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Light Duty Motor Vehicles Emissions Overview - India & Globe

P. S. GOWRISHANKAR
GM & Head - Regulations

13th November 2019

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Regulatory Updates and Dissemination for Light duty vehicles

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2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025

India

Emission Norms – All Models

- BS4 Norms continued up to 31st Mar'20
- BS6 1st Apr'20 MIDC + IRDE IRDE Monitoring, OBD I & Inservice Compliance
- BS6 1st Apr'23 MIDC + IRDE CF: TBD OBD II & IUPR

CO_2/FC

- April 2017 CAFÉ I: 130 g /Km
- April 2022 CAFÉ II: 113 g /Km

Europe

Emission Norms – All Models

- Euro 6b NEDC 1st Sept'15
- Euro 6c 1st Sept'18 WLTP + RDE Monitoring (PN + NOx)
- Euro 6d Temp 1st Sept'19 WLTP + RDE **Temp CF NOx: 2.1** **Temp CF PN: 1.5**
- Euro 6d 1st Jan'21 WLTP + RDE **Final CF NOx: 1.5** **Final CF PN: 1.5**

CO_2/FC

- 130 g /Km
- 95 g /Km – From 2025: 15% reduction

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Detailed Euro 5-6 and BS IV-VI Implementation Roadmap for Light duty vehicles

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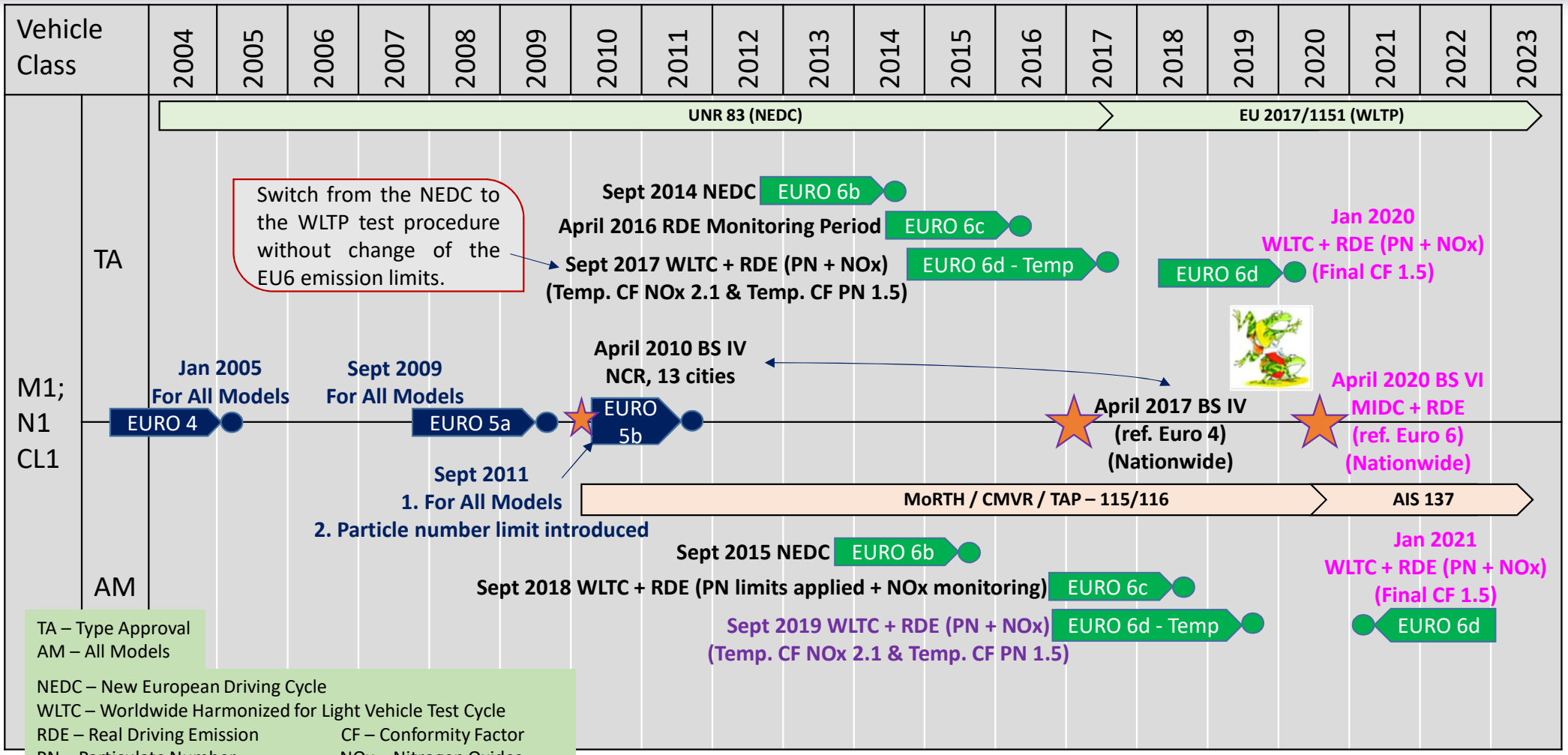

TA – Type Approval
AM – All Models

NEDC – New European Driving Cycle
WLTC – Worldwide Harmonized for Light Vehicle Test Cycle
RDE – Real Driving Emission
CF – Conformity Factor
PN – Particulate Number
NOx – Nitrogen Oxides

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India's Emission Roadmap For Less than 3.5T Vehicles

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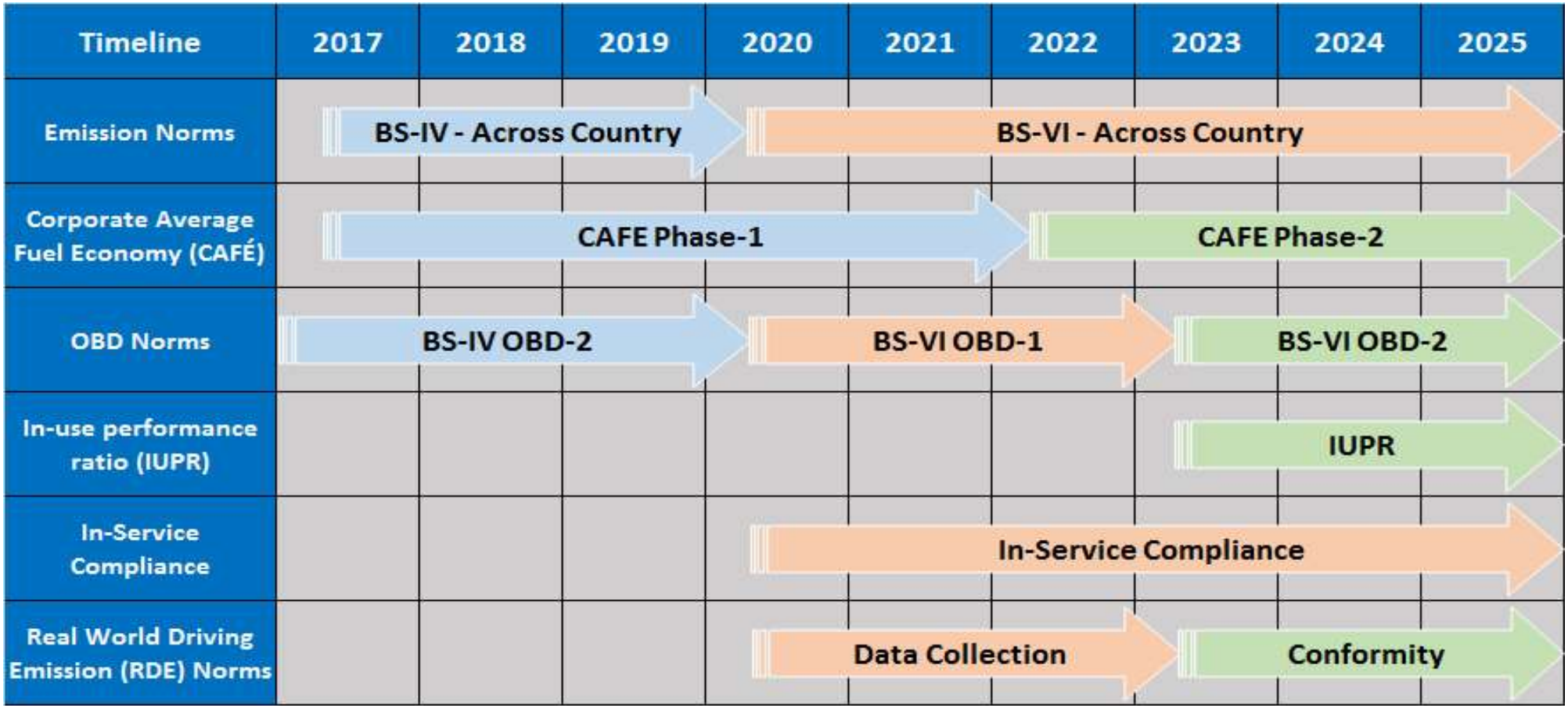

