

Reducing Vehicular Emissions: Comparing India's program against global benchmarks

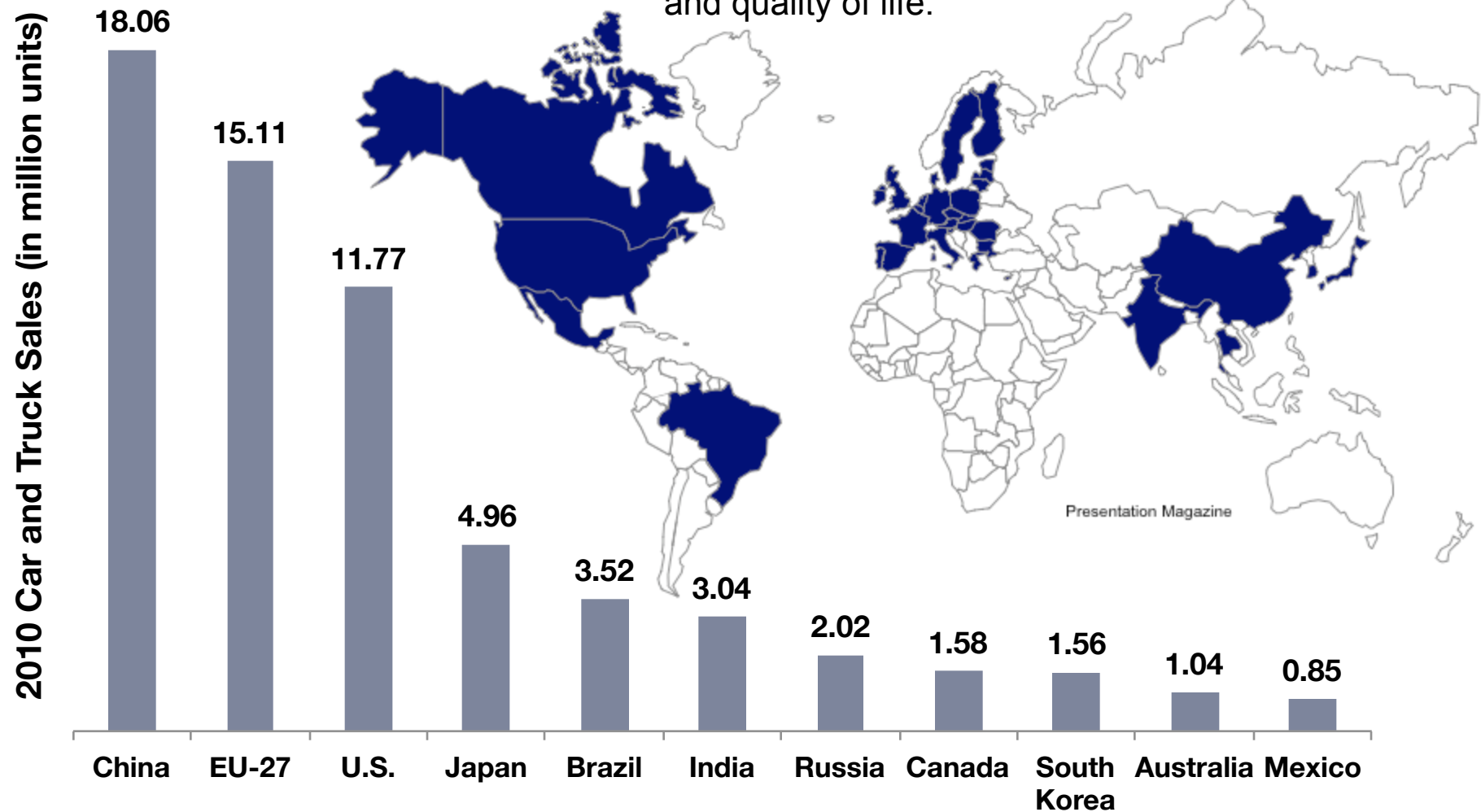
Anup Bandivadekar/ Gaurav Bansal

April 26th, 2012



The mission of the ICCT is to dramatically improve the environmental performance and efficiency of cars, trucks, buses, and transportation systems in order to protect and improve public health, the environment, and quality of life.

