



Key updates to drive technology change in Indian light duty segment

22nd Oct 2024

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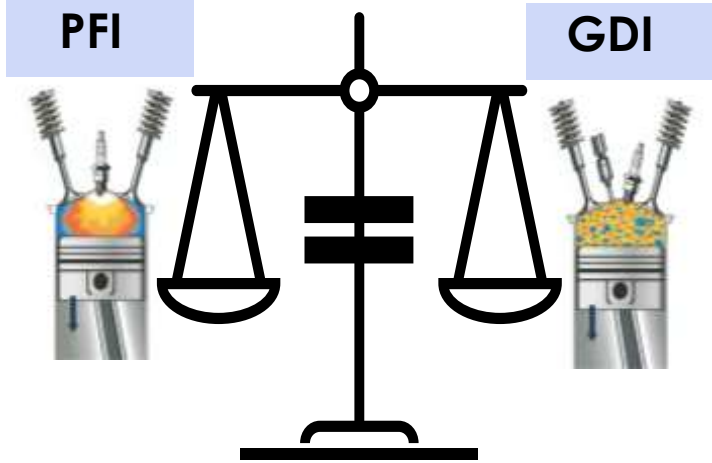
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Key topics in Euro7 driving technology change

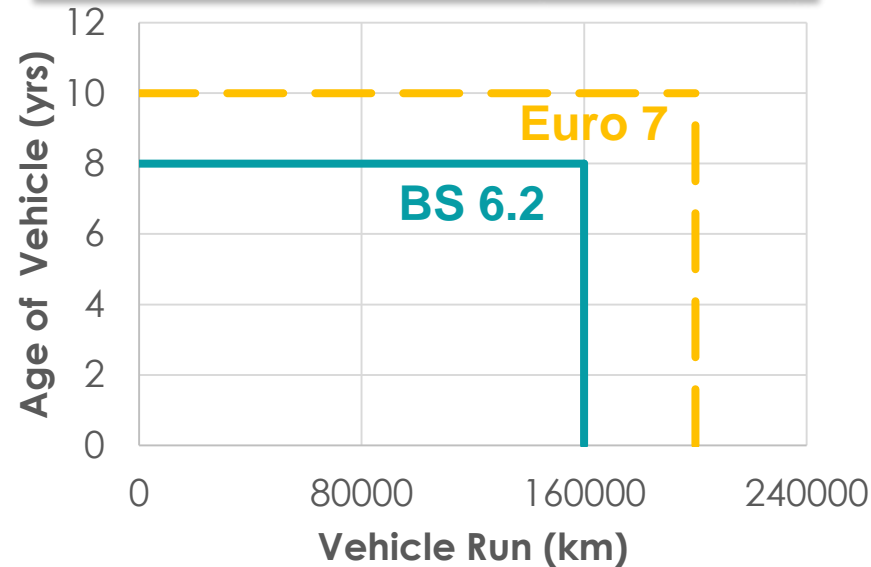
Technology Neutral Regulation

PFI Engines to have particulate limits same as Direct Injection / Diesel Engines



Longer emission durability

No DFs for upto 8 yrs under BS7 ~ E7, factor of 1.2 allowed beyond 8 yrs upto 10 yrs



