

Time for Action

A critical review of Source Apportionment
in Air Pollution Mitigation



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ABSTRACT

The Indian policy ecosystem is replete with laws designed to guarantee the right to clean air and water to its citizens. Some of these laws and policies have been in place for decades but have failed to achieve their ambition. This goes to emphasise that deteriorating air quality in the country is not due to a dearth of policies. In fact, the air quality discourse can benefit more if resources are allocated towards honestly understanding and addressing the implementation challenges facing the existing set of environmental policies. Experts working in the field of air pollution have also expressed their frustration with the excessive reliance Source Apportionment science for designing air pollution mitigation strategies⁰¹. In a country like India with high levels of pollution, a very poor implementation framework and limited financial resources, source apportionment studies are a mere indulgence. Logically speaking, a source apportionment study is most effective to understand the achievements of a well -implemented mitigation strategy, not to frame one. The question that then follows is whether the findings of SA studies are really influencing policy implementation. It is therefore vital for policy makers and regulators to ask the following questions with regard to source apportionment:

- How has source apportionment enhanced the implementation of existing laws and policies on air pollution?
- Does the identification of pollution sources and the exact percentage of their contribution result in proportionate action?
- Have previous source apportionment studies resulted in any positive action on ground?
- Can these resources be better utilised for mitigation measures?

OBJECTIVE

This paper aims to critically evaluate the relevance of source apportionment studies in planning and implementation of air pollution mitigation policies.

01. 10 Reasons Why Indian Cities Continue To Top the World's 'Most Polluted' Lists, Sarath Guttikunda, The Wire, April 6 2021
<https://science.thewire.in/environment/10-reasons-why-indian-cities-continue-to-top-the-worlds-most-polluted-lists/>

INTRODUCTION

Air pollution has been a staple element of the Indian policy making eco-system for almost a century. The Bengal Smoke-Nuisances Act of 1905⁰² was the first legislation aimed at regulating emissions from furnaces and fire places of (then) Calcutta and Howrah. Subsequently, the Bombay Smoke Nuisance Act was passed in 1912 following which, independent India's first Smoke Nuisance Act was passed by the state of Gujarat in 1963. The fundamental idea behind these legislations was to improve deteriorating air quality in big cities.

The science behind the behaviour of pollutants once they are liberated from various anthropogenic sources has piqued the interest of academics and scientists alike. Studies on air pollution issues in Indian cities began appearing in prominent Indian journals in the 1950s. The Indian Journal of Meteorology & Geophysics published the first study (as recorded by the Indian Air Quality Studies Interactive Repository) on air pollution in 1958 in the city of 'Calcutta'⁰³. In the 1970s, seminars and events to discuss the ills of air pollution began in earnest, and researchers produced a veritable treasure trove of studies on air quality. This included BARC's P K Zutshi^{04, 05}, who authored several papers on air pollution in the city of Bombay⁰⁶.

Despite these scientific advancements in the understanding of air pollution causes, polluted environment soon became an expected externality of the Indian growth process. Since the 1950s, India progressed from a Least Developed Country (LDC) to the 6th largest world economy, but its battle with air pollution still continues, now more than ever. In fact, the Indian example also elucidates the fact that economic growth alone is not a recipe for a cleaner environment. However, that's a debate for another day.

While Indians sought respite from environmental degradation through the decades, the science of air pollution progressed and researchers began investigating the links between specific sources and pollutants. Research institutions across India began developing knowhow on source apportionment technologies on the premise that isolating individual sources of pollution would help develop a targeted mitigation policy landscape. The country's first "source inventory" study was carried out in Mumbai in 1968 by the National Environmental Engineering Research Institute (NEERI). Following this, NEERI carried out similar source inventory studies for Mumbai, Calcutta and Delhi in 1990. Since then, around 73 source apportionment studies were carried out between 2001 and 2017 by various academic institutions (See Annexure 1).

02. The Bengal Smoke-Nuisances Act, 1905 Act 3 of 1905, PRS Legislative Archives - <http://www.commonlii.org/in/legis/wb/act/bsa1905210.pdf>

03. A Possible Role of Atmospheric Pollution on the Frequencies of Fog at Alipore, Dum Dum And Barracpore, Kumar Mukherjee, Ashoke, Indian Journal of Meteorology and Geophysics, 1958.

