

Auto Fuel Policy Roadmap for India – What Next?

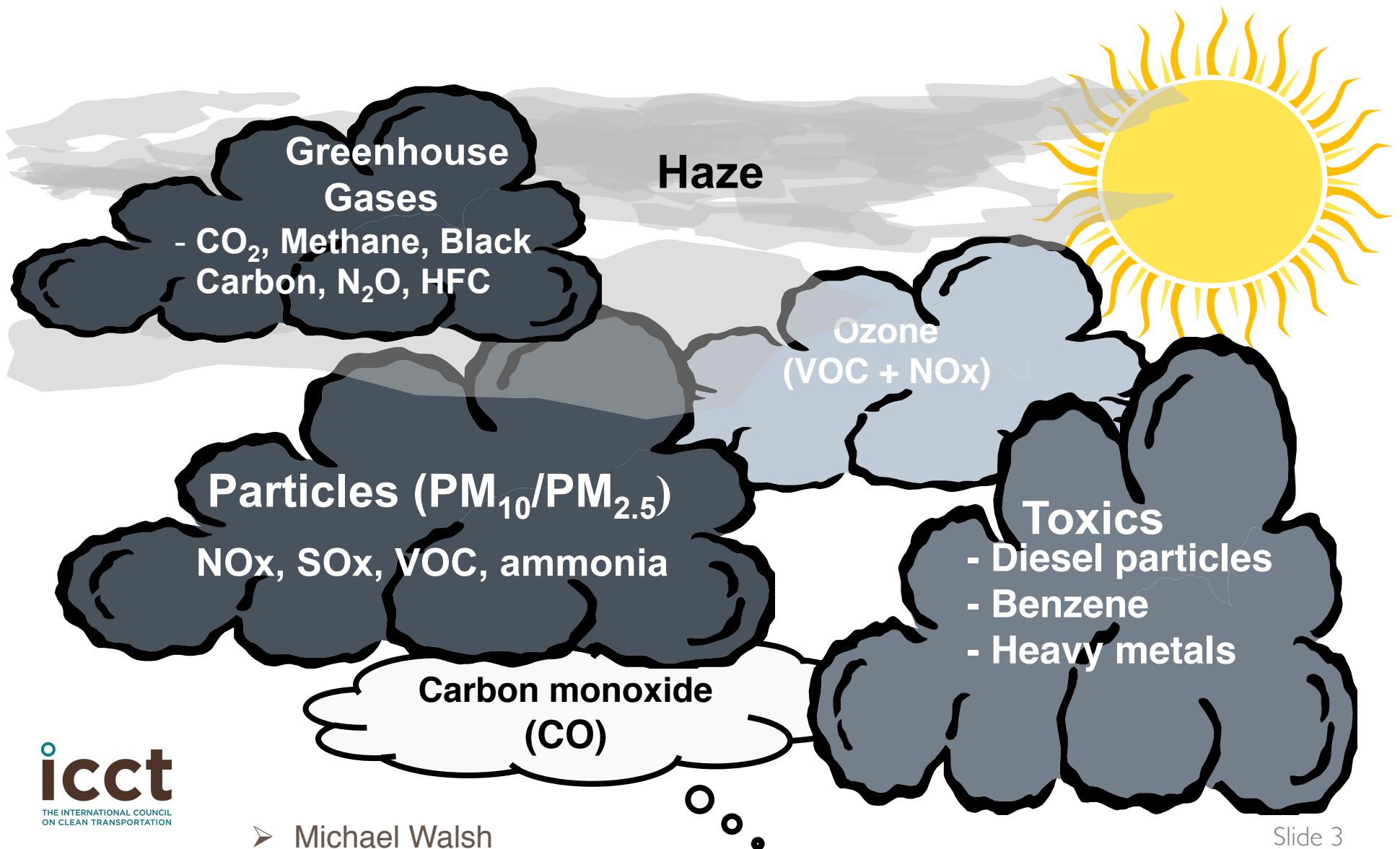
Anup Bandivadekar

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India's Clean Vehicle and Fuel Strategy at another critical juncture

- Review of policy developments in the past few years
 - Saumitra Chaudhuri committee report
 - Progression of BS IV standards
- Outlook for Bharat V and VI emission standards and fuels
 - Case for leapfrogging to BS VI emission standards
- Looking beyond the roadmap for emission standards
 - Need for a comprehensive strategy to reduce vehicular emissions

What pollutants are of concern?



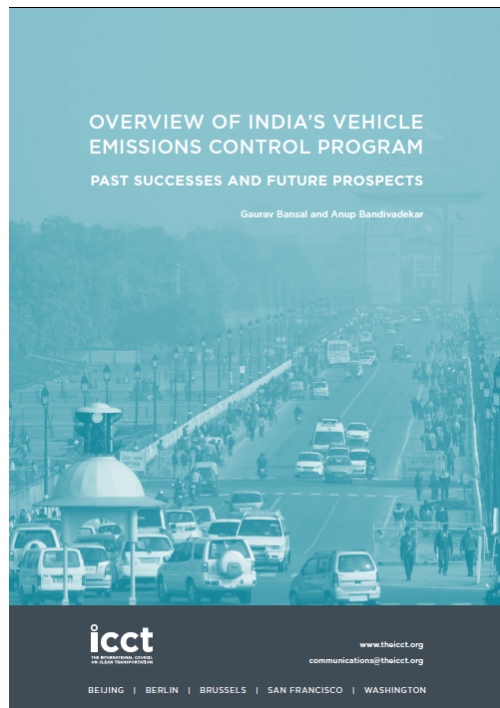
Multiple Pollutants with Multiple Impacts

- Adverse health effects
 - Especially from PM_{2.5}
 - Exacerbation of asthma and other respiratory diseases
 - Premature mortality due to cardiopulmonary diseases and lung cancer

- Global warming
 - BC, CH₄, N₂O, CO₂, O₃

- Adverse effects on agricultural yields
 - NO_x, PM, O₃

In 2013, ICCT completed a study to evaluate the past successes and future prospects of India's vehicle emission control program



- The study compared and contrasted global best practices with Indian Experience across:
 - New vehicle emission standards
 - Fuel quality standards
 - Vehicle compliance and enforcement program
 - Fuel inspection and compliance program
 - Alternative fuels and new energy vehicle policies
 - Fuel efficiency standards and labeling

India made tremendous progress on vehicular emissions front from 2000-2010, but fell behind after 2010.