On-Board Monitoring

OBM goes beyond OBD / fault detection to record real time emission exceedances



Key topics in Euro7 driving technology change

Random RDE Trip to be the prime path of evaluation

BS 6.2



Urban = 0.34 D
 $0 < V \leq 45$ kmph



Rural = 0.33 D
 $45 < V \leq 65$ kmph



Highway = 0.33 D
 65 kmph $< V$

BS 6.2 RDE Trip Distance $D \geq 48$ km

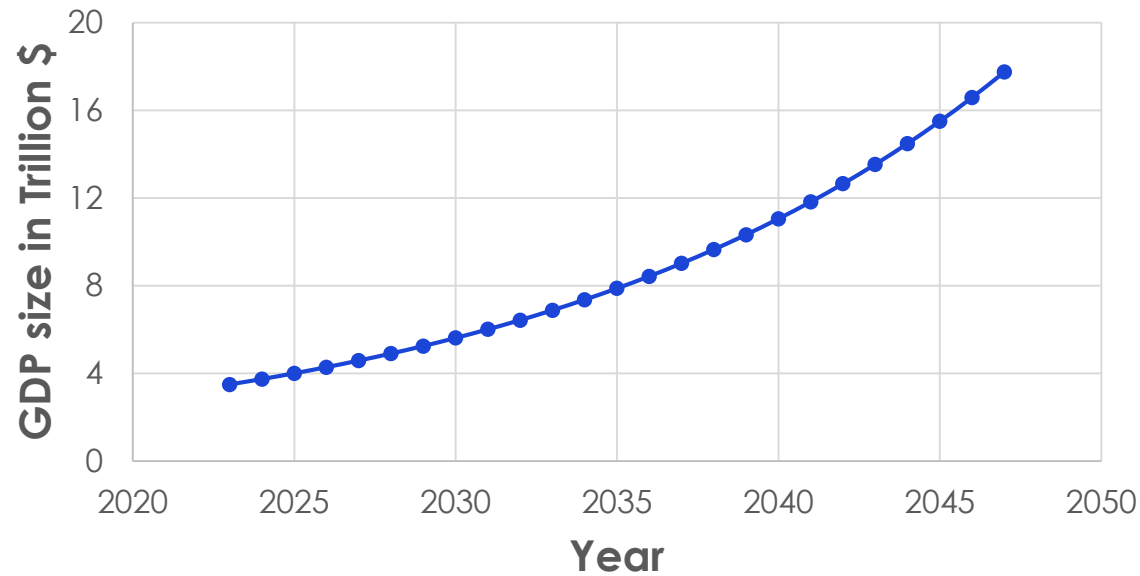
Euro 7



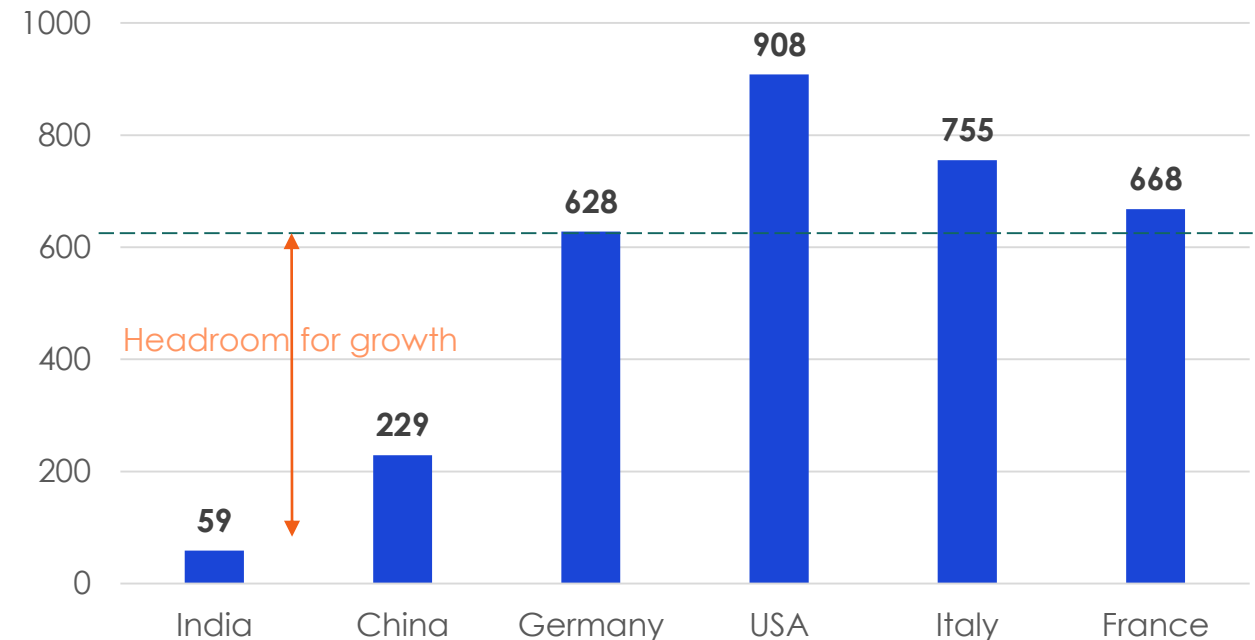
- No restriction on driving pattern – could be a combination of varying lengths of urban, rural and highway.
- Euro 7 Normal Trip Conditions :
 - $D \geq 10$ km,
 - For first 2 km after cold start, power @ wheel $< 20\%$ of maximum,
 - $V \leq 145$ kmph
- Euro 7 Very Short Trips :
 - For $D < 10$ km (very short trips), budget limit for criteria pollutants applicable.

Passenger car market to grow multifold by 2047

By 2047 India's GDP would be around China's as on date



Cars per thousand people

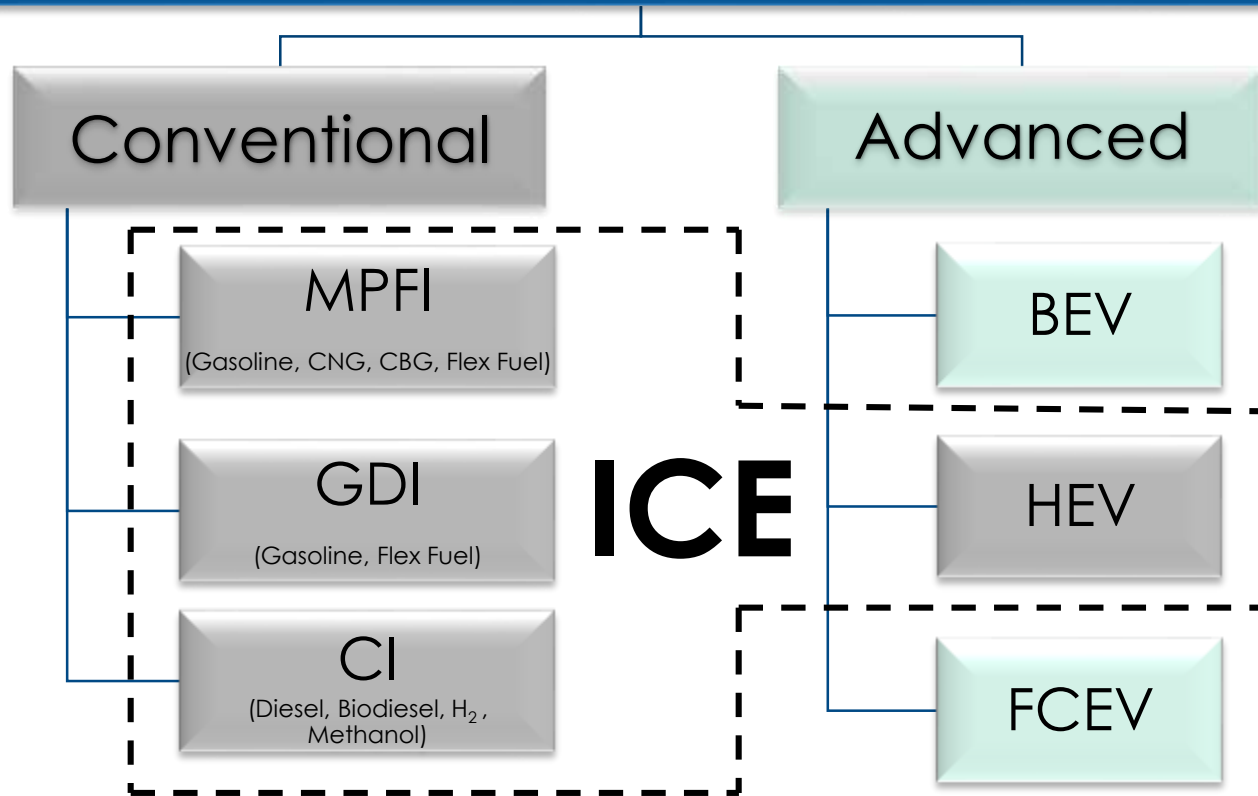


Source : [Cars by Country 2024 \(worldpopulationreview.com\)](https://www.worldpopulationreview.com)

