

Future Motorcycle Emission Legislation & Innovative Catalyst Technologies

Rajesh Sankaranarayanan

R&D and Application

BASF Environmental Catalyst and Metal Solutions

ECMA 16th International Conference
7-8th October, 2025, New Delhi, India

 **BASF**
We create chemistry

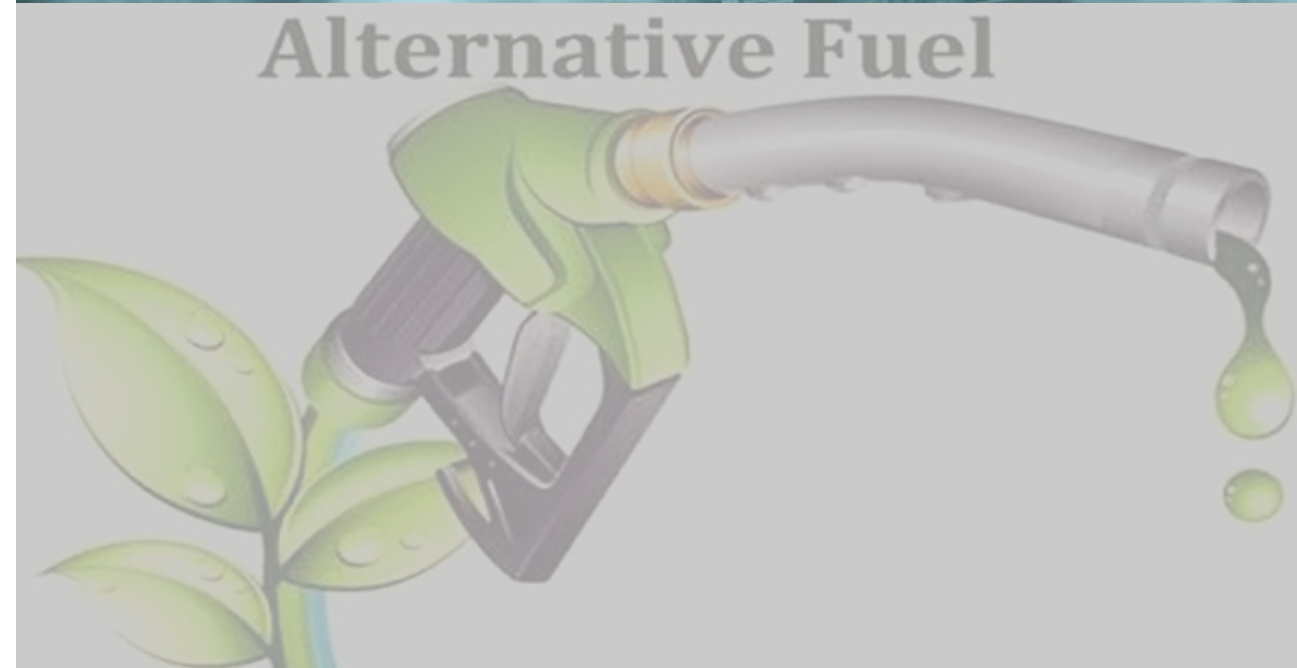
Agenda

■ 2W emissions control: next steps

- Air quality & contribution from 2W
- Emission legislation: next steps

■ Alternative fuels

- Key challenges in emission reduction
- Catalyst design for CNG
- Catalyst design for flex fuel



