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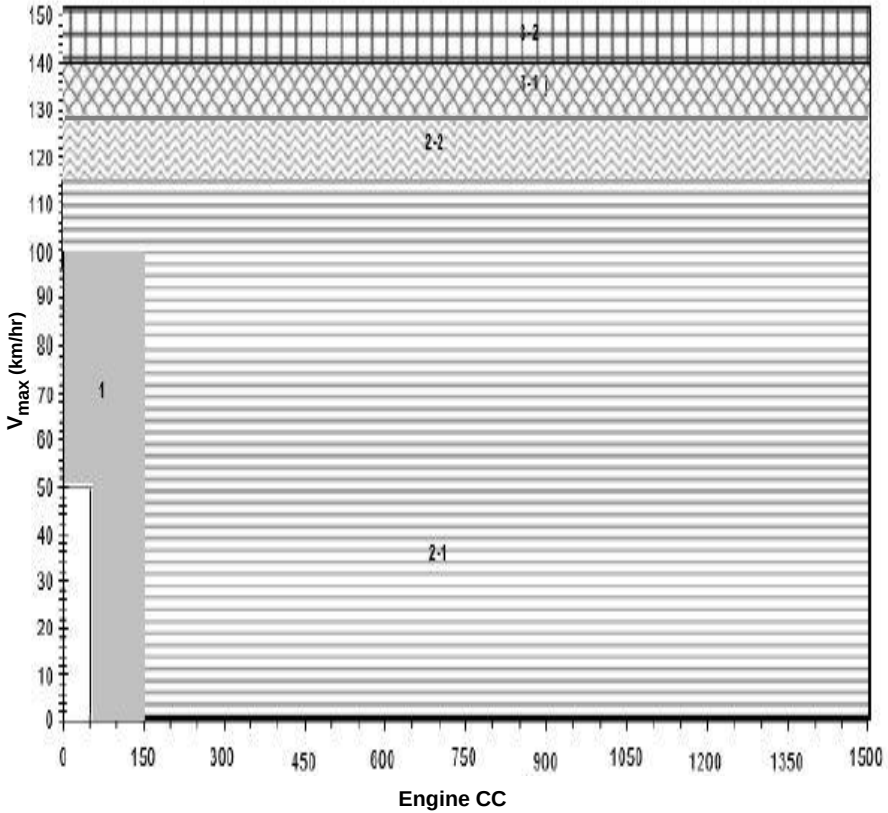
ECT 2017

2 & 3 Wheelers
BSVI Challenges

2W-BS IV & BS VI Emission Limits

2W-Classification



WMTC Class	Criteria
Class 1	50 cm³ < Engine CC < 150 cm³ and Vmax ≤ 50 km/h. or Engine CC < 150 cm³ and 50 km/h < Vmax < 100 km/h.
Sub Class 2.1	Engine CC < 150 cm³ and 100 km/h ≤ Vmax < 115 km/h. or Engine CC ≥ 150 cm³ and Vmax < 115 km/h
Sub Class 2.2	115 km/h ≤ Vmax < 130 km/h
Sub Class 3.1	130 km/h ≤ Vmax < 140 km/h
Sub Class 3.2	Vmax ≥ 140 km/h

