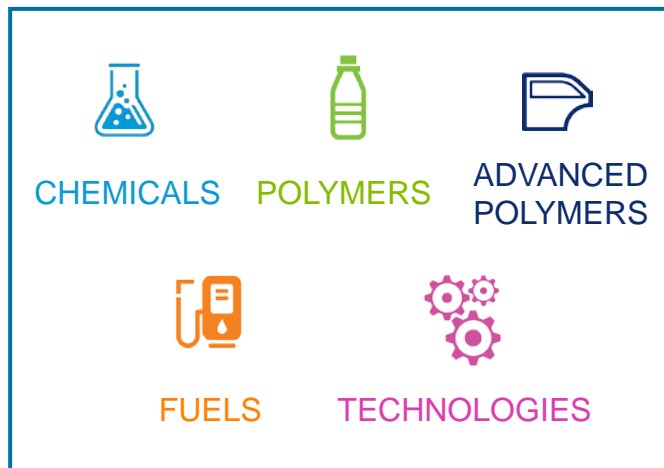
Sustainable & modern living

Materials that form components used in solar panels, wind turbines, children's toys, cosmetics, leak- and shatter-proof containers



Agricultural efficiency

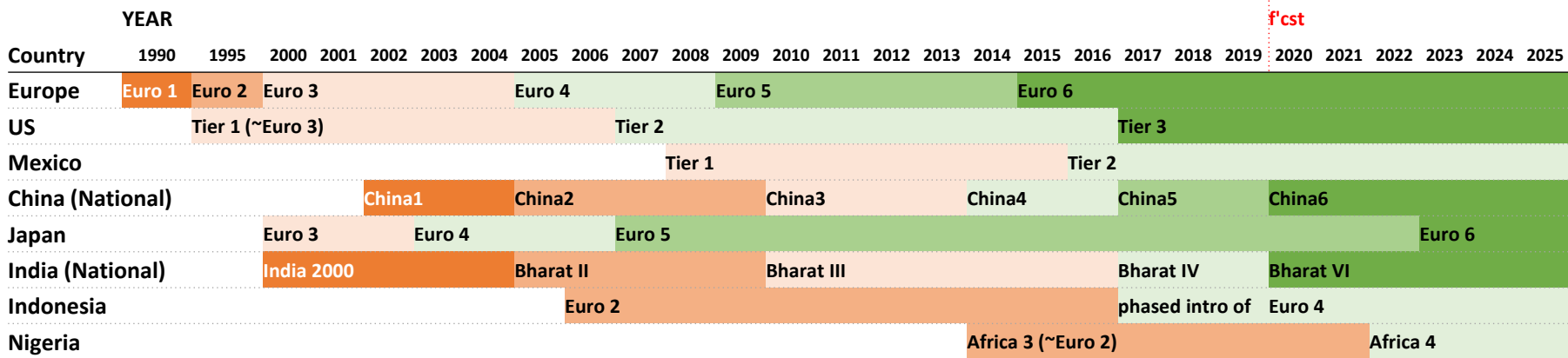
Lighter machinery, crop protection and soil conditioning used to be more efficient in agroprocessing



One of the world's largest plastics, chemical and refining companies producing products and materials key to advancing solutions to modern challenges

Petrol Quality Evolution

India's progress on the fuel quality curve will require additional octane



Removal of:

- Lead
- Metals and Organics such as MMT and Aniline



Health

Reduction of:

- Sulphur
- Benzene
- Aromatics
- Olefins



Air quality

Reduction of:

- NOx
- Sulphur
- Vapour pressure (RVP)



Emissions reduction

Increase of:

- Fuel efficiency
- Octane
- Biofuels



CO₂ improvement

Oxyfuels can contribute to India's progress along the fuel quality curve

*Other specifications not shown, e.g. CO, PN emissions tightened from Euro5 to Euro6

**Source: EIA, IHS, Concawe, EEA

What are Oxyfuels?