Air Pollution – A serious Concern in India

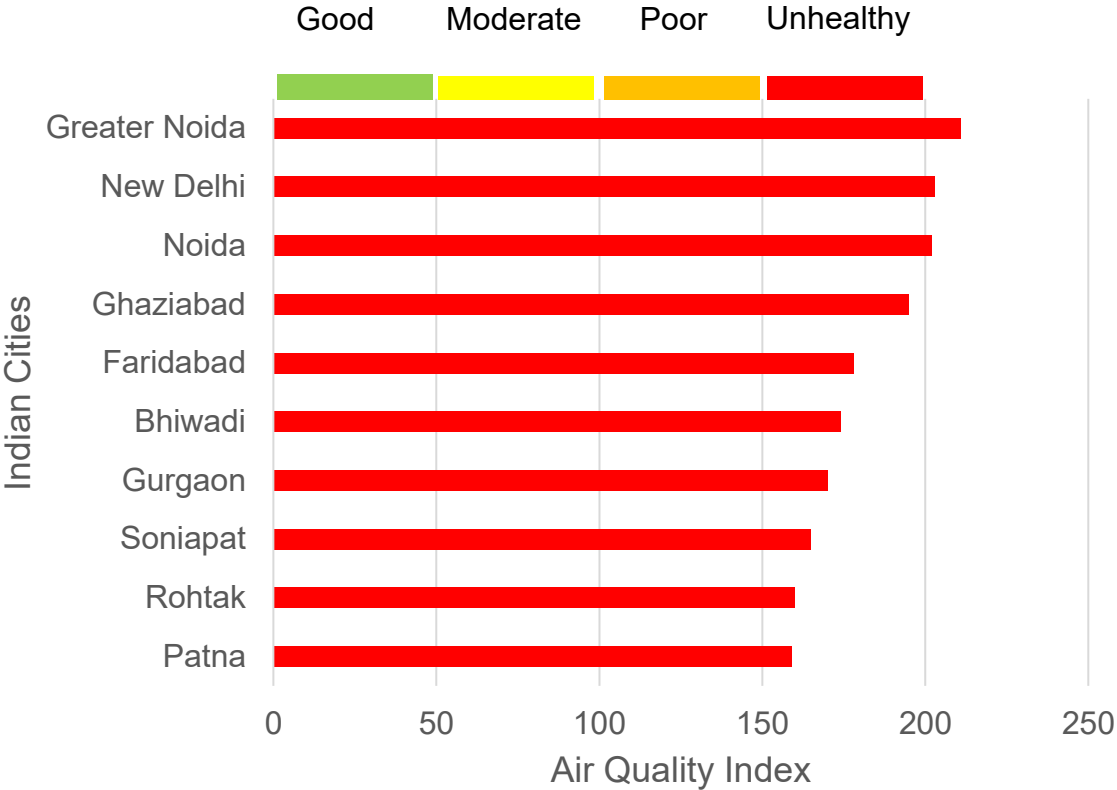
Urban air quality levels is one of the leading concerns, affecting health & quality of life in India.

AQI (Air Quality Index) India



Source: <https://www.aqi.in/>

AQI



Sources Influence Air Quality Index

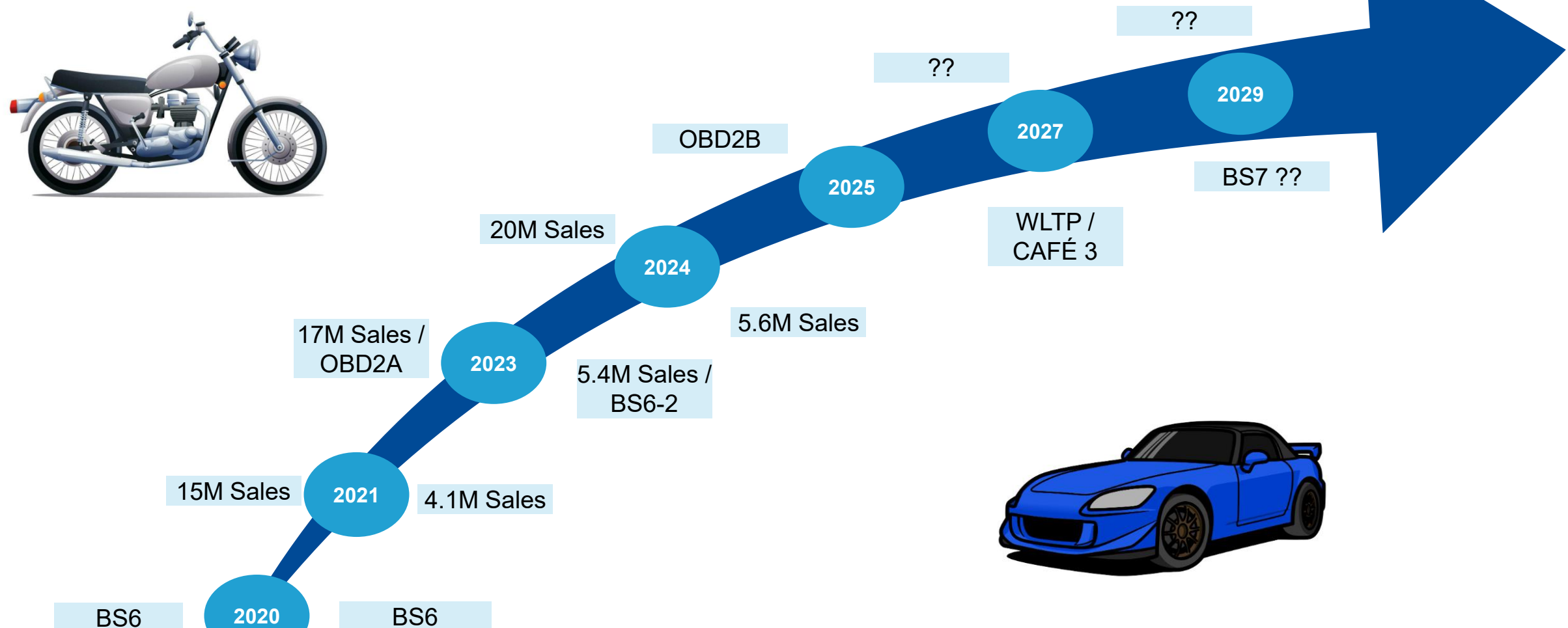
Though multiple sources contribute to the air pollution in India, automotive sector also plays a significant role.



