Anil Agarwal Environment Training Institute

Air Pollution, Beyond Delhi
Towards clean air action plan
Learning curve and roadmap for
the coming decade
Indian cities in top chart

- Out of the world's 50 most polluted cities, 28 are in India, 5 in China, 7 in Middle East and 2 in the Balkans.

- PM2.5 levels exceed WHO in 7 cities out of 10 globally, 8 out of 10 in Europe and essentially everywhere in Asia.
National Clean Air Programme (NCAP) target for 122 cities:

Reduce particulate pollution by 20-30 per cent by 2024 from 2017 levels……..

State Governments have been directed to implement the City Action Plans
Pollution – High and Low

- Increasing PM10 trend
- 32% increase between 2011 and 2017
- Reduction target = 52%

- Increasing PM10 trend
- 51% increase between 2011 and 2017
- Reduction target = 54%

Source: Based on data available on CPCB Envis centre and data submitted to Lok Sabha
PM10 in different climatic regions

Indo-Gangetic plain

Source: CSE’s analysis based on CPCB Envis centre and data submitted to Lok Sabha
PM10 in different climatic regions

Hot & Dry (South)

Warm and Humid (Coastal)—PM10 levels have gone up to 2 times the standard in case of Mumbai

Source: CSE’s analysis based on CPCB Envis centre and data submitted to Lok Sabha
Selected cities of Haryana and Punjab

- Ludhiana
- Bhatinda
- Sirsa
- Jind
- Hisar
- Karnal

Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov

Source: Based on data available on CPCB
Selected cities from UP and Bihar

Source: Based on data available on CPCB
Cities of Eastern Rajasthan and Agra

Source: Based on data available on CPCB

Table showing air quality for cities Alwar, Narnaul, Jaipur, Ajmer, and Agra from December to November with categories: Good, Satisfactory, Moderately polluted, Poor, Very Poor, Severe, Severe+ and Missing.
## Cities of West Bengal and

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Source: Based on data available on CPCB
Greater Mumbai region and Vapi

Source: Based on data available on CPCB
Tracking shifting smog peaks in Indo-Gangetic Plain during smog episodes

Source: Based on data available on CPCB Envis centre and data submitted to Lok Sabha
Pollution hotspots in Delhi
Episodic pollution
Stubble burning in Punjab and Haryana

Fire count from NASA

Source: CSE analysis of fire count data from NASA
Health is a leveler

Map: Death rate per 100,000 population

Map: Population-weighted PM2.5 concentration (micro-gm/m3)

Air Pollution high risk factor in Indian states (1990 vs 2016)

Source: India’s Health of Nation’s States Report, 2017: IHME-ICMR
Most productive age group highly vulnerable

Age group between ages 35 and 60 most vulnerable to non-communicable diseases. Increases vulnerability to air pollution.

Source: India State Level Disease Burden, Lancet, 2017
Health of children compromised......

2012 epidemiological study on children in Delhi (CPCB and Chittaranjan National Cancer Institute of Kolkata):-- Covered about 12,000 school-going children from 36 schools.

-- Every third child has reduced lung function. Sputum of Delhi’s children contains four times more iron-laden macrophages than those from cleaner environs, indicating pulmonary hemorrhage.

-- Levels of biomarkers in children higher in areas with high PM10 levels.

-- Children grow up with 10% smaller lungs (SK Chhabra study 2017)
Emerging evidences of health impacts in India......

Alveolar macrophage - biomarker of air pollution

Exposed group; Kolkata taxi driver

Increase in AM number

Control area: Sundarbans

Sputum cytology of a 14-year old girl, showing abundance of particle laden AM

Source: CNCI
Look at these black spots on the lung. The unfortunate owner lives in Delhi and has been breathing polluted air. Air full of carbon particles which accumulate in the lungs (black spots). What you can’t see is a cocktail of gases and tiny particles, even smaller than carbon that get into our bodies. Actually, you are getting polluted.
Be warned .... Most of the health effects occur at lower annual average levels

Integrated Exposure-Response function for Ischemic Heart Disease
Reduction needed to meet the national ambient air quality standard for particulates....
Reduction target for PM2.5

Source: CSE’s analysis based on CPCB Envis centre and data submitted to Lok Sabha
PM10 reduction target

Source: CSE's analysis based on CPCB Envis centre and data submitted in Lok Sabha
NCAP: Several questions

- Compliance, monitoring and accountability framework for implementation and to meet targets
- Scientific and technical support for the programme
- How will this work within the federal system?
- How to enable higher level of ambition at state/city level?
- How to build multi-sector and design rich solutions for effective impact?
- Funding strategy for action plans
- Can NCAP be on mission mode?
- Benchmark for effectiveness of clean air action plans
- How health can be a bigger driver
- How to align legal, technical, and behavioural solutions
- How can people be the partner in change?
Imperative of third generation action: Implementation

- **First generation**: Action for urgent relief – Address gross polluters - CNG, shifting of industry, old vehicle phase out

- **Second generation**: New generation policies and standards – Emissions standards for vehicles and power plants, Regulations for waste (C&D and MSW); NUTP, TOD, NHS, clean energy access etc. Changing governance principles

- **Third generation**: Need implementation, enforcement, compliance framework, institutional capacity, design rich solutions … for transformative changes at a scale across sectors

- More decentralised local and regional action
Lesson from Delhi
First generation reforms

2000-2010: Delhi has fought hard to get breathing space

On vehicles
- Introduced low sulphur fuels and petrol with 1 per cent benzene
- Mandated pre-mix petrol to two- and three-wheelers
- Moved from Euro I to Euro IV over the last decade
- Implemented largest ever CNG based public transport programme
- Capped the number of three-wheelers
- Phased out 15 year old commercial vehicles
- Strengthened vehicle inspection programme (PUC)
- Efforts made to divert transit traffic
- Set up independent fuel testing laboratories to check fuel adulteration

On industry
- Relocated polluting units
- Tighter controls on power plants. No new power plants.