Top Eleven Vehicle Markets, 2010



Purpose of this webinar series is to initiate a dialogue around Auto Fuel Policy in India.

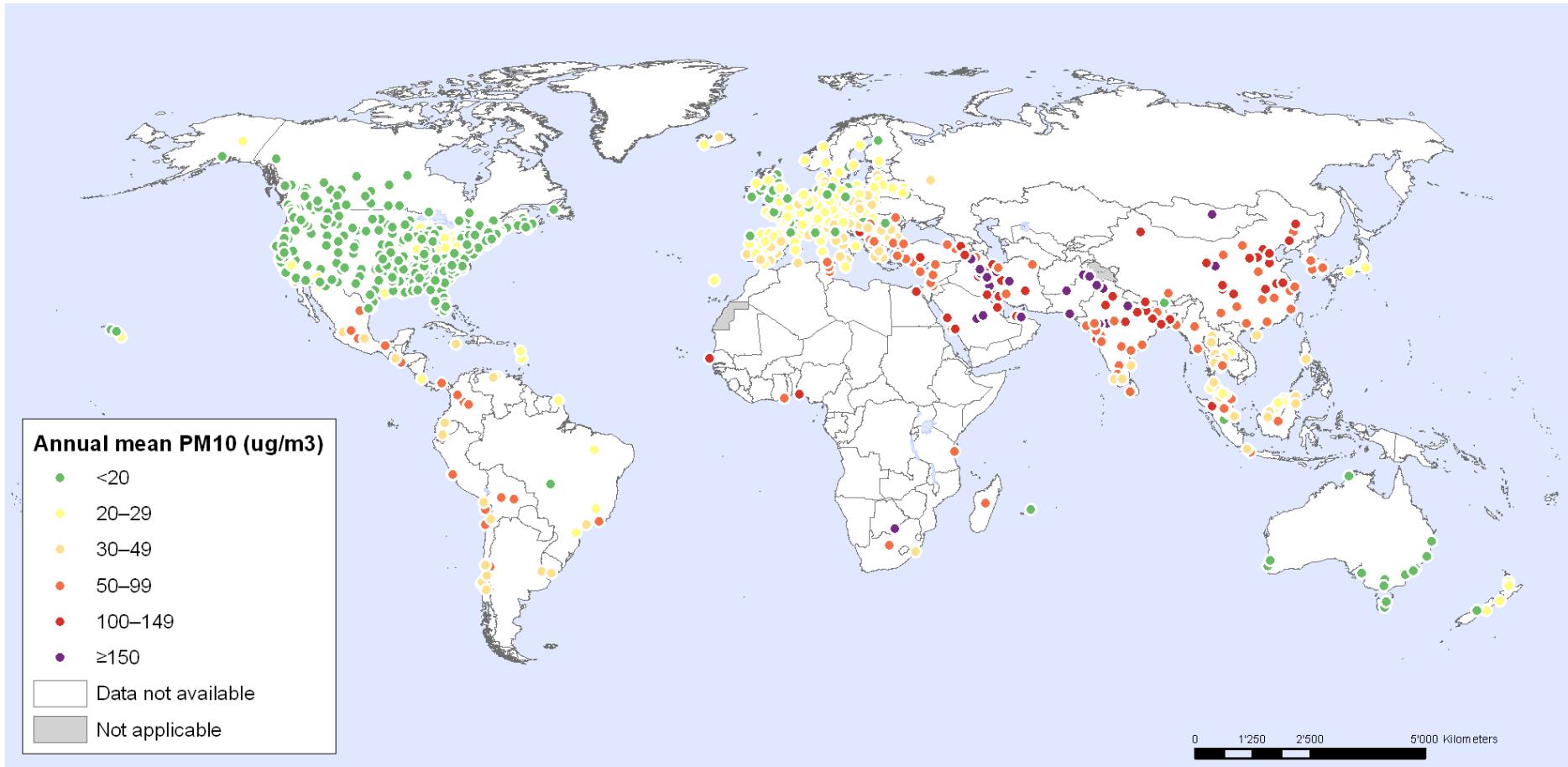
ICCT is conducting a study to evaluate the past successes and future prospects of India's vehicular emissions control program

- New vehicle and engine 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

Motivation

WHO estimated 1.34 million premature deaths from outdoor air pollution in 2008.

