

Module I : Understanding Air Pollution in India: From Awareness to Action

**Centre for Air Quality Research,
Air Quality Research Division**

1 hour

Suresh Ramasubramnaya Iyer, Area Convenor

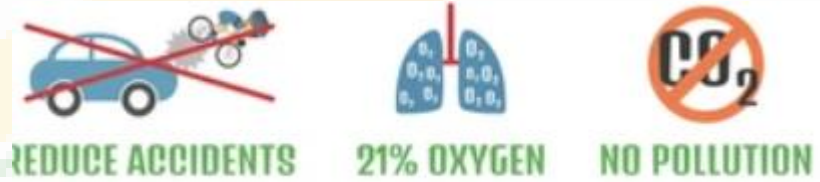
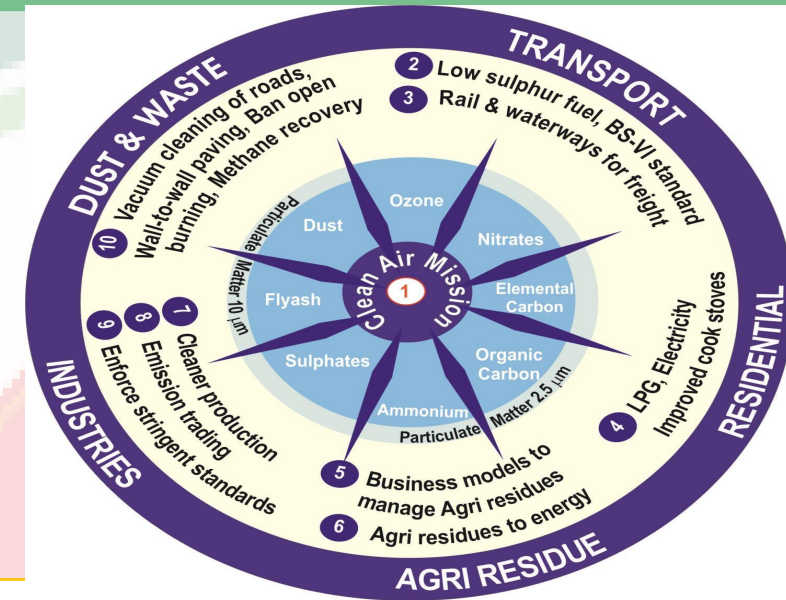
Module Outline

1. Introduction to Air Pollution
2. Causes of Air Pollution in India
3. Effects of Air Pollution
4. Monitoring and Measurement of Air Quality
5. Legislative Framework and Policies
6. Solutions and Mitigation Strategies
7. Personal and Collective Responsibility
8. Future Outlook and Sustainability
9. Interactive Workshops and Activities
10. Assessment and Evaluation



About the Course

The aim is to educate participants about the various aspects of air pollution in India, including its causes, effects, monitoring methods, and policy frameworks. Participants will explore practical solutions and mitigation strategies, encouraging personal and collective responsibility. Through interactive workshops, discussions, and real-world case studies, participants will gain the knowledge and skills necessary to become advocates for change in their communities and future careers.



This course offers numerous benefits to freshers, enabling them to gain a deep understanding of air pollution in India and empowering them to actively contribute to mitigating this critical issue:

In summary, this course not only imparts knowledge but also equips participants with the skills, awareness, and motivation needed to become advocates for change. By actively engaging in discussions, field visits, and interactive sessions, participants will be well-prepared to address the challenges of air pollution and contribute to creating a cleaner and healthier environment for all.

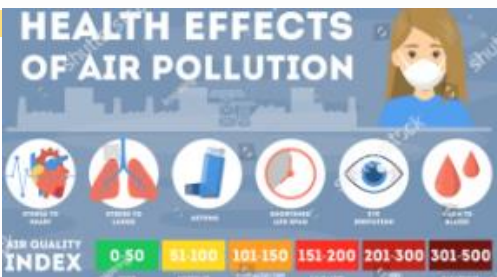
Background

- *Growing air pollution is of concern for many urban cities in India*
- *Particulate matter is a pollutant of concern - most of the cities are violating ambient air quality standards*
- *Anthropogenic PM concentrations typical of urban air sheds, directly affect human health*
- *More than a million mortalities and even more morbidities are associated with prevailing ambient air pollution in India. According to Global Burden Disease study, 1.7 million deaths were attributable to air pollution in India during 2019.*
- *About 30% reduction in wheat yields attributed to ground level ozone pollution in India*
- *The annual cost of health damages from PM_{2.5} exposure in India was 305869 million USD in 2019, which is as much as 10.6% of country's GDP (World Bank 2022)*

This course aims to create informed, proactive, and socially responsible individuals who are equipped to address the challenges posed by air pollution in India and work towards a cleaner and healthier environment for all.

1. Provide participants with a comprehensive understanding of air pollution, including its various types, causes, effects, and monitoring methods.
2. Increase awareness about the critical issue of air pollution, its impact on health, environment, and economy, and the urgency of addressing it.
3. Empower freshers with the knowledge and skills to actively contribute to mitigating air pollution in their communities and future careers.
4. Encourage participants to become advocates for clean air, engaging in discussions, debates, and community initiatives to raise awareness and influence positive change.
5. Instill a sense of personal and collective responsibility among participants, emphasizing the role of individual actions, community engagement, and advocacy efforts in reducing air pollution.