Air quality monitoring
- Adopted new ambient air quality standards
- Expanded air quality monitoring and reporting

Other sources
- Emissions standards for generator sets
- Ban on open burning of biomass
Second generation reforms.....
Soft options are now all exhausted

Post 2010: Momentum build up

Transport
Bharat stage IV emissions standards and Bharat Stage VI fuels
Environment compensation charge on each truck entry and cashless payment through RFID, ban on entry of 10 year old trucks, bypasses to divert truck traffic
H-CNG pilot for buses
Environment Pollution Charge on big diesel cars an Suvs
Ban on 10 year old diesel vehicles and 15 year old petrol vehicles
Metro expansion
Notification of parking policy as a demand management measure

On industry and power plants
Approved fuel list that bans coal and all dirty fuels; Petcoke and Furnace oil banned
Use of natural gas in industry expanded
All coal power plants closed down in Delhi
SOx and NOx standards
Half of brick kilns in NCR have moved to improved zig zag technology

Other sources
- Emissions standards for generator sets
- Ban on open burning of biomass
- C&D recycling
Desperate measures during winter

October 12, 2018 to March 15, 2019 - Very Poor category action implemented
- Badarpur coal power plant closed (Now permanently)
- Diesel generator sets not allowed
- Industrial units on coal and biomass shut; Brick kilns shut

November 1-12, 2018
- Ban on construction activities, hot mix plants and stone crushers

November 4-12, 2018
- Industries using coal and biomass as fuel shut

November 8-12, 2018
- Truck entry ban

December 24-26: Emergency action
- Industries closed in hotspots
- Construction ban
- Enforcement on waste burning and construction (enforcement challenges)

January 4-5, 2019
- Truck entry ban
Delhi: Decadal PM2.5 trend
25% drop; Need to cut another 67-75%

Source: CSE analysis of CPCB real-time PM2.5 data using US EPA methodology
How the years look like?
Number of cleaner days increasing; Severe days still obstinate

Almost 50% increase in number of days meeting 24-hr PM2.5 standard

Number of severe and sever plus days nearly constant

Very poor days declined

Source: CSE analysis of PM2.5 data from CPCB,
Delhi winter pollution: changing pattern

Source: Based on data available on CPCB
Compliance framework for meeting air quality targets
The WHO issues guidelines on air quality

India’s National Ambient Air Quality Standards are notified by CPCB under the Air Act (Prevention and Control of Pollution) Act, 1981: – Section 16 –subsection (2) (h)

Governance framework


-- Legislations, rules and policies in relevant pollution control sectors
Levers of power and authority to act: Power of the Union

The Environment Protection Act 1986 and Air Act 1981 are enacted under Union’s List 1 (Entry 13 and 14 with Article 253 of the Constitution). Makes powers of the Union government exclusive and overriding.

Section 3 and 5 of the EPA Act 1986 provisions are wide and empower the Central Government to empower inter alia coordination of action by state governments and planning and execution of nation-wide programme; MOEFCC can take these steps.

How will this enable multi-sector action?
The Environment Protection Act 1986

Central govt can lay down standards for quality of environment (sec 3 (2) iii).

Restrict areas –

Industry operations or processes can be restricted (sec 3(2) ix)

MOEFCC has the power to give directions under section 5 of the Act and make rules to regulate pollution

MOEFCC has power to take cognizance of offence by government department under section 17 of the Act – (Such prosecutions do not happen)

MOEFCC has powers to delegate powers and function specified under the Act
Power and authority of Boards

**Air Act Article 16 (a)** Central Board to *advise* the central govt

- (b) **Plan and execute nation-wide programme** for prevention, control, abatement of air pollution
- (c) **Coordinate activities** of state and resolve disputes
- (h) **Lay down standards for air quality; Technical support**

**Air Act Article 17: Functions of the state board**

- (a) **Plan comprehensive programme**
- (b) **Advise** state government
- (g) **Lay down in consultation** with the state board regarding air quality standards & emissions standards for industry & motor vehicles

**Air Act Article 18: Power to give directions**

- (a) **Central Board bound by directions** from central government
- (b) **State Boards bound by directions** from central board & state government
Air Act Article 19: Power to declare air pollution control areas

(1) State government after consulting state board may prescribe, alter, declare or merge air pollution control areas

This is confined to only industrial areas ..... What will allow broader interpretation for more effective intervention at city and regional level?
Lessons from global experience

US Clean Air Act: Compliance for clean air target

States are required to meet air quality standards within a certain time frame.

Timeframe depends on severity of air pollution problem.

Failure to submit an adequate implementation plan which EPA can approve results in a ban on major new industrial sources and a loss of federal transportation and water treatment funds.

In the extreme, EPA can step in to develop and implement its own plan for the state.

Citizens suits: EPA can be taken to court by private citizens and forced to take action. Similarly, for states.

What can we do?
Action planning begins

-- Air quality management and monitoring strategies
-- Industry
-- Power plants
-- Vehicle and transportation strategies
-- Open burning
-- Construction activities
-- Diesel Generator Sets
-- Solid fuel burning (cooking and open eateries)
-- Road dust
-- Greening
What’s causing the problem?
Source assessment
Need deep cuts and multi-sectoral approach

Emission inventory – PM2.5

Key approach...

National policies and norms – Common minimum
Aligning ongoing action in different sectors
Two Action Plans


Comprehensive Clean Air Action Plan – June 2018
Round-the-year Action
-- Priority, design and compliance
Air quality monitoring and source assessment

Realtime air quality monitoring to be scaled up

All non-compliant cities to carry out source apportionment and inventory studies

Need quality control and assurance

Standardised protocol for studies for quality control

Build capacity for such assessment
Industrial pollution control
Current legal approaches

Restriction on use of certain industrial plants (*Air Act Section 21*)

1. No permission without **consent to establish or operate** any industrial plants in air pollution control area.
2. Consent conditions have been detailed out.