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Introduction for Light duty vehicles standard in Europe

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Euro 5/6
EC 715/2007
(Procedure)

Amendment
EC 692/2008
(Limits)

Amendment
EU 2016/427
Euro 6 RDE Act 1

Euro
6c

Amendment of
EC 692
EU 2016/646
Euro 6 RDE Act 2
(Package 1 & 2)

EU 2017/1154
RDE Act 3
(Package 3)

EU 2018/1832
RDE Act 4
WLTP 2
(Package 4)

Euro
6d

EU 2017/1151
Euro 6d- TEMP, WLTP,
Consolidated version of 1 Jan 2019
(Contain amendments 2017/1154, 2018/1832, 2017/1347)

This regulation will mainly affect
- ✓ Diesel engine calibration and after treatment,
- ✓ PN emission reduction technology and NOx emissions for gasoline vehicles, especially GDI engines.

India is following the same series of standards for BS VI

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Emissions & RDE Packages - Europe

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Euro 6c

- Euro 6b
- OBD Euro 6-2
- E10 and B7 reference fuel : Assessed on regulatory lab test cycle (WLTC cycle)
- Final PN standard for PI vehicles
- **RDE PN (NTE emission limits applied) + RDE NOx testing for monitoring only.**

Euro 6d-Temp

- Euro 6b
- OBD Euro 6-2
- E10 and B7 reference fuel, assessed on regulatory lab test cycle (WLTC cycle)
- Final PN standard for PI vehicles
- **RDE testing against temporary Conformity Factors.**

Euro 6d

- Euro 6b
- OBD Euro 6-2
- E10 and B7 reference fuel, assessed on regulatory lab test cycle (WLTC cycle)
- Final PN standard for PI vehicles
- **RDE testing against final Conformity Factors.**

WLTC – Worldwide Harmonized for Light Vehicle Test Cycle
RDE – Real Driving Emission
CF – Conformity Factor
PN – Particulate Number
NOx – Nitrogen Oxides
PI – Positive Ignition Engines (Petrol/SI Engines)
NTE – Not To Exceed

Lab test cycle is NEDC, it shall be replaced by WLTC with the introduction of Euro 6d-Temp

The Real Driving Emission (RDE) test procedure is introduced in 3 phases.

- First a monitoring period starting in April 2016 on new type vehicles.
- Followed by a period with application of temporary conformity factors (Euro 6d-Temp).
- Then with application of final conformity factors (Euro 6d).

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Emissions & RDE Packages - Europe

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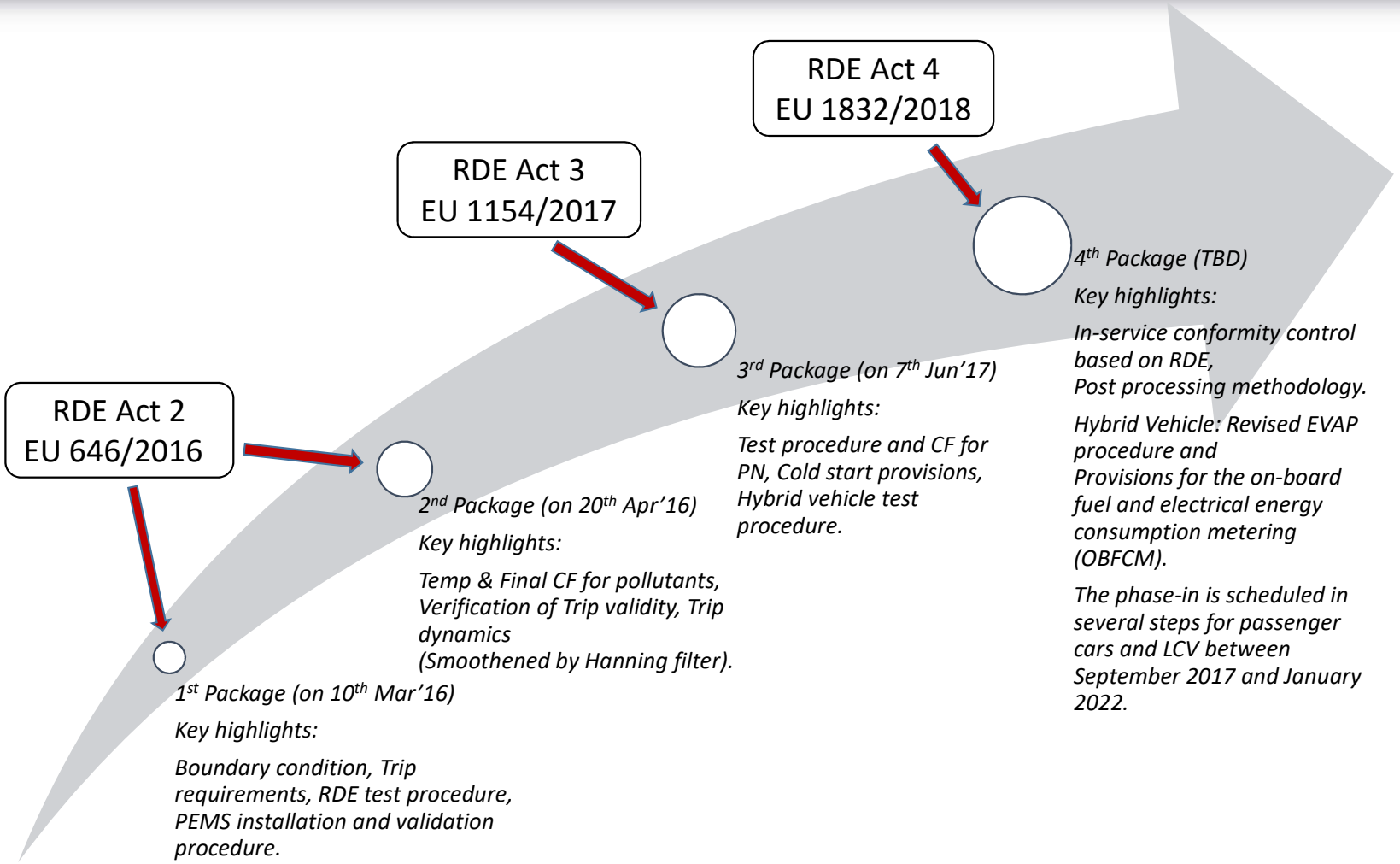

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IRDE - Indian Real Driving Emissions

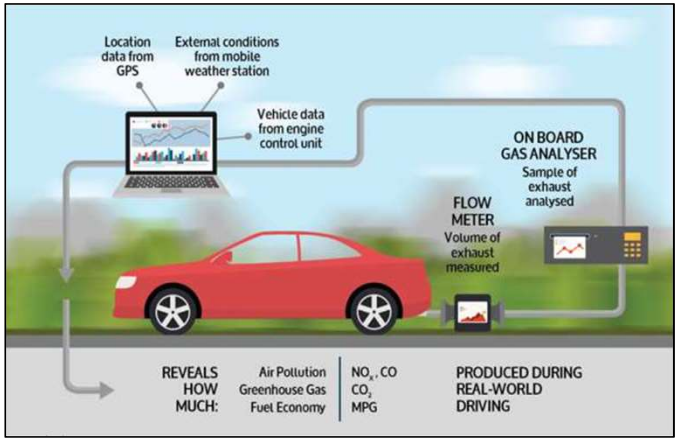
March 2017- June 2019:

- Basic Study.
- Data Collection & Evaluation.
- Analysis & Test Procedures
- Validation.
- Trip Dynamics.
- Post Processing.
- Final Test procedure.