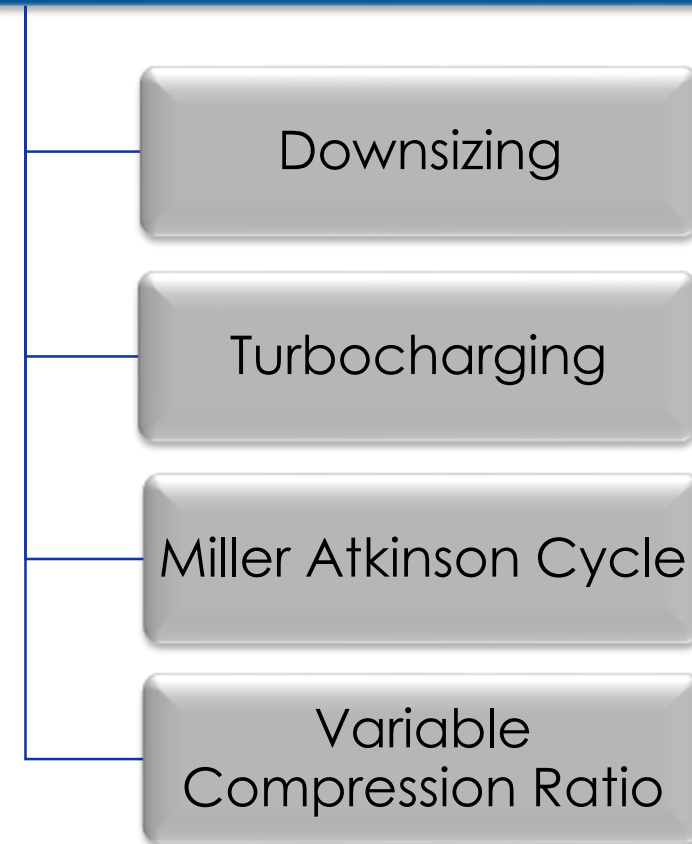
- ❑ Passenger Car Market Size in India is 4 million perm vis-a-vis 24 million per annum in China
- ❑ The rise of middle class with higher disposable incomes in India to spur demand for personal mobility
- ❑ With less than 2% penetration of the EV in 4Wh segment, traditional ICE based powertrains will be in demand for the next two decades

ICE is going to be the prime path for decarbonization for the next two decades at least