To improve overall AQI,
automotive emission also
needs to be tackled.

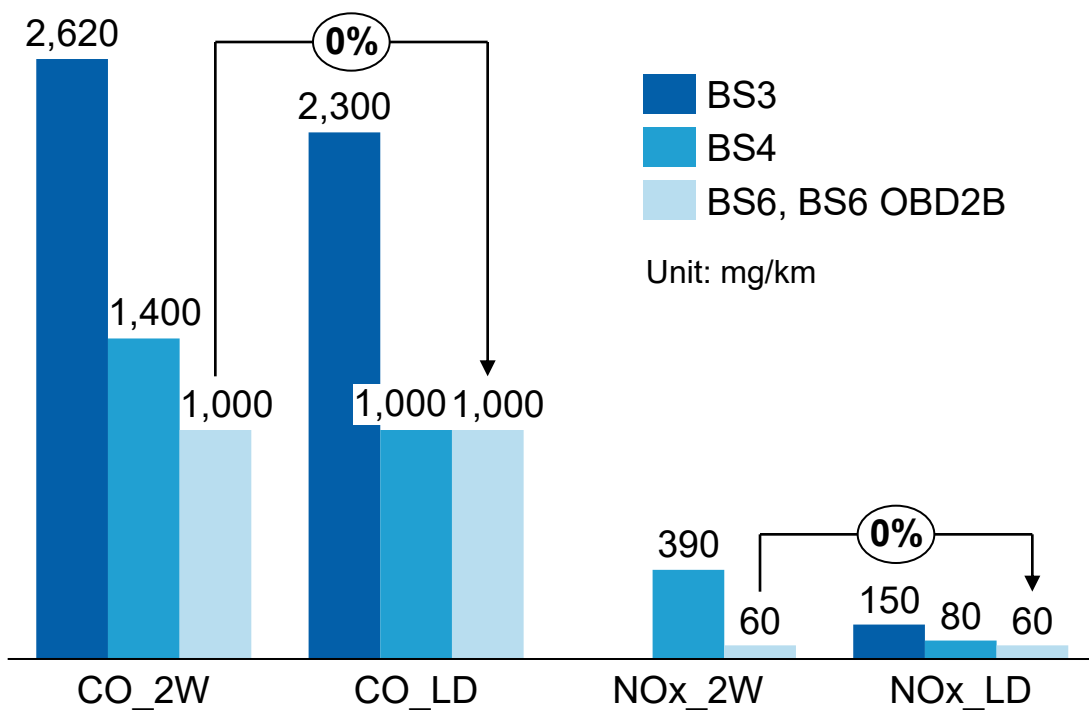
Vehicles Sales in India – Motorcycle vs Light Duty Segments

Motorcycle sales is 4X > LD sales in 2024 and expected to stay strong over the coming years, contributing to a significant portion of the automotive emissions.



Motorcycle Emission Norms – Overview

Motorcycle & light duty legislations



*2W – motorcycle legislations; LD – light duty legislations

- BS VI Emission limits were implemented in 2020, followed by OBD2A in 2023 and OBD2B 2025. There is no visibility beyond motorcycle BS6 OBD2B.
- Both the pollutants CO and NO_x have same legislation limits.
- To improve automotive contribution to AQI, we have to consider
 - ✓ Stringent emission legislation for 2W / 3W vehicles
 - ✓ PN limits for 2W / 3W vehicles
 - ✓ Deployment of alternative fuels like CNG / Flex fuels in rural areas.