Exposure to particulate matter with an aerodynamic diameter of 10 μm or less (PM₁₀) in 1081 cities, 2003–2010



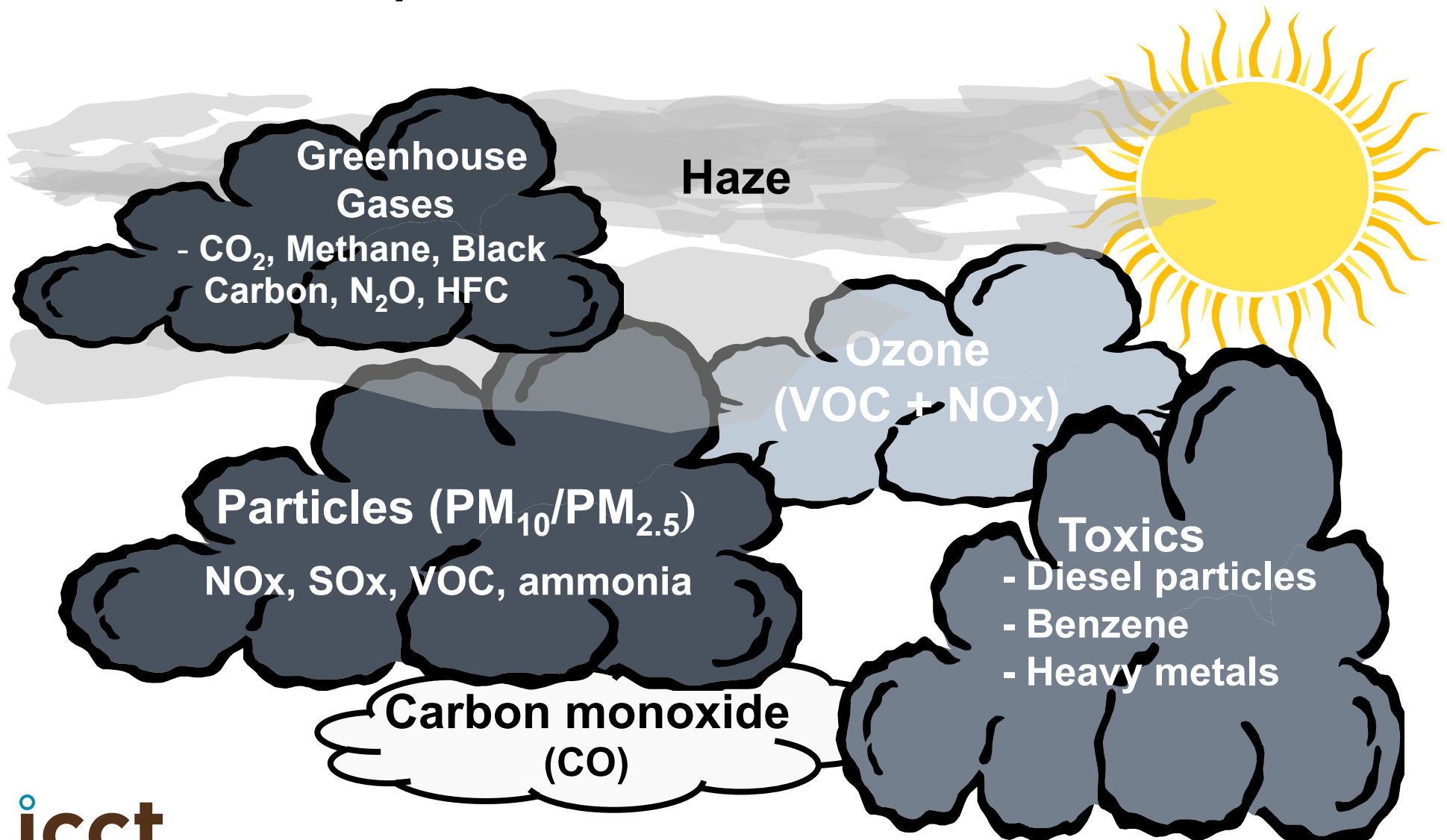
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Data Source: World Health Organization
Map Production: Public Health Information
and Geographic Information Systems (GIS)
World Health Organization