04. Environmental concentrations of some of the major inorganic pollutants at the BARC site, Trombay, Bombay, P.K Zutshi et al, Indian Journal of Meteorology and Geophysics, 1970.

05. Trends of the concentration of some gaseous pollutants in Bombay, Zutshi, P.K.; Mahadevan, T.N.; Banerjee, Tapoti, Indian Journal of Meteorology and Geophysics, 1973.

06. Over a Century of India's Air Pollution Policies and Research Now Available in New Online Repository, BreatheLife - <https://breathelife2030.org/news/century-indias-air-pollution-policies-research-now-available-new-online-repository/> 10.

Source Apportionment and Air Pollution Mitigation

The National Green Tribunal has been a strong proponent of source apportionment studies. Its orders in the ongoing petition (O.A 281 of 2018), the principle bench of the NGT have emphasised the need for source apportionment studies in air quality management. While the tribunal's position on source apportionment has been emphatic, its view on its role in pollution mitigation is not clear. For instance, in its order dated 21.08.2020, in an ongoing suo moto case on the implementation of NCAP, the tribunal has made the following observation – *“Depending upon assessed carrying capacity and source apportionment, the authorities may consider the need for regulating number of vehicles and their parking and plying, population density, extent of construction and construction activities etc. Guidelines may accordingly be framed to regulate vehicles and industries in non-attainment cities in terms of carrying capacity assessment and source apportionment.”*

The tribunal's observation offers no clarity on how a source apportionment study could add value to an action plan. For instance, regulating vehicle density, parking or construction activities have been part of urban planning agendas of various cities for decades and the failure to regulate them is not due to the lack of knowledge on their contribution to air pollution but due to persistent socio-political factors.

Despite this, non-attainment cities across the country continue to carry out often expensive, apportionment studies. According to the compliance report submitted to the tribunal by the CPCB, source apportionment studies have been Completed in 4 States (5 cities); is under progress in 14 States (54 cities); and in proposal stage in 10 States (37 cities). The Ministry of Environment Forests & Climate Change's (FY 2020-20) financial allocation for 'control of pollution' which includes financial allocation to meet the NCAP agenda action points is Rs. 460 crores⁰⁷. At Rs. 80 lakhs per study⁰⁸, the cumulative cost of carrying out studies in all 122 Non-Attainment Cities is Rs.97.6 crores (nearly 20% of the NCAP budget).

Revival of Source Apportionment under NCAP

The National Clean Air Program or NCAP was officially launched in January 2020 as a “long-term, time-bound, national level strategy to tackle the air pollution problem across the country in a comprehensive manner with targets to achieve 20% to 30% reduction in Particulate Matter concentrations by 2024 keeping 2017 as the base year.”

At the heart of the NCAP are city specific air quality management plans or the city action plans for 102 non-attainment cities. The city action plans in turn are guided by “a comprehensive science-based approach, involving source apportionment studies.” The programs' rationale behind the emphasis on source apportionment is that the action plans need to be “dynamic and evolve based on available scientific evidence”. The NCAP further envisages the source apportionment to serve as a cost-effective approach for improving air quality in the polluted areas by:

07. What Does the 2021 Union Budget Do To Improve Air Quality?, The Wire, February 6 2021 -

<https://science.thewire.in/environment/union-budget-air-pollution-quality-15th-finance-commission-ncap-lpg-subsidies/>

08. Information provided by CPCB under RTI

1 Identification of emission sources.

2 Assessment of extent of contribution of these sources on ambient environment.

3 Prioritizing the sources that need to be tackled.

4 evaluating various options for controlling the sources with regard to feasibility and economic viability; and

5 Formulation and implementation of most appropriate action plans.

In order to understand the efficacy of these above-mentioned objectives, a deeper analysis of the air pollution mitigation ecosystem is necessary. Therefore, the NCAP's emphasis on source apportionment needs to be critically analysed especially since SA studies are known to be resource intensive and compete for the same financial resources dedicated towards mitigation action.

From the policy making perspective, SA studies need to bridge the gap between science and policy. In that, it is vital for policy makers and regulators to ask the following questions with regard to source apportionment:

- How has SA enhanced the implementation of existing laws and policies on air pollution?
- Does the identification of pollution sources and the extent of their contribution result in direct mitigating action?
- Have previous source apportionment studies resulted in any positive action on ground?

