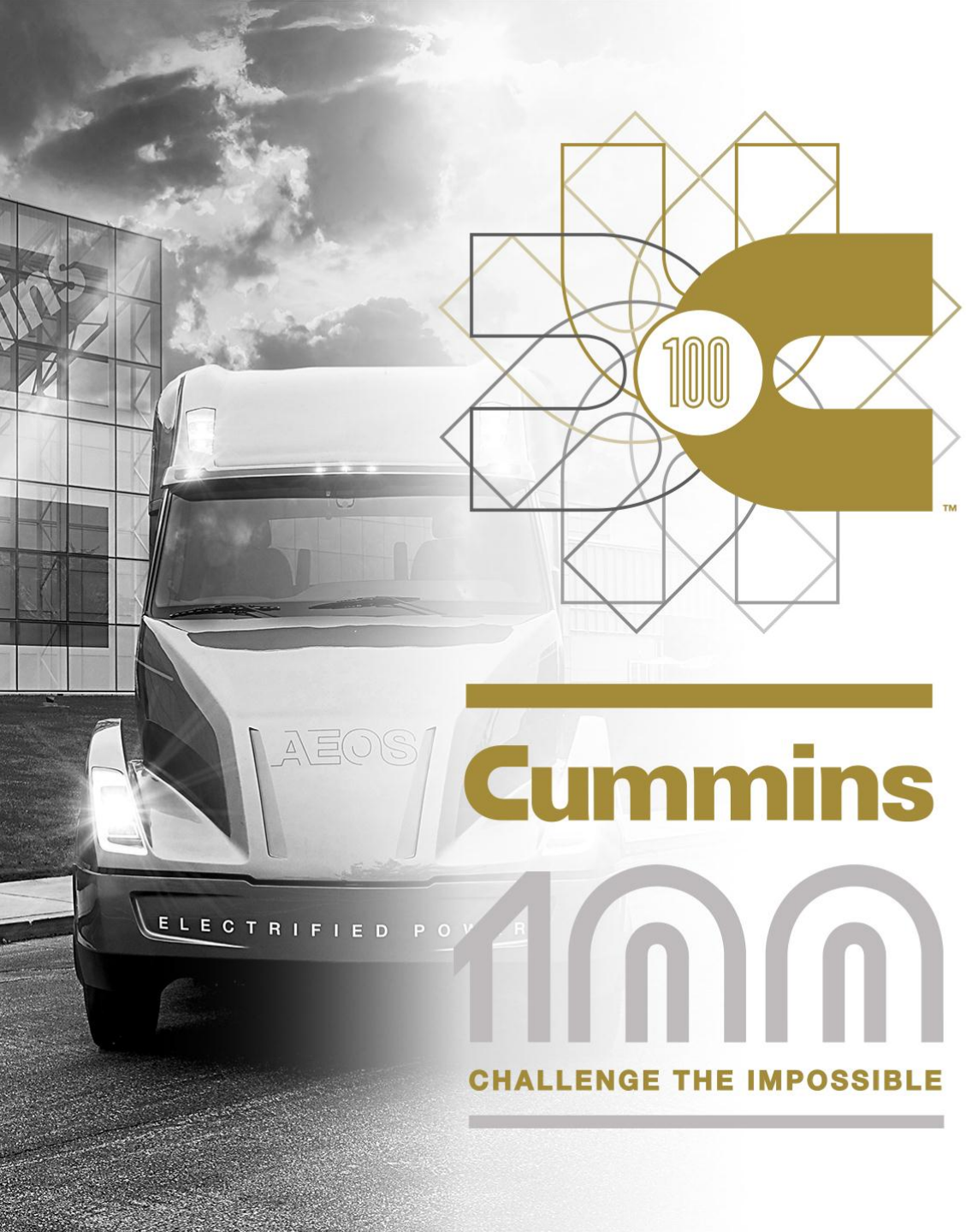


Meeting Off-highway Emission Regulations

Sangati Seth

CES India Engineering Director

Umesh Sawant

PC&C Director

November 14, 2019

Content

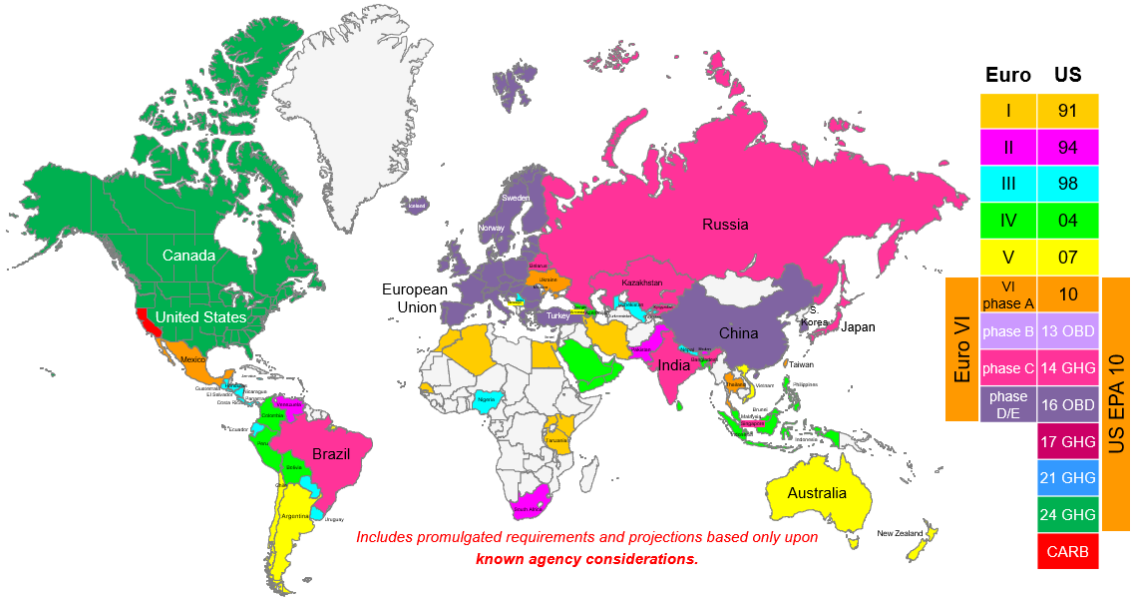
- India Off Highway Regulatory Scenario
- Market Segmentation and Drivers
- Meeting Emissions and Diagnostics Requirements
- Challenges
- Summary

India Regulations Scenario