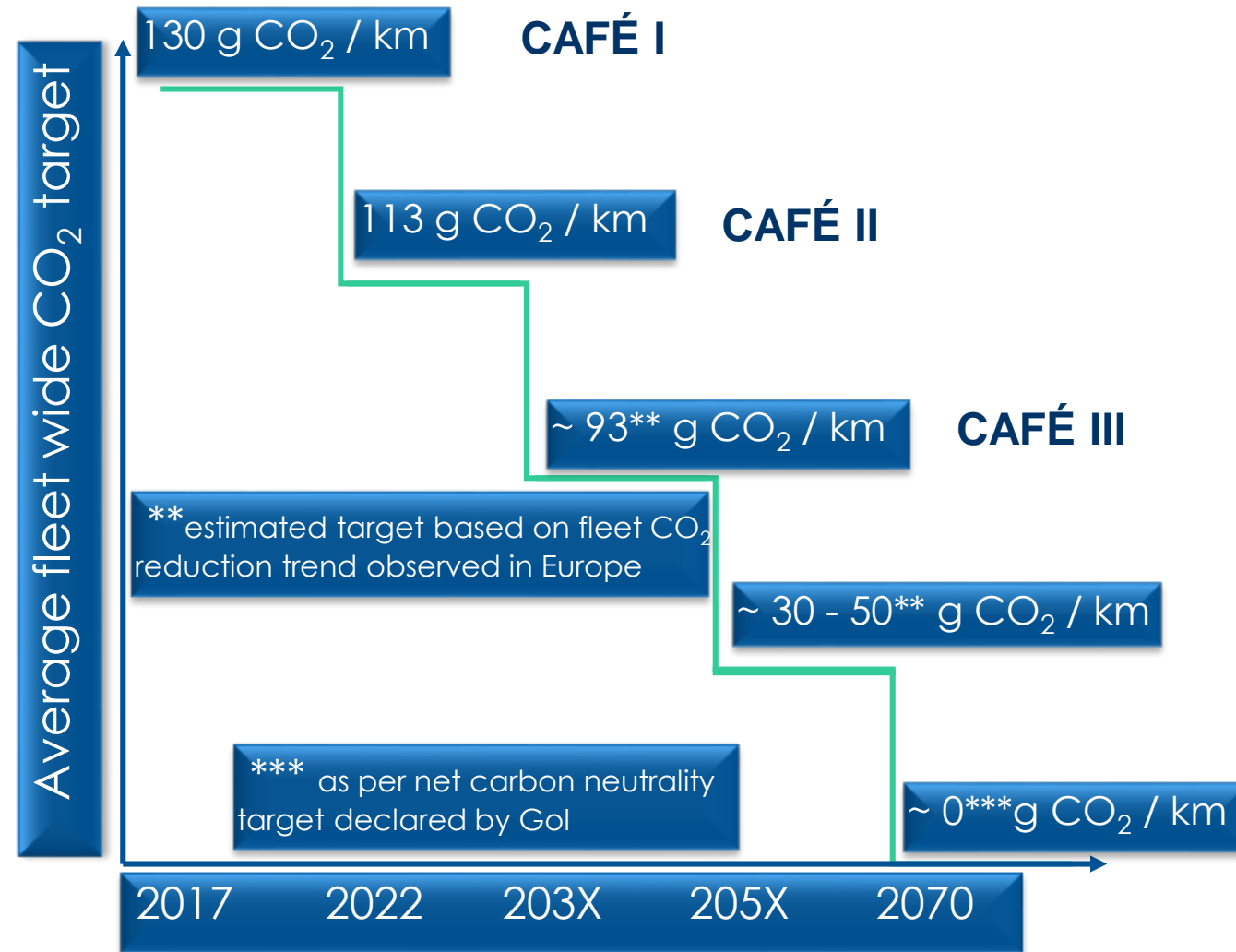
Powertrains for Decarbonization



ICE strategies to reduce CO₂



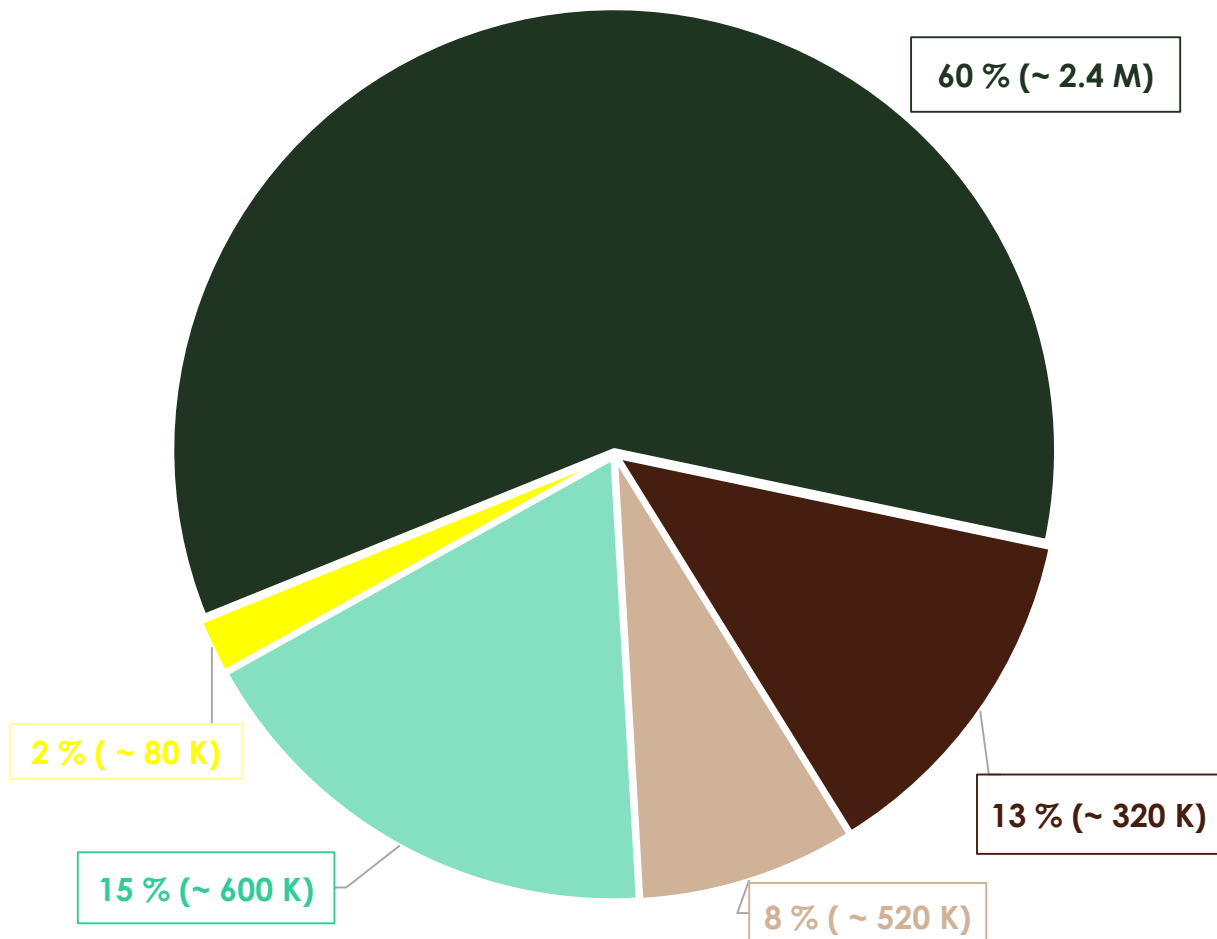
OEMs to focus on GHG (CO₂) emission reduction with advances in CAFÉ norms



Gasoline MPFI is the dominant powertrain in passenger cars

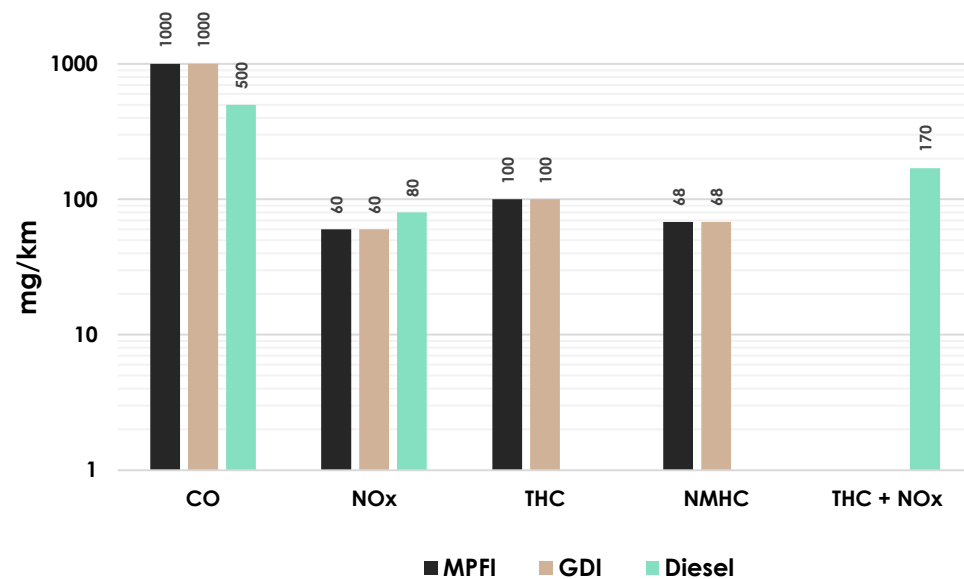
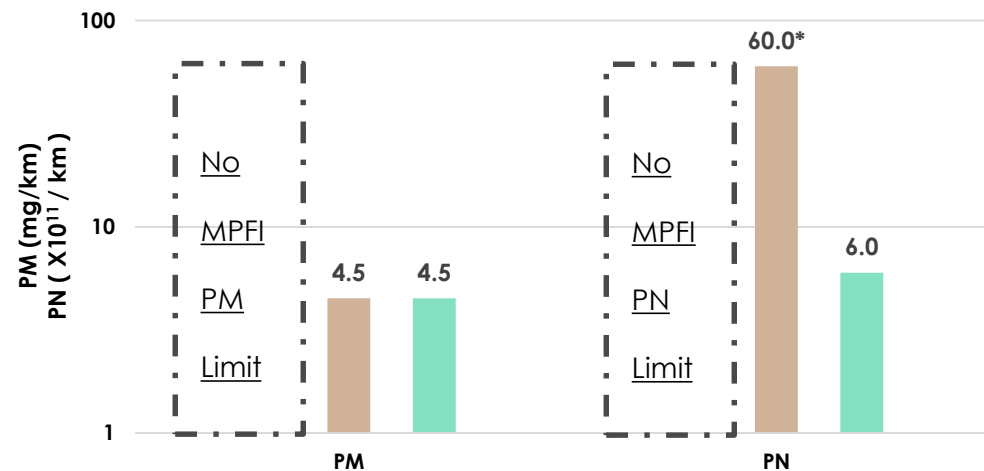
Powertrain Technology Mix in India Light Duty