Source Apportionment – Relevance to Mitigation

As mentioned earlier, around 73 source apportionment studies were carried out between 2001 and 2017 by various academic institutions (See Annexure 1). A quick analysis of these studies reveals that sources that contribute to poor urban air quality have remained constant over the past four decades, and so have the associated recommendations. For instance, a study titled 'Level of Air Pollution in Bombay' published in the Indian Journal of Environmental Protection (Rashmi Mayur, 1982⁰⁹) makes the following recommendations:

- Since automobile is the major culprit.. the urgent task is to reduce the number of cars and their movement in the city. It should not be difficult to provide an efficient public transport system
- Recognising that there are many old cars on the road, contributing to the problem of pollution, all efforts should be made either to remove them or to assure their performance at a given standard.
- There should be proper synchronisation of traffic signals in order that flow can be assured during peak hours.
- It was observed that one factor influencing the flow of traffic was parking on the thoroughfare sometimes illegally. If pollution in this area... is to be controlled, traffic regulations must be strict and should be implemented.

09. Mayur Rashmi, Level of Air Pollution in Bombay, Indian Journal of Environmental Protection, 1982.

Four decades later, the National Summary Report on emission monitoring and source apportionment compiled by the CPCB in February 2011 makes the following recommendations as the “way forward” for the transportation sector¹⁰:

- ▶ **Improvement of fuel quality** & vehicle exhaust norms – roadmap beyond 2010 for progressive implementation of BS – 4/6 norms¹¹.
- ▶ **Old vehicles** – retrofitting of pollution control devices, scrap policy, inspection & maintenance issues, etc.
- ▶ **use of IT [Information Technology] in traffic management**, guidelines for minimizing/ synchronization traffic signals, providing adequate parking, parking fee structure, etc.

A comparison of source apportionment studies carried out across 5 cities highlights the limitations that such studies have when it comes to articulating solutions. The sources and their targeted interventions remain similar across cities with little clarity on achieving these targets.

Delhi 2018

- Strict implementation of BS -VI norms
- Improvement and strengthening of inspection and maintenance system
- Penetration of electric and hybrid vehicles
- Traffic congestion management and synchronising of traffic signals
- Ban on 15 year and old private and 10 year old commercial vehicles
- Improving public transport as per the existing plan of the city
- Change to clean fuel (ethanol, biodiesel etc.)

Chennai 2017

- Adoption of BSV or VI norms to reduce the emissions from vehicular sources of NOx in particular.
- Banning of 10 year old commercial vehicles and 15 year old private vehicles to reduce the emissions of NOx.
- Improvement of public transport

Bangalore 2010

- Strengthening of Public transport system
- Ban on old vehicles (10 years old) in the city
- Installation of pollution control devices (DOC/DPF) in all pre-2010 diesel vehicles
- Introduction of hybrid vehicles/ electric vehicles
- Improve traffic flow
- Alternative fuels such as ethanol, bio-diesel
- Effective Inspection and maintenance regime for vehicles

10. Air quality monitoring, emission inventory and source apportionment study for Indian cities, National Summary Report, February 2011, CPCB.

11. Both BSIV and BSVI are emission norms that set the maximum permissible levels for pollutants emitting from a car or a two-wheeler exhaust. Compared to the BS4, BS6 emission standards are stricter. The Central government has mandated that all vehicle manufacturers, both two-wheelers and four-wheelers, should manufacture, sell and register only BS6 (BSVI) vehicles from 1 April 2020.

Pune 2010

- Implementation of BS VI norms
- Electric and hybrid vehicles
- CNG-LPG and Hydrogen-CNG blend for commercial vehicles (alternate fuel)
- Synchronization of traffic signals
- Banning of 15 year old private vehicle and 10 year old commercial vehicles
- Improvement of public transport: % share

Mumbai 2010

- Implementation of BS – VI norms
- Electric and Hybrid vehicles
- CNG/LPG, Ethanol blending (E10 – 10% blend) Bio-diesel (B5/ B10: 5–10% blend)- alternative fuels
- Synchronization of traffic signals
- Improvement of public transport: as per existing plan for the city
- Banning of 8 year old commercial vehicles and Banning of 15 year old private vehicle