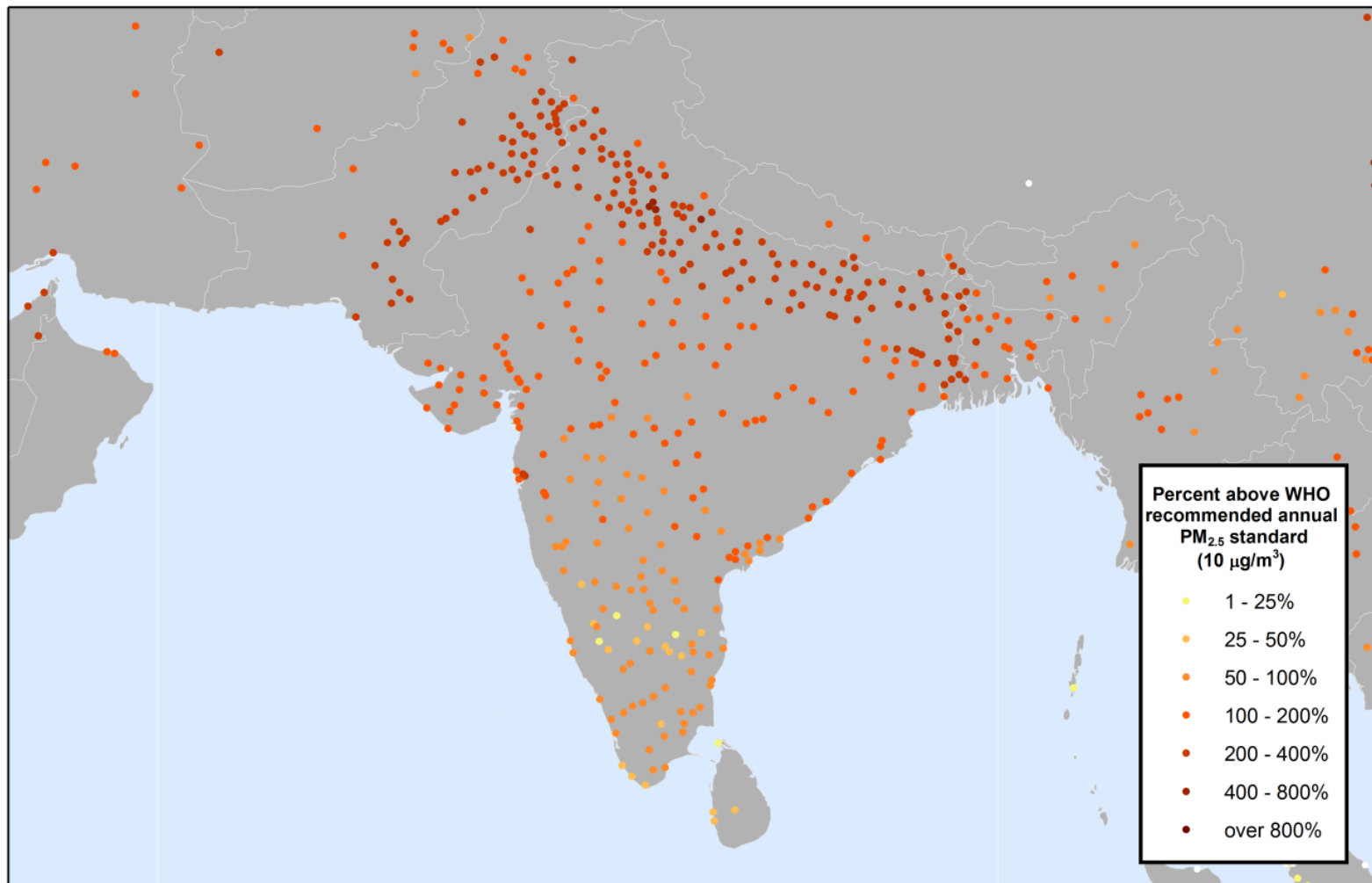
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What pollutants are of concern?