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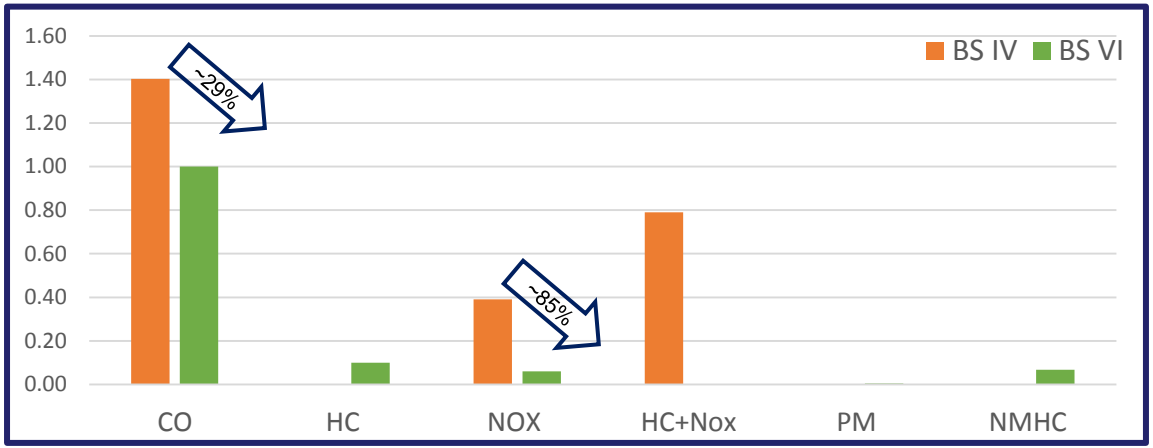
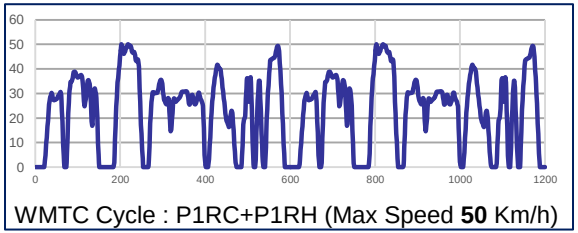
BS IV & BS VI mass emission norms comparison for 2 wheelers

Class 1 & 2.1

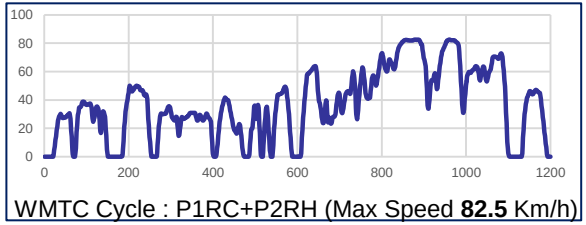


Pollutants	BS IV	BS VI
CO (g/km)	1.403	1.0
HC (g/km)	-	0.10
NOX (g/km)	0.39	0.06
HC+NOx(g/km)	0.79* / 0.59**	-
PM (g/km)	-	0.0045#
NMHC (g/km)	-	0.068

Class 1 Test Cycle →



Class 2.1 Test Cycle (BS VI) $ →



Notes:

* If the evaporative emission complies with 2 g/test

** If the evaporative emission complies with 6 g/test

\# Applicable to Gasoline direct Injection (PI) engines only

\- Respective DF applicable

$ **For BS IV WMTC cycle of Class 2.1 is same as class 1**

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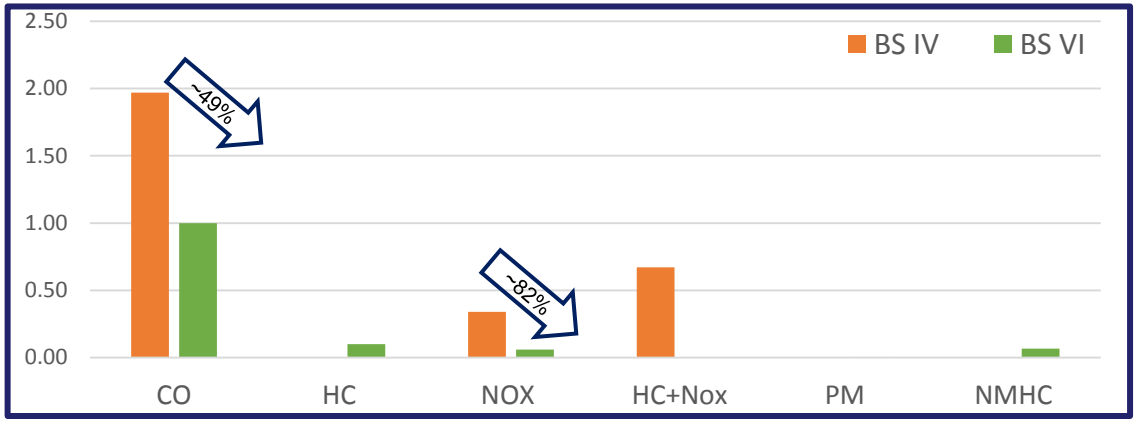
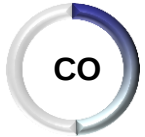
BS IV & BS VI mass emission norms comparison for 2 wheelers