Final IRDE TAP document has been released on August 2019.

Future course of actions include work on :

- PEMS uncertainty.
- Low and pulsated Exhaust Flow Rate.
- Effect of Temperature on Analyser Accuracy.
- PEMS Make variation.



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Exhaust Pollutants for Compression Ignition Engines - Reduction from BS IV to BS VI

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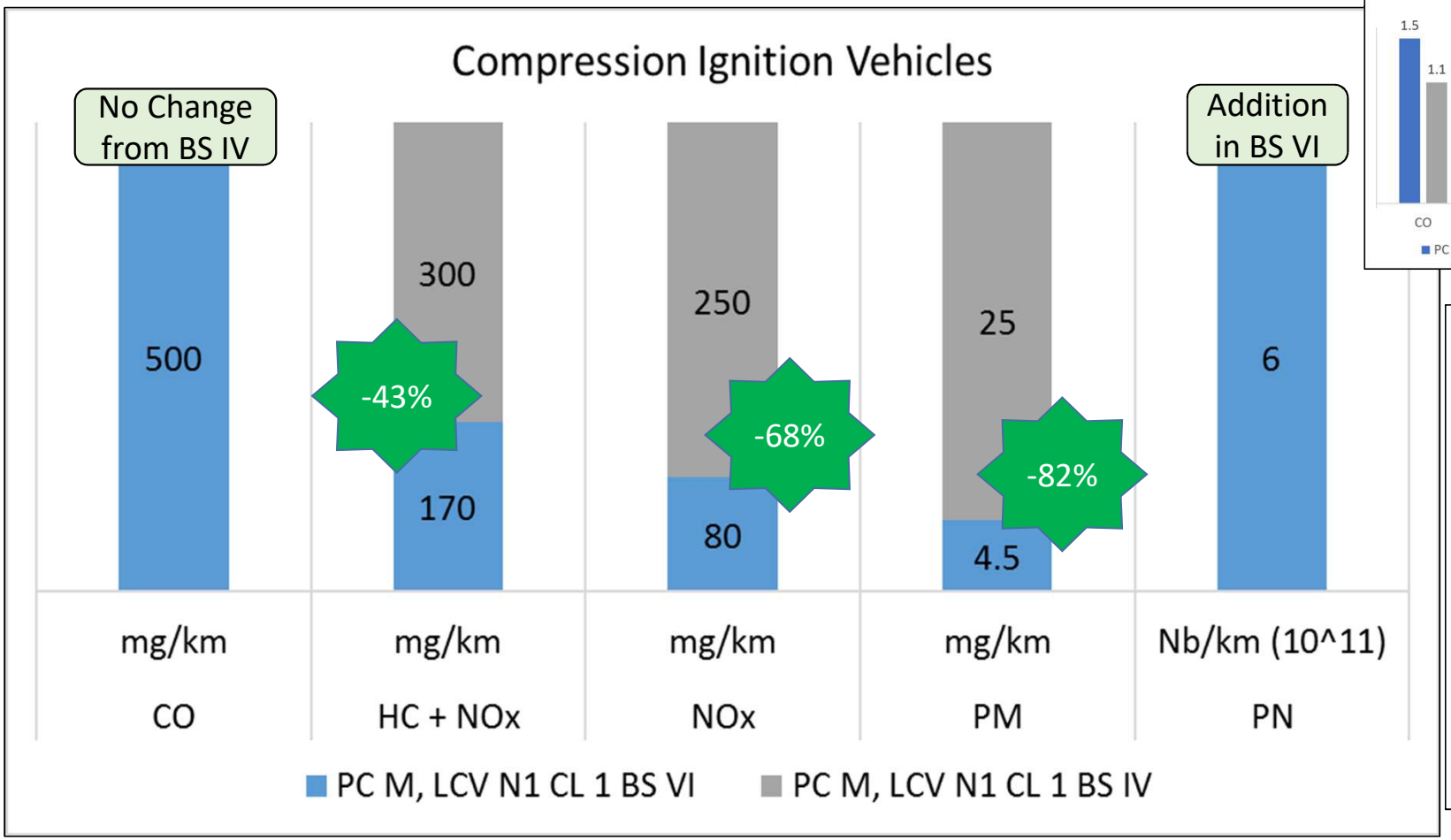

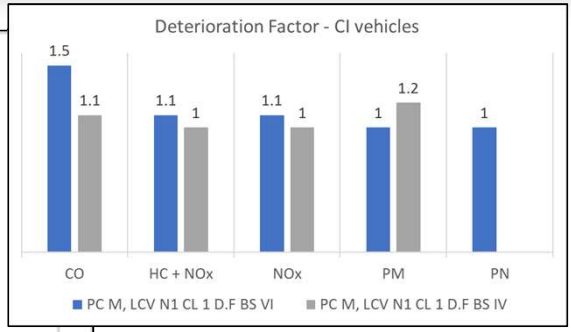

- BS6 for CI Engines mainly focus on stringency of NOx and PM pollutants.
- The pollutants which has reduction from BS4 to BS6 are as follows:
  - HC+NOx: 43%
  - NOx: 68%
  - PM: 82%
- Addition of Particulate Number, PN in BS6.
- CO remains unchanged in BS4 and BS6 standard.

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Exhaust Pollutants for Spark Ignition Engines - Reduction from BS IV to BS VI