No plant can emit excess of standards: *Air Act Section 22:*

**Power of Board to make application to court** (*Metropolitan and Judicial Magistrate*) for restraining person from causing air pollution (*Air Act section 22A*)

**Power to give directions** – (*Air Act Section 31A*)

1. Power to direct closure, prohibition or regulation of any industry, operation or process
2. Stoppage or regulation of electricity, water and other services

**Power to declare air pollution control areas** (*Air Act Article 19*)

3 & 4: Prohibit polluting fuels and allow only approved appliances
Gap between power and operations

CAG review of several SPCBs show several challenges:

- Failure to take action against polluting industrial units
- No database on pollution sources and pollution load in the state
- No mechanism to monitor validity period of consent and operation
- Consent for establishment and operations to highly polluting industries without mandatory inspections – even to red and orange categories
- “Ease of doing business” policy subvert environmental governance: Automatic consent is supposed to prevent halting of industrial operations – inspection and audit not carried out for deemed consent
- **Weak inspection**: Massive shortfall in number of inspection (could range from 41 to 49%). This weakens enforcement
- **Action on approved fuels very weak**
- Not exercising available powers
CAG review of several SPCBs show several problems

- **Lack of zoning map** for locations of industrial units
- **Problems with siting policy** – often ecologically sensitive areas are not properly identified or as per the MOEF guidelines
- Industrial units found to be operating without valid consent to operate.
- On-ground inspection show deviation from conditions for consent to operate (include raw material handling, fugitive emissions, etc)
- What constitutes compliance can be fuzzy – actual emissions or availability of emissions control systems?
- **Data on actual compliance status is often not compiled.**

Only legal power is not enough. Need capacity and robust operational systems
Need effective deterrence

Understanding current Penalty regime

Failure or contravention punishable with imprisonment (5 years and fine upto Rs 5 lakh) (Environment Protection Act - Section 15)

If fail to comply punishable with imprisonment for a term. If failure continues – additional fine (Rs 5000 per day for the duration of failure) (Air Act – Section 37 (1)

Emergency power to cut electricity and water

Bank guarantee: West Bengal, Andhra Pradesh, Maharashtra – started using bank guarantee system for defaulting industry to ensure compliance and corrective action. Renewal of consent is made conditional to posting of bank guarantee (normally 10% of cost of compliance is bank guarantee).

Forfeiture is a strong disincentive and a future deterrent

Hazardous waste Act – allows penalty – Maharashtra has used this.
Fiscal penalty

Court directives have evoked polluter pay principle

Polluter pay implicit in court orders and NGT Act

-- If non-compliant with NGT order – fine may extend upto Rs 10 crore; additional fee upto Rs 25000 per day; or imprisonment -- Fine may increase to Rs 25 crore. And one lakh per day…

-- Tribunal may fix relief and compensation to victims of pollution; recover damage to public health, property, and environment (Chapter III (
Penalty and deterrence: Address critical issues

Penal provision not adequate; not a deterrent and not proportionate to damage.

-- Penalty can be imposed but not directed by SPCBs. Court of law can issue penalty. SPCBs can only issue closure notice and cut off electricity and water.

-- Needs criminal prosecution by filing a complaint

-- No standard procedure for fixing penalty

-- Penal powers will have to be provided specifically in statute. SPCBs cannot demand payment for damage to environment

-- Absence of civil administration authority (to impose administrative fines) limits effectiveness of enforcement; Need market based mechanism

This requires reforms
Need reforms for advanced monitoring and compliance

Towards self regulations and environmental audit

Introduction of continuous emissions monitoring

Self monitoring data not used for enforcement – Sec 26 Air Act, Sec 11 of EP Act). Closure notice can be challenged in the court

Burden of proof:
In Europe burden of proof lies with the polluter; In India with SPCB. Therefore, results from polluter not admissible

Integrate compulsory audit – with compliance mechanism
Major industrial sources comply with Federal minimum standards. New source performance standards.

Depending on the state level air quality levels the state can require best available technology or lowest achievable emissions rates.

Failure to comply with the standards can result in fines or mandatory shutdowns.

If individual companies cheat on emissions they face legal challenges.
National action on dirty industrial fuels

Delhi-NCR: Petcoke and furnace oil:
- SC order -October 24, 2017: Ban on pet coke and furnace oil as fuels in Delhi, UP, Haryana, Rajasthan – Exemption to cement, calcium Carbide, Lime kilns, Graphite Electrode

• National
- SC order November 17, 2017: Requests all States of India to take measures to ban Furnace Oil and Petroleum Coke usage.
- DGFT Notification 24.8.2018 – Ban import of petcoke; Also MOEFCC to restrain its domestic use to be WTO compliant
- SC order - December 31, 2017: SOx and NOx standards for 34 groups of industry

Approved Fuels:
Delhi Government - Notification of Approved fuels list in Delhi: Coal, biomass and high sulphur fuels banned (selective use of charcoal)
SC order to all states in NCR to prepare approved fuel list
**Nation-wide**

**Organised sector**: Enforce existing and new NOx and SOx standards
- Scale up Clean fuel strategy -- natural gas, elimination of dirty fuels
- Use CEMS for enforcement and compliance monitoring with adequate safeguards

**Industry clusters** - Address cumulative impact and prescribe more stringent action for industries
- Restrict and regulate intensively polluting industries within urban air-shed

**Informal and unauthorised units**
- Control fugitive emission and hazardous pollution
- Implement local area action plan for pollution hotspots
- Strengthen siting policy
Delhi
• All coal power plants shut
• Strategies for fly ash pond
• Gas supply for Bawana plant – implemented in July 2018

NCR and National:
Implementation of new thermal power plant standards by an early date

Supreme Court Order 2018 – Prioritise high density areas - 400 persons per sq km –
- 57 central government units to meet SOx and PM standards by December 2021
- NOx standards by December 2022
- Need roadmap of state and private power plants;
- Ministry of Power to assess use of Merit Order Dispatch to accelerate the process

• Need phase out plan for very old plants
• Need plant-wise roadmap for phase in, and Incentivize them through Merit dispatch order
• Potential of gas based power plants
• Fly ash management
Challenge of dispersed sources
Brick kilns
How to monitor dispersed small scale units?