Class 2.2





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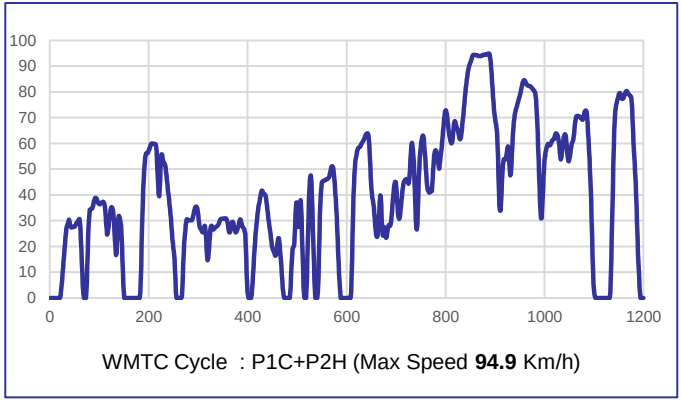
Pollutants	BS IV	BS VI
CO (g/km)	1.97	1.0
HC (g/km)	-	0.10
NOX (g/km)	0.34	0.06
HC+NOx(g/km)	0.67* / 0.47**	-
PM (g/km)	-	0.0045#
NMHC (g/km)	-	0.068

Class 2.2
Test Cycle



Notes:
* If the evaporative emission complies with 2 g/test
** If the evaporative emission complies with 6 g/test
# Applicable to Gasoline direct Injection (PI) engines only
- Respective DF applicable

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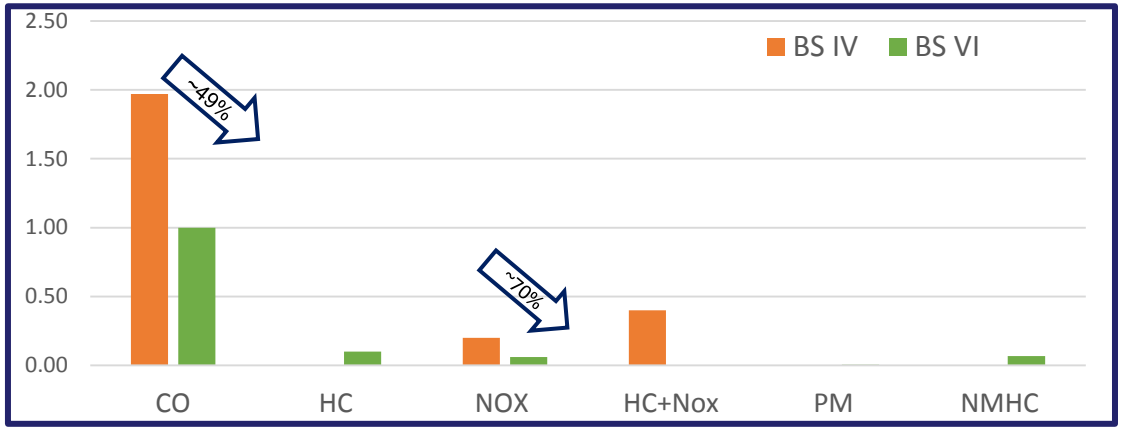
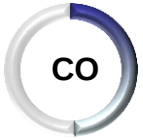
BS IV & BS VI mass emission norms comparison for 2 wheelers