- 1 ■ Manufactured from traditional hydrocarbons (Oxyfuels, MTBE) or renewable biomass (Bio-ETBE, Bio-MTBE, Advanced Oxyfuels)
- 2 ■ High-octane (113RON MTBE /118RON ETBE), high-energy petrol blendstocks
■ Clean and efficient replacement for other harmful high-octane compounds, e.g. toxic lead and polluting aromatics, olefins
- 3 ■ Fully compatible with petrol, vehicles, and blending/transport infrastructure
- 4 ■ Greater fuel efficiency and/or better air quality improvements vs. other high-octane components such as directly blended ethanol, aromatics, and olefins



Oxyfuels are key components for the production of petrol and increases petrol's performance, while reducing the emissions of air pollutants and CO2 across their life cycle.

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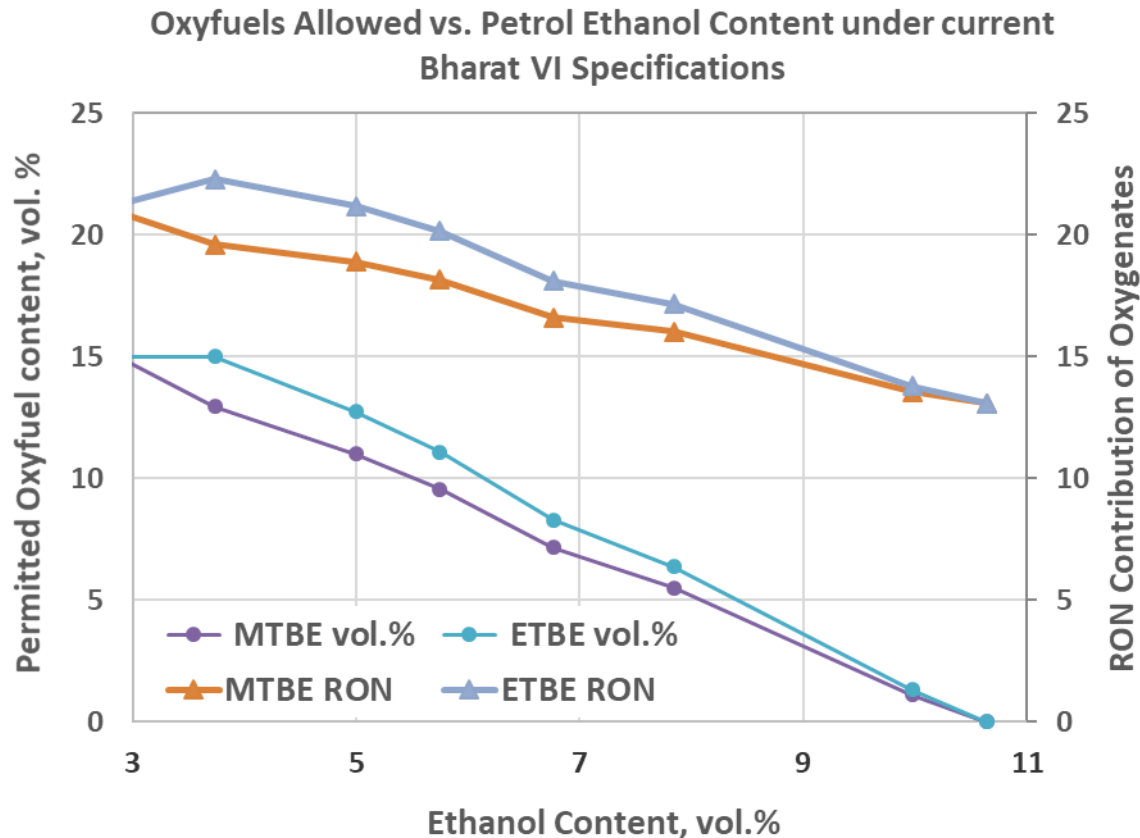
High-octane clean-burning fuel components that provide more energy, higher octane, and lower RVP than their feedstocks