Implementation of 2017 order of CPCB on brick kilns:
• Conversion of natural draft to induced draft
• Provide consent, failing which brick kilns to be shut
• Meet prescribed norm and siting guideline with immediate effect
• Strictly enforce siting guidelines
• Ensure the area around brick kilns is paved
• Ensure fine dust does not accumulate around brick kilns
• Move from natural draft to induced draft kilns (zigzag)
• Prescribe design specifications and ensure compliance checking
• Need promotional campaign replace traditional bricks with hollow and perforated bricks, flyash bricks, concrete blocks with recycled waste, etc

Delhi-NCR: Restrictions on operations of brick kilns within urban air shed zones during high pollution periods
Hotspot action

Delhi

• **Hotspot monitoring and identification for local issues**: Anand Vihar, Delhi Technical University in Delhi and Ghaziabad, Bhiwadi in NCR during 2017.

• DPCC preparing local area action plan for key monitoring stations

• **2018 micro level action planning and action** –
  – Bawana and Narela: vacant plots full of industrial waste, plastic, rubber etc
  – Two private players responsible for clearing industrial waste penalised Rs 10 lakh each. DSIIDC was fined Rs 50,000 each for lack of accountability
  – Industrial waste problem detected in Mundka, Dwarka, Nangloi, Tikri etc
  – More than 12,125 tonnes of waste cleared from these areas
  – Fines on 44 industries, two DDA construction sites for dust management
Local issues?

Mundka, Delhi Plastic recycling plants: massive plastic burning
Immediate action to link with controlled incineration
Delhi,

- **Dust control checklist for construction sites to address fugitive emissions** from material handling, conveying and screening operations. Needs enforcement.
- Punitive action – not a deterrent

**C&D waste recycling**

- Network of decentralized C&D waste segregation and collection sites across the city.
- Material handling, construction and demolition should be obligatory on part of the developers to provide evidence of debris on-site recycling and/or disposal at designated sites.
- Promote recycling of construction and demolition waste
- Uptake of recycled material for upmarket use
Step by step progress
Be prepared to address hurdles

Legal hurdles:
Indian standard specification for aggregates for concrete stated - these should be ‘naturally sourced’. Did not allow recycled or reused components.

National Building Code of India 2016:
Recycled Coarse Aggregate may be used in concrete for bulk fills, bank protection, base/fill of drainage structures, pavements, sidewalks, kerbs and gutters etc. Up to 30% of natural crushed coarse aggregate can be replaced with recycled concrete aggregate. This can be increased up to 50% for pavements.

New notification on C&D waste:
Utilise 10-20% of material from C&D waste in municipal and government contracts
Large developers accountable for collection and disposal of C&D waste
BIS to prepare a code of practice and standards for products of C&D waste
Indian Road Congress to prepare standards for use of C&D waste in road construction
Incentives to waste generators for salvaging, processing, and recycling, preferably in-situ.
No takers
Indian Best Practice

Supreme Court Extension Project used 1.8 million Recycled C&D waste blocks.
Waste Burning

Sustainable waste management -- Implement Solid Waste Management Rules and Regulations
- Solid waste byelaws not implemented
- Infrastructure for segregation not implemented at scale
- Waste management in unauthorised areas and slums
- Inventorisation of waste
- Implementation of EPR and circular economy
- Lack of compliance and enforcement capacity

- Landfill management
- Zero landfill policy

- Waste to Energy (WTE) Plants – to be last option – Not the first solution
- Co-processing before WTE
- Implement stringent emission norms – Need CEMS monitoring
- Only segregated waste
- Siting policy for WTE plants
A targeted programme to be implemented for 100 per cent coverage of households by distribution of LPG/PNG in all non compliant cities.

Challenge of reliable access and refill

Give access to LPG and electricity in low-income neighbourhoods, as well as roadside eateries/dhabas/ restaurants etc.

Link this with licensing policy. Incentivize move to LPG, electricity for residential and commercial use

Need health based campaign
Crop burning

In field solution
Mulch and mix with soil; Can reduce fertiliser cost for farmers

Ex-situ solution
Promote biomass-based power plants
Production of biofuels and fertilizers
Biomass pellets and other uses
R&D and crop diversification
Uniform decentralized mechanism for the collection, storage and commercial sale of crop residue

Provide farmers with alternatives and educate them on stubble burning
Vehicles and transport
Explosive numbers

Trends in total vehicle registration in India (1951–2015)

Source: Road Transport Yearbook, MoRTH, 2016
Motorization: High growth rate across Cities

Trend in total registered vehicles and average annual growth rate in the 14 cities (2006–16)

- Mega cities have very high vehicle stock; **Delhi highest**
- Metropolitan cities with smaller base have recorded very high growth rate

Source: MoRTH statistics
PM2.5 Emission inventory

Source: 2018, SAFAR High Resolution Emission Inventory of Delhi City, Indian Institute of Tropical Meteorology

Note: Others i- agricultural burning, crematoria, restaurant, airport, waste incinerators, Source: August 2018, Source Apportionment of PM2.5 & PM10 of Delhi NCR for Identification of Major Sources, Prepared by ARAI and TERI
Source: August 2018, Source Apportionment of PM2.5 & PM10 of Delhi NCR for Identification of Major Sources, Prepared by ARAI and TERI
How much pollution we breathe while travelling?

Source: Based on CSE exposure monitoring and DPCC data for ambient levels.
Vehicles and air quality governance
Uneasy linkage

The Environment Protection Act 1986 and Air Act are Union’s List 1. This makes powers of the Union government exclusive and overriding.

The Motor Vehicles Act 1988 is enacted under the concurrent list -- (List III, E35) to give Union’s Act a priority.

Air Act Section 20: Explicit power to give instruction for ensuring standards for emissions from automobiles.