- Vehicle emission standards and fuel quality standards implemented more or less as per schedule
 - BS-IV fuel supply steadily increasing (>35% of total fuel use)
- Use of CNG and LPG has increased, especially in city buses and autorickshaws
- Some progress on improving I&M program
 - 10 testing centers are being set up by ARAI/NATRIP/SIAM

What has been accomplished in India on fuel quality

- Lead removed from all fuels by the year 2000
- Sulfur levels have fallen dramatically
 - Gasoline: 2000 ppm to 150 ppm (50 ppm in 63 cities)
 - Diesel: 10,000 ppm to 350 ppm (50 ppm in 63 cities)
- Octane number increased in gasoline
 - Regular: 88 to 91
 - Premium: 93 to 95
- Benzene levels reduced in gasoline
 - 3% to 1%
- Aromatic content reduced
 - No regulation to 35% maximum

India Clean Vehicles and Fuels Policy Landscape changes since 2013

- Auto Fuel Policy and Vision 2025 (Saumitra Chaudhuri committee) report released (<http://petroleum.nic.in/docs/autopol.pdf>)
 - Committee recommendations:
 - 50 ppm sulfur fuels to be available by April 2017
 - 10 ppm sulfur fuels to be available by April 2020
 - BS IV in 2017, BS V in 2020, BS VI in 2024
 - Weaknesses in the committee report
 - BS VI standards not fully defined
 - No firm date for adoption of World Light Duty Testing procedure ([WLTP](#))
 - Proposed durability for BS V standards (120,000km) is weaker than Euro 5 durability (160,000km)
 - Stage I and II vapor recovery systems not required for refueling stations
- National Transport Development Policy Committee (NTDPC known as the Rakesh Mohan Committee) recommended implementation of BS VI standards by 2020 (see page 23: http://planningcommission.nic.in/reports/genrep/NTDPC_Vol_01.pdf)

BS IV standards for new 2-wheelers effective April 2016 (all vehicles from April 2017)

Emission Standard for 2-W	Motorcycle Class	Emission Limits (g/km) ^[1]			
		CO	NO _x	HC+NO _x	
				If Evap. Test ≤ 2.0 g/test	If Evap. Test ≤ 6.0 g/test
Bharat III (2010) IDC	All 2-W	1.0	-	1.0	1.0
Bharat IV (2016 TA; 2017 AV)	Class 1 and Subclass 2-1	1.403	0.39	0.79	0.59
	Subclass 2-2	1.970	0.34	0.67	0.47
	Subclass 3-1 and 3-2	1.970	0.20	0.40	0.20
European Standards - WMTC testing					
Euro 3 (2006)	V _{max} < 130km/h	2.62	0.17	0.92	0.92
	V _{max} ≥ 130km/h	2.62	0.22	0.55	0.55
Euro 4 (2016 TA; 2017 AV)	V _{max} < 130km/h	1.14	0.07	0.45	0.45
	V _{max} ≥ 130km/h	1.14	0.09	0.26	0.26

[1] Test procedure and driving cycles according to WMTC GTR-2 regulations, incorporating amendment 2, with preconditioning soaking and colds starts. Emission sampling starts at t=0 seconds.

BS IV standards for new 2-wheelers effective April 2016 (all vehicles from April 2017)

- Adoption of the Worldwide Harmonized Motorcycle Test Cycle (WMTC)
- Introduction of evaporative emission standards
- Prohibition on crankcase emission
- Minor improvements in PUC requirements
- NOx standards much weaker than Euro 4; nearly a decade behind EU
- Durability of 30,000km is weaker than 50,000km required in Europe
- No on-board diagnostics (OBD) requirements

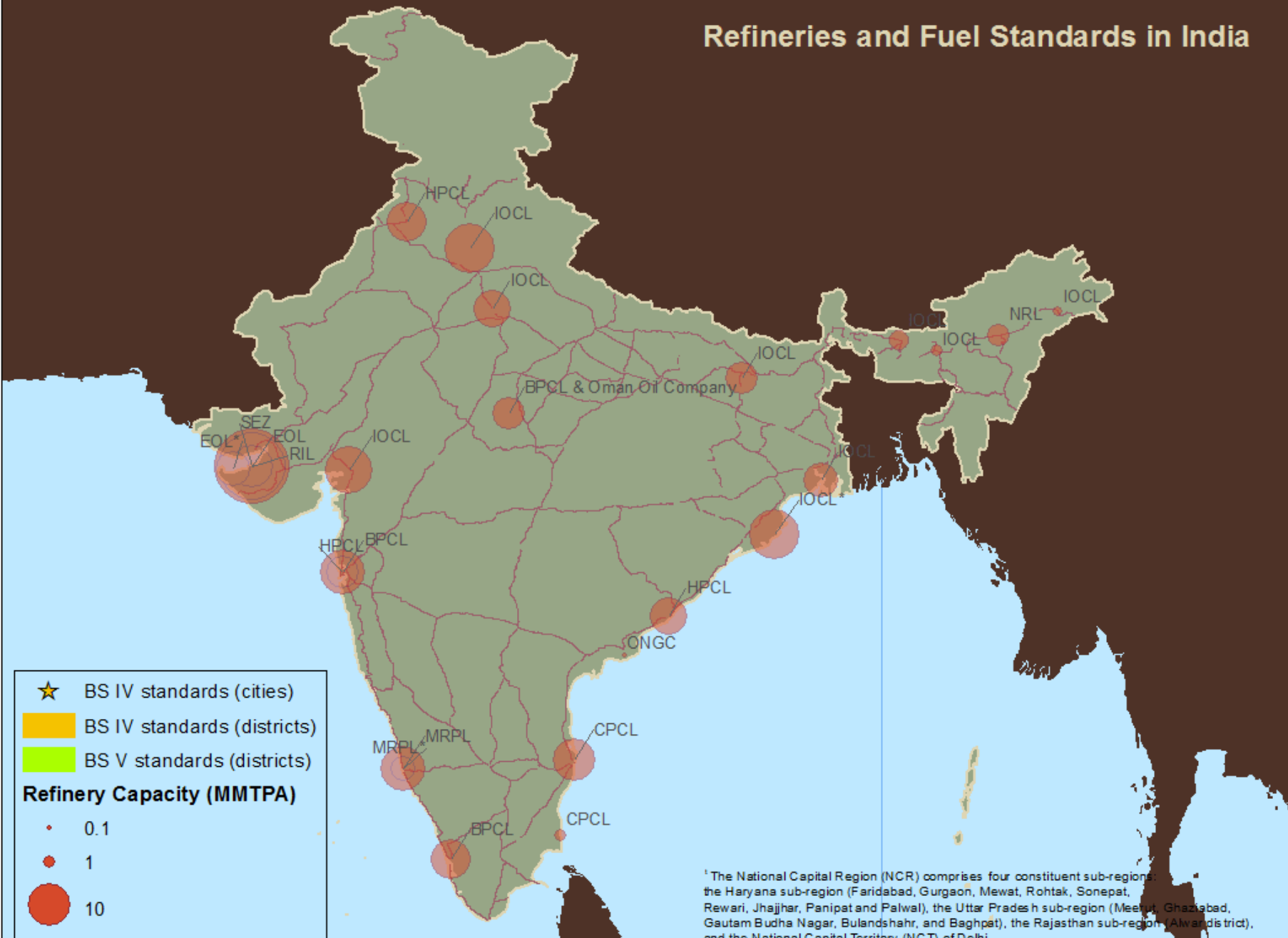
BS IV standards for 3-wheelers from April 2016