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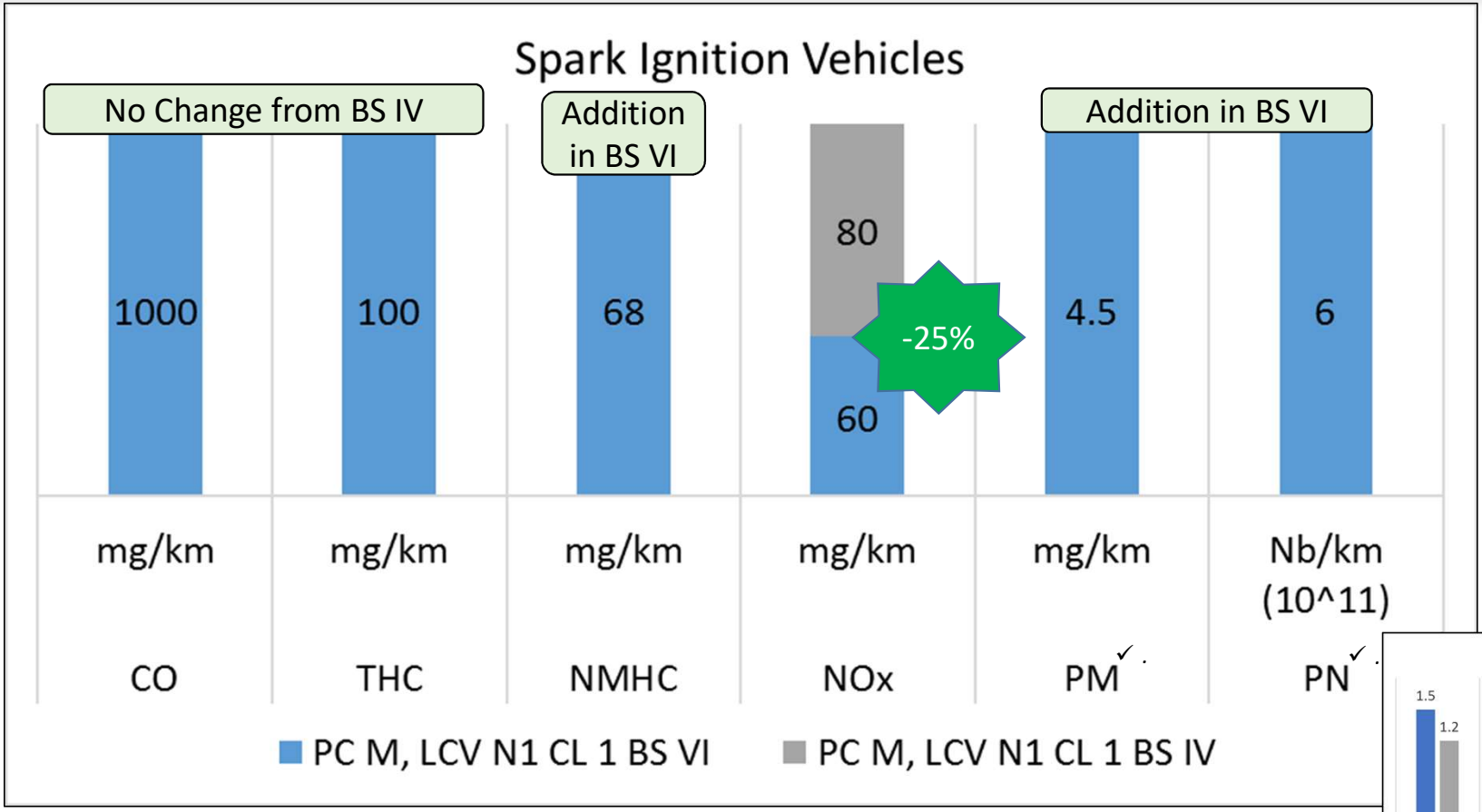
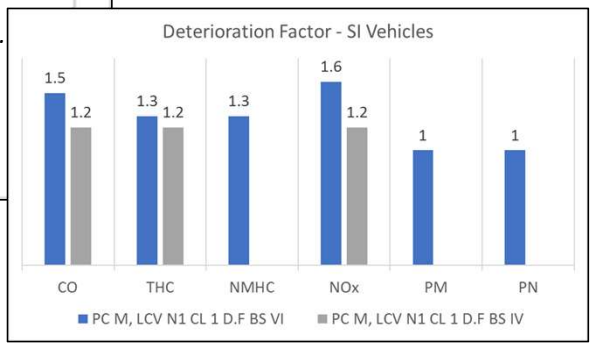


- BS6 for SI Engines mainly focus on stringency of NOx pollutants.
- The pollutants which has reduction from BS4 to BS6 are as follows:
  - NOx: 25%
- Addition of Non-Methane Hydrocarbon, NMHC Particular Matter, PM & Particulate Number, PN in BS6.
- CO & THC remains unchanged in BS4 and BS6 standard.



✓ *For positive ignition, particulate mass and number of particles limit shall apply only to vehicles with direct injection engines.*

✓ *Until three years after date of implementation for new type approvals and new vehicles, particle number emission limit of 6.0 X 10^{12} /km shall apply to BS VI gasoline direct injection vehicles upon choice of the manufacturer.*

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OBD Emission Standards - Compression Ignition Engines Reduction from BS IV to BS VI

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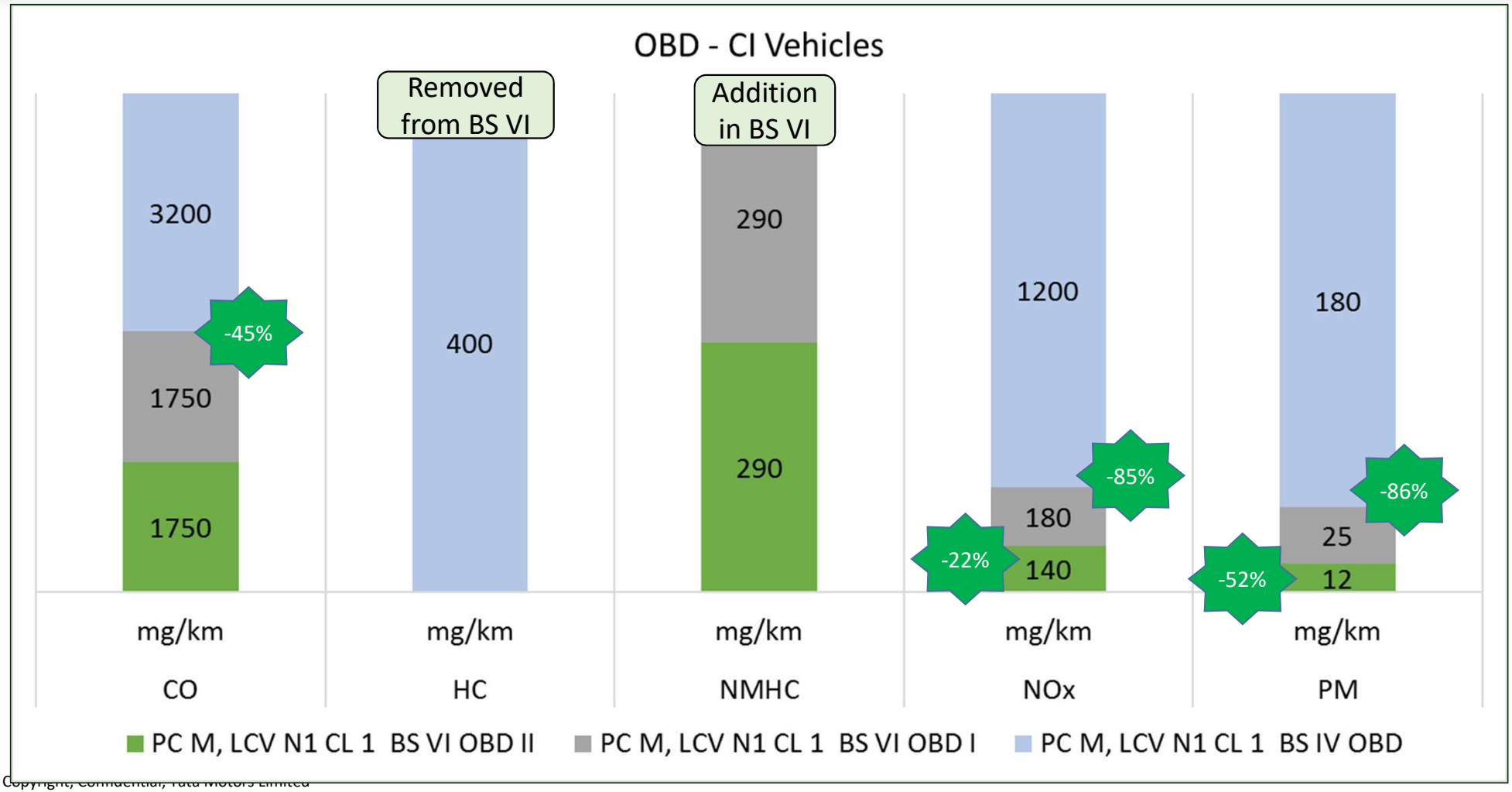