Section 17 (clause g/ subsection 1): State govt/State Board give instruction in charge of registration of motor vehicles under CMVA for compliance.

Form and particularity of this provision need to be defined. Nature of direction to concerned ministries and departments matters. These will have to be obeyed.

Nothing in the CMV Act prevents the EP Act and Air Act to create a oversight body or from giving detailed instructions to any authority or agency.
Precedent

Authority under EP Act exercised to notify standards for vehicles and fuels


Diesel fuel specification for emissions related parameters EPA notification – (GSRNo: 176 (E), April 2, 1996)

Motor gasoline: specification for emissions related parameters EPA notification – (GSRNo: 176 (E), April 2, 1996)
April 1: 2018: Delhi got Bharat Stage VI (BSVI) compliant 10 ppm sulphur fuels

April 1 2019: NCR to get BSVI fuels

April 1, 2020: The big leap
- Entire country will move to BSVI emissions standards for vehicles and BS VI compliant fuels
Clean fuel helps.....

- **On-road vehicles will spew less particles**: Sulphur contributes to formation of particles.

- **Sulphur dioxide emissions**—a deadly gas, is also directly proportional to the amount of sulphur in fuel.

- 10 ppm sulphur fuels allow emissions control systems of on-road diesel vehicles to perform more efficiently.

- Less engine wear-and-tear for all that can reduce emissions.

- **Petrol vehicles will also benefit**: Sulphur reduces the efficiency of catalysts and adversely affects heated exhaust gas oxygen sensors.

- Opens up opportunity for retro-fitment of advanced emissions control systems.
2005-2020: Deep cuts

Petrol cars -- NOx

- BS III to BS VI: 60%
- BS III to BS VI: 84%
- BS IV to BS VI: 25%
- BS IV to BS VI: 68%

Diesel cars -- PM

- BS III
- BS IV
- BS VI

HDV -- NOx

- BS III
- BS IV
- BS VI

CSE

6
5
4
3
2
1
0

Emission standards for NOx (in g/km)

5
3.5
0.46

Emission standards for NOx (in g/kWh)

6
5
4
3
2
1
0
Why BSVI is disruptive?

- India to come close to fuel neutral standards as the difference between petrol and diesel emissions will narrow down substantially.

- Not only the total mass of PM emissions from diesel vehicles will be weighed and regulated but also particle numbers will be **counted** to ensure effective emissions control devices are adopted.

- Vehicles will be tested for real world emissions – monitor emissions portable emissions monitors over the driving pattern of vehicles on the road.

- Two wheeler standards will become significantly more stringent. For the first time Nox and hydrocarbon will be regulated separately; evaporative standards; OBD.
Benefits much higher than the costs

280,000 cumulative avoided deaths by 2030 from fuel and emissions standard roadmap
Global learning curve: Huge risks if not done properly...
Eliminate gap between certification and real world vehicular emissions

**NO\textsubscript{x} EMISSIONS FROM EU CARS: REAL-WORLD VS OFFICIAL VALUES**

Diesel cars: Nitrogen oxide (NO\textsubscript{x}) emissions (in g/km)

- Euro 3 (MY 2000–2006): 0.5
- Euro 4 (MY 2005–2010): 0.25
- Euro 5 (MY 2009–2015): 0.18
- Euro 6 (MY 2014–2017): 0.08

Petrol cars: Nitrogen oxide (NO\textsubscript{x}) emissions (in g/km)

- Euro 3 (MY 2000–2006): 0.15
- Euro 4 (MY 2005–2010): 0.08
- Euro 5 (MY 2009–2015): 0.06
- Euro 6 (MY 2014–2017): 0.06

Source: FIA Foundation
Global action on diesel cars
Diesel car sales down

**London:** Pre Euro VI cars not to be allowed inside the ultra low emissions zone in Central London.

**France:** Euro VI diesel cars not to be included in the new category 1 colour coding scheme that classifies vehicles according to how much they pollute. French government to “progressively” ban diesel vehicles.

**Paris:** To phase out pre-2011 diesel cars by the end of the decade.

**Madrid:** To ban polluting diesel cars from the city centre from 2020.

**Netherlands:** In 1998 the Third National Environment Policy targeted to reduce diesel share to only 5% in 2010. Dutch registration and circulation taxes for diesel cars are close to prohibitive. Kept share of diesel cars in Netherland lower than EU average.

**Brazil** Sales of diesel passenger cars and commercial vehicles below 1,000 kg are banned

**Beijing** has banned diesel cars as a pollution control measure. China has the lowest diesel car penetration at less than 1%. China taxes do not differentiate between petrol and diesel fuel.

**Sri Lanka** has imposed several times higher duties for diesel cars compared to petrol cars and have reduced diesel car sales.
What happened in Europe after that? Focus shifts to real world emissions
Four packages of additional reforms to tighten lab tests and real world monitoring

Package one: RDE Act 1, 2016: Realworld Driving Emissions (RDE) test for monitoring purposes


Package 3 - RDE Act 3: RDE testing included Particle Number emissions for all new vehicle Real-world emission performance of a car disclosed by manufacturers. Not to Exceed Emission Limit (NTE) limit. PEMS test procedure for particle number and Conformity Factor for particle number.

Package 4 - RDE Act 4 - 2020: Type approval authorities to check each year the emissions of vehicles already in circulation ("in-service conformity" testing). Authorities and independent parties to perform tests through accredited testing centres. Reduce conformity factor in RDE measurements, from 1.50 to 1.43 (for Nox). Mat further reduce to 1 by 2023.
Changed the test cycle -- Worldwide Harmonised Light Vehicle Test Procedure (WLTP):

In-service conformity (ISC) tests for after market vehicles:

Independent market surveillance: Market surveillance authority independent of the type approval authority.

Enforcement mechanisms: Member states will be allowed to restrict or prohibit the usage of affected vehicles or require actions by the manufacturer.

