Air quality and climate policy integration in India

Dr.Kavitha M S

AIR POLLUTION

- Air pollution is the presence of one or more contaminants in the atmosphere, such as dust, fumes, gas, mist, odour, smoke or vapor, in quantities and duration that can be injurious to human health.
- The main pathway of exposure from air pollution is through the respiratory tract. Breathing in these pollutants leads to inflammation, oxidative stress, immunosuppression, and mutagenicity in cells throughout our body, impacting the lungs, heart, brain among other organs and ultimately leading to disease.

Introduction

- Air pollution has emerged as one of India's gravest social and environmental problems in recent years. At the same time, the country is experiencing signs of a warming climate with potentially devastating effects in the long term. Energy-related fuel combustion is at the heart of both crises. It is a main source of three major air pollutants, NOX, SO_2 and PM2.5, and the largest contributor to India's CO_2 emissions.
- In many locations, concentrations of particulate matter persistently exceed recommended national and international standards with severe implications for public health.
- In 2019 alone, India experienced an estimated 1.2 million air pollution-related premature deaths. At the same time, India's growing economy is driving CO_2 emissions, which increased by more than 55% in the last decade, and are expected to rise by 50% to 2040.
- Energy-related air pollutants and CO_2 emissions often arise from the same sources, therefore the adoption of an integrated approach to tackle both can deliver important co-benefits.