■ Gasoline MPFI ■ CNG MPFI ■ Gasoline GDI ■ Diesel ■ Electric



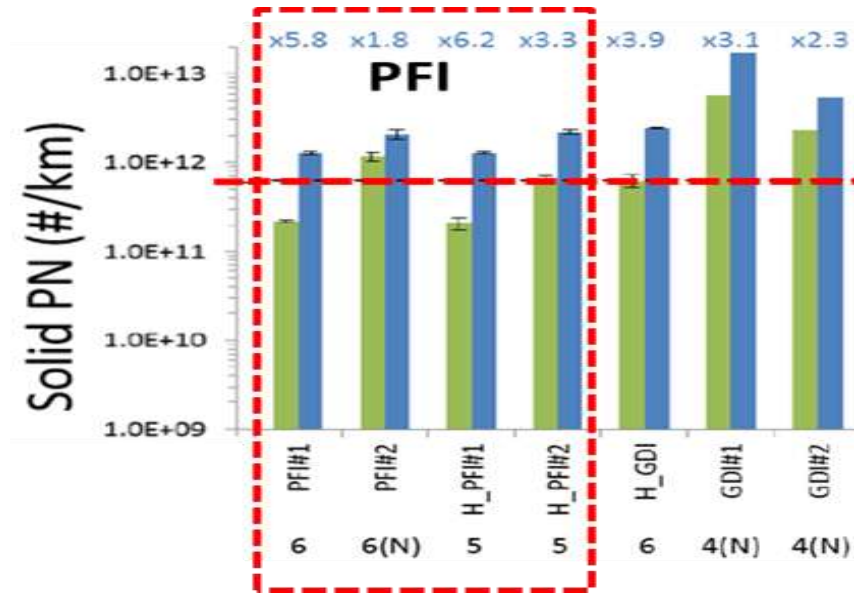
Source : Indian passenger vehicle market fuel-mix analysis : H1 2024 (autopunditz.com)

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*6 X 10¹² #/km up to 2023, 6 X 10¹¹ #/km

4Wh MPFI particulate emissions are high

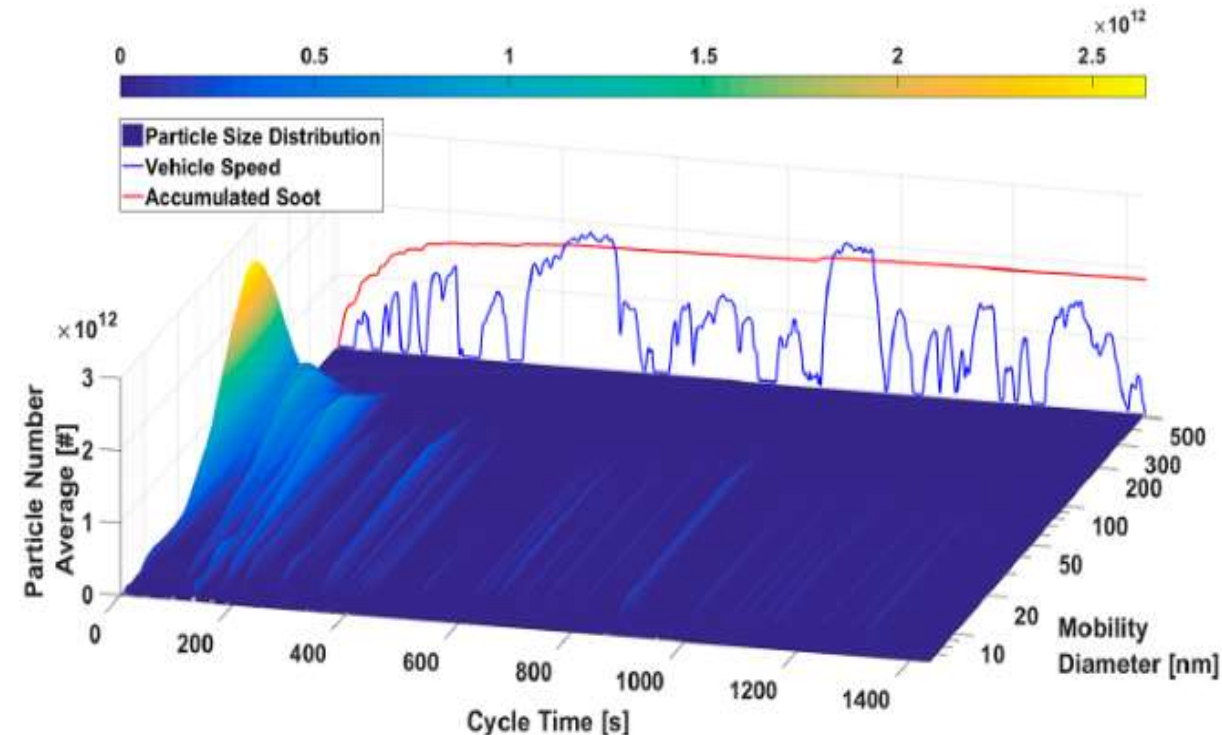


- ❑ Emissions of MPFI compared vis-a-vis GDI variants
- ❑ Engine out SPN_{23} for the MPFI is well beyond the PN limit under BS 6.2
- ❑ Engine out SPN_{23} for the MPFI could be as high as the GDI