Class 3.1 & 3.2





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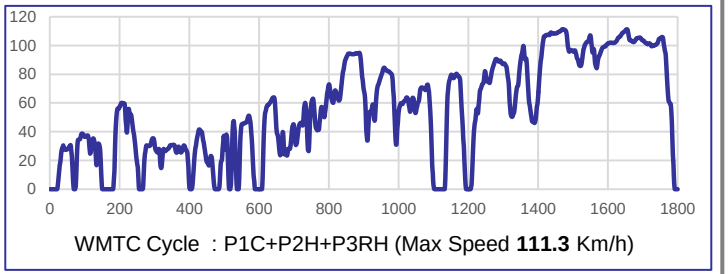
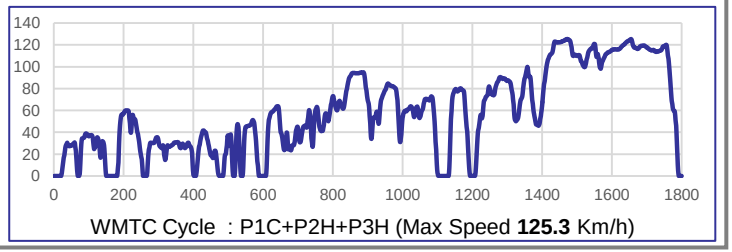
Pollutants	BS IV	BS VI
CO (g/km)	1.97	1.0
HC (g/km)	-	0.10
NOX (g/km)	0.20	0.06
HC+NOx(g/km)	0.40* / 0.20**	-
PM (g/km)	-	0.0045#
NMHC (g/km)	-	0.068

Notes:
*If the evaporative emission complies with 2 g/test
** If the evaporative emission complies with 6 g/test
# Applicable to Gasoline direct Injection (PI) engines only
- Respective DF applicable

Class 3.1 Test Cycle →



Class 3.2 Test Cycle →



BS IV & BS VI Other emission norms comparison for 2 wheelers

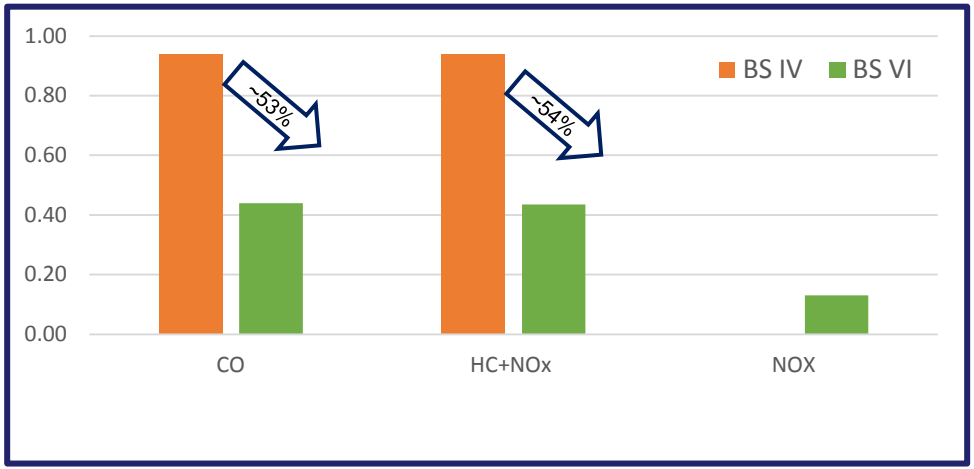
Type Of test	BS IV	BS VI
Evaporative emission (SHED) test (Gasoline)	2.0 g/test OR 6.0 g/test as opted by manufacturer	1.5 g/test (Fixed DF 0.3 applicable)
OBD	Not Applicable	OBD I (From 1st Apr'2020) OBD II (From 1st Apr'2023) OBD II includes OTL IUPRM min 0.1 with OBD II

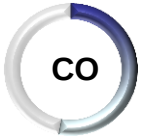
OBD Requirement :