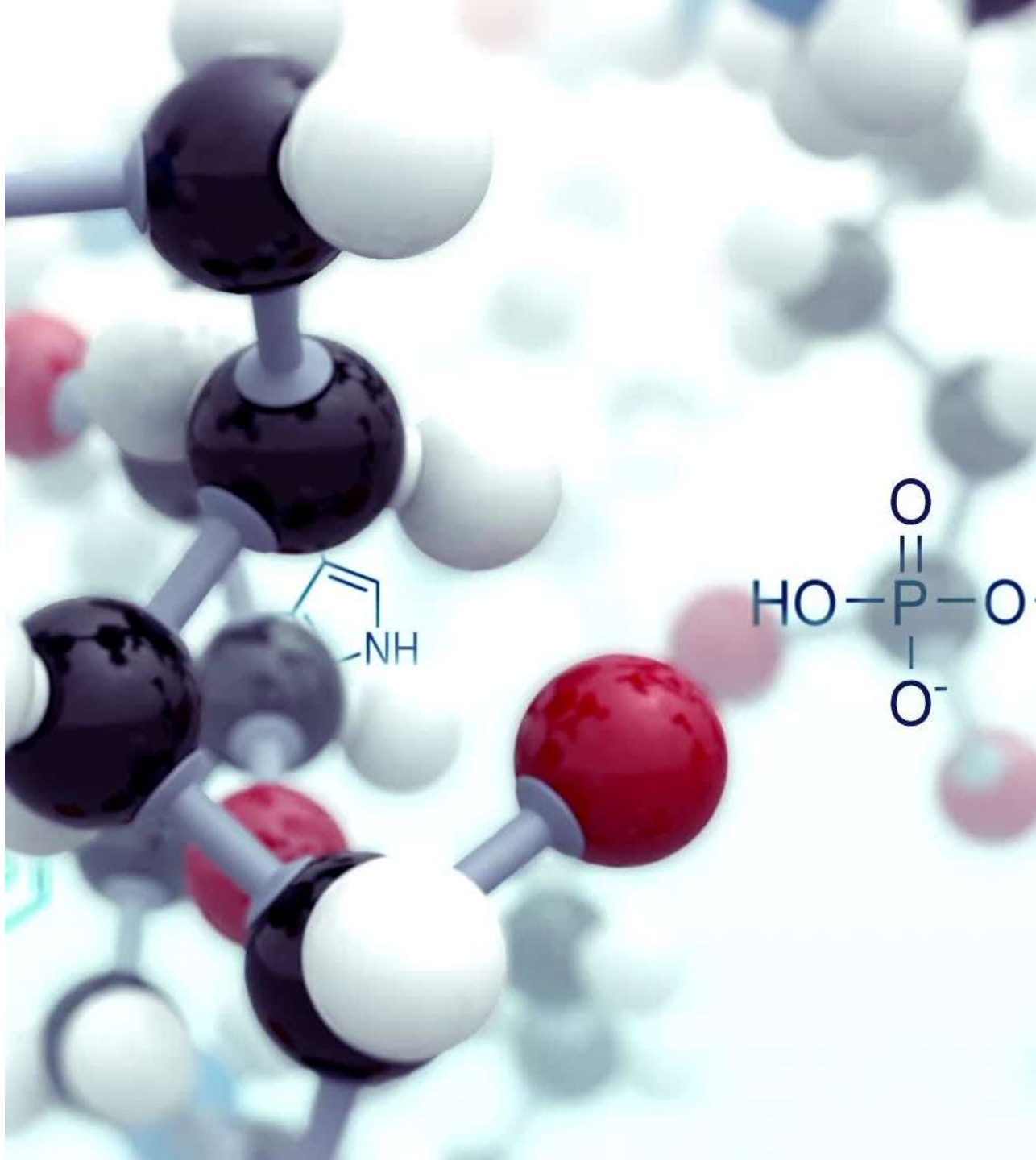
Most important air pollutants

- Although there are many toxins that have adverse impacts on health, pollutants with the strongest evidence for public health concern include particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2).

- Fine particulate matter are an especially important source of health risks, as these very small particles can penetrate deep into the lungs, enter the bloodstream, and travel to organs causing systemic damages to tissues and cells.

Particulate matter

- Particulate matter (PM) refers to inhalable particles, composed of sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust or water. PM can be of different size and is generally defined by their aerodynamic diameter, with PM2.5 and PM10 the most common in the regulatory framework and relevant for health.



Sources of PM

- Coarse particles (particles with diameter between 2.5 µm and 10 µm) will mainly consist of pollen, sea spray and wind-blown dust from erosion, agricultural spaces, roadways and mining operations.
- The finer particles (i.e., PM2.5) can be derived from primary sources (e.g., combustion of fuels in power generation facilities, industries or vehicles) and secondary sources (e.g., chemical reactions between gases).
- home - the combustion of polluting fuels in open hearths or poorly vented, inefficient stoves or space heaters. In addition to household activities like cooking, space heating, and lighting, other activities can be important sources of particulate matter pollution in the home environment, such as preparing animal fodder, heating water for bathing and brewing beverages.
- In outdoor environmentsinclude traffic and transportation, industrial activities, power plants, construction sites, waste burning, fires or fields.

Nitrogen Dioxide

- Nitrogen dioxide (NO_2) is a reddish-brown gas that is soluble in water, and a strong oxidant.
- sources - high temperature combustion of fuels - heating, transportation, industry and power generation.
- Household sources of nitrogen oxides (NOx) include equipment that burn fuels such as furnaces, fireplaces and gas stoves and ovens. Exposure to nitrogen dioxide can irritate airways and aggravate respiratory diseases.
- NO2 is an important ozone precursor, a pollutant closely linked to asthma and other respiratory conditions.

Ozone

- Ground-level ozone (O3) is a major component of smog. It is formed from photochemical reactions with pollutants such volatile organic compounds, carbon monoxide and nitrogen oxides (NOx) emitted from vehicles, and industry.
- Due to the photochemical nature, the highest levels of ozone are seen during periods of sunny weather. It is worth mentioning that ozone can also be generated by household equipment, such as portable air cleaners.
- Exposure to excessive ozone can cause problems breathing, trigger asthma, reduce lung function and lead to lung disease.

Carbon monoxide

- Carbon monoxide (CO) is a colourless, odourless gas produced by the incomplete combustion of carbonaceous fuels such as wood, petrol, coal, natural gas and kerosene in simple stoves, open fires, wick lamps, furnaces, fireplaces. The predominant source of carbon monoxide (CO) in ambient air is from motor vehicles.