- 25% reduction in BS IV CO, and HC+NOx limit value compared with BS III

- Evaporative emission testing introduced

- only 15% reduction in PM emission limit for diesel 3-wheelers
 - 20% reduction feasible (<http://www.theicct.org/two-and-three-wheelers-india-iyer-report>)

Refineries and Fuel Standards in India



¹ The National Capital Region (NCR) comprises four constituent sub-regions: the Haryana sub-region (Faridabad, Gurgaon, Mewat, Rohtak, Sonapat, Rewari, Jhajjar, Panipat and Palwal), the Uttar Pradesh sub-region (Meerut, Ghaziabad, Gautam Budha Nagar, Bulandshahr, and Baghpat), the Rajasthan sub-region (Alwar district), and the National Capital Territory (NCT) of Delhi.

Aftertreatment devices required to meet BS IV, V and VI emission norms

	BS IV	BS V	BS VI
Light-duty Gasoline (direct injection engines <u>only</u>)			Gasoline particulate filter <u>may</u> be required
Light-duty Diesel		Diesel particulate filter (DPF) <u>required</u>	Lean-NOx traps (LNT) for smaller engines, and Selective Catalytic Reduction (SCR) for bigger engines <u>required</u>
Heavy-duty Diesel	Selective Catalytic Reduction (SCR) preferred.	Selective Catalytic Reduction (SCR) <u>required for most engines.</u>	Diesel particulate filter (DPF) <u>required</u>

Advantages of Euro 6 over Euro 5

- Limits on particle number (PN) for all vehicle types
- Euro 6 narrows the gap between NO_x (or HC+NO_x) standards for diesel and gasoline
 - Ideally standards would be fuel neutral
- Portable Emission Measurement System (PEMS) based real driving emissions (RDE) testing
- On-Board Diagnostic (OBD) thresholds (OTLs) for Euro 6 are 70-75% lower than Euro 5 OTLs for NO_x and PM
- Adoption of World Harmonized Light Vehicles Test Procedure (WLTP)