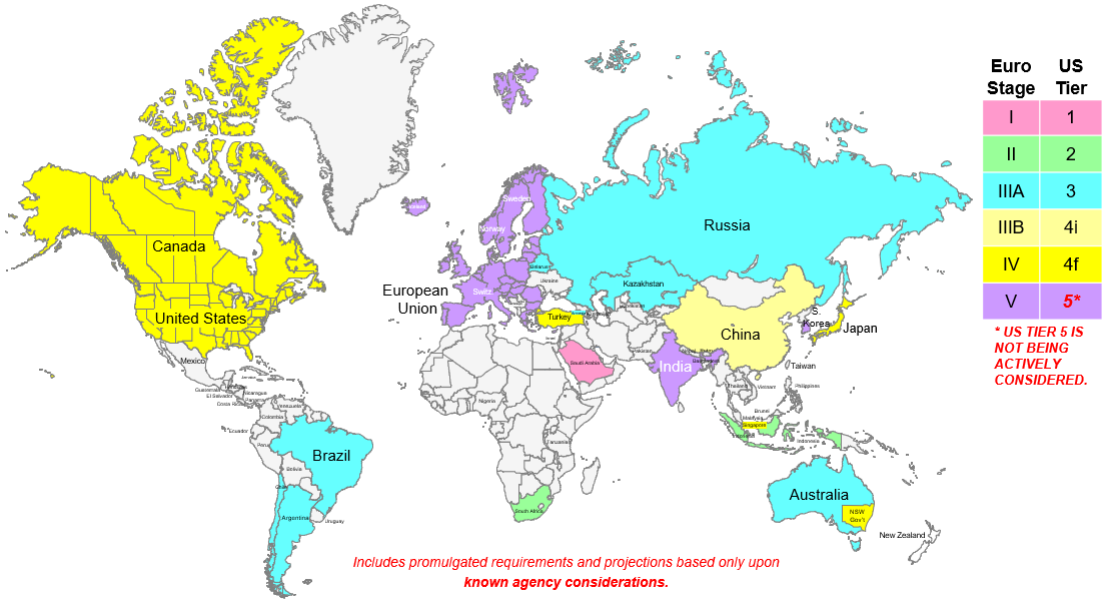
In various global survey's many Indian cities appear among top polluted cities in world

Apart from other efforts to curb pollution, India has significantly accelerated it's emissions regulation implementation in last 4 years and catching up with emission leading regions worldwide

Heavy-duty On-highway Emission Regulations - 2024



Nonroad Emission Regulations – 2024 (75-751 hp)