Source : Martini, G., "Scientific evidence on vehicle's emissions", presented at the EU Commission Stakeholder Event, Oct 24th, 2018 Brussels, <https://ec.europa.eu/docsroom/documents/32164>

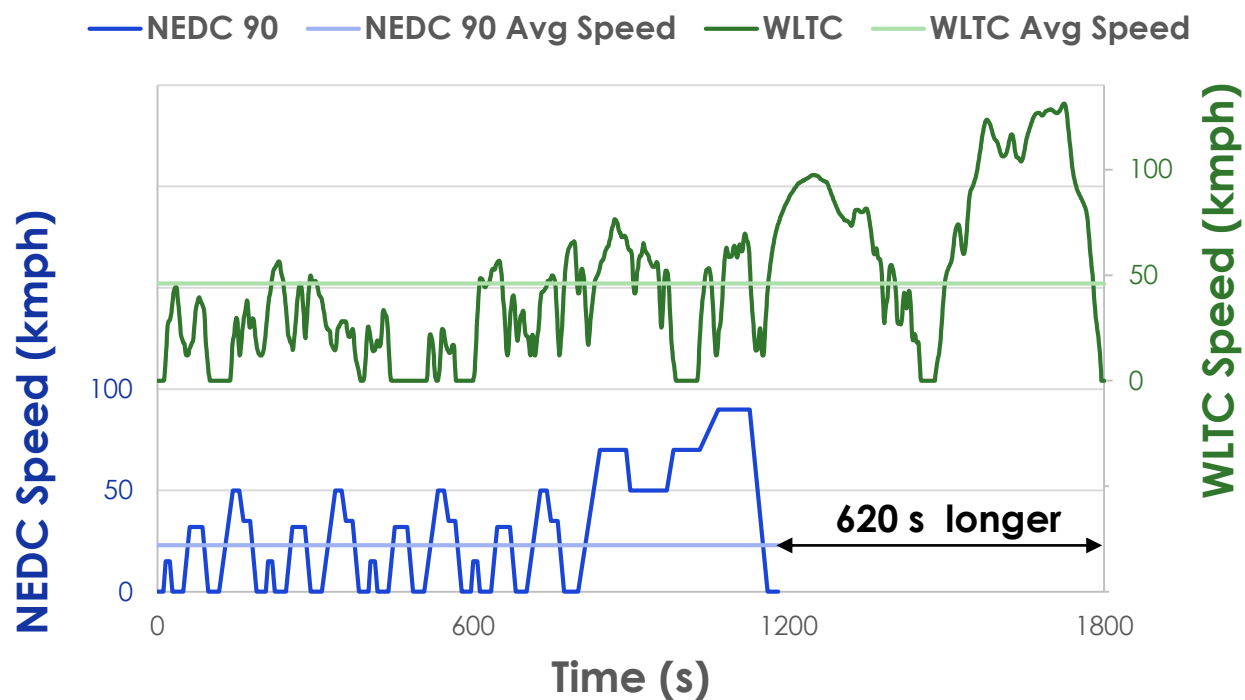
- ❑ Most of the SPN_{23} emissions recorded during the cold start
- ❑ Cold engine requires higher fueling to start and the fuel impingement on the cold surfaces of the piston and walls lead to high SPN formation
- ❑ This count would be significantly higher if the SPN smaller than 23 nm is taken into consideration

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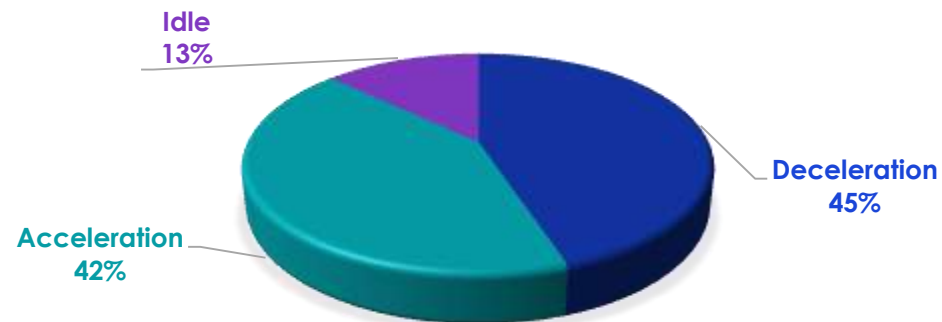


Source : Yang, J., et al. *Environ. Sci. Technol.*, 2018, 52 (5), pp 3275–3284.