Fuel	Blend component	Blending Properties		
		RON Octane	RVP (psi)	Energy BTU/Gal
Oxyfuel	ETBE	118	4	96,900
	MTBE	113	8	93,600
Alcohol	Ethanol	130	18-20	76,300
Unoxygenated blendstocks	Reformate	95	1	127,000
	Butane	92	57	102,600
	Naphtha	75	2	114,000
Finished Petrol		91-95	8.7-9.7	114,000

- Oxyfuels enhance the best properties of butanes and alcohols and minimize their drawbacks (RVP, low energy of ethanol)
- Oxyfuels add 8% more octane than their components
- Oxyfuels provide greater blend value than reformate and greatly reduce harmful emissions
- Oxyfuels enhance the value of lower value blendstocks such as naphtha

Oxyfuels improve air quality and fuel efficiency

Ethanol and Oxyfuels can co-exist under Bharat VI



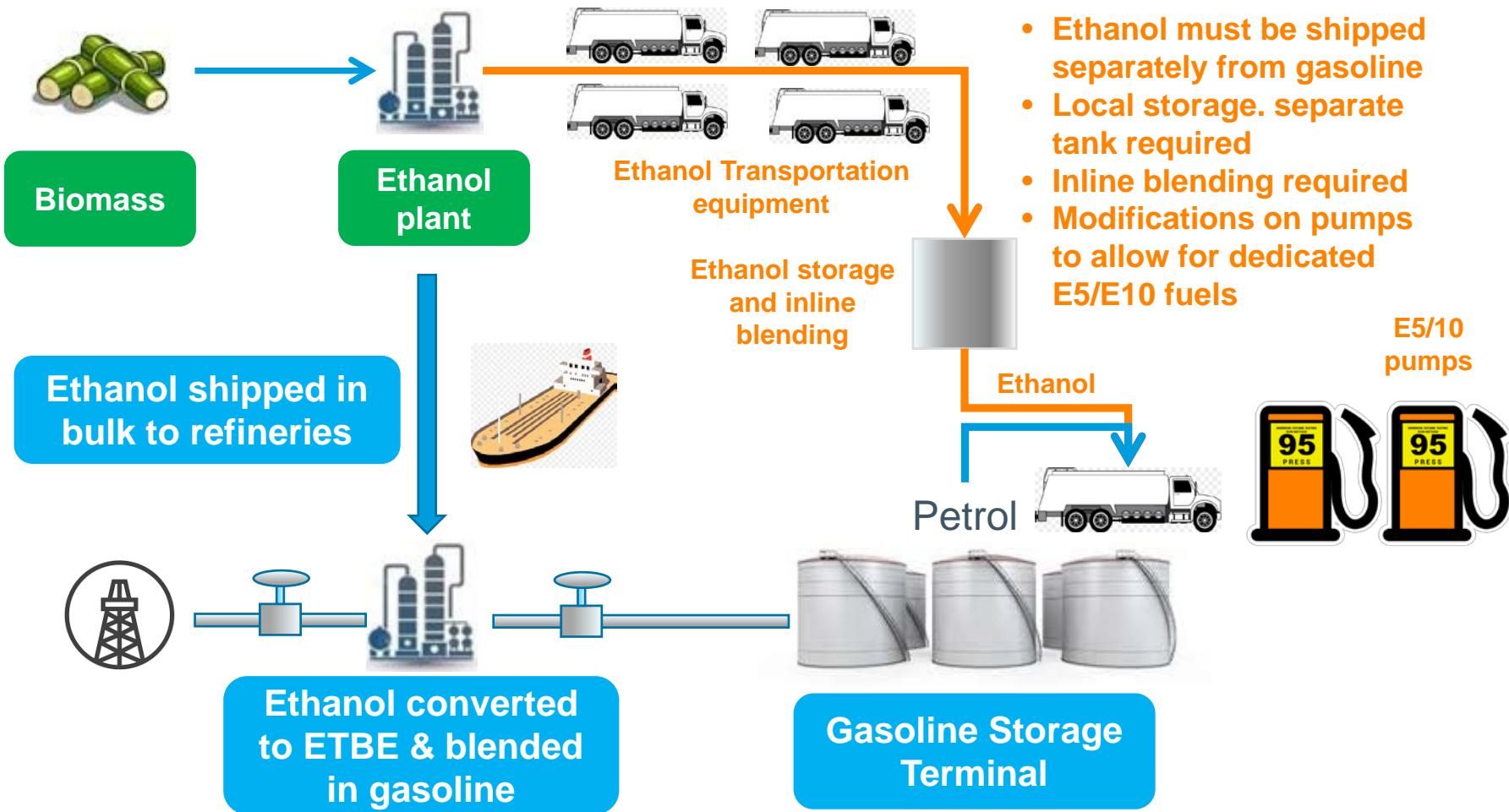
Max petrol octane decreases with decreasing Oxyfuel content and increasing ethanol content