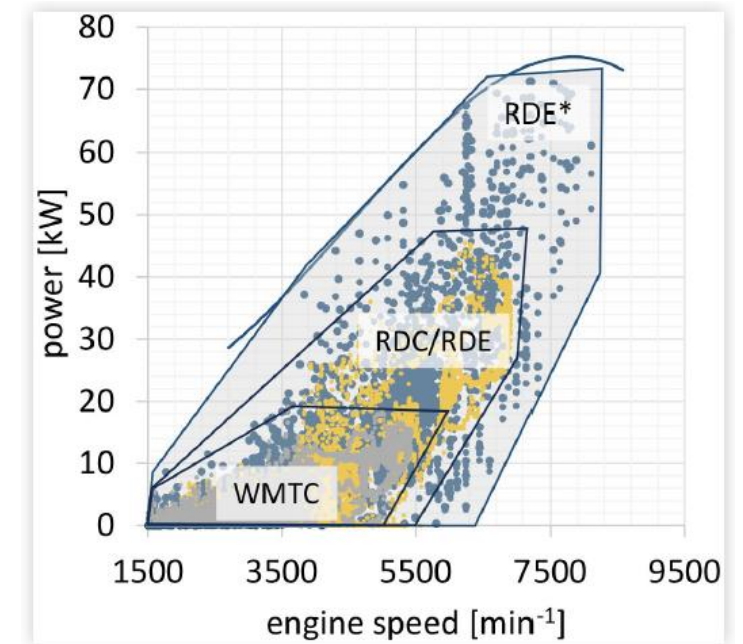
Next Steps in Emission Legislation - Real Driving Emission (RDE)

■ What is RDE

- ✓ Real Driving Emission (RDE) represents pollutant measurement from vehicles during actual road driving conditions.