Monitoring Items	OBD I	OBD II
Circuit continuity for all emission related power train component	√	√
Distance travelled since MIL (Malfunction indicator lamp) ON	√	√
Electrical disconnection of Electronic evaporative purge control device	√	√
Catalytic converter monitoring	X	√
EGR system monitoring	√	√
Misfire detection	X	√
Oxygen sensor deterioration	X	√

3W-BS IV & BS VI Emission Limits

BS IV & BS VI mass emission norms comparison for 3 wheelers





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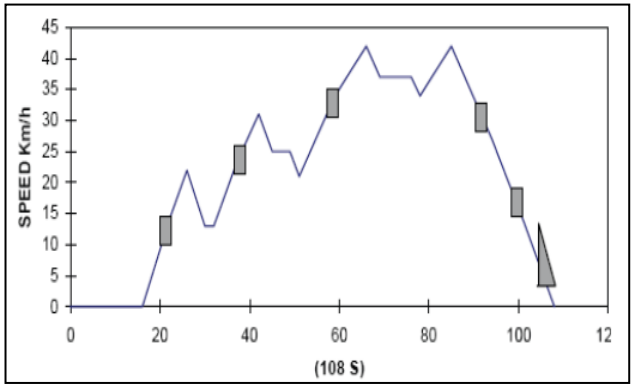
Pollutants	BS IV	BS VI
CO (g/km)	0.94	0.44
HC+NOx (g/km)	0.94* /0.74**	0.435
NOX (g/km)	-	0.13

Notes:
* If the evaporative emission complies with 2 g/test
** If the evaporative emission complies with 6 g/test
\- Respective DF applicable



Indian Driving Cycle Applicable for 3W BS IV & BS VI

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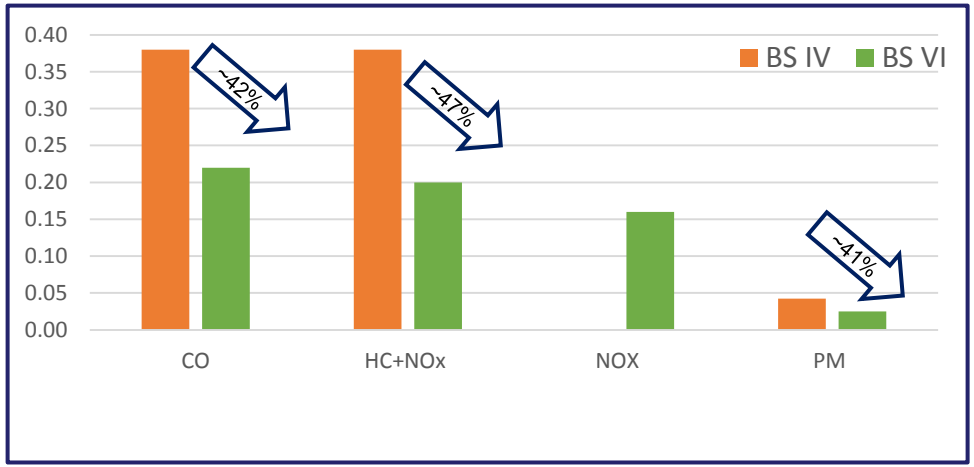
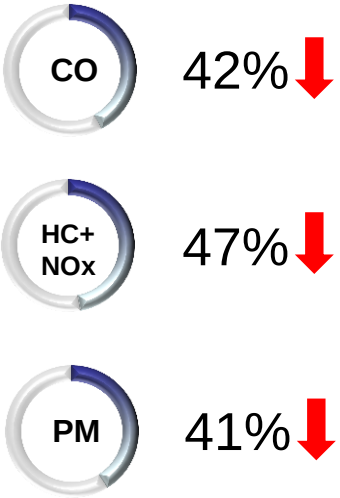
BS IV & BS VI mass emission norms comparison for 3 wheelers