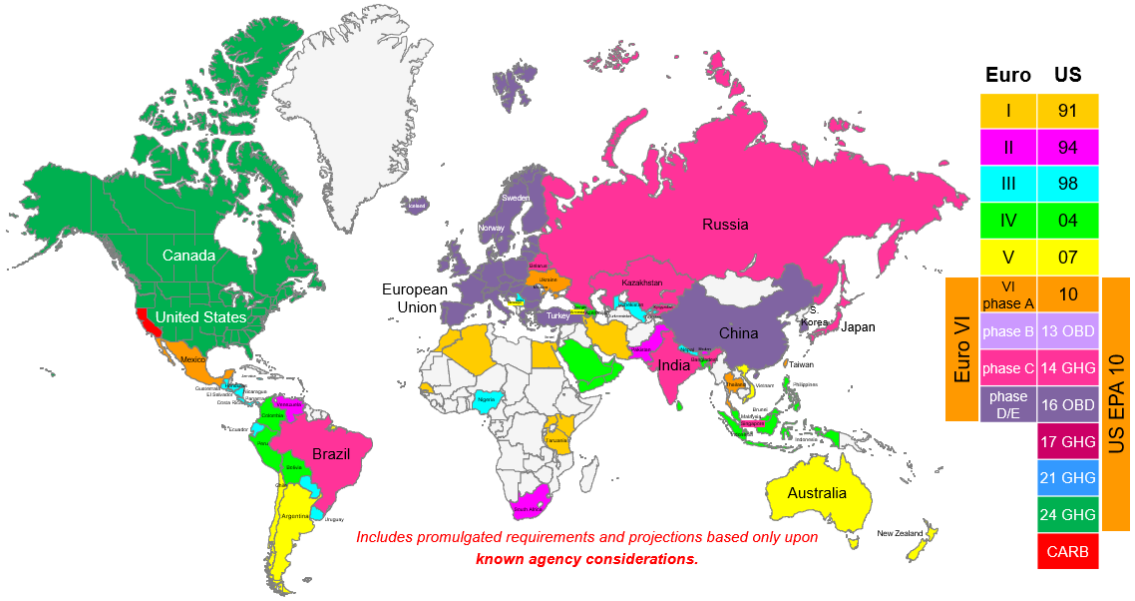
Above figures are for representation purpose only with known and in-progress emission norms

India Regulations Scenario

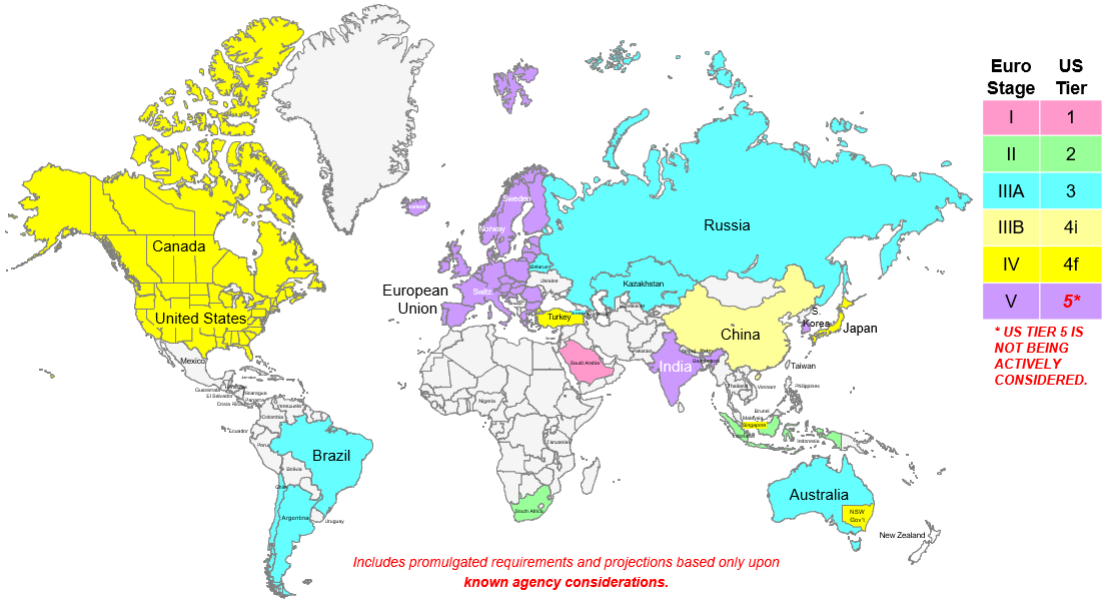
A 2024 scenario shows India will be at par with European Union and a leading emission country in Indian Continent for Off-Highway Segment