Fuel consumption meter: From January 2020 onwards on-board instantaneous and lifetime fuel consumption of each vehicle—fuel consumption meter.
AIS 137 -- India poised for further reforms in 2023: Get it right

Heavy-duty vehicles

- 1st April, 2020, emission measurement on vehicles using portable emissions measurement systems (PEMS) to be carried out on road for data collection

- 1st April, 2023 in-service conformity factor shall be applicable.

- 1st April 2023: For PEMS demonstration test at type approval, vehicle shall meet the requirements of in-service compliance from 1st April, 2023.

- World Not-To-Exceed (WNTE) Off-cycle laboratory testing limits for gaseous and particulate exhaust emissions limits are given in BS VI notification.

• **In-Service Conformity**: In service compliance of vehicles shall be as per procedure laid down in AIS137 and as amended time to time.

• **RDE**: From 1st April, 2020, real world driving cycle emission measurement using PEMS shall be carried out for data collection and from 1st April, 2023 real world driving cycle emission conformity shall be applicable.

• **Not-to-exceed Emission Limits**: to be prescribed based on conformity factors to be assessed by 2023

Light duty: Need in-service compliance linked to RDE for light duty vehicles; No confirmatory factor yet

Market surveillance and an independent verification testing and inspection by regulatory authorities of in-use vehicles and components. Makes testing authorities responsible for testing. Also adopt PEMS testing for in-service Conformity test

WLTP not yet adopted – RDE testing should be validated against WLTP; MIDC is weak

Public disclosure: AIS 137 says - manufacturer shall ensure that information is made available on a publicly accessible website without costs. But government and testing agencies should also release data. Disclose RDE results.

Define test trip on roads. Adopt total NOx emissions as per the package 4 of Europe or increase the weighing factor in the urban driving category. Will promote in-cylinder or EGR based NOx reduction strategies at low load, which the SCR system will not reduce.
Understanding implications for I/M regime and on-road surveillance…
On-road emissions management

PUC is not relevant for new generation emissions control technologies.

Global trend

**Tightening of in-use inspection: UK:** If DPF fitted vehicles emit smoke of any colour it is considered a major defect. The UK has even lowered smoke limit to 27 HSU in 2014.

**Checklist for physical checks:** To check if any emission control equipment fitted by the manufacturer is missing, modified or defective. This is categorized as a major defect. This includes Diesel Particulate Filters (DPF), Oxidation Catalysts and Selective Catalyst Reduction (SCR) valves.

**OBD integration:** Integrated on-board diagnostic systems with I/M programme. MIL is now part of the test and will be a major defect if it is inoperative or indicates a malfunction. Also checking if OBD is working (US)

Remote sensing measurements
10 Model I&C Test Centers being established.

- Centers to be facilitated by ARAI
- Centers to be facilitated by iCAT
- Center to be facilitated by SIAM

- Haryana
- Himachal Pradesh
- National Capital Region
- Rajasthan
- Uttar Pradesh
- Gujarat – Surat
- Maharashtra – Nasik
- Madhya Pradesh – Chindhwara
- Telangana – Hyderabad
- Karnataka – Bengaluru

This is not scalable: Leverage them strategically; Need other supportive measures for basic screening

Source: ARAI
China:
• Remote sensing in use since 2005. There are 22 removable remote sensing devices and 27 fixed remote sensing devices in Beijing. Vehicles that exceed the remote sensing standard needs to go to smog station for retest; it will be fined if it exceeds again.

• Remote sensing method for HDV is used to analyze and evaluate the vehicle.

• For compliance Government is revising local law to require that driving a HDV with visible smoke once photographed by the camera will be fined directly.

Europe: True initiative:
• Three-colour system based on remote sensing monitoring has been developed.
Fleet profiling

- NOx emissions are systematically much higher for diesel cars, even for the newest Euro 6 models
- All Euro 6 diesel models exceeded the Euro 6 diesel NOx emissions type-approval limits
- Remote sensing results are consistent with laboratory testing conducted by Transport for London

India
Remote sensing monitoring in Kolkata

Delhi: ICAT pilot; MORTH-ARAI to develop guidelines
To develop threshold limit to pull out gross polluters
How to use this for compliance

Source: CSE field visit
How do we operate and maintain this technology?
Diesel emissions control system

National Academies Press
Technology pathways for diesel and CNG
Prevent cheating and tampering

EGR tampering
External zapping device
• External black box plugged behind EOBD socket

Mechanical tampering
• Physical change in engine compartment
• blocking gas tube with a baffle
• sealing hose to the vacuum actuator

DPF removed
• Missing part or visible alteration (e. g. welding seam) of exhaust pipe
• Soot in exhaust of a Euro 5/6 vehicle, may indicate DPF removal (an indication, no proof for manipulation)

DPF gutted
• Soot in exhaust of a vehicle, may indicate DPF removal

Prevent tampering

SCR disconnected and ECU emulator

• Reagent tank gauge showing exactly 25%, 50%, 75% or 100%
• Reagent tank empty or level does not correspond with gauge
• Crystallisation and/or rust around the AdBlue tank cap and/or filler pipe when cap removed
• Fuse removed/blown from SCR system
• Modified wires in the harness
• Soldered wires
• Electronic device fitted in OBD-port or with wires spliced into the wiring from SCR ECU may be an emulator

Maintenance challenge

- Expensive after treatment systems; Good maintenance to reduce cost of repair
- Sensitise drivers, mechanics, about DPF and SCR and their working
- Specialised maintenance – maintenance intervals and schedule
- Inspection protocol
- Working of SCR: Frequency of urea refill and cost of urea
- Infrastructure for urea - highways
- Quality benchmarks
- Action against tampering and cheating devices
Moving beyond IC engines
Electric mobility

FAMEII and beyond

-- Need zero emissions mandate
-- EV policy linked to public transportation strategy
-- Design performance based incentives
-- Incentivise setting up charging Points/ Stations (and other EVs Investment)
-- Rationalise EV Charging electricity availability, intershare and tariffs
-- Raising EV pooled funds & programmatic financing
-- Need robust EV Supply Ecosystem
-- Strong Grid Upgradation and Management
-- EVs & Lithium Battery Promotions and Market Development
Vehicle technology: Next steps