6. Familiarize participants with environmental laws, regulations, and international agreements related to air quality, offering insights into policy-making processes.
 7. Inspire participants to think critically about practical solutions and mitigation strategies, encouraging a proactive approach towards addressing air pollution challenges.
 8. Enhance participants' critical thinking, problem-solving, teamwork, and presentation abilities through interactive workshops, group projects, and discussions.
 9. Introduce participants to potential career paths in environmental science, policy-making, advocacy, research, and sustainable development sectors related to air pollution control.
 10. Enable participants to actively engage in discussions, community participation, and advocacy, fostering a sense of social responsibility towards the environment and society.
- Motivate participants to take meaningful action, both in their personal lives and as active contributors to their communities and future workplaces, becoming catalysts for positive change.



Air pollution has significant and far-reaching impacts on the environment and ecosystems. Understanding these effects is crucial for recognizing the urgency of mitigating air pollution. Here are the direct and indirect impacts of air pollution on nature:

Direct Impact:

Plant Damage: Air pollutants, especially ozone and sulfur dioxide, can directly harm plant life. They damage leaves, impair photosynthesis, and reduce overall plant growth and crop yields.

Water Pollution: Some air pollutants can settle on water bodies, leading to water pollution. Acid rain, caused by sulfur dioxide and nitrogen oxides, damages aquatic ecosystems, affecting fish, plants, and other aquatic life.

Loss of Biodiversity: Air pollution contributes to habitat degradation, impacting both flora and fauna. Certain pollutants can lead to the decline of specific plant and animal species, disrupting ecosystems and reducing biodiversity.

Soil Degradation: Acid rain from air pollution can deplete essential nutrients in the soil, making it less fertile. This affects plant growth and agricultural productivity.

Corrosion of Buildings and Monuments: Airborne pollutants, including sulfur dioxide, can corrode buildings, monuments, and historical structures, leading to irreversible damage to cultural heritage.

Indirect Impact:

Climate Change: Some air pollutants, such as black carbon (a component of particulate matter), contribute to global warming. They absorb sunlight, leading to the warming of the atmosphere and accelerating climate change.

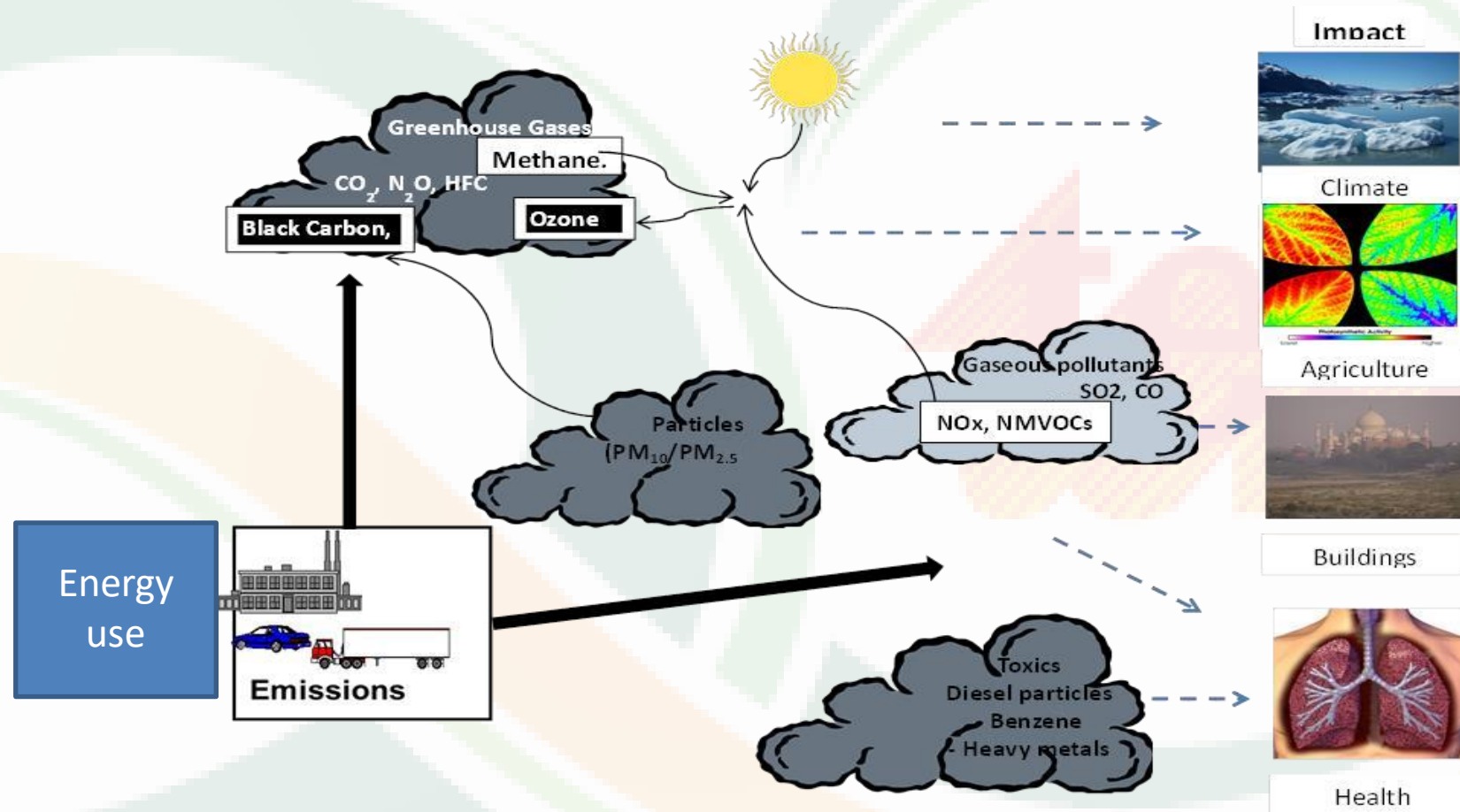
Altered Weather Patterns: Air pollutants can affect weather patterns, leading to changes in precipitation and wind patterns. This alteration impacts ecosystems and agricultural practices, potentially leading to droughts or floods.