154,000 lives lost each year in India due to PM_{2.5} alone...

2005 Annual Average PM_{2.5} Concentrations Relative to WHO Air Quality Guidelines



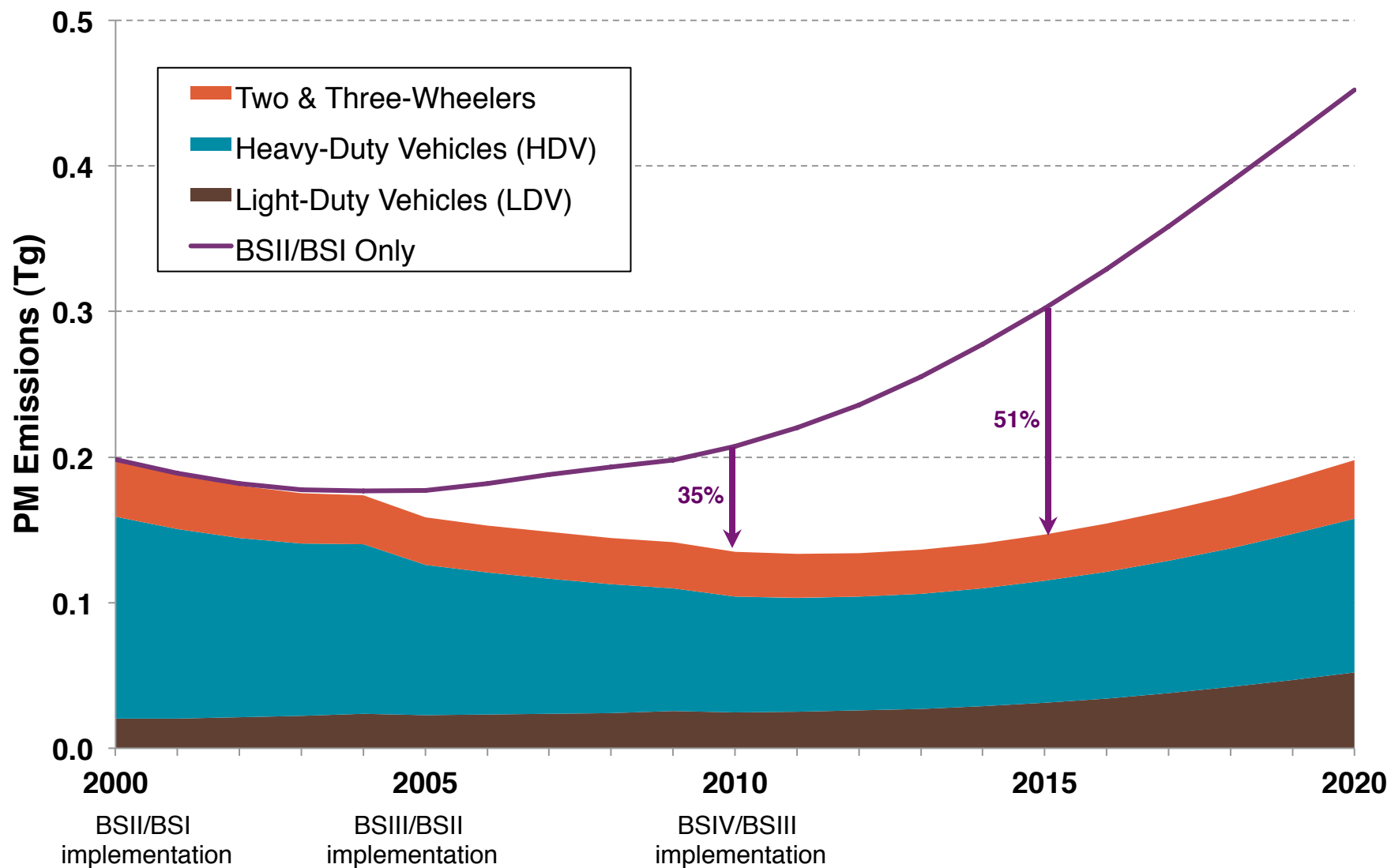
Today's webinar focuses on the vehicular emission standards and compliance program.