National level
- Align with latest package of Europe to reduce gap between lab and real world
- Further strengthen compliance and testing regulations for effective real-world emissions performance
- In-service compliance programme for LDVs
- Public disclosure and independent verification
- Compliance, Penalty, emissions warranty and recall
- Zero emissions mandate and EV policy

State level
- Upgrade vehicle inspection programme
- Automated advanced vehicle testing centres, OBD integration with I/M programme, and guidelines and norms for remote sensing monitoring, physical verification
- Maintenance protocol for bus corporations and truck operations
- Prevent tampering with emissions control system (especially SCR system; Urea refilling infrastructure)
Public transport and mobility strategies
What parameters influence energy use and emissions from urban commute?

Tracked Parameters that require policy focus

- Per person trip generation and volume of daily travel trips
- Average trip length by modes of transport
- Share of different modes in all motorised trips
- Average distances that modes cover and total kilometers they travel
- Level of vehicle technology and fuel quality etc

Challenges of such assessment

- Lack of official data base
- Mobility plans, Census of 2011, project reports, research studies
- Better data may modify ranking but the overall message from ranking will not change
Total particulate emission load from urban commuting in the 14 cities (kg per day)

Particulate load from urban commuting in Bhopal is 11 times lower than Delhi.

Source: CSE analysis
Comprehensive Ranking of the Cities
Emissions from urban commuting

Based on overall emissions and energy consumption

Based on per travel trip emissions and energy consumption

Source: CSE analysis
Share of private and public transport in motorized trips

- Only mega cities have higher share of public transport ridership. Mumbai and Kolkata have highest share.

- Other Metropolitan cities: Very high share of personal vehicle trips.
What’s working and not working?

Kolkata proves -- Only high population, high travel volume and economic growth need not necessarily lead to higher automobile dependency.
-- Lowest average trip length for all different modes
-- Average distance travelled by different modes lowest among all mega cities.
-- Lowest vehicle stock; second highest share of public transport.
-- Early investment in diverse and connected public transport
-- Most diverse public transport systems: buses, metro, trams, suburban rail, para-transit and waterways. -- Public transport and IPT trips 88 per cent.
-- Comparatively better parking restraint
-- Compact city design, high street density, short travel distances
-- Restricted availability of land for roads and parking…

Delhi has highest overall emissions from urban commuting
-- Very high volume of trip generation -- Per day around 20-30 million more trips are generated than Kolkata, Chennai, Hyderabad and Bangalore.
-- Total vehicle kilometres generated far exceeds that of any other megacity.
-- Highest vehicle stock
-- More sprawled
Missing mandate for public transport

Public transport regulated, but not mandated.

- Ministry of Road, Transport and Highways as central regulatory authority lays down conditions for plying of public transport (permit conditions, insurance, etc.)
- Ministry of Housing and Urban Affairs role limited to providing funding, if at all, for public transport; scheme based funding (e.g. JnNURM bus scheme)
- Metro funding tied to reforms
- State Transport Authorities (STAs) a second layer of regulation at State level (routes, fares, etc.); SPVs – no legal backing
- Public transport agencies formed under various acts such as Road Transport Corporation (RTC) Act, Companies Act, which are also regulatory frameworks for the organization’s operation.

No Act mandating the provision of public transport in cities at any level; 12th Schedule of Indian Constitution (that lists down functions of Municipal agencies as per the 74th Constitutional Amendment Act, 1992) does not mention public transport. Public transport remains an optional function under the Municipal Corporation Acts.

Disconnect with urban planning; Provision of ‘amenities’ considered a requirement for developed land under the Delhi Development Act; ‘amenities’ includes roads, but does not extend to public transport
National Transportation Policy: Central Government may develop a National Transportation Policy to—

- Establish a planning framework for passengers and goods transportation;
- Establish a medium and long term planning framework for all forms of road transport …. for the delivery of an integrated multimodal transport system;
- Establish the framework of grant of permits and schemes;
- Safeguard the interest of the public and promote equity, while seeking to enhance private participation and public-private partnership in the transport sector;
- Demonstrate an integrated approach to transport and land use planning
- Last mile connectivity; Reduce traffic congestion;
- Improve urban transport; promote safety of road users
- Promotion of energy conservation
- Rural transport;
- Protection and enhancement of the environment
Massive slide in public transport ridership in cities

**Delhi bus services:** Since 2013, DTC bus ridership declining at an average rate of 8.88% per annum. Overall, dropped by 34%. New buses to only replace the old.

**Bangalore Metropolitan Transport Corporation (BMTC):** Since 2009, ridership increased by 9%. But dropped recently -- accumulated losses. Withdrawing buses from low-revenue-generating routes – creating service deficit. Cut down full-day bus operations on 2,253 routes.

**Brihanmumbai Electric Supply and Transport (BEST):** Daily ridership of BEST buses gone down to its lowest ever: -- a sharp fall of 40% in the past seven years.