Ocean Acidification: Carbon dioxide, a major air pollutant, is absorbed by the oceans, leading to ocean acidification. This harms marine life, particularly organisms with calcium carbonate shells or skeletons, such as corals and shellfish.

Disruption of Ecosystem Services: Air pollution can disrupt vital ecosystem services, including pollination, soil fertility, and water purification. These services are essential for agriculture, biodiversity, and human well-being.

Impact on Wildlife: Air pollution affects wildlife, particularly species sensitive to changes in air quality. Birds, insects, and mammals can experience respiratory issues, making them more vulnerable to predation and diseases.

Air pollutant formations and impacts

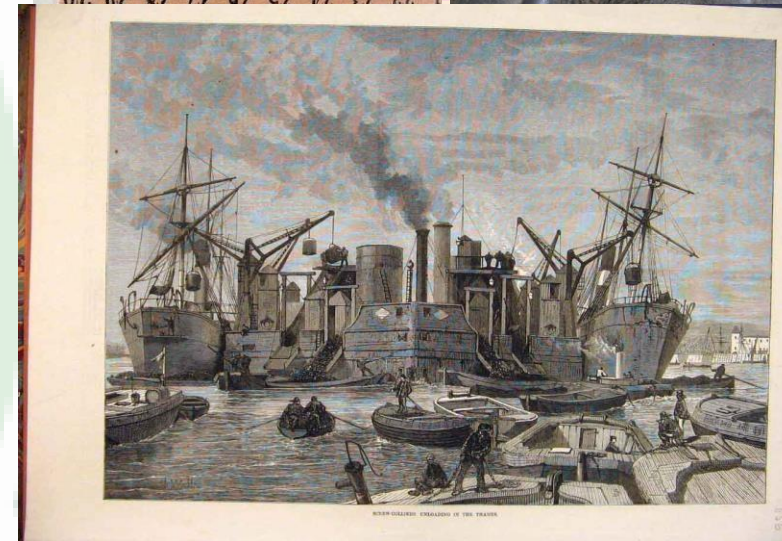


Before 1200 AD

- Air pollution from wood & coal burning, decaying trash, smelting of ores
- Greeks and Romans noted the smell of burning coal, and deteriorating air quality
 - invented “beach house” to escape
 - chimneys 7 to 8 m tall

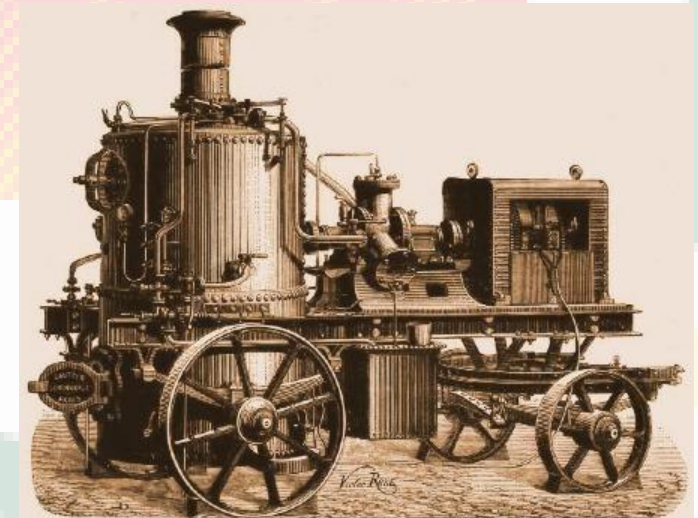
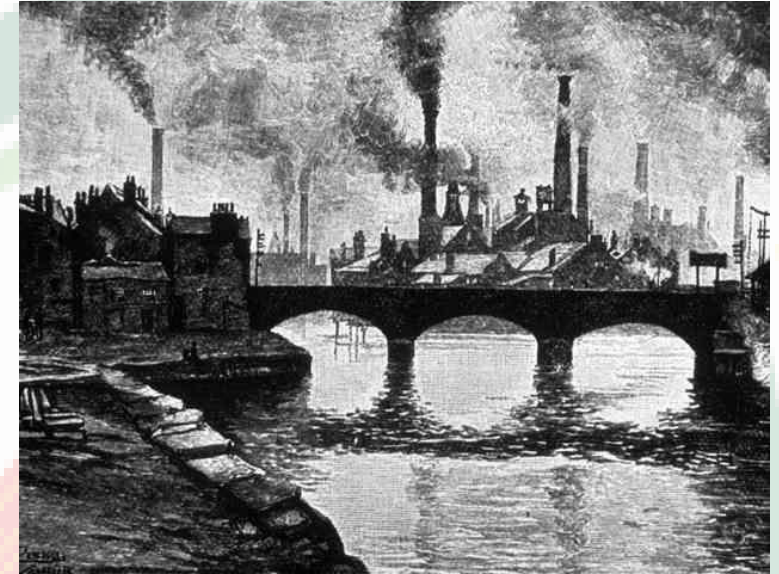
1200-1700 AD