Kanpur 2010

- Adoption of BS – VI for all vehicles
- Banning of 15 year old private vehicles and 10 year old commercial vehicles
- Inspection and Maintenance of vehicles
- Restricted vehicle Movement ~ 50% only (traffic management)
- CNG/LPG for Commercial Vehicles

It is interesting to note that, barring the sophistication in the language, there is little novelty that the CPCB report has to offer in comparison to the paper of 1982. The rest of the recommendations merely focus on technical aspects emphasising on improving the prowess of monitoring science, advancing more research on Source Apportionment, developing emission inventories etc.

Furthermore, SA studies carried out by various agencies/researchers differ significantly in their findings. A comparative analysis by Delhi based think tank, Council for Energy, Environment and Water (CEEW), concluded that, “in comparing various emissions inventories of air pollutants for Delhi and the NCR, this study finds significant differences in their estimates of total pollutant load and, especially, sectoral emissions.”¹² For instance, the study found significant variations in PM_{2.5} emissions across sectors ranging from 17.9 to 39.2% in transport, 2.3 to 28.9% in industries, 3.1 to 11.0% in power plants, 18.1 to 37.8% in road dust and 2.2 to 8.4% in construction.

Simply put, different source-apportionment approaches may lead to different conclusions (to support air quality planning) and these differences are a consequence of the intrinsic assumptions that underpin the different methodologies and determine/limit their range of applicability (Thunis et al, 2019)¹³.

In addition to imposing a challenge upon air quality planners, these issues also enquire the reliability of SA science as a policy planning tool and its ability to go beyond an exercise in academic inquisitiveness.

12. What's Polluting Delhi's Air? Understanding Uncertainties in Emission Inventories, CEEW, March 2019 - https://www.ceew.in/sites/default/files/CEEW_What_is_Polluting_Delhi_Air_Issue_Brief_PDF_12Apr19.pdf

13. P. Thunis, A. Clappier, L. Tarrason, C. Cuvelier, A. Monteiro, E. Pisoni, J. Wesseling, C.A. Belis, G. Pirovano, S. Janssen, C. Guerreiro, E. Peduzzi, Source apportionment to support air quality planning: Strengths and weaknesses of existing approaches, Environment International, Volume 130, 2019

Policy Paralysis

The idea of management plans or prioritisation of action based on source apportionment studies is a conundrum from a policy making point of view. A lay person's analysis of the logic behind source apportionment is to derive information about pollution sources and the amount they contribute to ambient air pollution levels. While this seems coherent in theory, there is a fundamental gap in the approach vis-à-vis the ground realities around the implementation of policies.

India's public policy ecosystem is replete with laws designed to guarantee the right to clean air and water to its citizens. A quick analysis of the policy landscape reveals that each target sector under programs like NCAP have dedicated policies/laws designed to address their environmental impacts. Table 1 gives an overview of the various sectoral interventions envisaged under city action plans of NCAP and the corresponding policies, court orders or action plans already in place. The idea behind presenting this table is to emphasise the fact that deteriorating air quality in the country is not due to a dearth of policies. In fact, the air quality discourse can benefit more if we invest resources towards honestly understanding and addressing the implementation challenges facing the existing set of environmental policies.

The question that then follows is whether the findings of SA studies are really influencing policy implementation? Does the knowledge on sector specific contributions (ie, 35% transport vs 22% DG sets) really help when logic calls for simultaneous interventions? To take the example of public transport which is at the core of several city action plans – it was clear that public procurement policies in this regard remain poorly ambitious and stagnant in their approach. For instance, In 1997, a [white paper](#) on Delhi's air pollution projected the need for 15,000 buses in 2000 – and in 2020, Delhi's [new action plan](#) still talks about the need for 15,000 buses¹⁴. A similar trend can be observed in other sectors as well wherein the lack of any historical policy stock-taking has resulted in the recycling of old schemes and ideas without any implementation strategies.

Moreover, when we analyse this in conjunction with the existing body of knowledge on source apportionment ([Annexure 1](#)), the common long-term interventions across cities are introduction of clean fuel, improving public transport, enforcing industrial emission standards, implementing waste management laws etc.