- Carbon monoxide diffuses across the lung tissues and into the bloodstream, making it difficult for the body’s cells to bind to oxygen. This lack of oxygen damages tissues and cells. Exposure to carbon monoxide can

Sulfur dioxide

- Sulfur dioxide (SO2) is a colourless gas that is readily soluble in water.
- It is predominantly derived from the combustion of fossil fuels for domestic heating, industries and power generation.
- Exposure to SO2 is associated with asthma hospital admissions and emergency room visits.

Lead

- Lead (Pb) and lead particulate compounds - home in contaminated dust from products such as paints, ceramics, pipes and plumbing materials, solders, gasoline, batteries, ammunition, and cosmetics.
- Lead -from vehicle exhaust of fuel with lead.
- Lead poses health risks of particular concern for children and pregnant women.
- The health impacts for children exposed to lead include behaviour and learning problems, lower IQ and hyperactivity, slowed growth, hearing problems, and anemia. In rare cases, ingestion of lead can cause seizures, coma and even death. For pregnant women, health risks include reduced growth of the fetus and premature birth. Adults exposed to lead also have a higher risk of cardiovascular effects increased blood pressure, the incidence of hypertension, decreased kidney function

Polycyclic aromatic hydrocarbons

- Polycyclic aromatic hydrocarbons (PAH) are present in the atmosphere in particulate form.
- They are a group of chemicals formed primarily from incomplete combustion of organic matter (e.g. cooking of meat) as well as fossil fuels in coke ovens, diesel engines and wood-burning stoves.
- They are also emitted from tobacco smoke. Short-term exposure can irritate eyes and breathing passages. Long-term exposure to PAH has been linked to lung cancer.

Formaldehyde

- Formaldehyde is a colourless gas with a pungent smell. It is one of the most common volatile organic compounds (VOCs) found indoors.
- Formaldehyde is emitted from building materials (e.g. particleboard, plywood, glue, paints) as well as household and personal care products (e.g. drapes, carpets, cleaning products, hair sprays).
- Additional indoor sources may be combustion processes such as smoking, heating, cooking, or candle or incense burning.
- Short-term exposure to formaldehyde can lead to eye, nose and throat irritation as well as increased allergic sensitization. However, long-term exposure to formaldehyde has been associated with nasopharyngeal cancer.

Exposure

Health problems in children and adults can occur because of both short- and long-term exposure to air pollutants. The levels and duration of exposure that can be considered 'safe' vary by pollutant, as well as the related disease outcomes. For some pollutants, there are no thresholds below which adverse effects do not occur.

Exposure to high levels of particulate matter, for example, can lead to reduced lung function, respiratory infections and aggravated asthma from short-term exposure. Whereas long-term or chronic exposure to fine particulate matter increases a person's risk for diseases with a longer onset, like some noncommunicable diseases including stroke, heart disease, chronic obstructive pulmonary disease and cancer.