- London : pollution from limestone kilns
- wood shortages led to use of sea-coal (high sulfur content)
- 1306 Edward I banned coal use in lime kilns (ignored and not enforced -little effect)
- 1661 John Evelyn wrote “Fumifugium”- London smoke caused fouling of churches, palaces, clothes, furnishings, paintings, rain, dew, water, and plants
- Proposed
 - Limit use of coal
 - Relocate industries
 - Develop new fuels
 - Planting green belts around city



Air quality concerns with development

- **1700-1840 (Steam engine, Industrial revolution)**
 - 100 time increase in Britain coal consumption during 1800-1900 leading to 7 times more deaths due to air pollution in Britain than world-wide (Clapp, 1994)
 - Industries centered around coal combustion developed globally (US, Europe, Japan, Australia, Russia, S. Africa)
 - 3 primary causes of death in Cincinnati 1881 : Tuberculosis, pneumonia, bronchitis - all lung related
-
- **1840-1930 (Regulation in UK, US)**
 - Railway Clauses Consolidated Act, Public Health Acts 1875, 1891, Smoke Abatement Act 1926, Chicago smoke reduction law, 1881.



- **London Smog of 1952 : 4,000 excess deaths**
 - 1952: electric trams were replaced by diesel-powered buses
 - combustion of oil and coal-factories
 - Meteorological conditions

- **Donora, Pennsylvania, US, 1948**

- **Bhopal Gas Tragedy**

- **Delhi -2016, 2017**



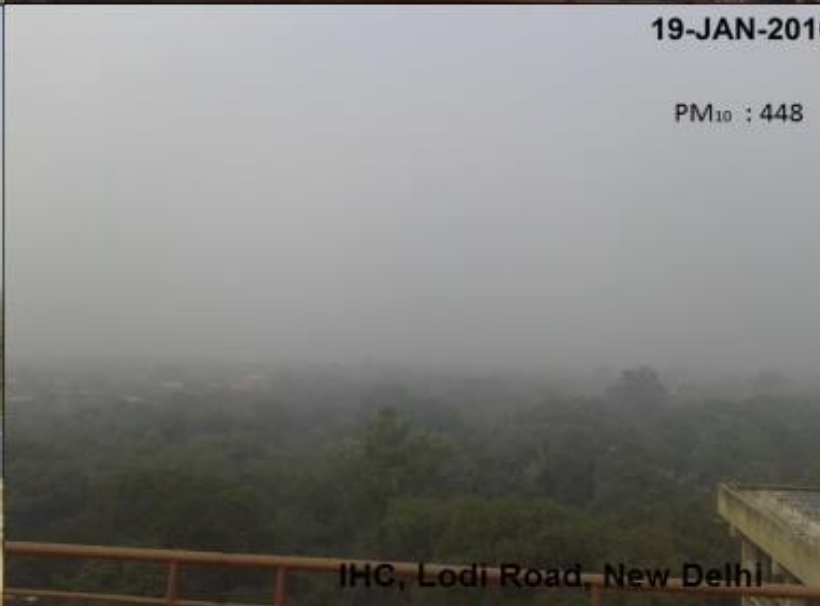


Photo credits : Sumit Sharma (TERI)

IHC, Lodi Road, New Delhi



Goal	SDG	Linkage
Goal 1	End poverty in all its forms everywhere	~40% PM _{2.5} emissions from biomass based cooking
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	20-30% loss of wheat due to Ozone pollution
Goal 3	Ensure healthy lives and promote well-being for all at all ages	~0.6-1 million people die annually due to air pollution
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all	Coal and biomass based energy
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	>40% PM ₁₀ emissions from industries. No standards for NO _x
Goal 13	Take urgent action to combat climate change and its impacts	Black carbon, Ozone contributors to warming

- **1981: The Air (Prevention and Control of Pollution) Act** was enacted in 1981 to provide for the prevention, control and abatement of air pollution in India.
- Mandates the CPCB and SPCBs to: Establish national ambient air quality standards ; Assist government in planning future environmental prevention and control strategies, Carry out research; Undertake nationwide air sampling to ascertain the ambient air quality and identification of the problem areas, Conduct air quality inspections in areas of concern.¹
- **1986: Environment Protection Act** in wake of the [Bhopal Tragedy](#), to implement the decisions of the [United Nations Conference on the Human Environments](#) for protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property. An “umbrella” legislation designed to provide a framework for central government coordination of the activities of various central and state authorities established under previous laws, such as the Water Act and the Air Act.