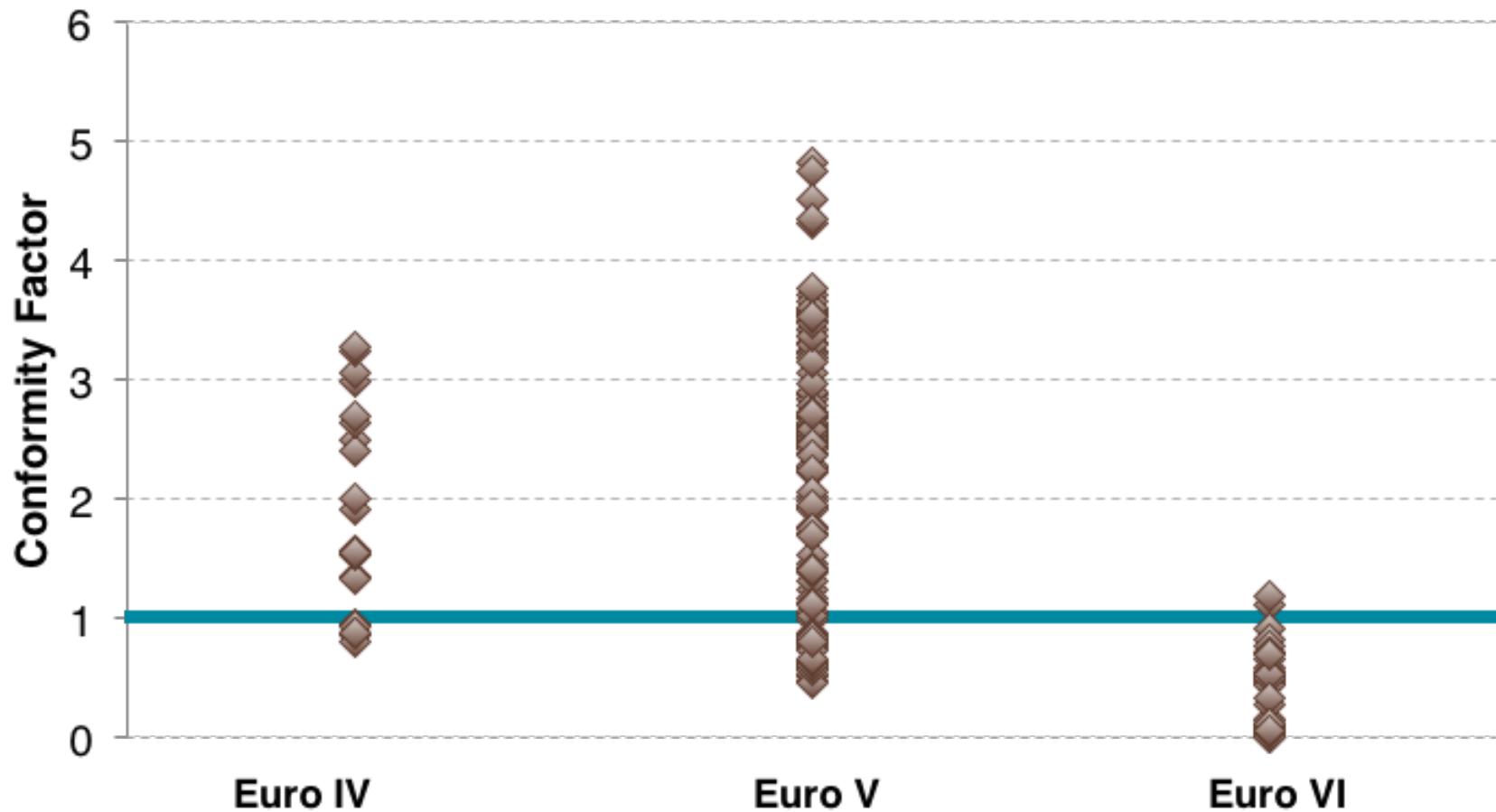
Advantages of Euro VI over Euro V

- Introduction of Diesel Particulate Filters (DPFs) on heavy vehicles
- Limits on particle number (PN)
- Adoption of World Harmonized Transient Cycle (WHTC) and Steady-State Cycle (WHSC)
- Introduction of in-service conformity (ISC) testing requirements using a Portable Emission Measurement System (PEMS)
- New limit on ammonia (NH₃) emissions
- Tighter methane limits for CNG vehicles by 50% and imposing the same limit on LPG vehicles
- Extended durability requirements
 - 160,000 km or 5 for small buses and pick-up trucks
 - 300,000 km or 6 years for mid-size trucks and buses
 - 700,000 km and 7 years for heavy trucks and buses

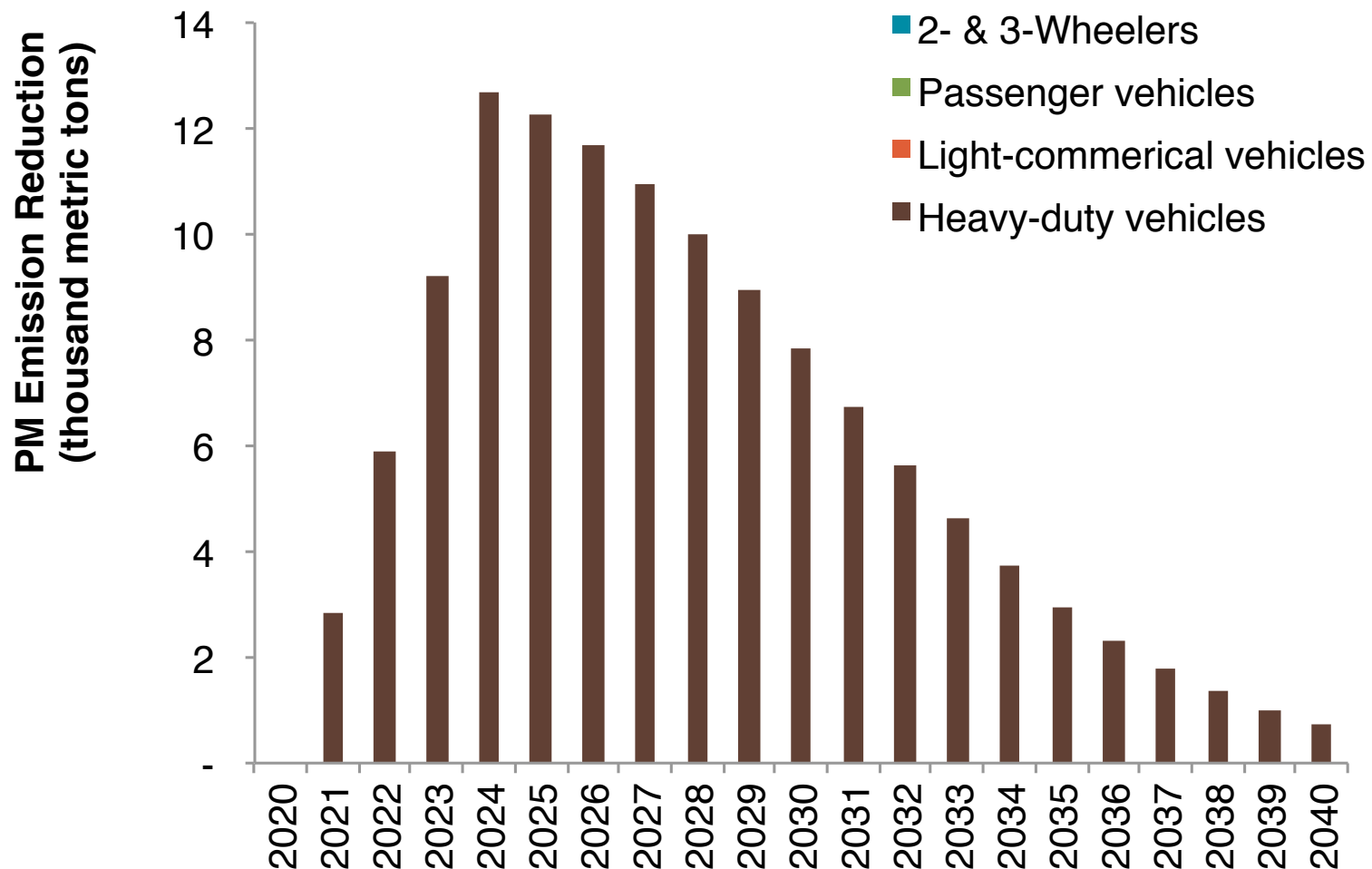
Extensive improvements in OBD systems

Good news for heavy-duty vehicles: Euro VI real-world NO_x emissions are now in line with emission limits