Note that we are not focussing on the short-term interventions like traffic management, dust suppression actions or pollution sequestration technologies like air guns or road sweeping as they are not relevant from the point of sustainable public policy in the long-term.

It is therefore vital for policy makers and regulators to ask the following questions with regard to source apportionment:

- How has SA enhanced the implementation of existing laws and policies on air pollution?
- Does the identification of pollution sources and the exact percentage of their contribution result in a proportionate action?
- Have previous source apportionment studies resulted in any positive action on ground?
- Can these resources be better utilised for mitigation measures?

14. 10 Reasons Why Indian Cities Continue To Top the World's 'Most Polluted' Lists, The Wire, 6 April 2021

Impoverished Regulators

Ultimately, at the heart of the air quality debate is the issue of policy implementation. It is evident based on the information above that India's regulatory framework needs to be critically evaluated for its gaps and incompetence. A detailed [academic analysis](#) published in 2013 by the School of Habitat Studies at the Tata Institute of Social Sciences (TISS), Mumbai found that, "lack of strong financial, human and technical resources of pollution control boards at the State level and the increasing interference of State governments in the affairs of State pollution control boards are the dominant factors of non-implementation of environmental laws at the implementation level." Furthermore, a recent [study](#) across 8 SPCB's by the Delhi based non-profit, Centre for Chronic Disease Control (CCDC) found staff shortages, increased workloads, poor understanding of the health impacts of pollution, poor coordination with related agencies and low levels of motivation and accountability among the staff.

Given these facts, the most logical intervention would be to empower these agencies by infusing funds. However, for the financial year 2020-2021, the government has allocated Rs 3,100 crore to the Union environment ministry – nearly Rs 1,200 crore short of the ministry's request of Rs 4,295 crore¹⁵. Furthermore, there is no marked increase in the NCAP budget ([Rs.470 crores](#)) despite the fact that it remains the only route of financial support to 90 of the 124 non-attainment cities and key state agencies like pollution control boards and transport departments¹⁶. Interestingly, 100 crores (over 21%) from NCAP has been allocated for source apportionment studies.

CONCLUSION AND RECOMMENDATIONS

There is no disputing the fact that source apportionment science is important in informing air quality management. However, they seem to hold less relevance as a policy planning tool for countries like India that boast a strong policy ecosystem but lack the capacity to implement laws. All scientific studies reviewed for this paper show that Indian air quality is being impacted by multiple sources. Contrary to the popular notion, common policy sense should tell us that, these sources have to be addressed simultaneously and not consecutively. The air pollution policy landscape reviewed earlier in this paper underscores the reality that India has an abundance of policies but suffers from a policy paralysis. Moreover, the continued impoverishment of the regulatory agencies does not align well with the overall agenda outlined under ambitious programs like NCAP. To conclude, source apportionment is relevant as a tool, but policy logic would apply them to study and evaluate the impact of a well implemented policy. Indian cities are better off spending their limited resources on pollution mitigation initiatives rather than affording themselves the luxury of expensive science.

15. Air Pollution is No Longer a Priority for the Government, 11 March 2020, The Wire -

<https://science.thewire.in/environment/air-pollution-union-budget-2020-government-moefcc-mohua-cpcb-priority/>

16. What Does the 2021 Union Budget Do To Improve Air Quality, The Wire, 6 February 2021 -

<https://science.thewire.in/environment/union-budget-air-pollution-quality-15th-finance-commission-ncap-lpg-subsidies/>

In terms of the way forward, the idea of Source Apportionment needs to be assessed from the perspective of policy implementation landscape. The following recommendations can strengthen the contribution of Source Apportionment in environmental decision-making:

1. All non-attainment cities need to carry out extensive implementation research to assess the root causes behind the failure of pollution mitigation policies.
2. Source apportionment studies should only be recommended to assess the impact of a well implemented policy.
3. City action plans based on Source Apportionment studies should not prioritize recognised sources based on the share of their contribution but aim to address them simultaneously.
4. Recognise the fact that the air pollution crisis in India is a result of cities over-shooting their ecological capacities. Hence, all non-attainment cities should carry out cumulative impact assessment to understand the combined impacts of all sources and sectoral carrying capacity studies aimed at fixing limits on the unchecked growth of sectors.