- Compare and contrast India's program with that in US, EU, Japan and China
 - What's working
 - What's not working
 - What could be improved
 - Barriers to progress
 - Preliminary recommendations for discussion
- Next webinar (May 24) will focus on fuel quality standards and compliance programs, while the third webinar (June 28) will focus on evaluation costs and benefits of cleaner vehicles and fuels in India

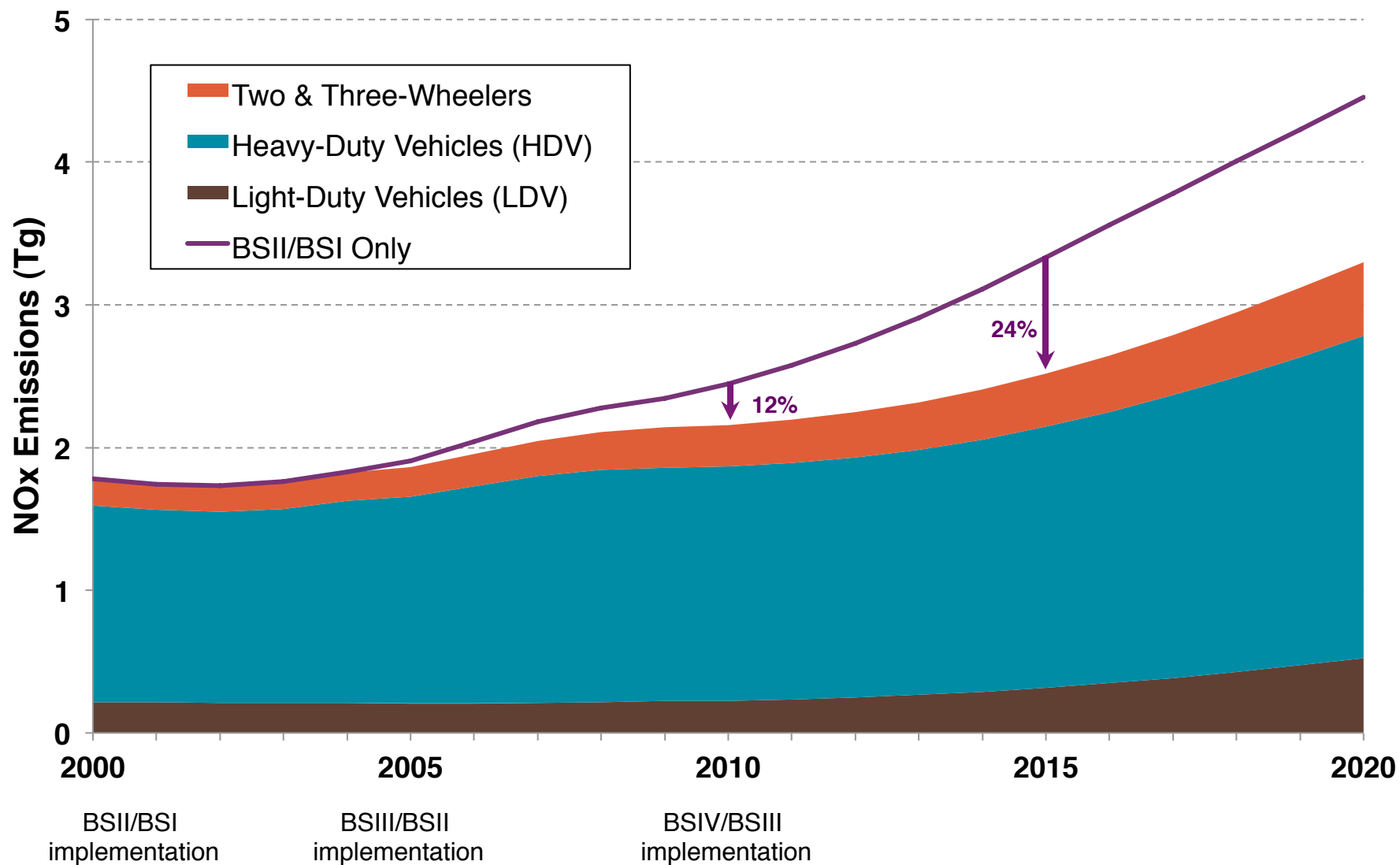
What has been accomplished as a result of Auto Fuel Policy of 2003?