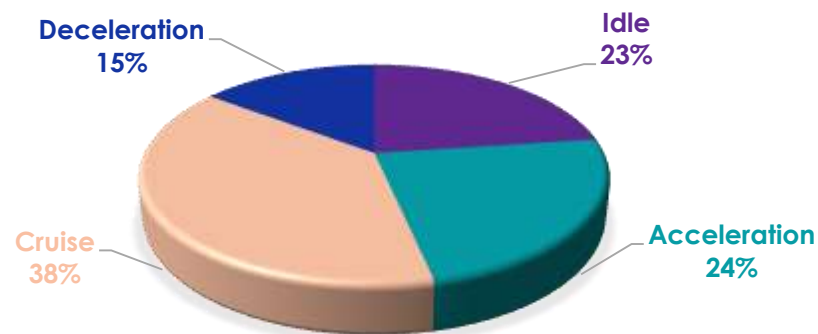
A more dynamic certification cycle



WLTC DRIVE PATTERN



NEDC DRIVE PATTERN



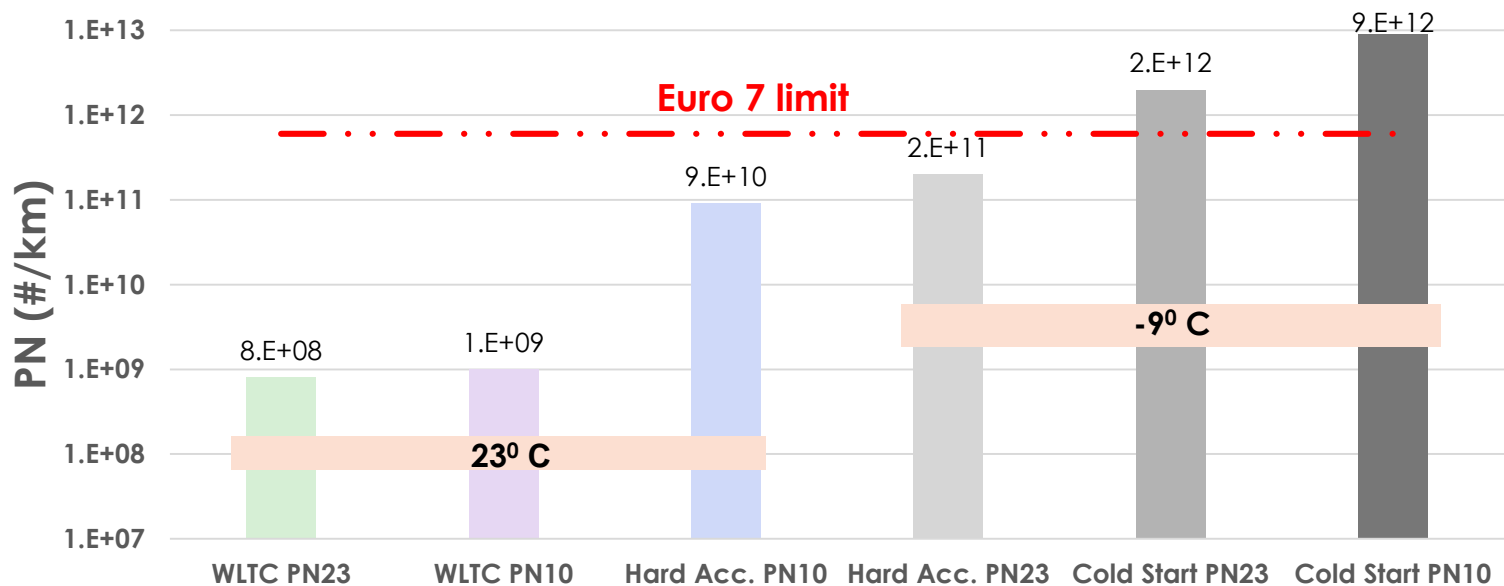
WLTC longer than NEDC 90 by 620 s, with shorter proportion of idling time

Average Speed of WLTC (46 kmph) > Average Speed of NEDC 90 (23 kmph) >>>

Criteria pollutant and GHG emissions are expected to be higher in WLTC as compared to NEDC.

Absence of cruising (steady state points) in WLTC

Cold start poses a further challenge

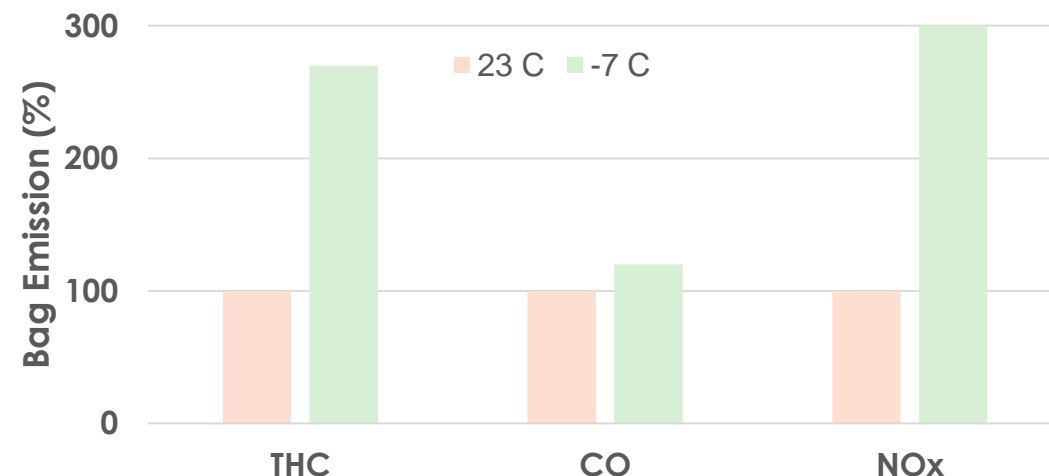


Source : JRC, EU Commission, Catalysts 2022

- ☐ Three factors contribute to rise in SPN
 - a) Operating condition
 - b) Low temperature (cold start)
 - c) Inclusion of sub-23 nm count

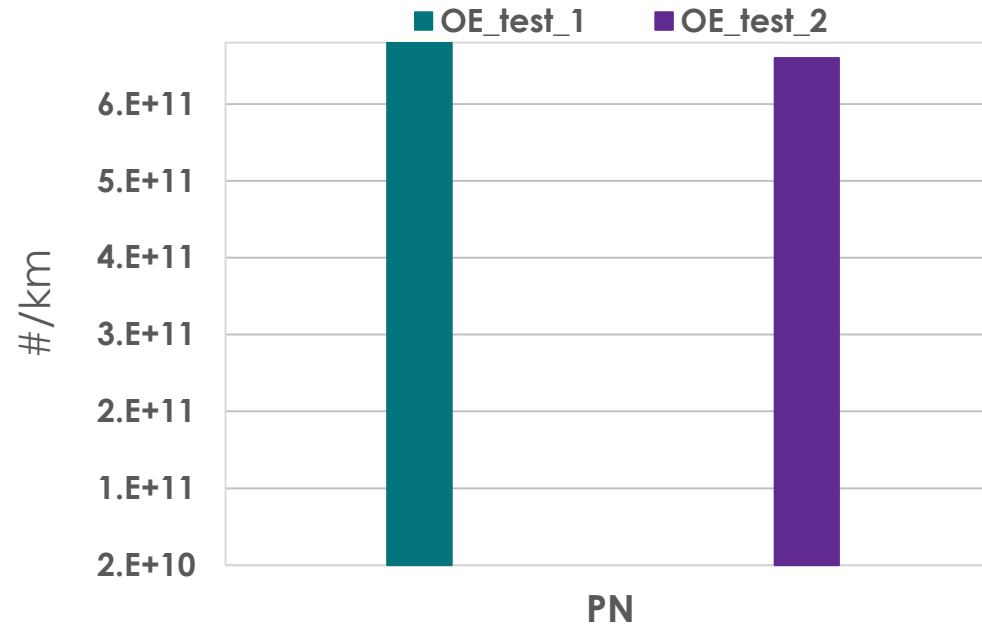
- ☐ Low temperature (cold start) operation requires fuel rich mixtures which when undergo incomplete combustion increase base PN and HC emissions
- ☐ Situation is further worsened as the TWC light off is delayed causing lesser conversion of the HC and NO_x