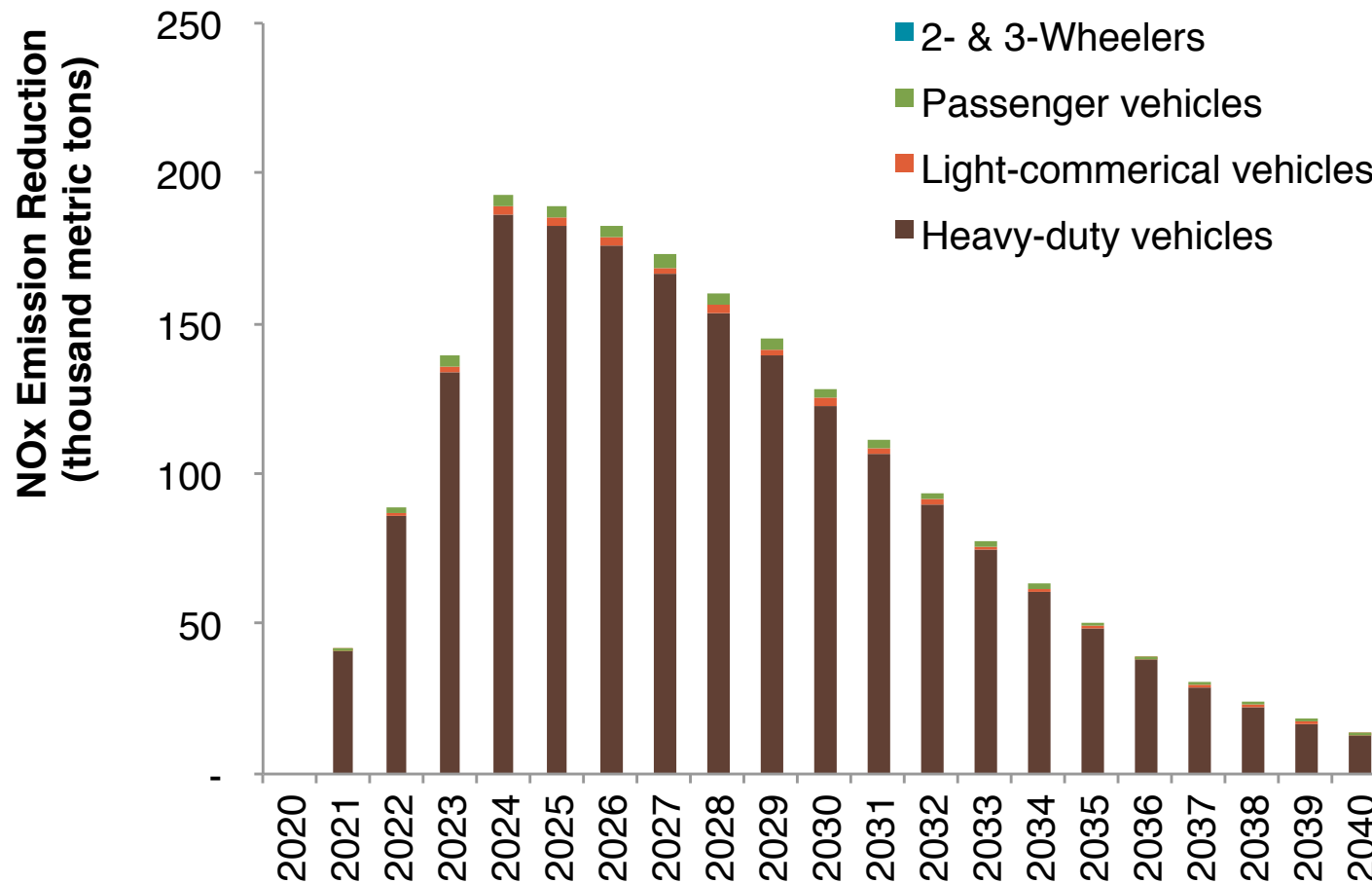
NO_x emissions conformity factors for all tests plotted vs. Euro level
Conformity factor of one indicates that vehicle emissions meet the corresponding Euro standard.



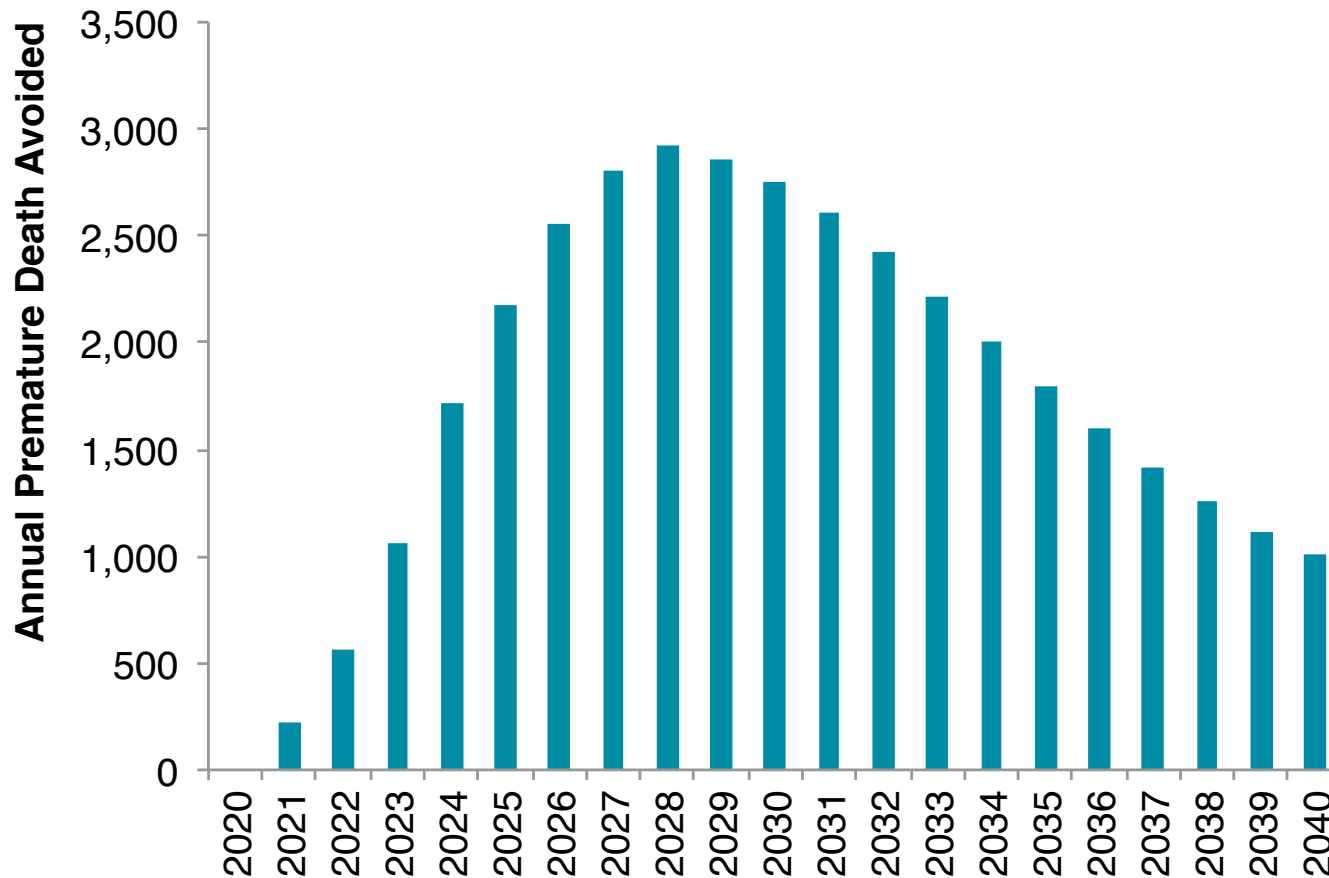
India has the opportunity to leapfrog BS V and move directly to BS VI standards in 2020