- Vehicle emission standards and fuel quality standards implemented more or less as per schedule
- Use of CNG and LPG has increased, especially in city buses and autorickshaws
- Some progress on improving I&M program
 - 10 testing centers to be set up by ARAI by 2012

Annual PM Emissions (2000-2020)



Annual NOx Emissions (2000-2020)



India covered a lot of ground from 2001-2010, but risks falling behind now

- For 2/3 wheelers:
 - GTR2 not yet adopted
 - HC+NOx combined standards
- For Light-Duty Vehicles:
 - Diesel car share has increased to 40% of new vehicle sales in 2011-2012
 - Euro IV diesels emit three times NOx and an order of magnitude higher PM emissions than Euro IV petrol
 - Little progress on refueling evaporative emissions
- For Commercial Vehicles and Buses:
 - BS IV limited to a few bus fleets, trucks still at BS III

Indian emission standards still 6-10 years behind

Light-duty Vehicle Emission Standards Schedule

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---------------------|-----------------------------|--|------------|-----------|---|--|----------|-----------|------------|--------|
| India | Bharat II | | | | | Bharat III | | | | |
| India - 7 Cities* | Bharat II | | | | | Bharat III | | Bharat IV | | |
| India - 13 Cities** | Bharat III | | | | | Bharat IV | | | | |
| Brazil | PROCONVE 3 | | PROCONVE 4 | | PROCONVE 5 | | | | PROCONVE 6 | |
| China | China II | | | China III | | | China IV | | | |
| S. Korea | US NLEV | CARB K-ULEV and Euro 4 (diesel vehic.) | | | CARB LEV-2 and Euro 5 (diesel vehicles) | | | | | |
| Europe | Euro 4 | | | | | Euro 5 | | | | Euro 6 |
| Japan | FY 2005 Emission Regulation | | | | | Post New Long Term Emission Regulation | | | | |
| United States | US Tier 2 | | | | | | | | | |

Heavy-duty Vehicle Emission Standards Schedule

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---------------------|-----------------------------|-----------------------|-----------|--------|---------|--|------|----------------------|----------|------|
| India | Bharat II | | | | | Bharat III | | | | |
| India - 7 Cities* | Bharat II | | | | | Bharat III | | Bharat IV | | |
| India - 13 Cities** | Bharat III | | | | | Bharat IV | | | | |
| Brazil | PROCONVE 4 | PROCONVE 5 (Euro III) | | | | | | PROCONVE 7 (Euro IV) | | |
| China | China II | | China III | | | | | | China IV | |
| S. Korea | Euro III | | | | Euro IV | | | | | |
| Europe | Euro 4 | | | Euro 5 | | | | | Euro 6 | |
| Japan | FY 2005 Emission Regulation | | | | | Post New Long Term Emission Regulation | | | | |
| United States | US 2004 | | US 2007 | | | US 2010 | | | | |

