THE WAY FORWARD

Charting a path to a climate-resilient future
Mitigation in the air: Decarbonising the transport sector for air pollution and climate benefits

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Clean Air and Sustainable Mobility
CSE

November 7, 2023
3 Indian cities in the world’s top 20

<table>
<thead>
<tr>
<th>Ranks</th>
<th>Cities</th>
<th>Ranks</th>
<th>Cities</th>
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<tbody>
<tr>
<td>1</td>
<td>DELHI, INDIA</td>
<td>11</td>
<td>CHENGDU, CHINA</td>
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<tr>
<td>2</td>
<td>KOLKATA, INDIA</td>
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<td>SINGAPORE, SINGAPORE</td>
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<td>3</td>
<td>KANO, NIGERIA</td>
<td>13</td>
<td>ABIDJAN, COTE D’IVOIRE</td>
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<td>4</td>
<td>LIMA, PERU</td>
<td>14</td>
<td>MUMBAI, INDIA</td>
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<td>5</td>
<td>DHAKA, BANGLADESH</td>
<td>15</td>
<td>BAMAKO, MALI</td>
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<td>6</td>
<td>JAKARTA, INDONESIA</td>
<td>16</td>
<td>SHANGHAI, CHINA</td>
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<td>7</td>
<td>LAGOS, NIGERIA</td>
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<td>DUSHANBE, TAJIKISTAN</td>
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<td>8</td>
<td>KARACHI, PAKISTAN</td>
<td>18</td>
<td>TASHKENT, UZBEKISTAN</td>
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<td>9</td>
<td>BEIJING, CHINA</td>
<td>19</td>
<td>KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO</td>
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<tr>
<td>10</td>
<td>ACCRA, GHANA</td>
<td>20</td>
<td>CAIRO, EGYPT</td>
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Smog leaves Delhi gasping for breath

TNM | Nov 3, 2012, 01:35 AM IST

Air pollution 5th largest killer in India

Air Quality Index

- Good
- Satisfactory
- Moderate
- Poor
- Very Poor
- Severe

Last year, the Environmental Preference Index ranked India 174 out of 178 countries for air quality. A WHO survey last year found that 15 of the most polluted 20 cities in the world were in India.
Deaths Attributable to Air Pollution in India in 2019

<table>
<thead>
<tr>
<th>Sources</th>
<th>Number of deaths, in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>1.67 (1.42–1.92)</td>
</tr>
<tr>
<td>Ambient particulate matter pollution</td>
<td>0.98 (0.77–1.19)</td>
</tr>
<tr>
<td>Household air pollution</td>
<td>0.61 (0.39–0.86)</td>
</tr>
<tr>
<td>Ambient ozone pollution</td>
<td>0.17 (0.08–0.26)</td>
</tr>
</tbody>
</table>

- Air pollution causes 17.8% of total deaths (9.39 million);
- On an average 4,575 deaths daily across India
Average annual PM2.5 concentration levels in India

About 70% of the country exceeded the recommended national annual average concentration level of 40 μg/m³ of PM2.5, and almost one-fifth experiences levels over 80 μg/m³.
Poor Air Quality Monitoring in India

- **Manual ambient air quality stations**: under National Air Quality Monitoring Programme (NAMP) are total 804 spread across 344 cities/towns and few villages.

- **Continuous ambient air quality monitoring**: 368 real-time monitoring stations are operating in 186 cities. Out of 368, **40 monitoring stations present in Delhi**

- Considering 6,166 urban agglomerations/ cities / towns in India (Census 2011) the monitoring network is very limited -- **present coverage is only in about 10 per cent of cities/towns**
Accepted Standard is 60 ug/m³ (micrograms per cubic meter) per annum

However, it started impacted our health in 29 ug/m³

Identified 131 Non-attainment Cities (NACs)
What's causing the problem? Source assessment
Need deep cuts and multi-sectoral approach