Table 1: Air pollution policy landscape

Sector	Intervention	Policy Outline
Transport	Electric / Hybrid Vehicles (EV)	<p>India's agenda on electric vehicles can be traced back to 2010 when the Ministry of New and Renewable Energy (MNRE) announced the Alternate Fuels for Surface Transportation Program (AFSTP) that aimed at supporting battery operated vehicles, support pilot technology for battery operated vehicles and raise awareness on electric vehicles, plug hybrid vehicles and hybrid electric vehicles among others. The current status of the AFSTP is not known.</p> <p>Most recently, India's mission to achieve 100% EV transition by 2030 is well underway with policies such as the National Electric Mobility Mission Plan of 2020, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles or FAME I 2015 and FAME II 2019 already in place. In addition to this, the India Energy Storage Mission aims to develop globally competitive battery manufacturing in India to support this transition to EV and the National Policy on Electronics 2019 to support R&D innovation into the next generation of solid state batteries and Electric Vehicles. Furthermore, as a fiscal measure, the ministry of road transport proposed a (draft) amendment to the Central Motor Vehicles Rules (CMVR), 1989 to exempt battery operated vehicles from the payment of fees for the purpose of issue or renewal of registration certificate.</p> <p>Additionally, 14 states across the country have proposed or adopted EV policies. These include, Andhra Pradesh, Bihar, Haryana, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Meghalaya, Delhi NCR, Odisha, Punjab, Tamil Nadu, Telangana, Uttar Pradesh and Uttarakhand.</p>
	Bharat Standard (BS) 4 and 6	<p>Bharat stage emission standards were first introduced in 2000 and since, progressively stringent norms have been rolled out. All new vehicles manufactured after the implementation of the norms have to be compliant with the regulations. Since October 2010, Bharat Stage (BS) III norms have been enforced across the country. Bharat Stage IV emission norms have been in place since April 2010 in 13 major cities and it has been enforced for entire country since April 2017. In 2016, the Indian government announced that the country would skip the BS V norms altogether and adopt BS VI norms by 2020. According to experts, the immediate motivation appears to be the poor air quality in New Delhi. Following this, the Supreme Court has banned the sale and registration of motor vehicles conforming to the emission standard Bharat Stage IV in the entire country from 1 April 2020.</p>

Alternative Fuels		<p>MNRE's Alternate Fuels for Surface Transportation Program (AFSTP) mentioned above also touches upon alternate fuels.</p> <p>In addition to this, various fiscal measures are in place to encourage the use of AF.</p> <p>The Ministry of Road Transport and Highways passed an order on 18 October 2018 (S.O 5333E) whereby EVs and vehicles running on alternate fuel (ethanol/methanol) have been exempted from the requirements of permit in order to encourage their use.</p> <p>The (draft) amendment to the Central Motor Vehicles Rules (CMVR), 1989 proposed the inclusion of H-CNG (18 per cent mix of hydrogen) as an alternate fuel.</p>
Ban on vehicles ¹⁷		<p>The issue of old vehicles and their contribution to air pollution has been the subject of debate since the 1990s. Acknowledging their contribution to deteriorating air quality in the Delhi NCR, the Supreme Court in its order dated 22.09.1998, banned vehicles older than 15 years from plying.</p> <p>The National Green Tribunal had as early as 28th November 2016 directed the Ministry of Heavy Industries to bring out a vehicle scrapping policy looking at different practical aspects of scrapping of old vehicles. Simultaneously, the Central Pollution Control Board (CPCB) also came out with the Guidelines for Environmentally Sound Management of End-of-Life Vehicles (ELVs) in November, 2016. Recently the Draft Guidelines by MoRTH for scrapping of vehicles was published for public consultation in October, 2019 as part of the larger amendments to the Central Motor Vehicles Rules 1989. The guidelines are aimed at setting up, authorising and operation of Authorised Vehicle Scrapping Facility (AVSF)</p> <p>Most recently, the ministry announced its intent to move towards a voluntary vehicle scrapping policy wherein fiscal measures will replace mandatory compliance of scrapping old/polluting vehicles. There is still a lack of clarity on the legal compatibility of such a policy with the order of the Supreme Court in 1998 and then in 2018.</p>
Inspection and maintenance		<p>Currently in India, the inspection and maintenance (I&M) programme consists of periodic PUC certifications for all types of vehicles and annual fitness certifications for commercial vehicles. Private vehicles need to undergo fitness tests and re-registration after 15 years from the date of the first registration. The current I&M regime was found to be insufficient by expert bodies like TERI, which recommended urgent reforms in its detailed report of 2014 and Sakthi Foundation in its 2016 position paper. Following this, the MoRTH announced the 14th financial circle guidelines of 2017-2020 for inspection and certification of vehicles addressing some of these concerns.</p>
Scattered business timings		No policy available