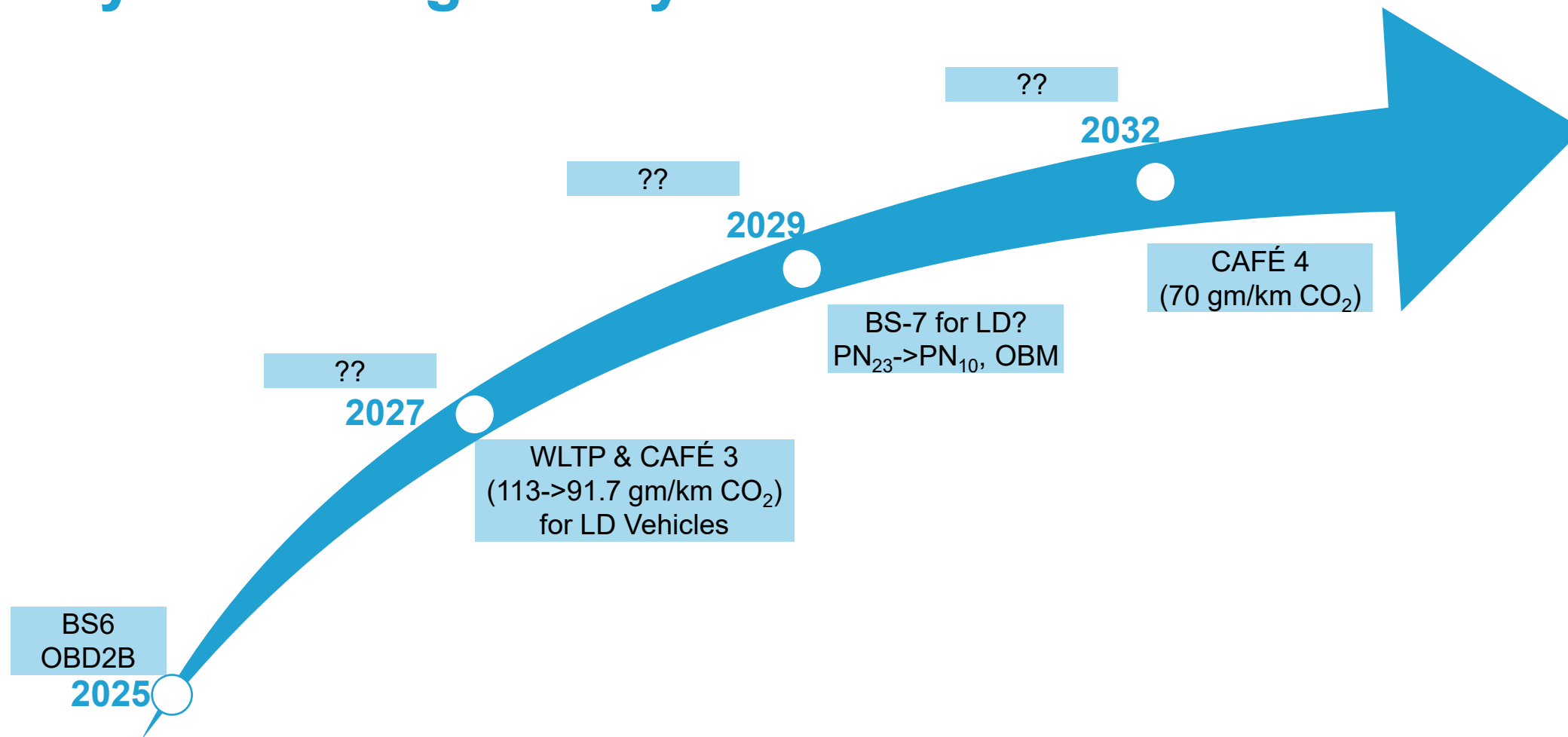
■ Why RDE is required

- ✓ There is always a gap between emission test measured under controlled laboratory conditions and emission test measured during real driving conditions. To understand the difference and close the gap, RDE is required.
- ✓ Since the emission norms are getting stringent, if RDE is implemented, the actual pollutant emission will be significantly reduced.



Source: SAE – 2024-32-0073

Next Steps in Emission Legislation – Motorcycles vs Light Duty Vehicle



Agenda

■ 2W emissions control: next steps

- Air quality & contribution from 2W
- Emission legislation: next steps

■ Alternative fuels

- Key challenges in emission reduction
- Catalyst design for CNG
- Catalyst design for flex fuel