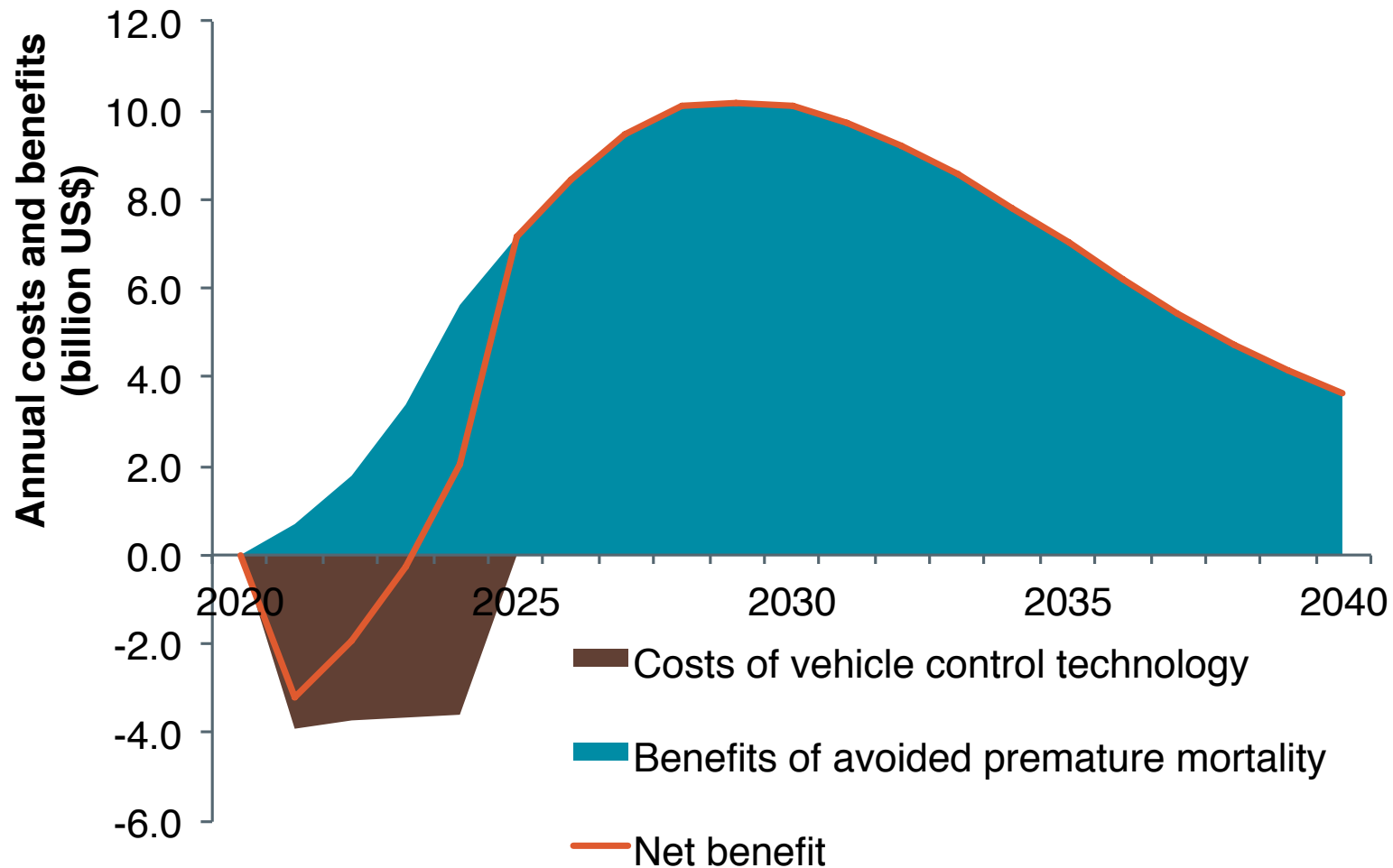
India has the opportunity to leapfrog BS V and move directly to BS VI standards in 2020



Long term public health benefits from advancing BS VI standards timeline



Advancing BS VI standards is cost-effective even with conservative assumptions



Fundamentals of controlling air pollutant emissions from motor vehicles

New vehicle standards

Technology neutral (but technology-forcing...) emissions standards for new vehicles.

Must consider emissions from all mobile sources: on-road, off-road, marine, locomotives, aviation...

Limit values only as good as:

- Compliance and enforcement
- Real-world performance

Fuel quality standards

High fuel quality (especially low sulfur levels) enables advanced emission control technologies to be deployed in the fleet.