Early Indian responses

- Ambient air quality standards

With the goal of providing for the prevention, control, and abatement of air pollution, the first ambient air quality standards were adopted in 1982 by the Central Pollution Control Board (CPCB) and revised in 1994 and again in 2009.



- 53 cities million plus cities. expected to grow to 85 by 2025
- 31% urbanisation , expected to grow to 38% by 2025.
- Rapid economic growth but still more than 80% rural households rely on biomass

Sources of pollution in India



Industries



Transport



Power plant



Residential



DG sets



Road dust



Agri. burning



Refuse burning



Construction dust



Crackers



NH3 sources



VOC sources



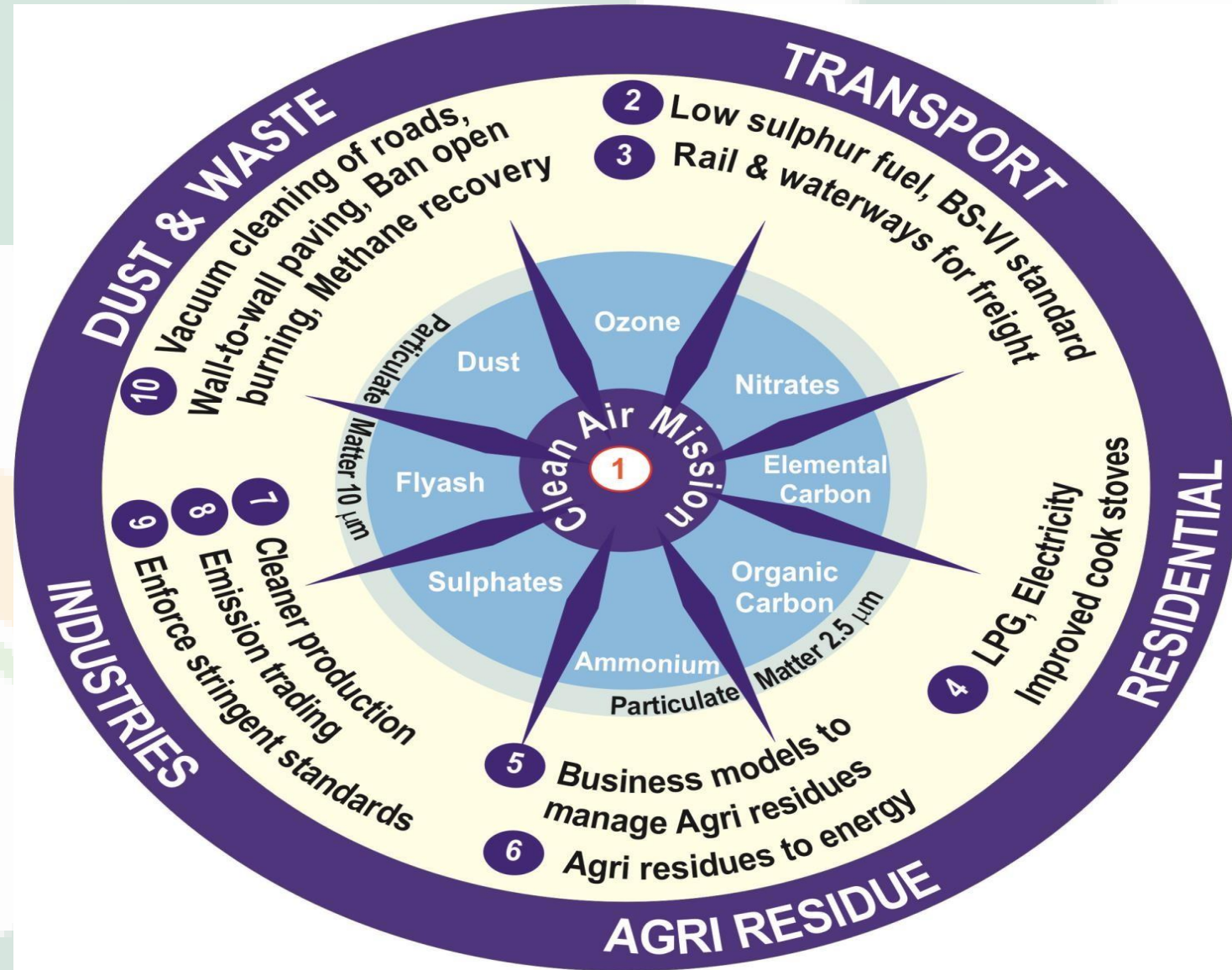
Steps taken by government in tackling air pollution