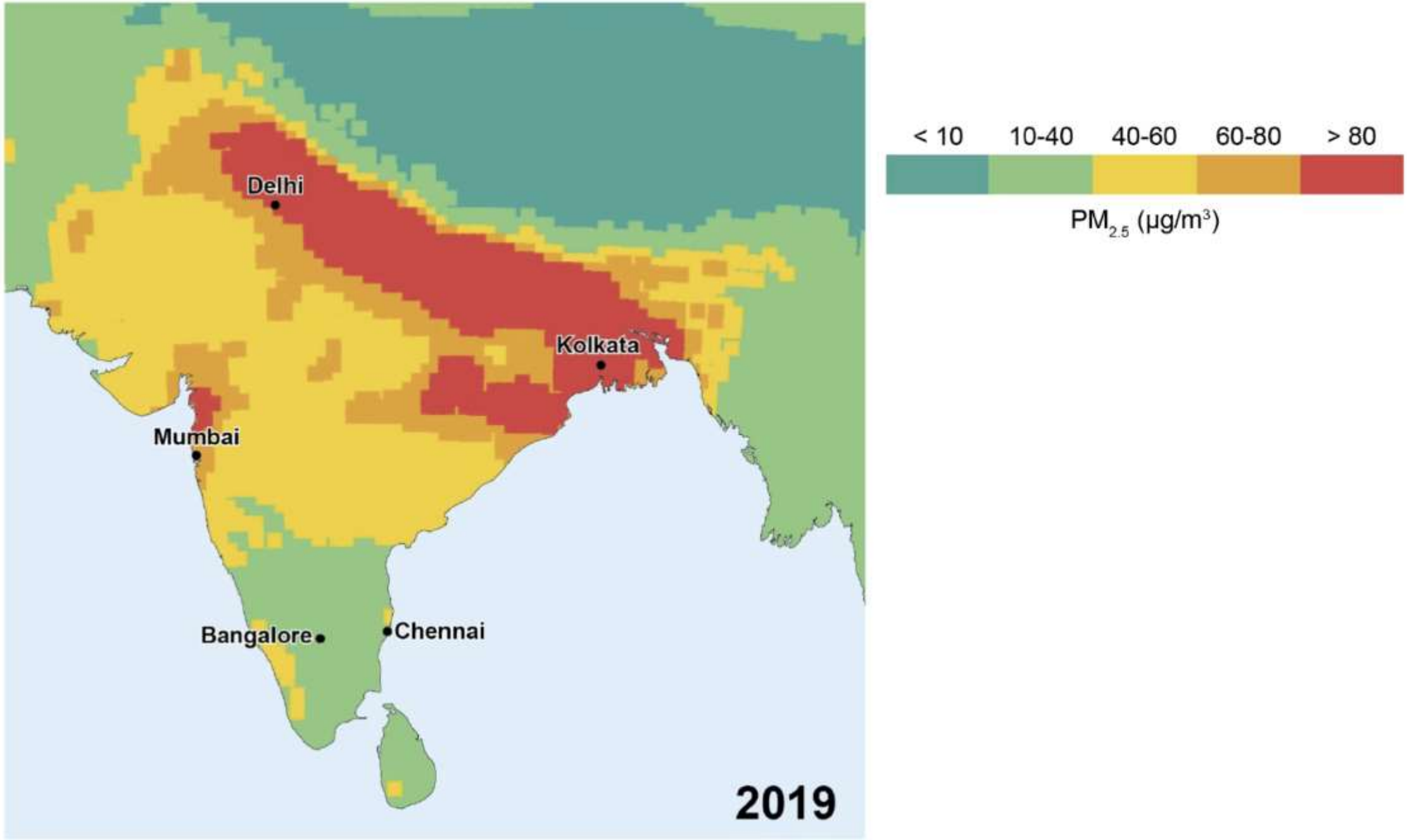
What organs are impacted by air pollution?

- Almost every organ in the body can be impacted by air pollution. Due to their small size, some air pollutants are able to penetrate into the bloodstream via the lungs and circulate throughout th e entire body leading to systemic inflammation and carcinogenicity.

Diseases associated with air pollution

Air pollution is a risk for all-cause mortality as well as specific diseases. The specific disease outcomes most strongly linked with exposure to air pollution include stroke, ischaemic heart disease, chronic obstructive pulmonary disease, lung cancer, pneumonia, and cataract (household air pollution only).

There is suggestive evidence also linking air pollution exposure with increased risk for adverse pregnancy outcomes (i.e. low-birth weight, small for gestational age), other cancers, diabetes, cognitive impairment and neurological diseases.


Delhi
Kolkata
Mumbai
Bangalore
Chennai
2019
< 10
10-40
40-60
60-80
> 80
PM2.5 (µg/m3)

Policy integration and alignment is needed to boost India’s clean energy transition

- Timing and technological choices are crucial for making measures such as renewables deployment, enhanced emissions standards, energy efficiency measures in industry and the thermal power segment, as well as residential clean energy access a consistent policy framework, fostering clean energy transition.
- While air pollution measures enable short-term CO_2 emissions stabilisation, climate policies prevent long-term technology lock-in and deliver lasting air pollution reductions. A power sector transition from fossil to renewable energy, for example, addresses both concerns and deliver significant air pollution and CO2 emissions reductions.