Fuel quality compliance programs critical to prevent damage to engines and prevent misfueling

In-use vehicle emission control

Clean up legacy vehicles on the roads

Comprehensive program includes:

- Catching gross-emitters (I/M, remote sensing, maintenance, etc.)
- Cleaner fuels
- Scrappage/replacement programs
- Retrofit programs
- Complementary strategies (low emission zones, driver training, etc.)

“Systems Approach”

Not shown but also important: transportation demand management, modal shift, traffic optimization, and more

<http://www.theicct.org/global-health-roadmap>

<http://www.theicct.org/best-practices-emission-control-in-use-hdvs>

A scrappage program for heavy-commercial vehicles can overcome financial barriers

Implement a five-year program (2020 to 2024) to scrap older commercial vehicles and buses

- Heavy-duty vehicle owners can get a subsidy to replace their older (Bharat I, II or III), still-operational vehicle with a new Bharat VI vehicle at the price of a Bharat V-equivalent vehicle
 - subsidies to offset the price increase of Bharat VI vehicles would take the burden off transporters and goods carriers
 - > 99% reduction in old HDV PM emissions
 - Additional safety benefits of newer trucks
- ICCT is currently working on the details of such a program. Your input and participation is most welcome!

India needs to improve both vehicle compliance and Inspection/Maintenance (I/M) programs

- Suggested improvements in compliance program
 - Vehicle manufacturers should be required to test a select number of low-mileage and high-mileage vehicles manufactured by them (In-Use Verification Program), and report all data to MoRTH
 - Detailed in-use compliance testing (IUCP) should be required if samples fail during IUVP
 - MoRTH, through NATRiP, should conduct in-use surveillance tests
 - MoRTH must have the ability to recall vehicle models failing in the IUCP and/or in-use confirmatory tests

Suggested improvements in Light-Duty I/M program

- For BS III and older vehicles, require a lug-down test instead of a free acceleration test
- For BS IV and newer vehicles, use on-board diagnostics (OBD) for I/M purposes.
 - ✓ At present, BS IV vehicles cannot get a PUC certificate, if malfunction indicator (MIL) is on.
 - Improve OBD based I/M to overcome fraudulent practices by:
 - Connecting scanning tool directly to vehicle and computer so that inspector cannot modify data during inspection
 - Overcoming code cleaning practices with “readiness indicators”
 - Overcoming clean scanning by matching vehicle identification numbers

Suggested improvements in Heavy-Duty I/M program

- Note that Euro VI standards establish strict rules for the detection of malfunctions and the storage of malfunction codes in the OBD control unit
 - Adoption of BS VI standards by 2020 critical to improving in-use emissions
- For BS IV and newer vehicles, use on-board diagnostics (OBD) for I/M purposes.
- For BS III and older vehicles, require free acceleration tests
- MoRTH should conduct two pilot programs in 2015 to improve I/M practices for HDVs
 - Use of remote sensing in detecting high emitters (“dirty screening”)
 - **Use of On-road Heavy-duty Vehicle Emissions Monitoring System (OHMS)**

India's air pollution problems are not intractable

- Vehicles are not the only source of pollution, but they are one of the most important source that need to be cleaned.
- Action taken now to promote cleaner fuels and vehicles by adopting Bharat VI standards by 2020 will go a long way towards addressing air quality problems.
- In-use emission control strategies such as scrappage and better inspection/maintenance needed to fully realize the benefits of cleaner new vehicles.

For more information...

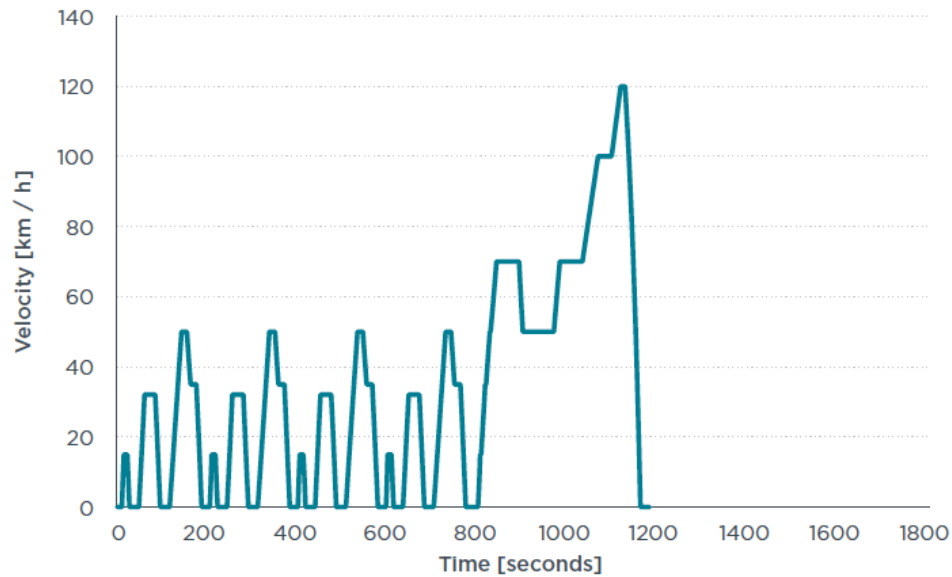
- Direct Progression from Bharat IV to Bharat VI national emission standards in India:
<http://theicct.org/leapfrogging-bsIV-to-bsVI-india>
- Advantages of Euro 6/VI emission standards over Euro 5/V:
<http://www.theicct.org/briefing-leapfrogging-to-euro-6-vi-mar2015>
- Comparison of real world off-cycle NOX emissions control in Euro IV, V, and VI:
<http://www.theicct.org/comparing-real-world-nox-euro-iv-v-vi-mar2015>
- Making Bharat VI Affordable:
<http://www.theicct.org/blogs/staff/making-bharat-vi-affordable>
- Survey of best practices in reducing emissions through vehicle replacement programs:
<http://www.theicct.org/vehicle-replacement-program-best-practices-mar2015>