S.No	Initiatives	Dates
Transport sector		
1	Notifying advanced vehicle emission and fuel quality standards– BS-IV from 2017 and BS-VI from 2020	2016
2	Introducing gas as an automotive fuel in many cities	Ongoing—2003 onwards
3	Introduction of fuel efficiency standards for cars and in process to decide the norms for HDVs.	2015
4	Plan to introduce a voluntary fleet modernization and old vehicle scrappage programme in India	2016 (currently being discussed)
5	Introducing National Electric Mobility Mission Plan 2020	2012
6	Introduction and enhancement of metro-rail and advanced bus based public transport systems in select cities	Ongoing—2002 onwards
Residential sector		
1	Push to accelerate the LPG penetration program for cooking in households	Ongoing – special emphasis 2015 onwards
2	Accelerating electrification of villages to reduce kerosene consumption for lighting	Ongoing process
3.	Introducing energy efficiency labeling program for energy intensive home appliances like air conditioners	2006
Power sector		
1	Ambitious targets for power generation through renewables (100 GW solar by 2022)	2015
2	Shift towards high efficiency super critical technology for power generation	Ongoing process
3	Converting coal based power stations to gas based in select cities	-
4	Notifying more stringent standards for PM and new standards for gaseous pollutants for coal-based plants	2015
5	Notifying new stringent standards for diesel generator sets for stand by power generation	2016
Industrial sector		
1	Notifying and revising standards for highly polluting industries	Ongoing process
2	Pilot testing of emission trading scheme (ETS) in select industrial zones	Announced in 2010
3	Continuous monitoring of select large industries	Ongoing under the ETS
Others		
1	Imposition of ban on open agricultural residue burning	2015 (NGT)
2	Imposition of ban on refuse burning in some cities	2015 (NGT)
3	Launch of an official air quality index for Indian cities	2015
4	Setting up the Steering Committee on Air Pollution and Health Related Issues	2014

Despite which air quality deteriorated Measures were

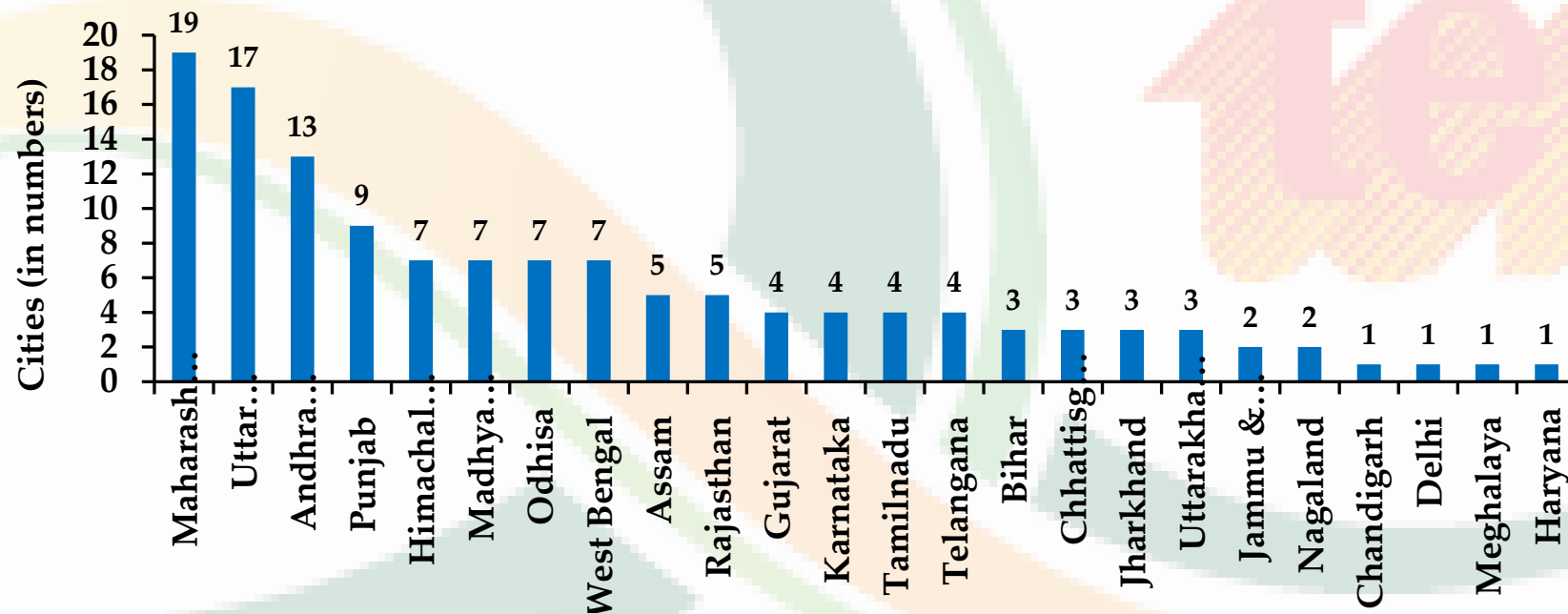
- not enough
- inadequate
- need time
- Not enforced