- Although higher ethanol direct blending reduces octane potential and,
- 15 vol.% cap on Oxyfuels unnecessarily limits petrol octane

But higher ethanol content and Oxyfuel cap limit blending flexibility and octane

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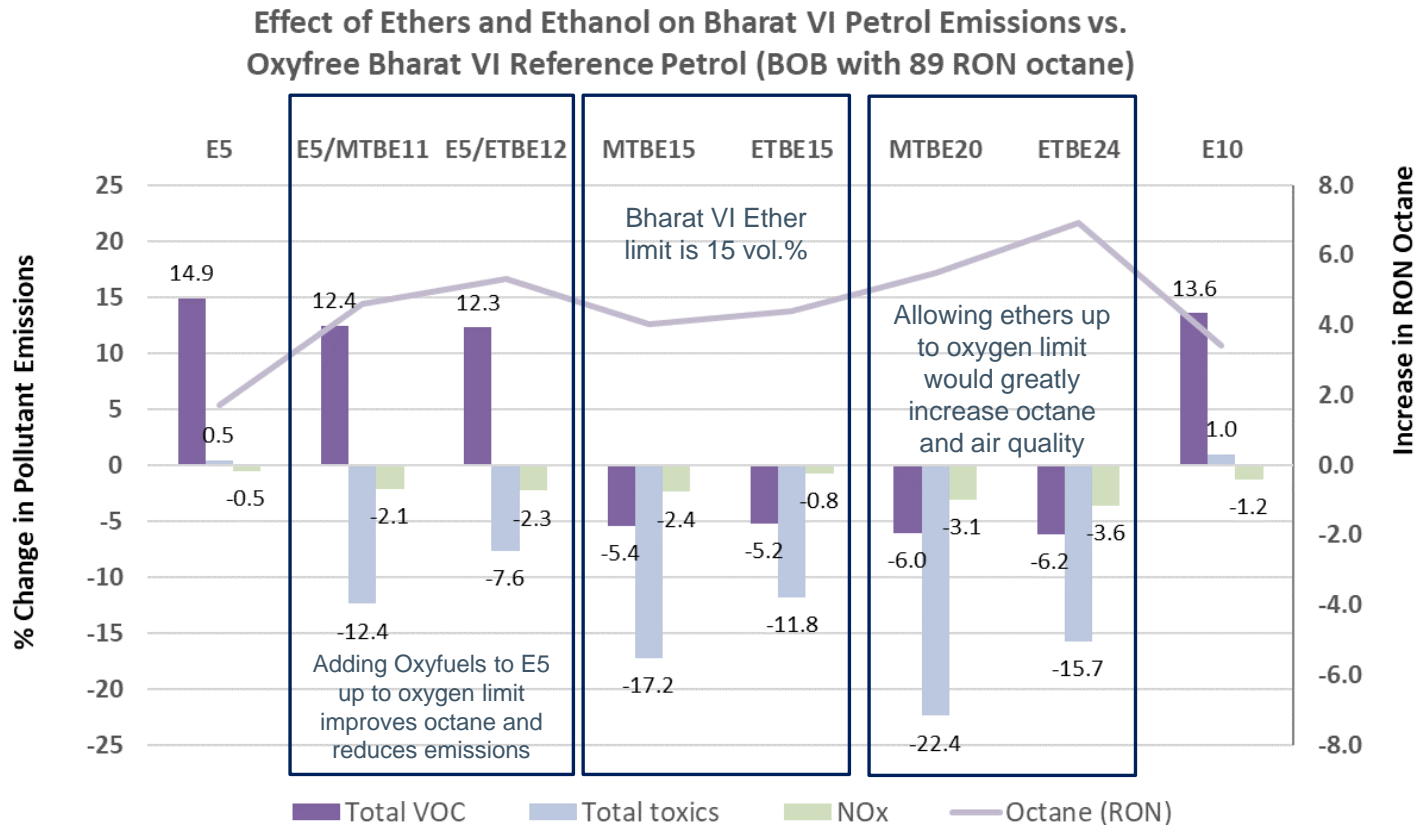
Enables advanced fuels to be distributed throughout the whole country without additional infrastructure investment