Note: Percentage share of different sectors in overall emission load.
* Delhi-NCR including Delhi city.
Source: CSE analysis of selected studies
Real-time: Average fractional contribution of sources of pollution to PM2.5 in Delhi (December 1, 2021– January 31, 2022)

Note: 1) Data for few hours on December 27 and 28 is missing. However, it was raining during these hours.
2) This is the mean of the daily average contribution for period December 1, 2021– January 31, 2022
3) The "other districts" category includes contributions from all the other regions/districts (apart from the 19 districts already included in the NCR districts). This includes the remaining districts of Haryana, UP, MP, Bihar, Rajasthan, etc and also across the borders

Source: CSE’s analysis based on Decision Support System for Air Quality Management in Delhi of IITM
As transport demand is increasing, cities are getting more polluted. According to WHO, 18 out of world’s top 30 most polluted cities are from India.

1. Muzaffarpur (UP)
2. Gwalior (MP)
3. Allahabad (Prayagraj) (UP)
4. Varanasi (UP)
5. Raipur (CG)
6. Delhi (DL)
7. Agra (UP)
8. Ludhiana (PN)
9. Gurgaon (HR)
10. Khanna (PN)
11. Firozabad (PN)
12. Amritsar (PN)
13. Gobindgarh (PN)
14. Patiala (PN)
15. Dehradun (UK)
16. Howrah (WB)
17. Dhanbad (JK)
18. Bhopal (MP)
How to improve Air Quality and reduce carbon emissions.....?

What kind of mobility strategies, we can adopt to control emissions in the city without hampering the growth?
Main Aim is to reduce vehicular emission

Objectives:

✓ Adopting more sustainable transport modes.
✓ Discouraging the use of polluting modes.
✓ Reducing distance of travel.
✓ Reduce the requirement of travel

Strategies:

Use of Active mode of transport; Walking & Cycling
Use of Parking Regulation as vehicle restrain measure. Congestion pricing
Use of Public Transport
Use of Greener mode of transport; EV
Encouraging Compact, Mix-use Development; TOD
Use of Technology
CO2 emissions from transport sector: Obstinate

Source: ourworldindata.org
Challenges across the world
Legacy challenge of car locked world

Motor vehicle ownership per 1000 population

Data available for 2014.

Data Source: OurWorldInData  Map prepared by CSE
Global transport energy intensity

Energy intensity: Total energy consumption per unit of GDP.

Boe: barrels of oil equivalent

Data Source: IEA, 2019
Map prepared by CSE
Factors which have a bearing on transport emissions

- Increasing mode share of private vehicles at the expense of declining sustainable modes.

- As cities grow bigger, both in terms of economy and scale, mobility pattern is also increasing rapidly – both trip rate and length is increasing

- Steady shift towards bigger engine vehicles – which are energy guzzlers. In between 2010-21, number of bigger engine cars has increased from 0.2 to 1.3 millions almost 6.5 times.
Pandemic and transport CO2: Nose dives; but recovers
Emissions Gap report 2020

EMISSIONS COULD BE 7% LOWER IN 2020 DUE TO COVID-19

But in the **long-term**, this year’s dip means only a **0.01°C reduction** of global warming by 2050

Source: Emissions Gap Report, 2020 | UNEP
Technology pathways

- Ambitious target for fuel efficiency
- Electrification and going beyond IC engines
How countries are moving forward in CO2 emissions targets by country

Data Source: ICCT, 2020

Map prepared by CSE
The EV race

Till date, the penetration of EV is less than 5% in big global vehicle markets.