Anup Bandivadekar
anup “at” theicct.org

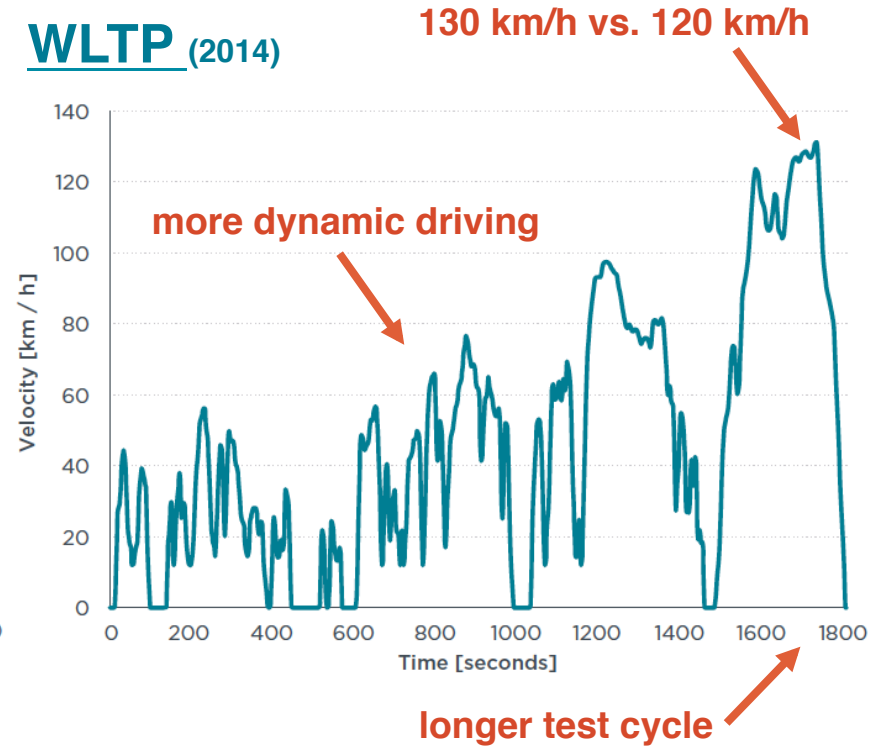
[@theicct](https://twitter.com/theicct)

Introduction of World Harmonized Light-Duty Testing Procedure (WLTP)

NEDC (1970s / 1990s)



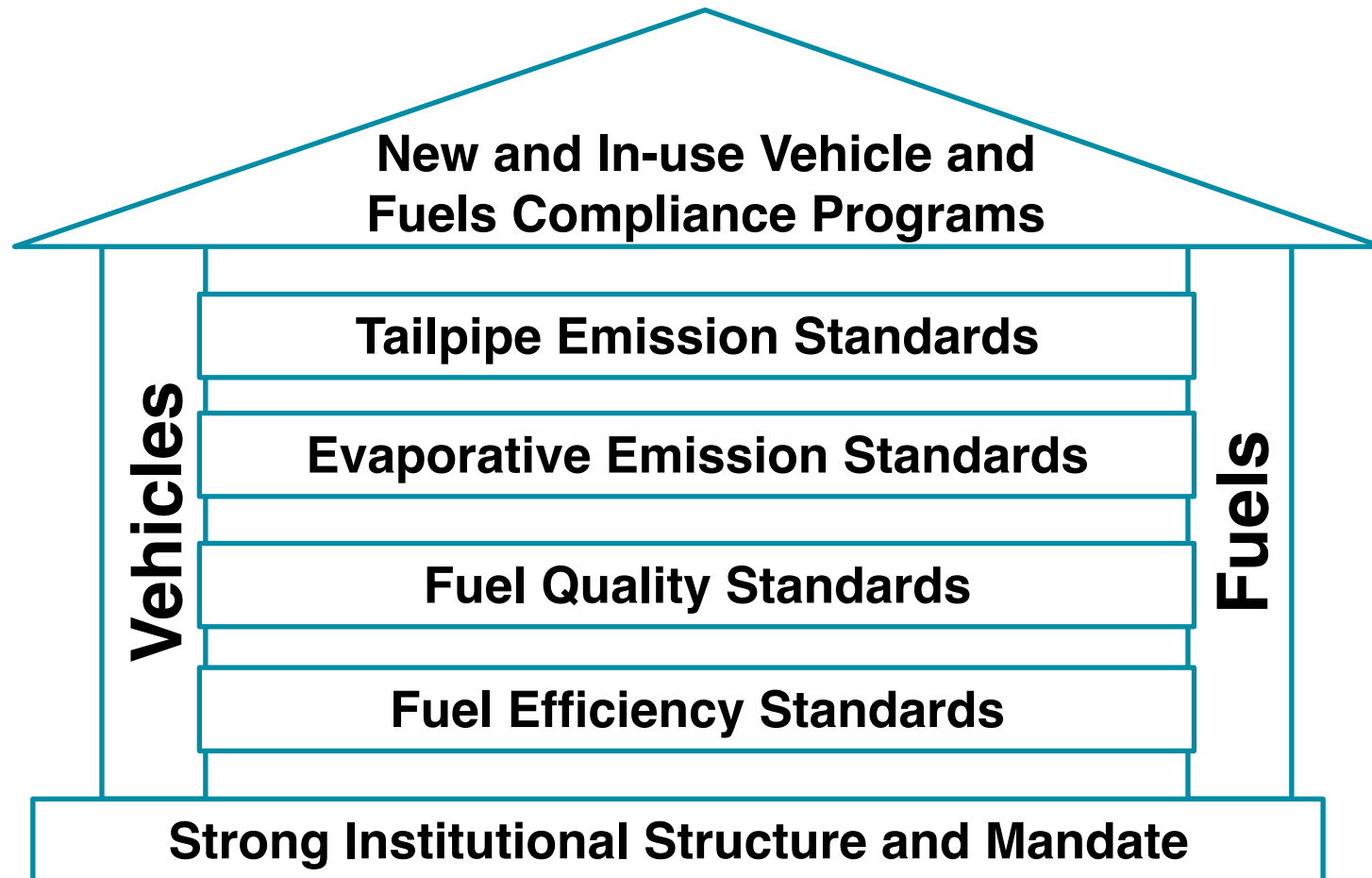
WLTP (2014)



+ improved test procedure

Summary

The next phase of Auto Fuel Policy should continue to emphasize a systems approach.



India's program to match global best practices by 2025