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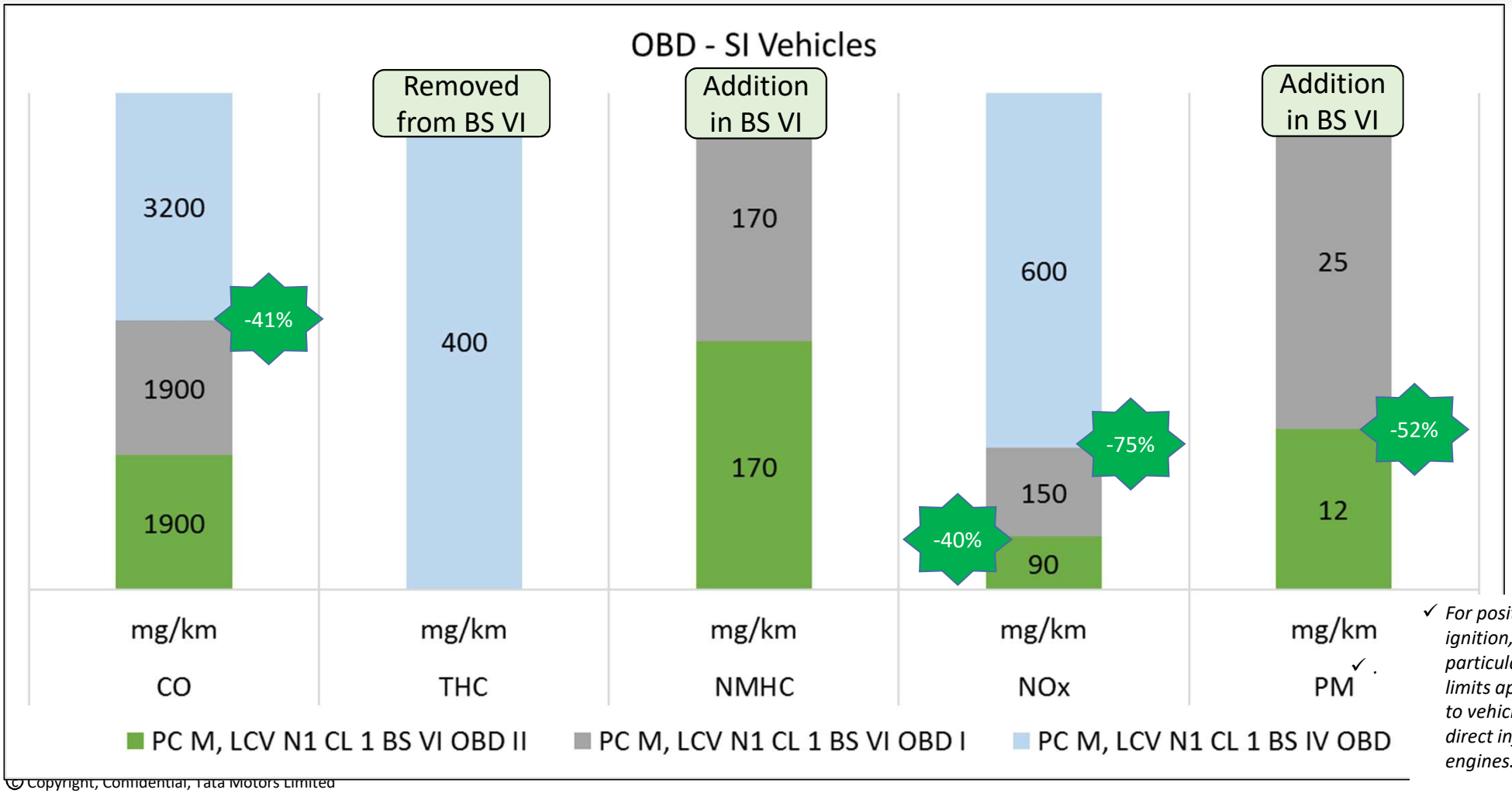
OBD Emission Standards – Spark Ignition Engines Reduction from BS IV to BS VI

TATA



✓ *For positive ignition, particulate mass limits apply only to vehicles with direct injection engines.*

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Main UN agreements driving the EU CO2 Emission Policy

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United Nations Framework Convention on Climate Change 1992

Agreement of cooperation and reporting, installation of regular conferences.

Decision making through Conference of the Parties (COP)

Phase 1: 2008 - 2012

Phase 2: 2013 - 2020

Kyoto Protocol 1998

COP 3

India ratifies phase 2 on 08th Aug 2017

Paris Agreement 2015

Target: 2021 – 2030

The Paris Agreement replaces the approach taken under the 1997 Kyoto Protocol.

Objective: Global temperature increase well below to 2°C to keep it to 1.5°C above pre-industrial levels.

Greenhouse Gas Emission reductions.

As per the Kyoto protocol: European Union

Phase 1 (2008 – 2012): 8% reduction target compared to 1990

Phase 2 (2013 – 2020): 20% reduction target compared to 1990

Paris Agreement to a GHG reduction target (2021 – 2030): 40% reduction target compared to 1990

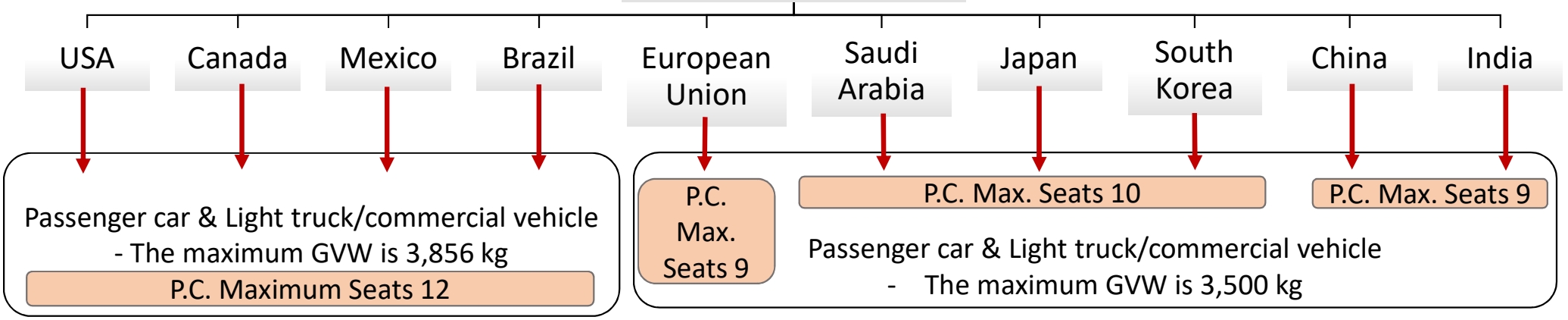
For 2050 the European Union set itself a target of Net-Zero Greenhouse Gas Emissions

The evolution of the CO2 regulation remains the main driver for changes in vehicle technology.

M1 category CAFE around the World

CAFE – Corporate Average Fuel Economy

CAFÉ
(Fuel Economy or GHG emission standards for LDVs.)



ICCT: LDV GREENHOUSE GAS AND FUEL ECONOMY STANDARDS: 2017 GLOBAL UPDATE

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Light duty vehicles - Europe & India CO2 emissions target

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European CO2 emissions target for 2020/2021

P.C.: EU 333/2014
Target: 95 gCO2/km

LCV: EU 253/2014
Target: 147 gCO2/km

NEDC test procedure

NEDC 2020-2021

WLTP EU 2017/1151

The CO2 emissions measured using the WLTP must be converted to a NEDC basis until 2020 to be compared to the CO2 emission target values defined for the NEDC (130 gCO2/km until 2019 and 95 gCO2/km starting 2020).

CO2 reduction target for 2025 compared to 2021 for passenger cars and LCV is **15%** .

For 2030 the targets compared to the 2021 baseline are **-37.5%** for passenger cars and **-31%** for LCV.

CO2 emission targets for 2025 and 2030

Indian CO2 emissions target for 2022 to Passenger Cars – GVW not exceeding 3500Kg issued notification on 23rd April 2015

Ministry of Power Notification

S.O.1072(E)

G.S.R. 954(E) on 4th October, 2016

G.S.R 1461(E) on 27th November, 2017.

MoRTH has adopted this procedure under CMVR, 1989 vide notification number as stated.