70% of EVs in in few countries

<table>
<thead>
<tr>
<th>Country</th>
<th>EV Penetration</th>
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<tbody>
<tr>
<td>Norway</td>
<td>55.93%</td>
</tr>
<tr>
<td>Iceland</td>
<td>22.60%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>15.14%</td>
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<tr>
<td>Sweden</td>
<td>11.43%</td>
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<tr>
<td>Finland</td>
<td>6.90%</td>
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<tr>
<td>Portugal</td>
<td>5.67%</td>
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<tr>
<td>China</td>
<td>4.94%</td>
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<tr>
<td>Germany</td>
<td>3.01%</td>
</tr>
<tr>
<td>Canada</td>
<td>2.96%</td>
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<tr>
<td>UK</td>
<td>2.85%</td>
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<tr>
<td>New Zealand</td>
<td>2.82%</td>
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<tr>
<td>France</td>
<td>2.77%</td>
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<tr>
<td>US</td>
<td>2.05%</td>
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<tr>
<td>Japan</td>
<td>0.90%</td>
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<tr>
<td>Chile</td>
<td>0.12%</td>
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<tr>
<td>India</td>
<td>0.07%</td>
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</tbody>
</table>
100 per cent EV ambitions

Many developed nations like Norway, UK, France, Germany has already set up 100% EV transformation targets.

Source: ICCT Reports
Challenge of developing countries

Emissions standards and fuel quality roadmap continues to improve

2020: India -- BSVI emissions standards
Asia in varying stages

Africa:
2015 - 2019: East Africa Community (EAC) adopted low sulphur diesel fuel standards (of 50 parts per million or less). Also adopted low sulphur petrol fuels (also 50ppm)

2020, ECOWAS: From January 2021 only used vehicles meeting Euro IV standards will be permitted in 15 Ecowas countries following their adoption of new fuels and vehicle standards

Discussing electric mobility
India’s challenge

Need high ambition for electrification – set target, zero emissions mandate, FAME III for well structured longer term incentives and state level action

Aggressive improvement in fuel efficiency – Need stronger targets across vehicle segments – light and heavy duty and two wheelers

Decarbonise transport fuels

How can we build ambition to ensure green recovery?
Transport emissions trend in India

According to MoEFCC, India’s transport sector- 12.1% of energy related CO2 emissions and 9.7% of the country’s total GHGs

Road transport plays a greater role in transport sector emissions, as it’s account for about 87% passenger traffic and 60% freight traffic.

Transport- emissions continue to grow, as the increased demand for travel outweighs the technological efficiency gains (Banister et al., 2012)

GHG emissions from transport sector in India (in percentage)

- Road Transport: 90%
- Civil Aviation: 6%
- Railways: 3%
- Domestic water borne navigation: 1%

90% of India’s transport sector GHG emissions are contributed by road transport.

Source: Second Biennial update report 2018, MoEFCC, GOI
Concerning trends: increasing demand for mobility and energy

Explosive motorization - the number of registered motor vehicles in India has doubled from 1.4 to 2.8 billion in the last decade (2011-2021).

Transport sector energy demand has already grown by 2.5 times in between 2000-2019. Transport sector is the 2nd largest consumer of energy, after Industry.

Energy consumption in transport by modes

Transport sector is the 2nd largest consumer of energy, after Industry.
Explosive motorisation!!

Source: 2016, Road Transport Yearbook, MoRTH
Agenda: clean vehicles but also less vehicles on road
Mobility transition
Transportation and vehicle restraint strategies
Are we getting there?
Global commuting pattern
More walking and cycling in developing world

![Bar chart showing commuting pattern in developed and developing cities](chart.png)

Source: UITP Mobility in Cities Database
Mobility pattern in India (urban working population)

Trip length for work trip in urban India

- 0-1: 24%
- 2-5: 35%
- 6-10: 19%
- 11-20: 9%
- 21-30: 5%
- 31-50: 3%
- 51+: 3%
- Not stated: 3%

Source: Census 2011

Mode share for work trips in urban India

- Walk: 30%
- Bicycle: 15%
- Scooter/Motor-cycle: 5%
- Car/Jeep/Van: 4%
- Tempo/Auto/Taxi: 17%
- Bus: 22%
- Train: 0%
- Water transport: 0%
- Any other: 1%

Source: Census 2011
Mobility demand in India

Increase in passenger km per annum and by mode in business-as-usual scenario

- Passenger km is expected to increase more than 3 times by 2050.