Proposed Next Level Genset Norms are also close to this level

Heavy-duty On-highway Emission Regulations - 2024

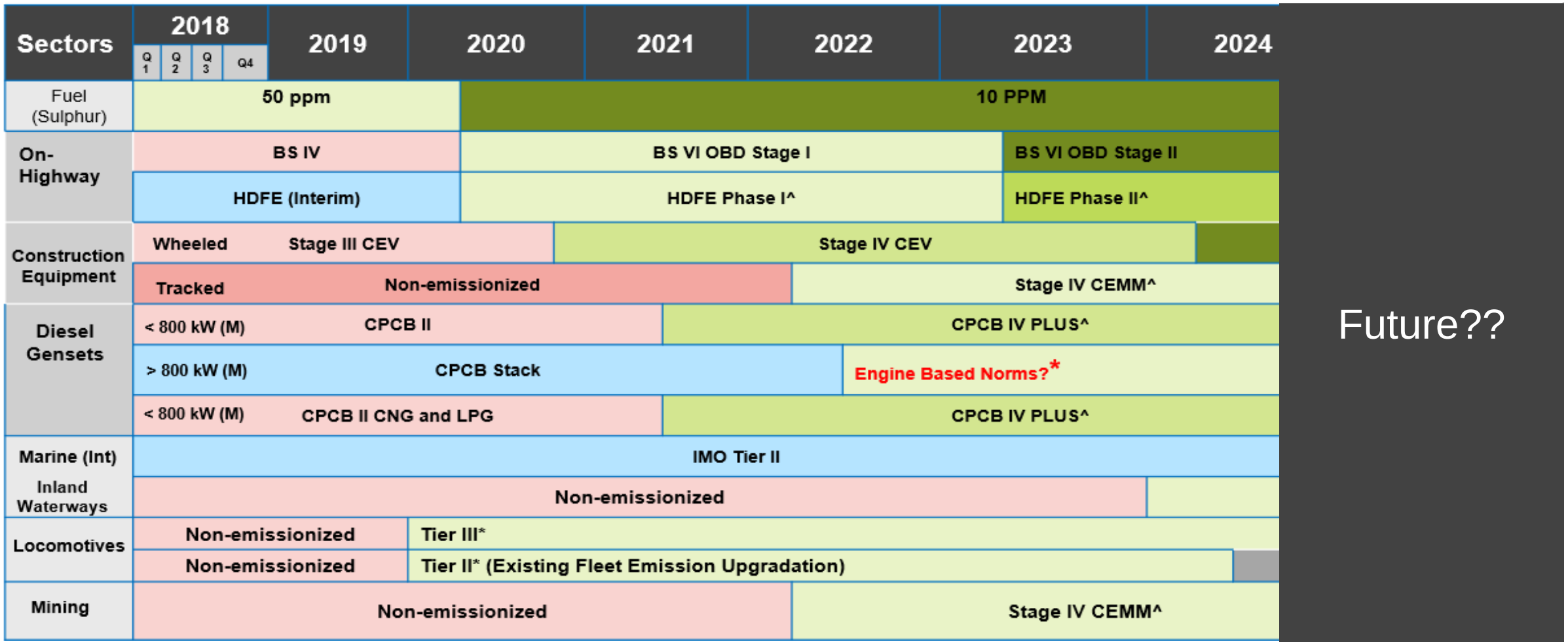


Nonroad Emission Regulations – 2024 (75-751 hp)



Above figures are for representation purpose only with known and in-progress emission norms