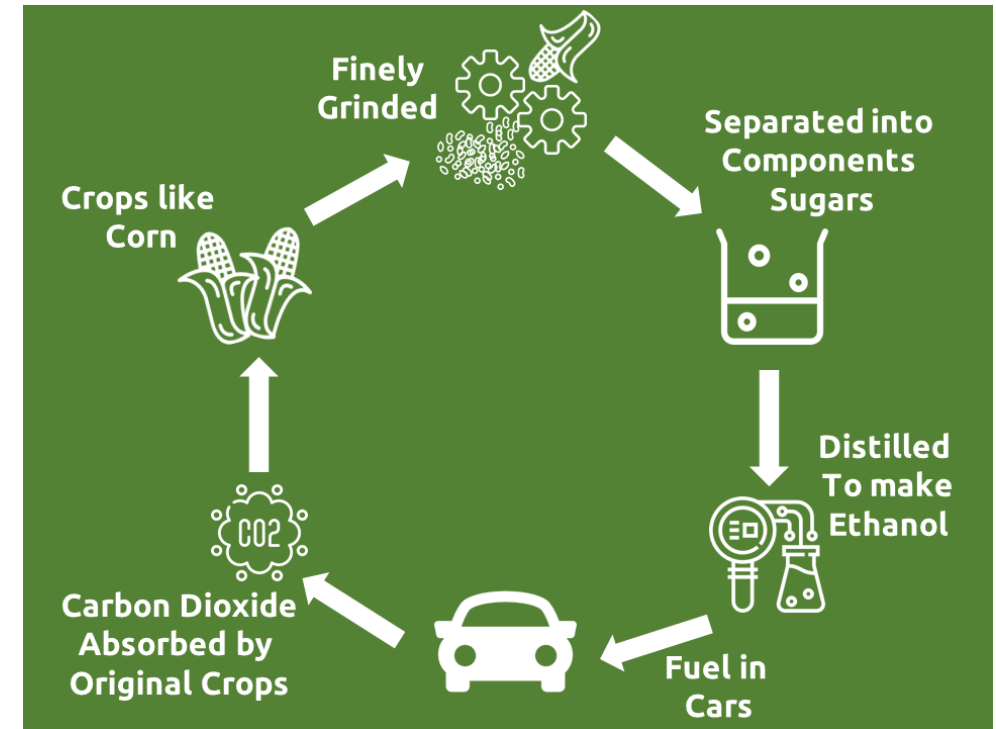
Alternative Fuel



Alternative Fuels – Cleaner & Greener Fuels



Ethanol

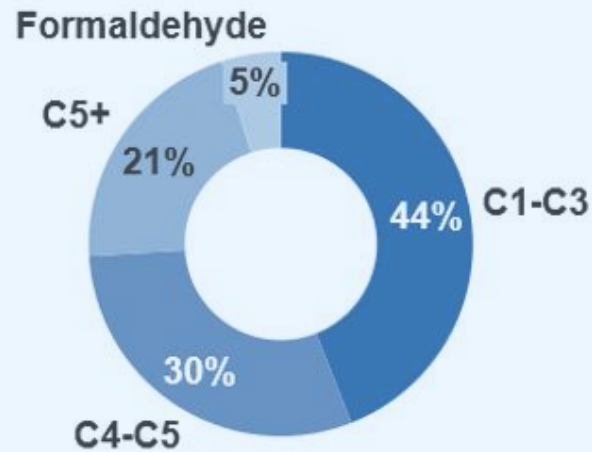


<https://techoid.com/bioethanol>
<https://www.ajrtrucking.com/blog/choose-a-greener-tomorrow-advantages-of-cng-over-traditional-fossil-fuels/>
<https://ioagpl.com/benefits-of-cng/>

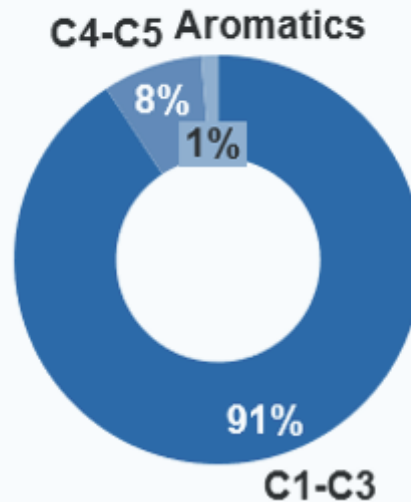
Alternative Fuels – Challenges in Emissions

- Focus on alternative fuels in India, to reduce import dependency and also reduce CO2 emissions
- Unique fuels have unique emission control challenges & needs specialized Catalyst designs

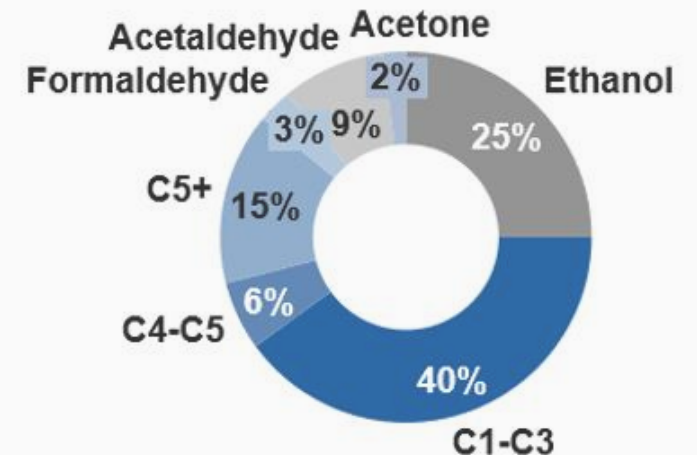
Gasoline



Compressed Natural Gas

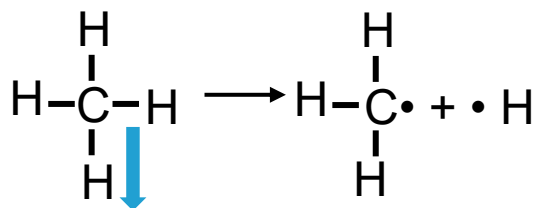


E85

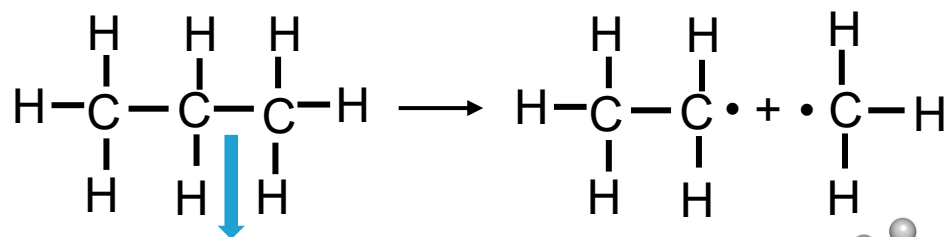
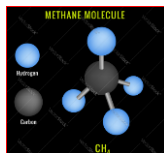