- Trip length and rate will also increase as city size and income increase.

- Demand for different mode of transport will increase over time. Without adequate public and para transit, private transport will overtake public transport mode share by 2040.

Source: UNEP, 2015
Urban Mobility

Distance

Most daily trips are short distance trips

- 60% of urban India travels daily only within 5 km.
- For Delhi-NCR it is 47% and for Delhi-NCT it is 48%

Mode

Most daily trips are still on foot and cycle

- 47% of urban India travels daily on foot and cycle.
- For Delhi NCR, it is 39% and in Delhi NCT it is 37%

Barely 14% people on cars shouldn’t occupy 80% of road space and most of on road emissions
Scale of change still small

Restructuring Ajmal Khan road

22 streets in Delhi identified for pedestrianisation

Restructuring Chandni Chowk
Mobility Strategy: Use of Active mode of transport; Walking & Cycling

Meenakshi Temple, Madurai

Image: Pedestrianisation in India and across the Globe, ITDP
Africa doing this right: NMT policy; infrastructure despite pandemic
Europe: Rediscovering walking and cycling

Pop up bike lanes
Emerging strategies on vehicle restraint & electric vehicle programme

1. Amritsar
   - Renovation of Golden Temple area as no-car zone

5. Delhi
   - TOD amendment in master plan
   - Bus fleet augmentation and route rationalisation
   - EV policy 2020
   - Phase III metro approved
   - Pedestrianisation of Ajmal Khan, Road, Chandni Chowk

7. Jaipur
   - PBS through smart city programme
   - ITMS for traffic management
   - EV policy formulation underway

8. Mumbai
   - AC Bus fleet augment in 2019
   - EV fleet induction in 2020

10. Hubli-Dharwad
    - Proposal in 2019 to replace all ICE buses with EVs

12. Bangalore
    - Convert 7000 buses through “soot free urban bus fleet”
    - EV fleet induction in 2018
    - Dedicated bus priority corridors in 2019

2. Shimla
   - No car zones on mall road - pedestrian tourism
   - 75 EV buses deployed for long distance operations

6. Noida - Ghaziabad
   - DMRC card integration - last mile connectivity
   - E-rickshaws for last mile

3. Fazila, 4. Chandigarh
   - ecoCABS program - community based dial-a-rickshaw service

13. Puducherry
    - Pedestrianisation of streets - no parking zones, street furniture
    - Proposed 10.3 km cycle track

9. Nanded
   - City beautification to promote pedestrian traffic

11. Mysuru
    - PBS system - 52 docking stations across city

14. Kolkata
    - Vehicle restraint by regulating parking
    - AC trams introduced in 2019
    - 80 EV buses launched in 2019

15. Ajmer
    - Vehicle restraint by street design in central city area

16. Gangtok
    - No car zones and pedestrianisation by street design in central city area
Ban entry of old and polluting vehicles in targeted city areas: identified as low emissions zones

- Low-emission zone (LEZ)
- Certain vehicles are prohibited in LEZ to:
  - Prevent local emissions,
  - Encourage vehicle owners to purchase cleaner vehicles,
  - Incentivize modal shift to lower-polluting transport modes,
  - Reducing congestion and noise.
- Local air pollution and congestion are typically the primary drivers of the creation of an LEZ
Where are we with Electric Vehicles?

- Electric vehicles crossed a million mark in 2022 – 4.72% share (212% growth from 2021)

- E-2Ws had the largest share at 63%, E-3Ws - 33.7%, cars/taxis - 3.8% and E-rickshaws - 29% of total fleet and 86% among E-3Ws

- Uttar Pradesh (15.2%), Maharashtra (12.7%) and Karnataka (8.8%) were the top three states with max EV sales

Source: CSE based on VAHAN data base
Why electric vehicles?