India Regulations Scenario

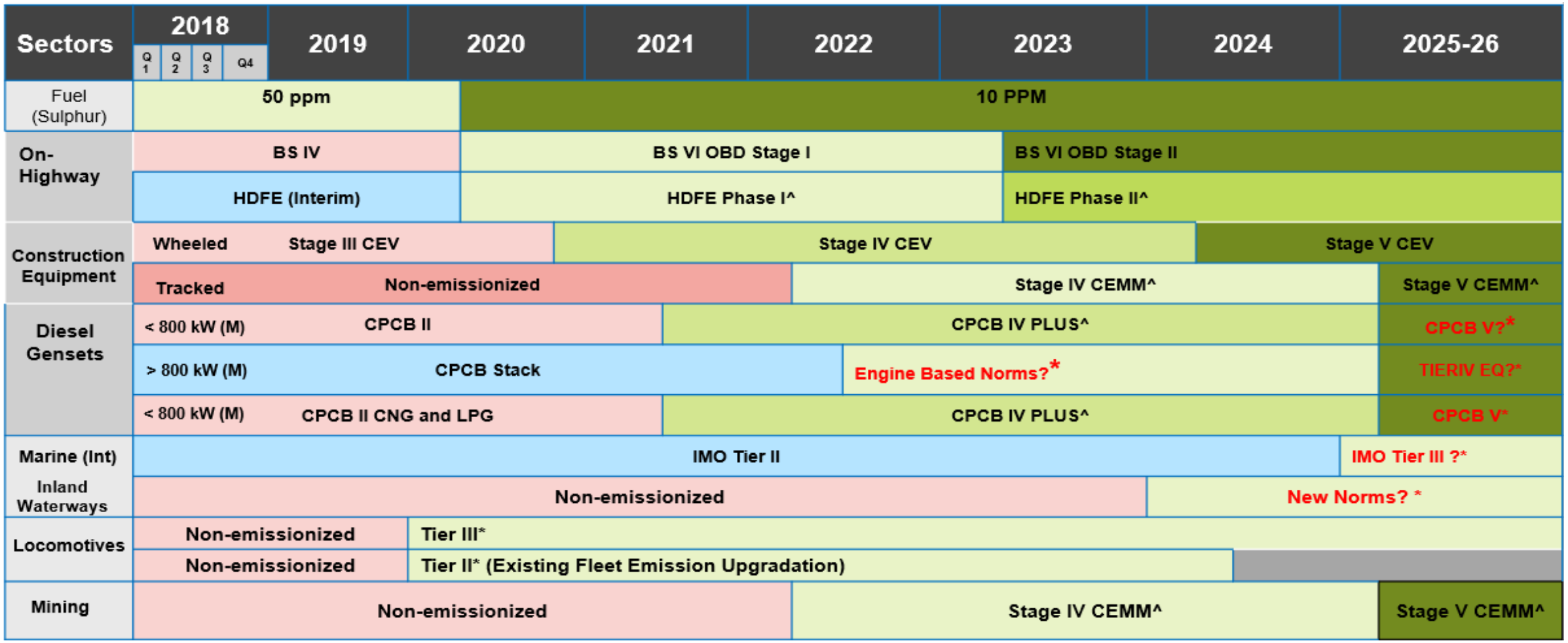


^ Denotes: Under active rulemaking. Best known effects dates represented

* Denotes: Extrapolatory. No rulemaking in active phase yet

Information complied based on published, Work In Progress information and projected future state. A Generic representation and shall not be considered as individual position

India Regulations Scenario



^ Denotes: Under active rulemaking. Best known effects dates represented

* Denotes: Extrapolatory. No rulemaking in active phase yet

Information complied based on published, Work In Progress information and projected future state. A Generic representation and shall not be considered as individual position

India Off Highway Compared to EU NRMM

European Non Road Mobile Machinery (NRMM)

- Off Highway Roadable
- Off Highway non-roadable
- Agriculture and forestry
- Marine
- Railways
- Mobile Gensets
- Portable and hand held equipment

India Off-HWY Norms

Equipment / Machine Category	Ministry	Emissionized?
Construction Equipment Vehicles	MoRTH	Yes
Farm Tractors and Combine Harvesters	MoRTH	Yes
Tracked Construction Vehicles, Earthmovers, Mining, material handling	MHI	Proposed-2022
Stationery & Mobile Gensets <=800 kW	MoEF	Yes
Gensets >800 kW	MoEF	Yes – Stack Emissions
Railways	MoEF	Under Rulemaking
Marine – Inland waterways	MoShipping/IWAI	No
Water Pumps	MoEF	No

Macroeconomic Trends & Market Requirements

Macroeconomics

- Real Estate (Housing, Corporate Office, PMAY)
- Road Construction (Bharatmala, PMGSY, BRO)
- Railway Infrastructure (DFC (West:1499KM, East:1839KM))
- Urban & Rural Infrastructure (AMRUT, MRTS)
- Emissions Cost & Sustainability (BSIII to BSIV & V)
- Organized Industry (Captive Usage vs Rental)

Industry

Maximize Revenue
- Productivity (TAT)
- Uptime (Reliability, Service Support)

Minimize Cost
- Fluid Economy
- Spare Parts Price
- Initial Cost

Packaging
- Limited Space for Engine & A/T

Equipment Requirements

- Power Node transition
- Higher Service Interval
- AMC & On Site Service Support
- Engine Downsizing
- Safer Cabins
- Connected Diagnostics™
- Mini Excavators & Forklift