17. <https://www.livelaw.in/columns/delhi-air-pollution-judicial-intervention-in-abating-vehicular-emissions-151202>

Odd/even		<p>Delhi's flagship program launched in January 2016 was aimed at rationing the use of private vehicles by restricting the movement of cars based on their license plates. The maiden phase of the scheme ran from January 1 2016 to November 11 2017. The second phase was launched subsequently and the third one in November 2019.</p> <p>The odd-even measure continues to be part of Delhi's Graded Response Action Plan but there is no indication on extending odd-even to the rest of the country.</p>
Fiscal measures		<p>Fiscal incentive and disincentives have been part of the Indian policy-making ecosystem for several decades. Central and state duties, cess, taxes etc., targeting polluting activities have been in practice across the country. Some such measures have been captured by research think tanks. However, all the measures cannot be documented due to the limited scope of this paper.</p>
Traffic Light Synchronisation		<p>Smart traffic management has been discussed as part of urban air pollution management strategy for several years. Various research institutions have developed integrated traffic management systems and introduced AI in traffic management in various cities such as Delhi and Chennai.</p> <p>In addition to this, the Ministry of Urban Development has launched the Traffic Management and Information Control Centre (TMICC) Operations Document, with the primary objective to assist various government organisations and public authorities in India embarking on the process of establishing TMICCs.</p> <p>There is no information on the investments by various cities in TMICC systems.</p>
Metro Train/Public Transport		<p>According to experts' investments in public transportation are still inadequate and heavily tipped in favour of metros¹⁸. Between 2014-17, 1,236 crores were allocated under AMRUT scheme for procurement of buses for all states across the country. In the same time period, the MoHUA allocated 26,377 crores for metro projects nationwide¹⁹.</p> <p>A detailed analysis of the public transport sector in India by KPMG notes that Indian cities lag behind in the physical coverage of public transport network to most of the cities across the globe. Moreover, public procurement policies remain poorly ambitious and stagnant in their approach. For instance, In 1997, a white paper on Delhi's air pollution projected the need for 15,000 buses in 2000 – and in 2020 a new action plan still talks about the need for 15,000 buses[4].</p> <p>Moreover, adequate state policies and schemes are already in place to promote public transportation such as the Maharashtra State Urban Transport Policy and Urban Mobility Policy, Chennai Unified Metropolitan Transport Authority.</p> <p>Urban transport in India is riddled with several challenges. Urban policy think-tanks such as Indian Institute for Human Settlements have captured these issues and recommended institutional reforms to sustainably address these challenges.</p>

18. India's public transport challenges, The Mint, September 16 2019 - <https://www.livemint.com/news/india/india-s-public-transport-challenge-1568355574941.html>