Solutions to improve air quality



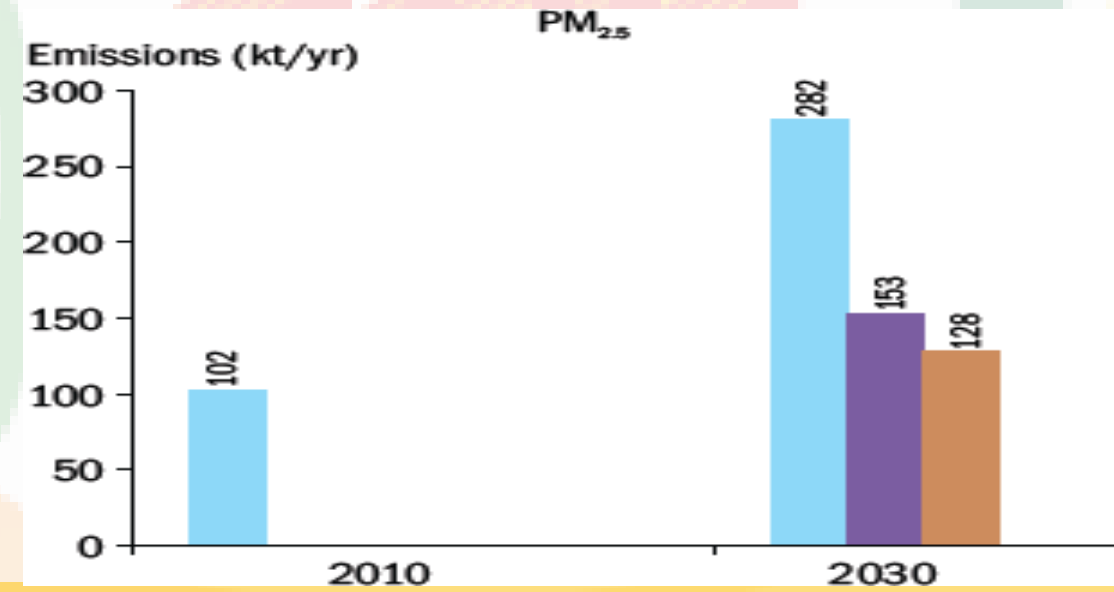
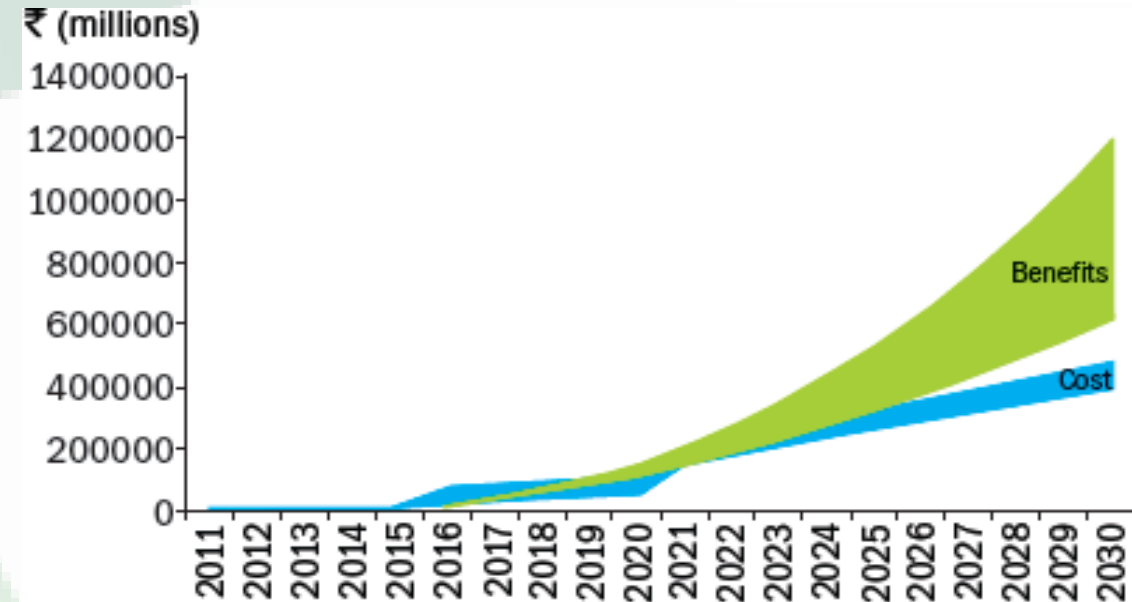
Launched in 2019

- Identified 132 non-attainment cities in India
- Interim target – 20-30% reduction by 2024
- NCAP focus on developing regional scale plans for air quality improvement with annual targets.
- Scientific Air Quality Management including monitoring