Power plants

- Captive power plants, also known as auto-producers, are employed by heavy industry and service companies to generate electricity in the face of concerns regarding cost and reliability of grid supply.
- This fossil-fuel intensive sector is understood to make up around 14% of India’s power supply in 2019, and with its greater share of coal and oil use, accounted for 16-18% of all power-related CO2 and air pollution emissions.
- To meet India’s decarbonisation targets, the power sector is expected to shift away from coal towards cleaner sources of power. While the government has introduced stricter pollution limits, the majority of thermal power plants are unlikely to meet the air pollution standards by the mid-2020s.

Higher emissions without control technologies

- Failing to implement air pollution control technologies, however, would see emissions across all air pollutants more than doubling and SO2 emissions reaching more than 1.5 Mt in 2040, a level 16 times higher than under the implementation of emission control measures.

PAT Scheme

- India’s Bureau of Energy Efficiency estimates that the industry sector could contribute 60% of possible energy savings until 2031 and several programmes have been introduced to meet this target.

- The Perform, Achieve and Trade (PAT) scheme is the cornerstone of these efforts. Established in 2012, the first PAT cycle targeted large energy-intensive industries.

- Following initial success, the scheme was extended, and phases PAT II-VI have been rolled out annually in two-year cycles since 2016. By improving energy efficiency and avoiding additional energy consumption in industry, the PAT scheme indirectly delivers environmental benefits as lower energy consumption results in fewer CO_2 and air pollutant emissions.

- Nonetheless, it could be argued that the PAT scheme was not ambitious enough and targets could be set higher, such as by means of benchmark setting as well as broader coverage of large

PAT scheme

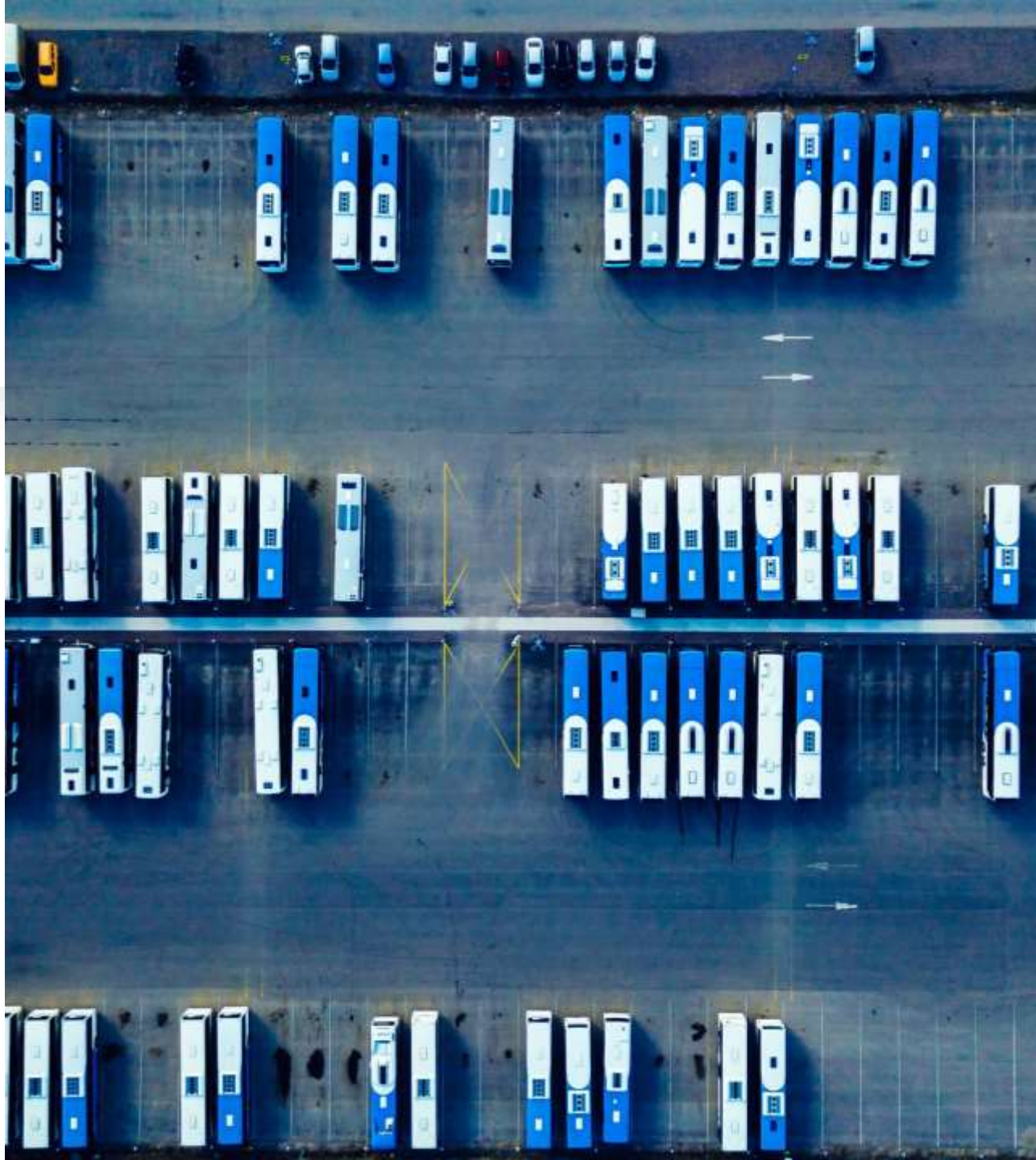
- IEA analysis estimates that a continued and expanded PAT scheme could result in more than 80 Mt of avoided CO_2 emissions in 2030 and 265 Mt CO_2 in 2040, of which iron and steel would contribute about 70% and cement more than a quarter.
- Converting the PAT scheme's energy saving to carbon saving certificates could further trigger fuel switching, which would contribute additional CO_2 emissions reductions.
- Furthermore, expanding the PAT scheme could save more than 10% SO_2 and NOX pollution from large industry