19. Ibid

Power DG Sets	Inspection and Maintenance	A detailed analysis by Delhi based Shakti Foundation and the ICF International on diesel generators in India has concluded that the current norms in place have brought India's emission standard for diesel generators closer to world benchmarks. The norms are equivalent to Euro Stage IIIA which was prevalent in Europe till 2010 for all size categories. Furthermore, the NCAP has been encouraging state governments to adopt policies to completely phase out generators run only on diesel fuel. Studies show that 91% of DG Sets have no regulations beyond the point of manufacture. In 2018, the NGT reemphasised the need for DG regulations in all states and the need to shift to gas based systems. However, so far only Haryana and Tamil Nadu pollution control boards have acted on the order.
	Adequate power supply	Government data claims that India is power surplus and a net exporter of power since 2017. However, this hasn't translated into uninterrupted power supply as a result of which cities continue to rely on diesel generators. Experts point to the several issues behind this including the debt ridden DISCOMS that are unable to maintain and build power supply infrastructure.
Open Burning	Ban on open burning	Open burning of municipal waste and biomass remains a punishable offence under various central and state laws such. Courts in various states have applied various sections of the Indian Penal Code to make penalties for open burning as stringent as possible. In 2016, the NGT " banned " the illegal activity and announced penalty of Rs. 25,000 for offenders. Most recently, the Kerala government announced fines up to Rs.50,000 for open burning of plastics. Despite this, big cities have been unable to curb the menace.
Industry Based on Action Plan for Clean Industry, Report of the Task Force on Clean Industry, NITI Aayog and CII.	Fuel Change	Confederation of Indian Industries in partnership with NITI Aayog launched the ' Cleaner Air Better Life Initiative ' in November 2016. Under the initiative, four task forces have been constituted by NITI Aayog for Clean Transportation, Clean Fuel, Clean Industry and Biomass Management. The initiative's Action Plan for Clean Fuel is a comprehensive roadmap for adoption of cleaner fuels. In addition to this, in 2018, the Supreme Court banned the use of pet coke by industrial units in the Delhi NCR. The implementation status of this ban could not be ascertained.
	Fugitive emission control	The Action Plan for Clean Industry, Report of the Task Force on Clean Industry , recommends a comprehensive set of actions to address fugitive emissions from construction, infrastructure, coal, diesel generators etc., in the Delhi NCR. The current status of implementing these recommendations is not known.
	Shifting polluting industry	Shifting polluting industries outside city limits has been on the urban planning agenda of several state governments. However, very few such projects have succeeded while most remain on paper. Most recently, Mumbai and Hyderabad have announced such policies. AS per the compliance report filed with the NGT principle bench in O.A No. 681 of 2018 – only 13 states have provided information or action plans on the matter while 11 have not provided any information.

	Compliance monitoring	Industrial compliance to emission regulations in India continues to be poor. A detailed study by Energy Policy Institute at the University of Chicago and Harvard Evidence for Policy Design highlighted serious problems in the enforcement of existing regulations across India. The study further found that 'equipment mandates' (which require installation of air pollution control equipment) remains a common form of policy intervention. However, while installations can be easily enforced, it is difficult for regulators to monitor and enforce their continued use. As a result industries in India continue to be the most polluting despite being compliant on paper.
Area Sources	Shift to Domestic LPG	<p>The shift to LPG is well underway in the country. As per government data, by the end of 2019 around 95% of the population had access to LPG through ongoing schemes like DBT Pratyaksh Hanstantrit Labh (PAHAL) and Pradhan Mantri Ujjwala Yojana (PMUY). In the FY 2020-21, Rs.35605 crores and Rs.1118 crores, were allocated to DBT-PAHAL and PMUY respectively.</p> <p>A study by Washington based policy think tank, Initiative for Sustainable Energy Policy (ISEP), found that while LPG access has increased, majority of rural households still use solid fuels. PMUY beneficiaries were found to be consuming about 30% less LPG as compared to non-beneficiaries even after accounting for socio-economic and demographic differences. The main barriers to adoption cited include cost of refills and poor service delivery network.</p>
	Fuel change for commercial facilities (LPG)	No schemes are available to encourage roadside commercial establishments to shift to LPG. Businesses continue to make fuel choice decisions based on commercial viability.
	Clean Tandoor	<p>It is estimated that there are roughly 9,000 tandoors in the city of Delhi which contribute to air pollution²¹. CSIR-NEERI has developed a clean tandoor based on biomass pellets. The tandoor is under fabrication, testing and</p> <p>Performance optimisation. It is reported to be available</p> <p>For INR 20,000-30,000 per unit.</p>
Construction	C&D Waste Rules implementation	According to a report by the Centre for Science and Environment , the country generates an estimated 150 million tonnes of C&D waste every year. But the official recycling capacity is a meagre 6,500 tonnes per day – just about one per cent. The study further notes that of the 53 cities that were expected to set up C&D recycling facilities by 2017 – only 13 have done so as of 2020.

[Please click here to view a compilation of all Source Apportionment studies carried out in various cities of India.](#)

21. Sharma, M. and Dikshit, O. (2016). *Comprehensive Study on Air Pollution and Green House Gases (GHGs) in Delhi*. Indian Institute of Technology Kanpur. New Delhi, India.



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