**Ahmedabad:** BRT services – expanded network from 35-km corridor 125km but passenger traffic has not seen an upswing. - BRT passenger traffic stagnant

**Vijaywada:** Made an early transition to BRT. But it has stopped operating the system

**No strategy to make public transport work in cities** – poor last mile connectivity, Cheap or free parking, Subsidised road taxes for cars, Lack of integration, Lack of operational reforms are big barriers
Car centric road design locks in enormous pollution

Engineering changes once made cannot be reversed easily… It permanently decides our travel choices
Clean air action plans are mandating public transport reforms

- Augment bus numbers and service, modernise bus fleet
- Modernise crew scheduling of buses; install GPS units and automated scheduling software
- **Implement the full range of ITS integration** within the city bus system – ETVMs, Smart Card, GPS tracking and central monitoring, PIS
- **Implement a fare policy for the city/capital region** to reduce journey cost by not penalising interchanges
- **Bring in physical integration of modes** – physically align infrastructure for all modes (like halting point for rickshaws) around bigger modes (buses)
- **Integrate Smart Card payment for all modes** including bike-sharing, parking, etc. Introduce a parking policy and implement parking area management; Adopt a state level street design guidelines and implement;
- **Enforce bus lanes**; bus rapid transit lanes
- **Organise para transit**
Clean air action plans mandating non-motorised transport and compact urban design

- **Implement urban street design guidelines** to prioritise design for public transport access, walking and cycling infrastructure
- **Design safe and universal access**
- **Implement zonal plans for NMT network**
- **High street density with well designed pavements and cycling facilities** & adequate protection for pedestrians and cyclists
- **Ensure safe accessibility of stations/stops** or the last mile connectivity for public transport planning
- **Adopt compact urban form code** to create high density, mixed use, mixed income development; high density accessible streets to reduce distances
- **Enable balanced mix of jobs and housing along public transport corridors** – follow transit oriented development norms; Discourage sprawl
Complete street management for all road users is not scalable yet. No practice of street audits.
Cities have natural pedestrian precincts, by virtue of the sheer volume of pedestrians. This can be further built on to make pedestrian zones.
Push for compact urban form and pedestrianisation and low emissions zones

Car-free Ajmal Khan Rd of Delhi: Exposure to PM2.5 on nearby heavy traffic road 35% higher than pedestrian street

Spurs decision to pedestrianise 22 commercial streets/areas in Delhi
Parking policy: losing the plot
Why are we wasting so much valuable space for parking?

Enormous legal parking provisions….
Parking Policy: A clean air tool not well understood

Draft parking Rules in Delhi
It is an area level plan to be prepared local body
Demarcates all types of legal parking spaces for all modes in an area
  • On-street, off-street and multi-level parking facilities and there integrated management
  • Vending zones
  • Multi-modal integration facilities
  • Green open spaces along with the allied traffic
  • Pedestrian / NMT circulation plans
  • No parking in green areas, near intersection, near bus stands etc

Penalise illegal parking
Introduce variable parking pricing
Promote shared, priced and public parking
Parking revenue for local area development
IT based parking area management and reform of contractual agreement
Pilot project in Delhi: Supreme Court intervenes
How parking area management plan helps?

Case study: Lajpat Nagar II, New Delhi (EPCA Report 98/July 2019)

Housing plots: 448
Total number of floors: 1680
Total cars: 3510

After applying parking rules – (no parking on footpaths, green areas, parks, near intersection and keeping one lane free from encroachment)

Total number of cars accommodated: 1830
Gap : 1680
Alternative sites outside the colony identified

Informal Residential Parking Pricing already in place
NMT policy also requires Parking Policy
For the 12 largest Indian cities, satellite imagery shows that, the proportion of built-up area outside a city’s official boundaries exceeds that within its boundaries --- also exceeds the proportion of population, -- low density sprawl. (World Bank 2015)
Cities grew about twice as fast in area as they grew in population, declining average city population densities and increasing sprawl.

Faster population growth on the peripheries of major cities.

For the 12 largest Indian cities, satellite imagery shows that, the proportion of built-up area outside a city’s official boundaries exceeds that within its boundaries --- also exceeds the proportion of population, -- low density sprawl.

(World Bank 2015)
Sprawl increase trip length in bigger cities

Source: Based on MOUD/WSA 2008 database
Good practice in Kolkata: Mixed use development; Meet all needs and yet reduce parking and traffic chaos

The TOD Building typology - in Kolkata:

-- Roof of retail used as public space for residents.

-- Zero Setbacks.

-- Mixed Use (Commercial/ Civic/ Residential within same block)

-- Privacy of residents ensured.

-- Retail facing the street with homes overlooking, keeps pedestrians (women) safe
Step forward

Time-bound targets for modal share of public transport, walking and cycling

Integrate urban planning with transportation; adopt transit oriented planning to reduce distances & motorized trip generation; improve sustainable modes

-- Promote compact urban form – small block sizes, density norms, mixed land use, mixed income neighbourhood, dense and permeable streets

Need restraint measures for personal vehicle usage through parking policy, low emissions zones approach, tax measures and congestion pricing approaches.

Integrate urban mobility strategies with clean emissions and fuel efficient vehicle technologies and clean fuels

Link funding strategies with reforms in public transport sector

Apply sustainability indicators for evaluating progress of interventions from the perspective of lowering of emissions, carbon and inducing modal shift towards sustainable modes.
Empowerment, autonomy and accountability and compliance – only legal powers do not help.

**Departmental responsibilities**, Institutional and departmental coordination for cross-sector action.

Capacity audit and improvement of implementing agencies.

**Strengthening of CPCB and SPCB**

**Inadequate skilled human resource:**

Similar challenges among municipal corporations and transport departments – weakens enforcement

Need impact monitoring.
NCAP funding for air quality monitoring and some support for studies and plans

Align CAP principles and guidelines with the budget of all line departments – leverage existing line funding

Mobilise resources based on polluter pay principles to create dedicated funds – Eg from Delhi – Environment Compensation Charge on trucks and big diesel cars and SUVs; Air Ambience cess on each litre of diesel etc. Sector specific funds

Reform based funding
Incentive for meeting clean air targets?

15th Finance Commission:

- Considering environment and pollution abatement performance grant for states.

- Commission to propose measurable performance-based incentives for States, among others. --- One of the criteria for finalising the states' share in central taxes and grants.

- The last finance commission used forest cover, apart from population, area and income distance as criteria to decide the devolution of taxes to the states.

- Leverage this opportunity
Need massive transition

Transition to clean fuels and technology

Massive mobility transition

Paradigm shift in waste management

Need scale and effectiveness

Need accountability

Awareness and advocacy to deepen understanding and build support for solutions
Dutch Minister visits the queen

Source: GIZ
Thank You