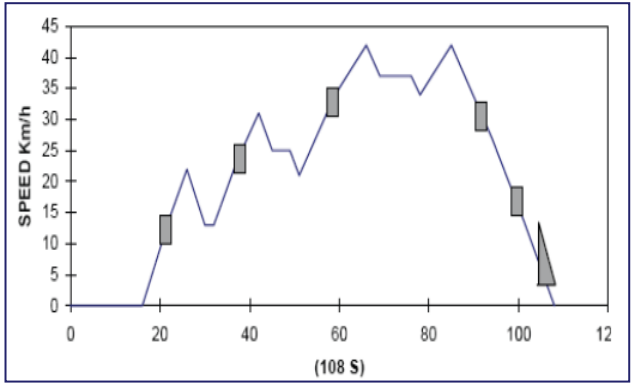
CI





Pollutants	BS IV	BS VI
CO (g/km)	0.38	0.22
HC+NOx (g/km)	0.38	0.20
NOX (g/km)	-	0.16
PM (g/km)	0.0425	0.025

Notes:
- Respective DF applicable



Indian Driving Cycle Applicable for 3W BS IV & BS VI

BS IV & BS VI Other emission norms comparison for 3 wheelers

Type Of test	BS IV	BS VI
Evaporative emission (SHED) test (Gasoline)	2.0 g/test OR 6.0 g/test as opted by manufacturer	1.5 g/test
OBD	Not Applicable	OBD I (From 1st Apr'2020) OBD II (From 1st Apr'2023) OBD II includes OTL

OBD Requirement :

Monitoring Items	OBD I	OBD II
Circuit continuity for all emission related power train component	√	√
Distance travelled since MIL (Malfunction indicator lamp) ON	√	√
Electrical disconnection of Electronic evaporative purge control device	√	√
Catalytic converter monitoring	X	√
EGR system monitoring	X	√
Misfire detection	X	√
Oxygen sensor deterioration	X	√

Technologies for BS IV & BS VI

Systems	Technologies employed in BS IV 2W	Technologies for BS VI 2W
Fuel	Primarily Carburettors (some models are with Fuel Injection)	Closed loop Fuel Injection
Ignition control	Variable ignition timings - Speed & load based. Use of simple TPS, or electronic estimation of engine load	Variable ignition timings - Speed & load based. Use of regular TPS, TMAP and various other sensors.
Exhaust after treatment devices	Catalytic Converters placed either in the exhaust tube or inside the Muffler	Catalytic Converters in the exhaust tube placed more closer to the exhaust port & additional converters downstream.
	Secondary Air Injection to aid in catalytic reaction for better conversion	Secondary Air Injection to aid in catalytic reaction for better conversion
Engine Management system	CDI unit, mainly for only ignition control	Electronic Control Unit for controlling many actuators for fuel, ignition etc based on inputs from various sensors

Challenges for BS VI

- **Technical Challenges - CAT converters**:
  - Individual limits for HC and Nox & additional separate limit for NMHC :
    - Quick / early light off for good conversion under cold conditions.
    - Conversion durability.
  - Mechanical durability due to high exhaust gas temperatures when packaged closer to the exhaust port
  - Improved conversion abilities with compact CAT sizes

- **Technical Challenges - FI systems:**
  - Fuel pump durability working with fuel contaminated with dust and other.
  - Demand on electrical systems and their effect on efficiency loss

- **Technical Challenges - Engine / Vehicle performance:**
  - Re engineering to maintain desired / targeted engine performance.
  - Engine durability enhancement to withstand the thermal loads due to Lambda 1 Air fuel ratio control.
  - Challenges to limit loss of Fuel efficiency to customer

Challenges for BS VI

- **Other challenges:**
  - Multiple models for emission & engine development
  - Limited time to meet the deadline
  - Need to convert both the existing models as well as new models to BS6 in one go without a phase in period of 1 year as available in BS IV and also in Euro V
  - Huge production volumes to be transitioned
  - Supply chain challenges for FI system parts
  - Packaging multiple CAT converters without affecting the aesthetics of a visible motorcycle exhaust system
  - Cost up to the customer.

Thank you