- Advanced technology– Zero emissions
- EVs have less number of parts than ICE vehicles, cheaper to operate
- Its more energy efficient than its ICE counterpart
- Regenerative braking is possible – 15-20% of total kinetic energy can be restored
- No noise
EVs in new sales in states (2022)

States crossing 5% benchmark, Delhi - 10%
Karnataka, Maharashtra, and Goa show low e-rickshaw registrations
Some states with high EV shares show high e-rickshaw registrations --
Tripura, Assam, Uttarakhand and Uttar Pradesh

Source: CSE analysis based on VAHAN data base
How can India rebuild bus transport?

Bus ridership declining in major cities of India

Combined Daily Bus Ridership in Indian Cities
(Ridership of 17 major cities in India)

| Year   | Delhi | Mumbai | Chennai | Bengaluru | Vijayawada | Hyderabad | Pune | Madurai | Trivandrum | Kanpur | Lucknow | Mysore | Faridabad |
|--------|-------|--------|---------|-----------|------------|-----------|      |         |            |       |          |        |           |
| 2013-14| 24,973,341 | -1,691,000 | -469,000  | -2,127,277 | -1,74,000  | -1,18,867 | -41,979 | -20,469 | -19,690     | -8,208 | -3,956     |        |            |
| 2014-15| 23,260,911 | -1,24,1,948 | -469,000  | -2,127,277 | -1,74,000  | -1,18,867 | -41,979 | -20,469 | -19,690     | -8,208 | -3,956     |        |            |
| 2015-16| 21,829,134 | -2,84,685  | -469,000  | -2,127,277 | -1,74,000  | -1,18,867 | -41,979 | -20,469 | -19,690     | -8,208 | -3,956     |        |            |
| 2016-17| 20,896,219 | -3,84,602  | -469,000  | -2,127,277 | -1,74,000  | -1,18,867 | -41,979 | -20,469 | -19,690     | -8,208 | -3,956     |        |            |
| 2017-18| 20,333,950 | -4,34,817  | -469,000  | -2,127,277 | -1,74,000  | -1,18,867 | -41,979 | -20,469 | -19,690     | -8,208 | -3,956     |        |            |

Source: RTI filed by CSE, 2019

Between 2013 - 18, 12 cities have lost combined ridership of 40.8 lakhs
NTDPC report: Passenger traffic will grow by 15-16 times over a economic growth of 7-9% per annually; India needs to invest 8-10% of GDP in transport infrastructure
Post 2019: Spread of e-bus services

Almost 81% of all e-bus are concentrated in 5 states

Cities with operational e-bus fleet

Source: MoRTH Press Release (5th Aug 2021)
CO2 mitigation strategies from transport in India

Source: Dhar & Shukla, 2015
What strategies should India adopt towards net zero goals?

- Stringent fuel economy regulation – India has already implemented BS6 emission norms. RDE to continue in 2023 and frame BS7 standards for implementation in 2027.

- Ambitious electrification programme – Implement and meet 30-40 percent electrification targets by 2030-35, which includes developing of EV ecosystem.

- Greater focus on improving public transport services across India. As per the estimates India has a deficit of over 60000 buses in million plus cities alone.

- Develop adequate infrastructure for walking, cycling and safe access.

- Apply vehicle restraint and demand management measures to manage mobility demands and promote sustainable modes like walking, cycling and public transport.

- Adopt compact city design and transit oriented design to reduce travel distance and improve public transport access.
What is CSE doing about it?

- Policy-sided interventions, in the form of capacity building and advocacy driven by real-world data driven experiences
- Improving accountability by setting goals and deadlines
- Increasing public awareness, through schools, universities, media so that everyone can do what we do.
Thank You!

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