Transportation

- The past two decades have seen seven-fold increase in the number of passenger cars on India’s roads leading to significant increases in urban air pollution levels and associated health problems.
- In response, India has adopted tighter emissions standards (Bharat Stage VI) effective for all vehicles manufactured after March 2020 and introduced the ambition to reach a 30%-share of EVs in total vehicle sales by 2030.

Road transportation and air pollution

- In terms of air pollution, road transportation was responsible for more than 40% of total NO_X emissions (3.3 Mt) and around 7% combustion-related $PM_{2.5}$ emissions in 2019.
- Implementing existing policies, including stricter fuel and vehicle standards, could lead to road transport-related NO_X emissions peaking around 2025 and then declining by over 60% by 2040.
- This would reduce road transport's share of combustion-related NO_X emissions to one quarter by 2040. India's transport sector directly emitted almost 320 Mt CO_2 in 2019 or 14% of the country's carbon emissions, more than 90% of which arose from road transport.



Projected emissions

- Growing demand for road transport sees projected emissions from the sector rising to more than 450 Mt CO_2 by 2030, and almost 600 Mt CO_2 by 2040. Furthermore, the growing use of EVs leads to indirect emissions in the power sector.
- While these emissions amounted to less than 0.5 Mt CO_2 in 2019, their importance is expected to grow with the uptake of EVs. By 2030, CO_2 emitted by EV electricity consumption could reach 20 Mt CO_2, and more than double by 2040.
- The speed at which the power sector reduces its CO_2 intensity is closely related to the net mitigation potential of large-scale EV deployment.
- A power mix that remains as carbon-intensive in 2040 as it was in 2019 could lead to the EV fleet emitting 20Mt CO_2 more than an equivalent fleet of conventional cars, while decarbonising the power mix as currently planned could deliver savings of more than 35 Mt CO_2.

Clean energy in cooking

- Around 660 million people, just under half of India's population, relied primarily on traditional use of biomass for cooking and heating in 2019.
- Burned indoors in poorly ventilated spaces, these fuels directly expose households to indoor air pollution, often with severe consequences for their health.
- A quarter of the almost 2.5 million premature death cases resulting from indoor air pollution globally occurred in India.
- Over the past decade, the country developed a comprehensive policy framework to promote clean cooking solutions notably targeting poor, rural households resulting in the share of the population relying on biomass, kerosene or coal declining by almost 20% over the period 2010-19, with half of the total population using cleaner fuels such as LPG.