BASF Unique Catalyst Design for Methane Conversion

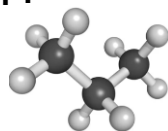
Character of Methane



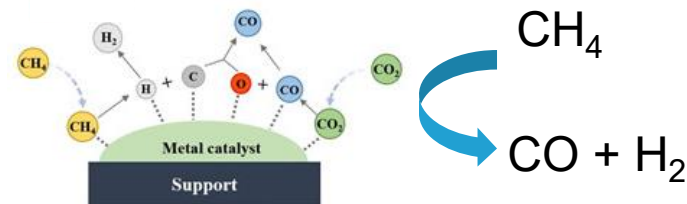
Bond Energy = 439 kJ/mol



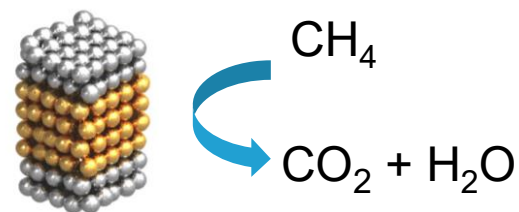
Bond Energy = 332 kJ/mol



BASF CNG catalyst



Methane steam reforming



PGM synergy

- Methane is difficult to convert due to high bond energy
- BASF catalysts with good methane steam reforming activity boost methane conversion
- PGM synergy (usage of other metals along with Pd to boost activity of methane conversion) for better methane conversion activities. With this innovation, we have proven wash coat in Indian Market.

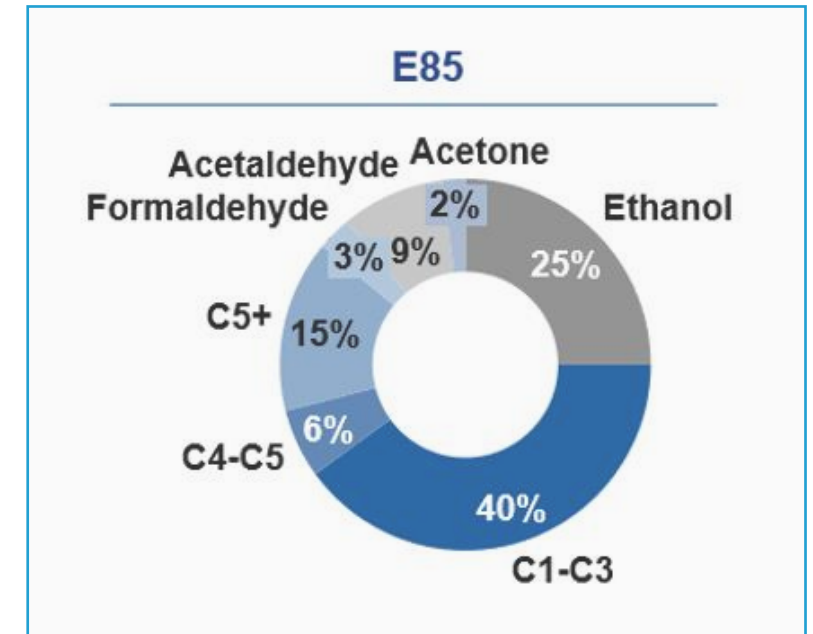
Flex Fuel: Need for Alternative Catalysts

Effects of ethanol blending on EO emissions

- Flex fuel $\leftrightarrow$ exhaust emissions
 - Lower EO emissions
 - Lower cold-start temperature rise
 - Higher HC and CO, but low NO_x TP emissions

Countermeasures to meet tailpipe emissions

- Catalyst for flex fuel
 - Optimized PGM effectiveness
 - special design for cold-start HC performance (oxygenate oxidation, light-off)
- Calibration: faster cold-start heat-up
 - Start-up enrichment





Summary

- India is one of the most polluted countries in the world as per the AQI data from 2020 to 2024.
- Motorcycle sales (ICE) increased from 15M to 20M vehicles from 2021 to 2024. Exhaust emissions from motorcycles needs more attention.
- To reduce emission contribution from motorcycles
 - To implement stringent emission norms
 - To use alternative fuels like CNG / flex fuels
- BASF have innovative catalyst technologies for CNG / flex fuel applications and future emission regulations.



We create chemistry