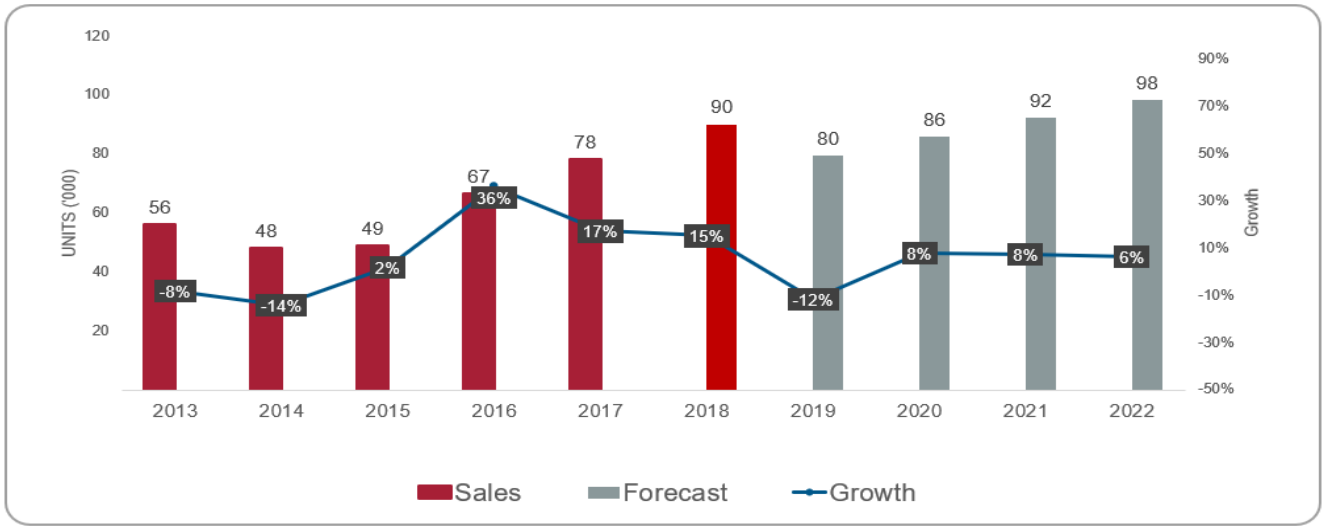
2018 — 2020 — 2022 — 2024 — 2026

- *Equipment price increase with BS IV CEV norms in Oct'2020 and CEMM norms in April 2022?*
- *Some segments may leverage favorable emission power band*
- *Volume transition from backhoe loader to excavator for better productivity*
- *Customer focus to shift from initial cost to TCO*

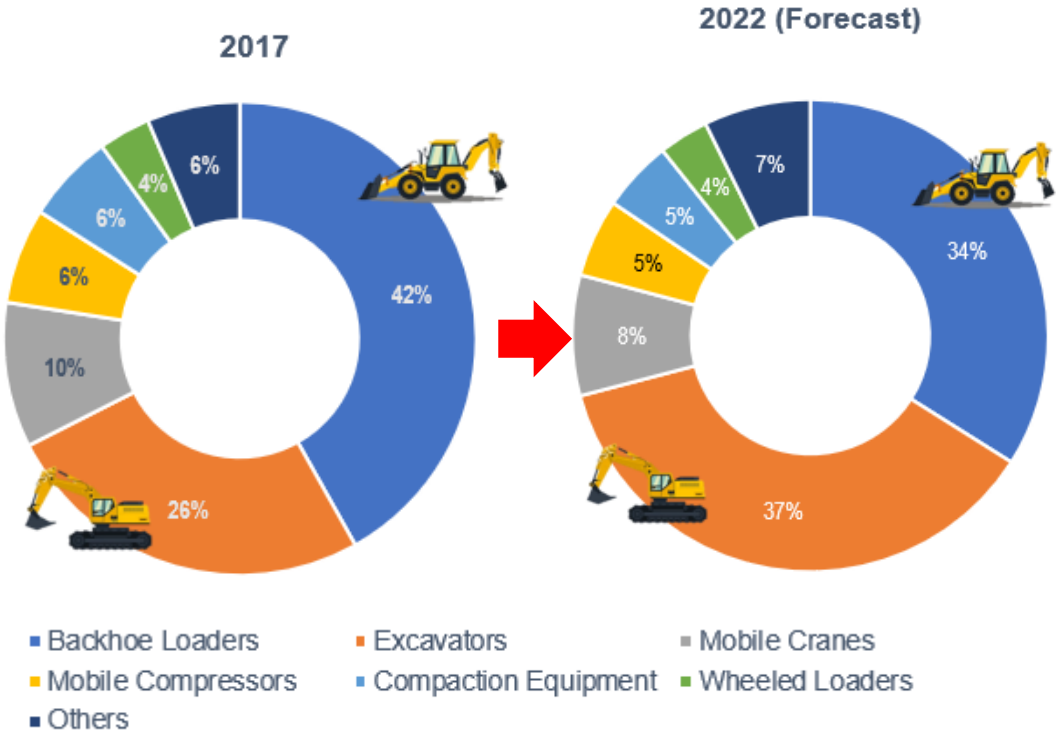
- *BSV norms will require DPF*
- *Increased focus on productivity & uptime - higher power nodes*
- *Engine downsizing for excavator & compressor segment*
- *EV adoption for small excavators (3T) & Forklift feasible*
- *Specialized equipment in place of generalized equipment*

CE Market Segmentation and Growth

Off Highway segment is expected to exhibit growth

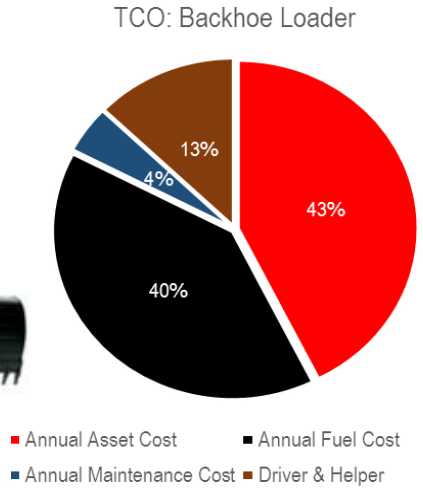


Construction Equipment sales are expected to be at 100000 by 2022



Market is dominated by six equipment types (accounting 93 to 96% of volumes)