MoRTH/CMVR/ TAP-115/116: Issue No.: 4 AMENDMENT No. 7

CO2 Emission target:
2017: 130 gm/km
2022: 113gm/km

CO2 emission targets

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Overview of regulation specifications for passenger cars

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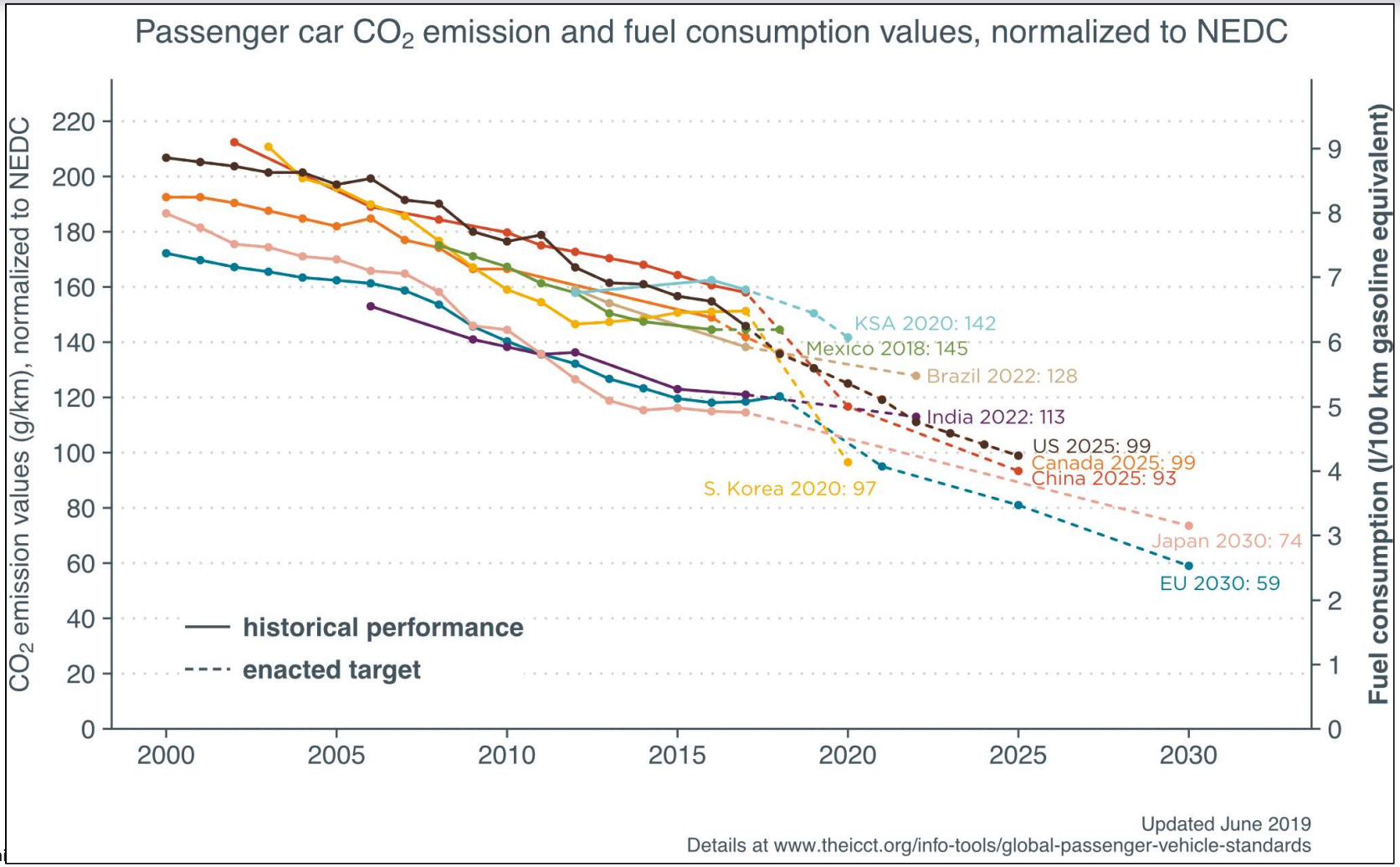
EU 2021 PV Standard	India 2022 PV CAFÉ Standard
NEDC Equivalent – 95 gm/km	MIDC – 113 gm/km
WLTC Equivalent – 108.8 gm/km	
JCO8 Equivalent – 87.3 gm/km	

Source: ICCT 2016



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CAFE Norms for M1 Category (< 3.5T GVW)

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CAFE
Corporate Average Fuel Economy

- MoP & MoRTH notified fuel efficiency norms
- Norms applicable to M1 category vehicles <3.5T GVW
- Compliance to norms on basis of manufacturers weighted avg. performance
- Implementation to be done by MoRTH through iCAT as a nodal agency
- FE TAP Document for CAFÉ implementation has been released

FY 2017-18
Phase I

130 gCO2/km @ 1037 kg average kerb mass

FY 2022-23
Phase II

113 gCO2/km @ 1145 kg average kerb mass

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CAFE Norms for M1 Category (< 3.5T GVW)

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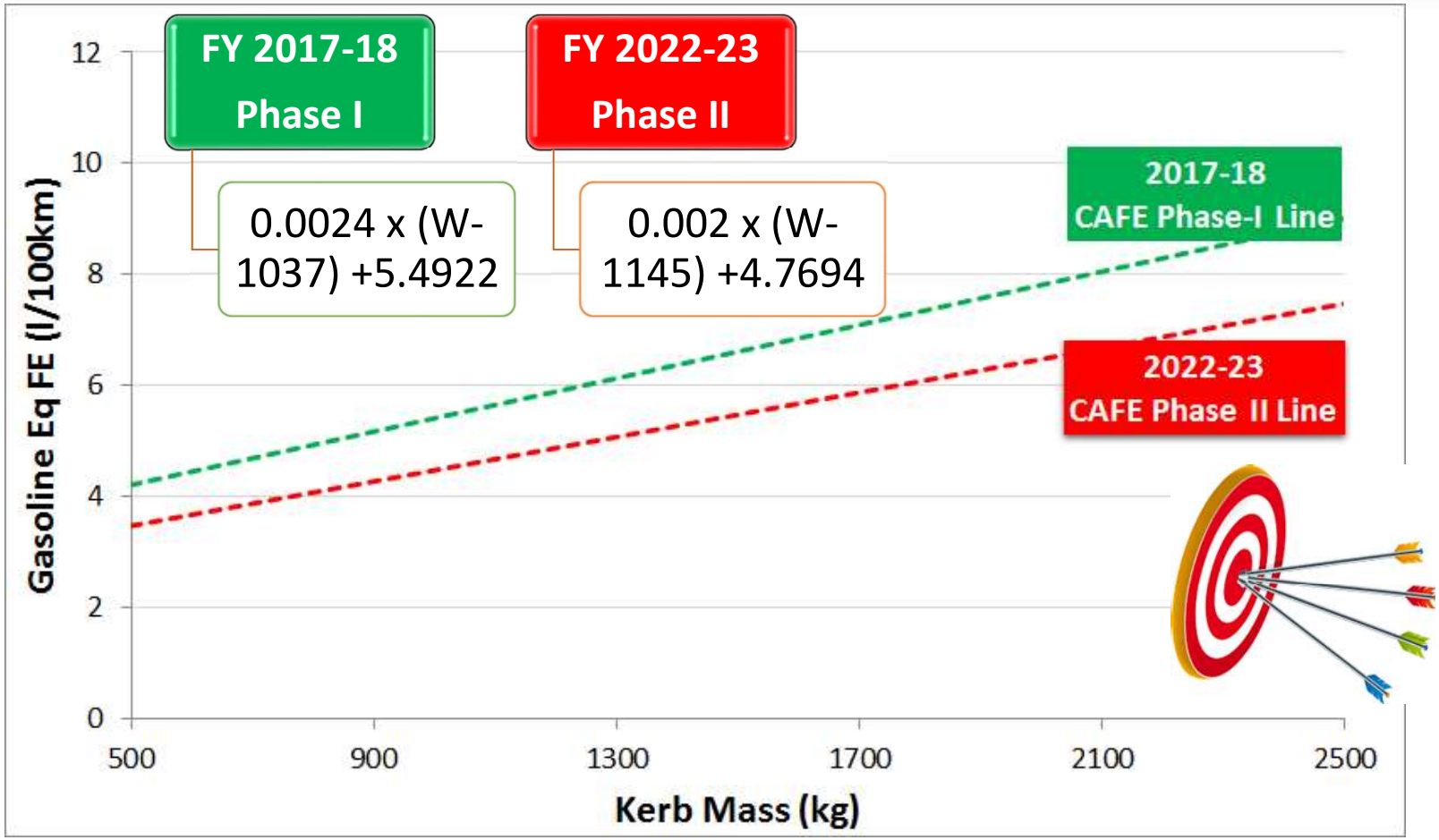