Gas Emissions



Source : 43rd International Motor Symposium, Vienna 2022

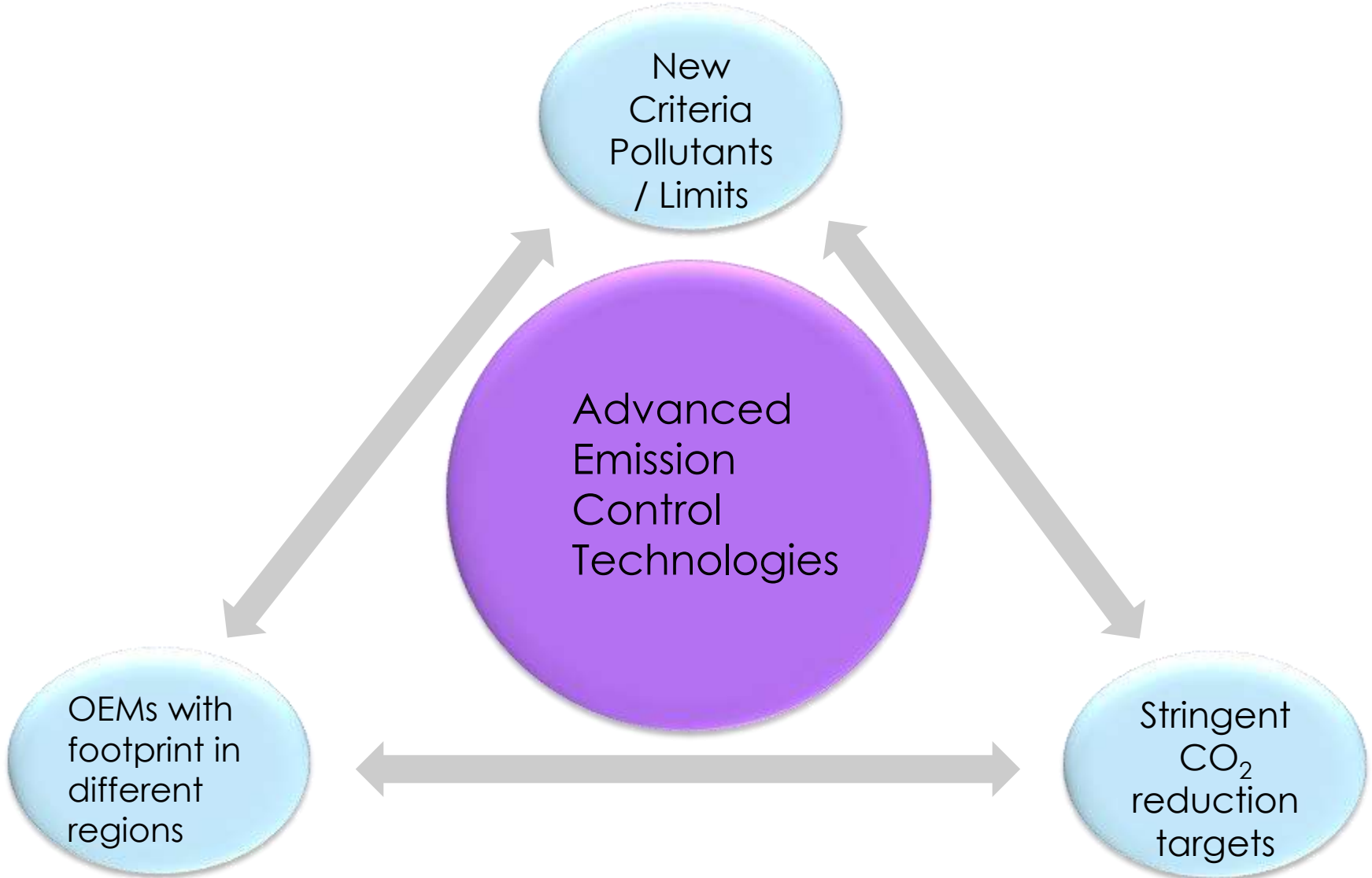
Even 2Wh particulate emissions are high



Source : Aditya Bhimavarapu, SK Singh, Rohit Kataria, Dominik Rose, Thorsten Boger. GPF – An effective technology to minimize 2Wh particulate pollution. SIAT Technical Paper, 2024 – 26 – 140.

- ❑ Figure shows the SPN_{23} measured on a Class 2-1 motorcycle under WMTC test conditions
- ❑ The SPN_{23} count exceeded the BS6.2 PN regulatory limit set for GDI and Diesel powertrains.
- ❑ 2Whs in India do not have a particulate limit currently as they are powered by an MPFI engine.

Need for advanced solutions



Key Takeaways

- ❑ Based on the historical trend of emission regulation in India, BS7 is expected to be close to Euro7 with a few customized clauses specific to Indian driving pattern and climatic conditions.

- ❑ There is a step change in the compliance requirements of Euro7 from what is in force under BS6.2 in India.

- ❑ There is a need to explore advanced emission control solutions to meet the multifaceted challenges of
 - a) new criteria pollutant limits (PN for MPFI),
 - b) compliance under WLTC, RDE with extended boundary conditions, and
 - c) lowering fleet averaged CO₂ requirements

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