Backhoe Loaders, Excavators, Cranes, Compressor, Compactors & Wheel Loaders

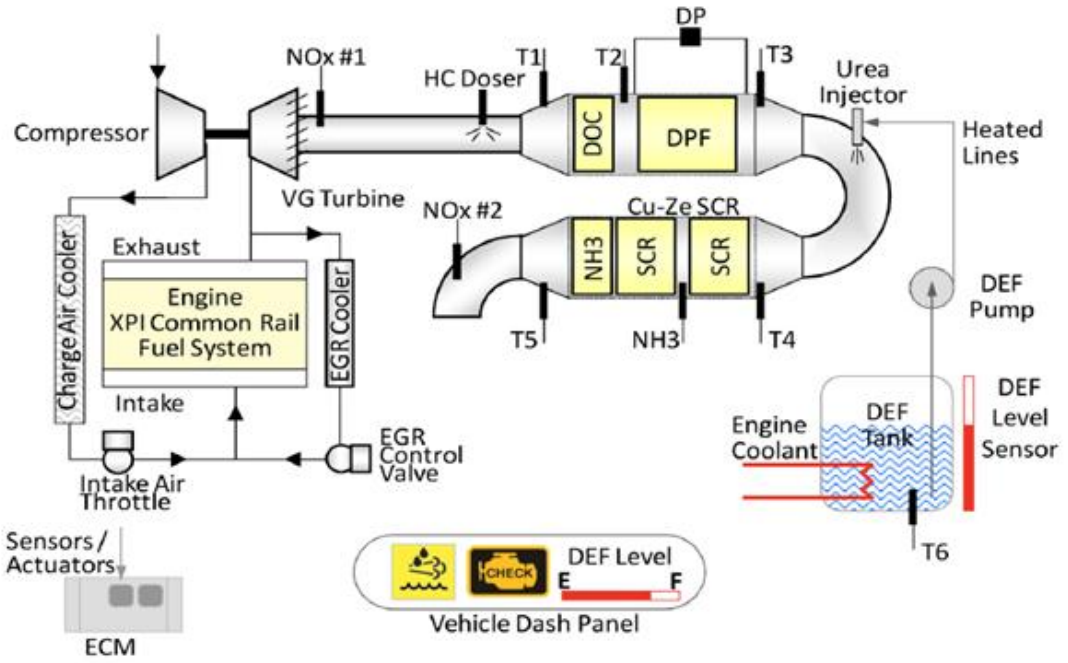


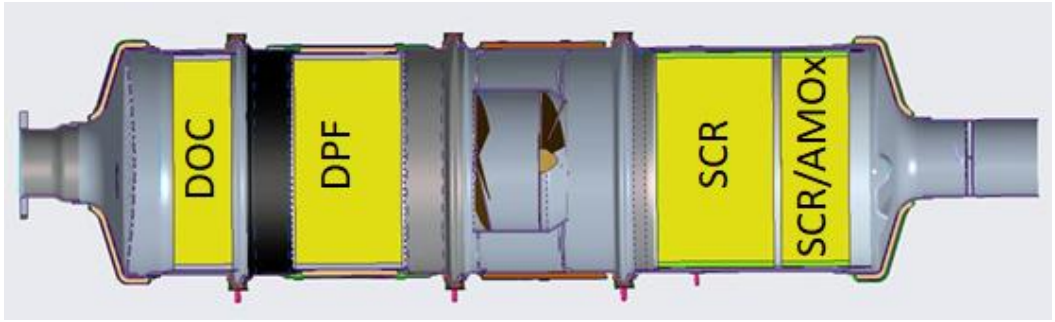
Backhoe Example:

Initial Cost & Fuel Efficiency are the most important parameter for backhoe owner