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Overview of technologies for reducing CO2 emissions

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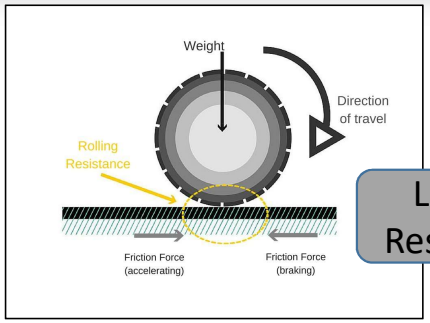
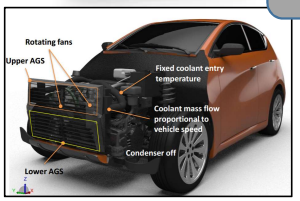
Start – Stop System

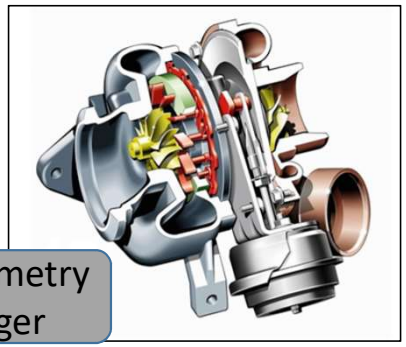


Low Rolling Resistance Tire

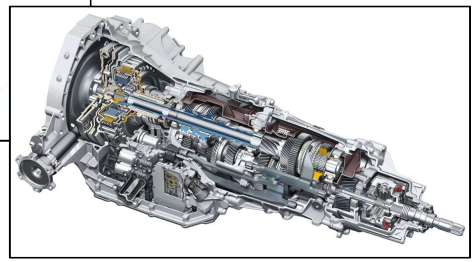
Energy Efficient Lights

Active Grille Shutter



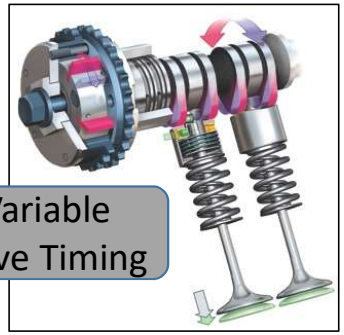


Variable Geometry Turbocharger

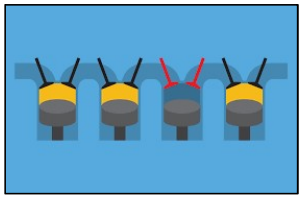


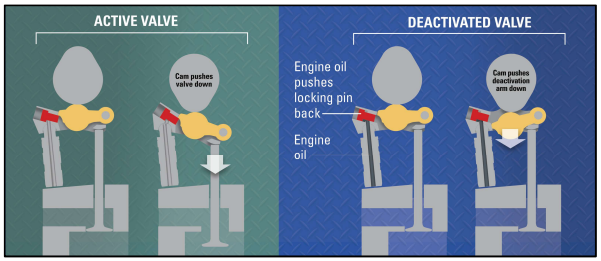
6-speed/CVT/dual-clutch transmission

Tire Pressure Monitoring System



Variable Valve Timing





Cylinder Deactivation

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Overview of technologies for reducing CO2 emissions

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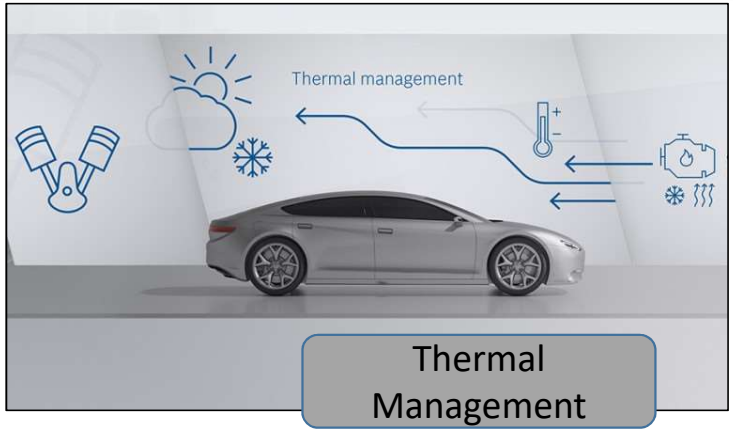
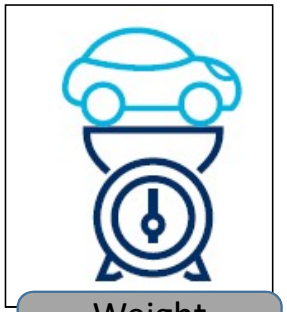
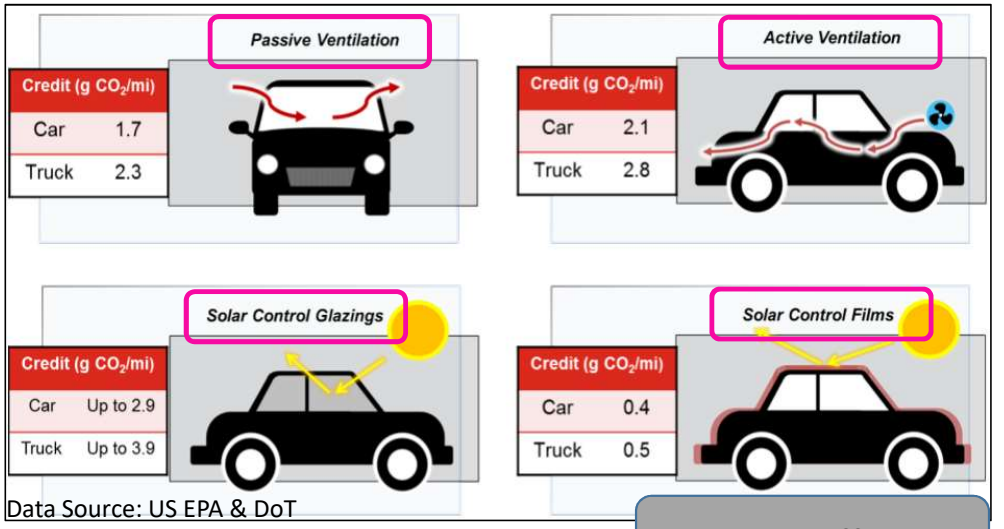