*Puducherry, Mathura, Vapi, Jamnagar, Ankleshwar, Hissar, Bharatpur

**Delhi, Mumbai, Kolkata, Chennai, Bangalore, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur

New vehicle emission standards are getting more stringent

- Exhaust emissions standards
 - Tighter standards
 - Euro 6/VI: PM and NOx aftertreatment on all diesels (DPF+SCR)
 - By 2020, EU motorcycle emissions down to Euro 5 level
 - California LEV III/ US Tier III: SULEV average by 2022
 - Improved test cycle, cold start measurement, particle number limit, increased durability
- Evaporative emissions
 - Whole vehicle diurnal plus hot soak standards – near zero emission expected from all vehicles including E10 vehicles
 - On-board Refueling Vapor Recovery (ORVR) widespread across US
 - under consideration in China V standards

Manufacturers responsible for in-use emissions over full range of real world driving conditions.

- In-use compliance tests
 - Detection of type specific design related defects or inadequate maintenance instructions
- Strengthening of on-board diagnostics
 - Frequency of monitoring: In use performance ratio (IUPR) monitoring
- Periodic exhaust inspection
 - High opacity as measured on snap acceleration test may indicate engine malfunction and increased emissions of air pollutants, primarily unburned fuel hydrocarbons or soot particles.

Comparison of US and India Vehicle Compliance Programs

| | India | US |
|--------------------------------|--|---|
| Testing Protocol | Type approval (TA) and conformity of production (COP) through testing centers | <ul style="list-style-type: none"> TA, COP and in-use testing by manufacturers. EPA runs confirmatory tests, in-use surveillance tests, and oversees the selective enforcement audits (SEAs). |
| Compliance Testing | Manufacturers advised before selection of vehicles for COP | Vehicles from models identified for testing selected at random |
| Compliance Testing | Vehicles/engines must pass standard test cycle | Vehicles must pass supplementary test cycles (SFTP/ NTE) in addition to standard test cycles |
| Durability Requirements | <ul style="list-style-type: none"> 100k km (BS IV-LDVs) Deterioration rates or 125k-167K km (HDVs) | <ul style="list-style-type: none"> 180k km/ 10 years (LDV) 700K km/ 10 years / 22K hours (HDV) |

Comparison of US and India Vehicle Compliance Programs

| | India | US |
|-----------------------------------|---|--|
| In-use Vehicles | I/M (PUC) inspections conducted by independent operators not linked to vehicle registration | I/M inspections conducted by state/local authorities linked to vehicle registration |
| In-use Vehicles | Certificates issued to PUC compliant vehicles | Visible sticker issued to I/M compliant vehicles |
| In-use Vehicles | PUC data not sent to centralized system | I/M data accessible to EPA to identify vehicles for in-use testing program |
| On-Board Diagnostics (OBD) | OBD-II will go into effect on BS-IV LDVs only starting 2013 | <ul style="list-style-type: none"> • LDV OBD since 1996 • HDV OBD since 2005 • Increasing reliance on OBD for in-use monitoring |
| Non-compliance | No mandatory recall policy | Mandatory recall for vehicles not in compliance |

Preliminary recommendations for discussion

- Test cycles more representative of real-world driving conditions
 - Adoption of World Harmonized cycles as soon as possible
 - India already participating in WLTP discussions, and should make a commitment to adopt WLTP and WHDC
- Greater emphasis on real-world emissions performance
 - More stringent durability requirements
 - Testing beyond new vehicle TA and COP to ensure life-cycle emission standards are met
 - Linking data from I/M tests to a national in-use compliance program
- One agency to regulate fuels and vehicle standards, as recommended by 2003 Auto Fuels Policy Committee?

Preliminary recommendations for discussion

- Long term roadmap needed quickly to give industry adequate lead-time
 - Technology already in the market, but on limited models in India
 - Leapfrog to stricter emission standards may be possible
 - Clear pathway to closing the gap with the best-practices

- One Country, One Fuel, One Regulation!
 - More on this during the next webinar!

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