Solutions : Transport

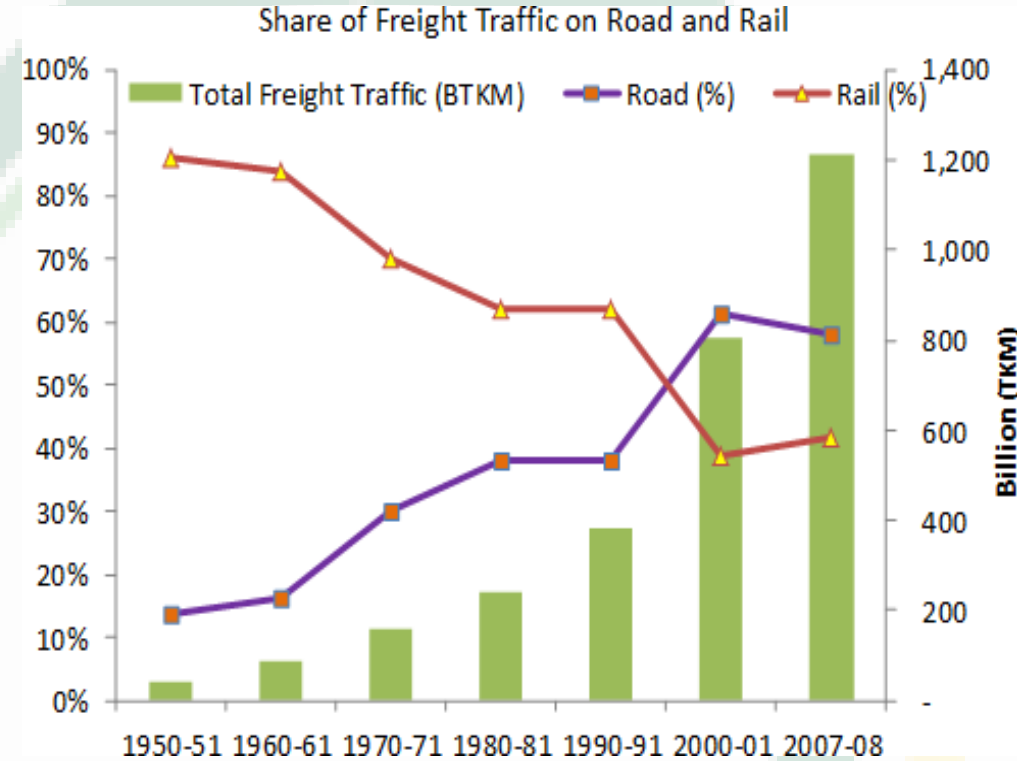
Switch to low sulphur fuel (10 ppm) and implement Bharat-VI (similar to Euro-VI) standards for engine emissions which require tail-pipe controls like diesel particulate filters (DPF) for PM and selective catalytic reduction (SCR) for NOx.



Shift freight transport from road to lower-emission modes such as rail, inland waterways, and coastal shipping

Others :

- Inspection and Maintenance System,
- Fleet Modernization,
- Electric vehicles,
- Vehicle ownership and usage controls, Strengthening public transport,
- Setting up low-emission zones



Solutions: Residential

Provide cleaner fuels (LPG, Electricity) and biomass stoves with an efficiency of 50% or more and with a forced draft fan for those who cannot afford LPG.

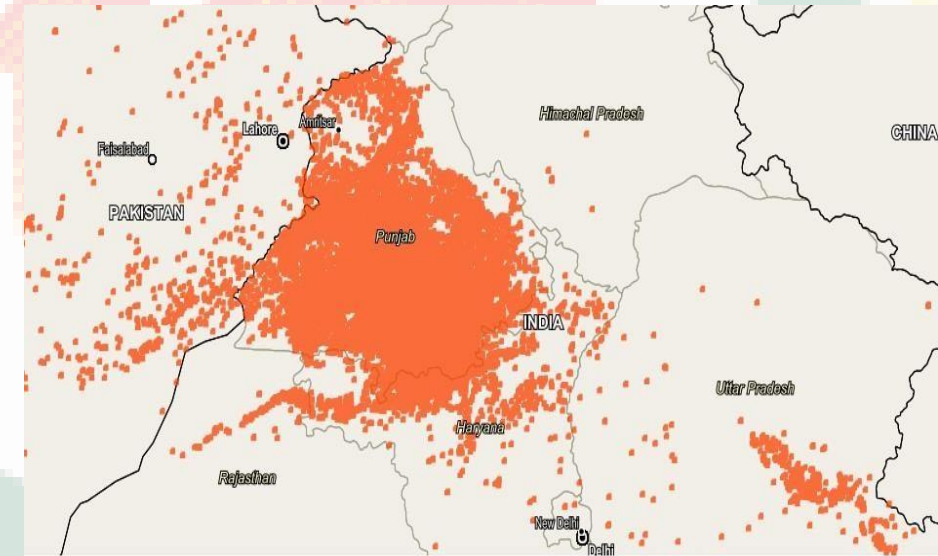
- Rapidly expand the access to clean fuels (such as LPG; Electricity) to the households reliant on solid fuels.
- LPG penetration can be enhanced through an aggressive marketing strategy wherein differently sized LPG bottles should be made available to rural households.
- For those who cannot afford LPG in the near term, market access should be increased to biomass/biogas stoves that are compliant with emission rates recommended by the World Health Organization .

Agricultural burning

Develop business models for collection, transport, and storage of agriculture residues and farm manure.



Convert agriculture residues and farm manure to electricity for rural power and biomass pellets for women who depend on biomass stoves.



Industries and power

Adopt cleaner and efficient production technologies

Deploy national Emission Trading Schemes (ETS) with cap-and-trade for power generation and other large polluting industries.

Implement stringent emission standards to control emissions from both power plants and big industries.

Dust and Waste

Wall-to-wall paving of streets and vacuum cleaning of roads; enforce ban on open burning of solid waste; management of waste and recovery of methane from landfills.

- Scientific management of municipal solid waste is required to control refuse burning
- Control methane emissions from landfills.



Assessment and Evaluation

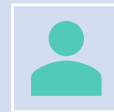
- Prioritization of the issue
- Scientific assessments and planning
- Effective monitoring network
- Standards and enforcements
- Capacity
- Resources
- Early warning systems and response planning



THANK YOU



Suresh Ramasubramnaya Iyer



Area Convenor



The Energy and Resources Institute



Email Id: sureshr@teri.res.in