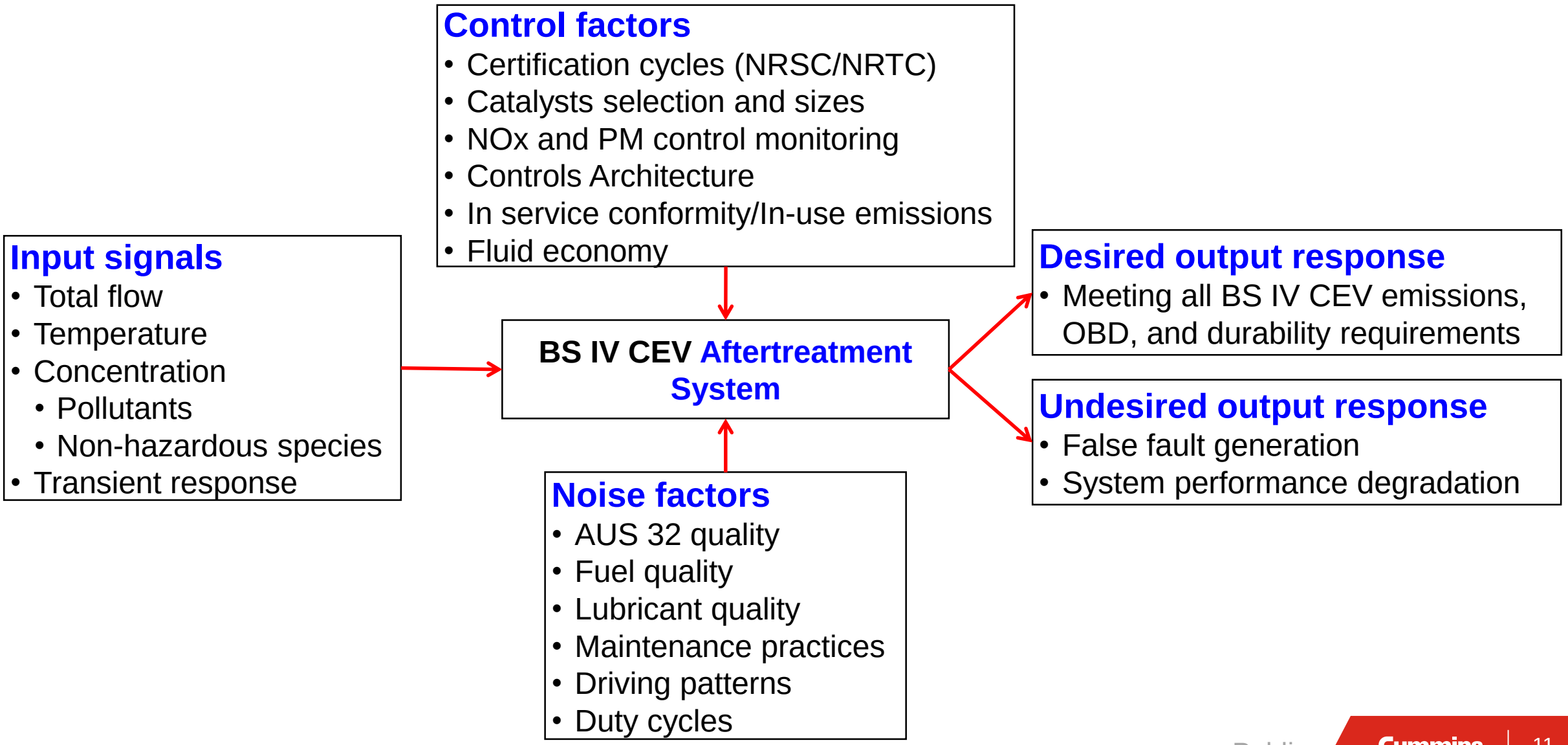
Cummins aftertreatment experience

- Cummins Emission Solution (CES) was able to meet US 2010 regulations, including OBD: 3 years ahead of schedule and before urea infrastructure became available: using LNT-based system for Dodge Ram 2500/3500 vehicles
- Over 10 years of SCR experience
- First HD OEM to introduce Cu-Zeolite SCR
- Full range of Euro IV, V, and VI and Tier IV solutions
- TWC- based systems for a range of natural gas-powered engines, including world's only 0.02 g NOx/hp-hr system
- Pro-active internal and collaborative RDE work





P Diagram for BSIV CEV aftertreatment system



Off Highway Challenges

- Migration from Mechanical to Electronic Engines
- Space claim for aftertreatment System
- NCD and PCD introduction (Diagnostics and Operator Inducement)
- Severe duty cycles

- Engine + ATS integration capability
- Compact and flexible ATS architecture
- Capable diagnostics controls those are functional over emissions durability period without false faults
- Capable engine and ATS with thermal management and protection suit

Cummins High Horse Power SCR

Cummins Single Module

Off Highway Challenges

- **Operator Training** for electronic engines and advance aftertreatment system
- **10 PPM Sulphur fuel availability** with acceptable cleanliness
- Clean **AUS32** (reagent) availability that complies to strict standard (IS 17042, ISO 22241)
- Capable **maintenance and service practices** to avoid machine inducement
- Rational **initial cost** and operating cost – **fluid economy**

Summary

- India is on right path and aggressively bringing in latest emission norms that will help clean up air for near future
- Complex aftertreatment system is must to meet upcoming Off-highway Emission norms. Both for De-NOx and ultra low Particulate matters
- Apart from meeting certification requirements, designing engine and aftertreatment system for emissions durability period will be mandatory
- Although technology access due to leading emission norms - BSVI is available, Off highway applications has their own nuances and challenges to fulfill
- Fluid economy will remain driver for competitive success factor along with initial cost
- Cummins has worldwide experience in Off-Highway products as well as good understanding of noise factors uniquely positioning them as well prepared partner for OEMs

Q+A


Cummins