Thermal Management



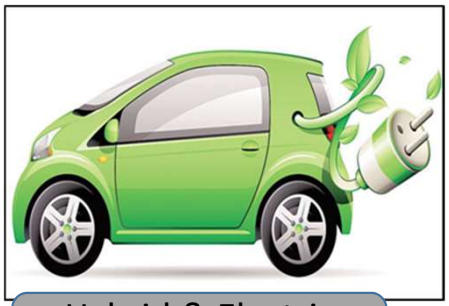
Weight Reduction



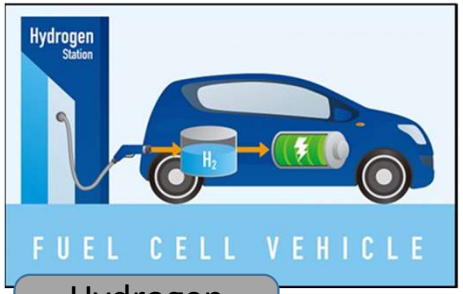
Data Source: US EPA & DoT

Thermal Off-Cycle

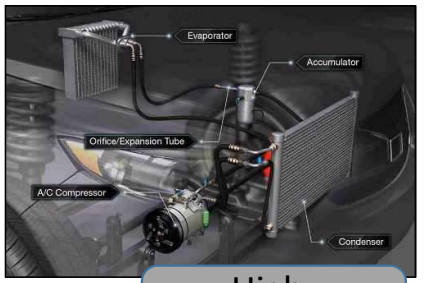
Gear-Shift Indicator



Hybrid & Electric Powertrains



Hydrogen Fuel Cell



High-efficiency A/C

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Type Approval Europe and India

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Test	Europe	India
Type I	Tailpipe Emissions	Tailpipe Emissions
Type II	CO emission test at idling speed for Gasoline Free acceleration smoke for Diesel	CO emission test at idling speed for Gasoline Free acceleration smoke for Diesel
Type III	Crankcase gases emissions	Crankcase gases emissions
Type IV	Evaporative emissions	Evaporative emissions
Type V	Durability of anti-pollution devices	Durability of anti-pollution devices
Type VI	Low temperature test	-
Type VII	On-board diagnostics	On-board diagnostics
	RDE – Real Driving Emissions	RDE – Real Driving Emissions

- ECE regulations are similar to EU regulations. A base regulation is updated with a consecutive series of amendments.
- The series of ECE-R-83 regulations reflects the Euro 1-6 regulations.

- INDIA follows the same strategy as per ECE regulations for TA test.
- TAP 115/116 regulations reflects the BS I - IV regulations. (Euro 1-5)
- AIS 137 regulations reflects the BS VI regulations. (Euro 6)
- As India comes under Tropical region, where average temperature falls around 24◦ C, the Type VI test of Low temperature is not performed.

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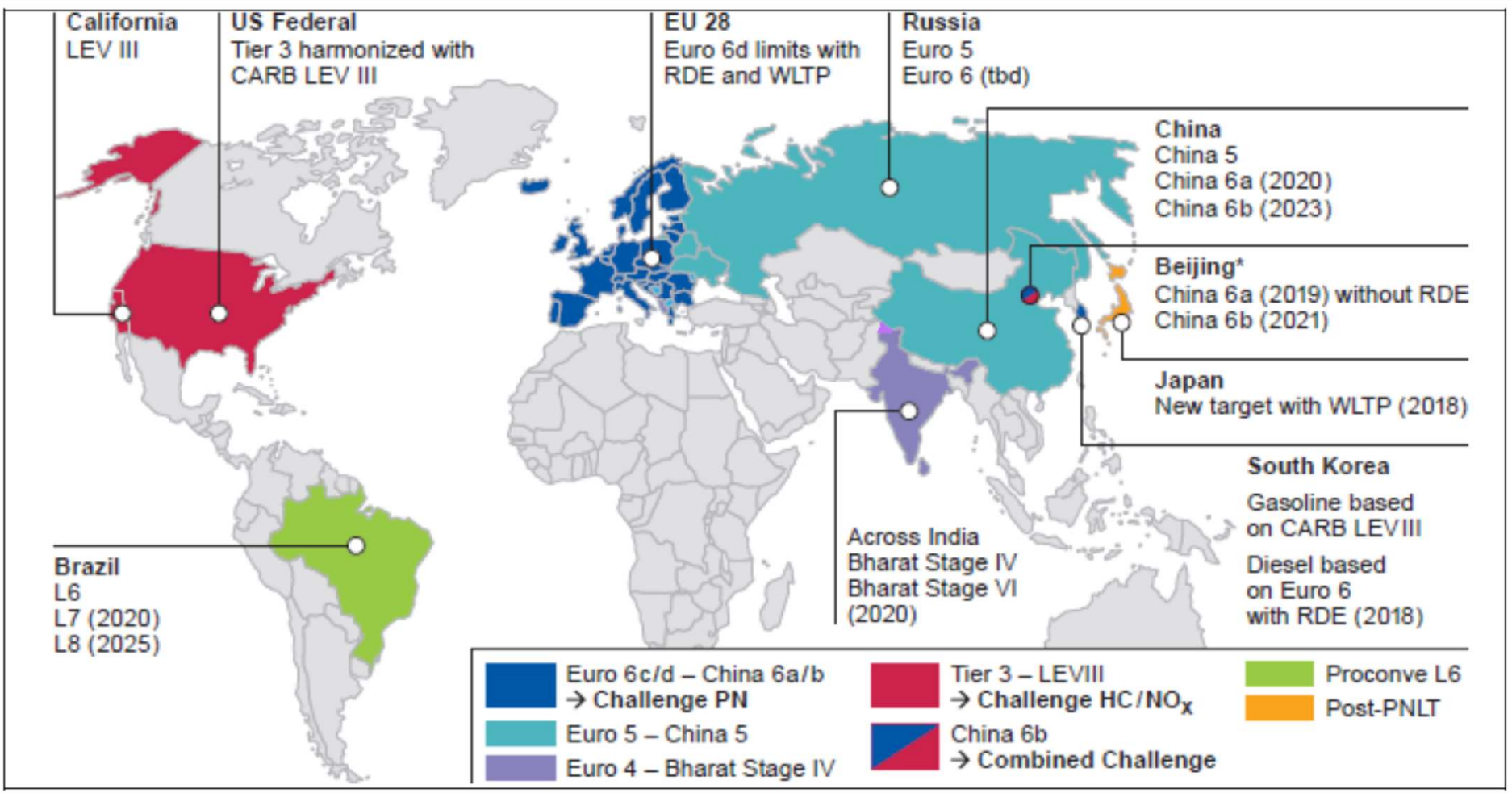
Emission Certification Cycles - Global Scenario



Source: Continental Emission Booklet

Likely Way Forward

Limits	• Introduce fuel- and technology-neutral emission limits • Tighten the emission limits to harmonize with other markets • Introduce application-neutral emission limits
Ultrafine particles	• Lower the size cutoff for particle counting from 23 nm to at least 10 nm • Develop a methodology to measure volatile and semi-volatile particles • Include emissions that occur during filter regeneration • Make particulate number (PN) standards fuel- and technology-neutral • Investigate the feasibility of PN tailpipe measurements
Unregulated pollutants	• Set limits for ammonia emissions • Set limits for CH_4 and N_2O emissions and account for them in the CO_2 standards • Set limits for aldehyde emissions • Regulate all VOCs and not just HC. • Set emission limits for brake wear particles • Consider limits for NO_2 emissions

Source: ICCT

Thank You!!!

❖ Vehicle Scope.		
• M1 & M2 N1 & N2	Defined in Directive 2018/858 and EU 715/2007	Reference Mass ≤ 2610 kg
• Extension possible at the manufacturer's request to M1,M2,N1 & N2.		Reference Mass ≤ 2840 kg

Category	Description	Sub - Category	Number of persons	Mass limit	
M	Carriage of passengers, min 4 wheels Passenger Cars	M1	Up to 9		
		M2	>9	GVW ≤ 5000 kg	
		M3		GVW > 5000 kg	
N	Carriage of goods, min 4 wheels, LCV	N1 CL1	N.A.	GVW ≤ 3500 kg	RM ≤ 1305 kg
		N1 CL 2			1305 kg < RM ≤ 1760 kg
		N1 CL 3			1760 kg < RM ≤ 3500 kg
		N2		3500 kg < GVW ≤ 12000 kg	
		N3		GVW > 12000 kg	

❖ Until Euro 4 & BS IV: Two subgroups: M1 w/ GVW ≤ 2500 kg and M1 with 2500 kg < GVW ≤ 3500 kg.