- Ethanol must be shipped separately from gasoline
- Local storage. separate tank required
- Inline blending required
- Modifications on pumps to allow for dedicated E5/E10 fuels

Upgrading to flexible MTBE/ETBE production at refinery is ~ 1/3 the capital cost of direct ethanol blending infrastructure

Oxyfuels is even more beneficial to air quality than direct blending alone



1. Emission reductions and RON increases vs. Bharat VI 89 RON unoxygenated reference fuel baseline.
2. Model used: US EPA Complex Model

MTBE/ETBE provide significant air quality benefits vs. ethanol direct blending

Japan chose Bio-ETBE for their Renewable Fuels Program in 2009

- **Japan's Kyoto Protocol Target Achievement Plan**
 - Called for the substitution of 500 million liters equivalent of crude oil by 2010
 - By using bio-ETBE, utilization of ethanol in the production of petrol was possible
 - Up to 7~8% of ethanol to be added as bio-ETBE by 2020
- **METI concluded bio-ETBE has benefits:**
 - Low solubility of bio-ETBE in water does not give rise to phase separation
 - Low vapor pressure of bio-ETBE reduces evaporative VOC emissions
 - Bio-ETBE improves air quality by reducing evaporative and exhaust emissions
 - Avoiding investment in infrastructure
- **Bio-ETBE-blended petrol did not require changes to the vehicles or petrol distribution infrastructure**
- **New mandate announced by the Japanese government in 2018 - 2023 minimum 55% GHG reduction compared to fossil petrol**



In 2017, Japan renewed their commitment to bio-ETBE

Bio-ETBE is a component of all petrol grades in France

- In France, bio-ETBE is present in all petrol grades
- In SP95 and SP95 E10 ethanol and ETBE are co-blended to get the maximum bio-content into the petrol pool
- Both SP95 and SP95 E10 use the same petrol blendstock “BOB” with 6.2 vol.% bio-ETBE added
 - The base petrol is blended at refineries and pumped via pipelines to terminals
 - Ethanol is then added at the terminal truck loading racks to SP95 and SP95 E10 specifications
- SP98 contains 8% bio/ethanol equivalent as ETBE and is compatible with older cars and two wheelers
- Close collaboration between local ethanol industry and ether producers



ETBE provides more flexibility, energy, and octane supply than ethanol direct blending alone

India's success story by using (advanced) MTBE/ETBE

(Advanced) MTBE/ETBE will

- make full use of the available bio-ethanol and domestic feedstocks to reduce crude imports
- make it easier and cheaper for refiners to meet Bharat VI specifications and produce 95RON gasoline
- bring advanced fuels to the whole of India with reduced need for additional infrastructure investment
- be used in conjunction with ethanol to improve air quality and increase octane
- improve air quality and reduce emissions of ozone and particulate matter
- set the stage for higher octane consistent with EU trend to reduce emissions and improve fuel efficiency

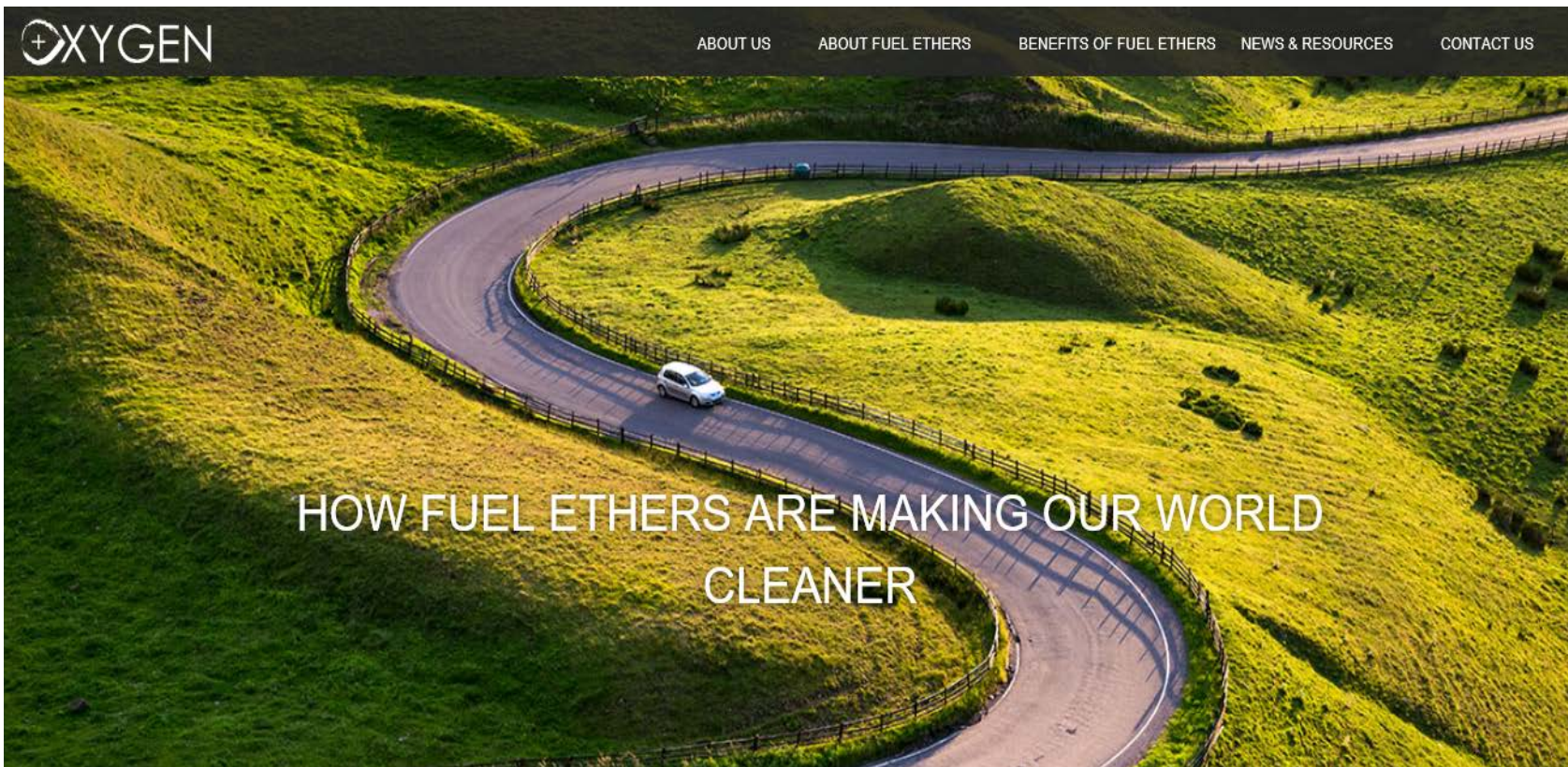


What is required to enable this

- Allow Oxyfuels up to 3.7 weight % oxygen limit
- Allow Oxygenates in import gasoline

Oxyfuels are the best solution for improved air quality and energy independence

More information



<https://globalfuelethers.com>

<https://sustainablefuels.eu>