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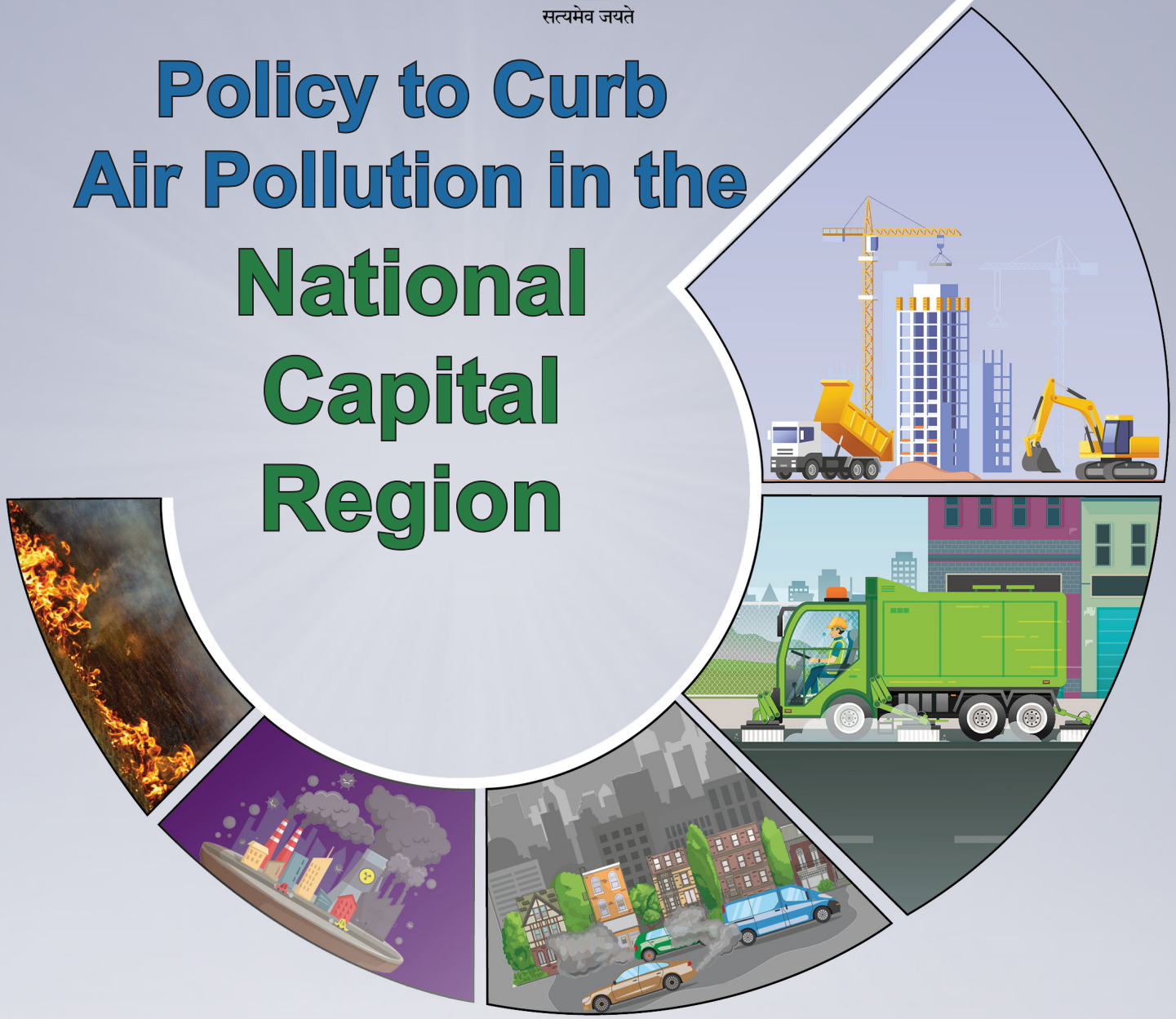
Policy to Curb Air Pollution in the National Capital Region



CAQM

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Policy
to Curb Air Pollution in the
National Capital Region

July, 2022

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Abbreviations

ACA:	Additional Central Assistance
AIS:	Automotive Industry Standards
AOD:	Aerosol Optical Depth
AQEWS:	Air Quality Early Warning System
AQI:	Air Quality Index
ARAI:	Automotive Research Association of India
AVLS:	Automatic Vehicle Location System
BIS:	Bureau of Indian Standards
BPCL:	Bharat Petroleum Corporation Limited
BS:	Bharat Stage
C&D:	Construction and Demolition
CAAQMS:	Continuous Ambient Air Quality Monitoring Stations
CAMPA:	Compensatory Afforestation Fund Management and Planning Authority
CAQM:	Commission for Air Quality Management in National Capital Region and Adjoining Areas
CBG:	Compressed Bio-Gas
CCTV:	Closed-Circuit Television
CEA:	Central Electricity Authority
CEMS:	Continuous Emission Monitoring System
CER:	Corporate Environmental Responsibility
CFS:	Container Freight Station
CGD:	City Gas Distribution
CHC:	Custom Hiring Centre
CMVR:	Central Motor Vehicle Rules
CNG:	Compressed Natural Gas
CO:	Carbon Monoxide
COVID-19:	Corona Virus Disease of 2019
CPCB:	Central Pollution Control Board
CRM:	Crop Residue Management
CSR:	Corporate Social Responsibility
CTO:	Consent to Operate
DC:	Direct Current
DCMC:	Dust Control & Management Cell
DDA:	Delhi Development Authority
DDUGJY:	Deen Dayal Upadhyaya Gram Jyoti Yojana

DERC:	Delhi Electricity Regulatory Commission
DG:	Diesel Generator
DHI:	Department of Heavy Industries
DIMTS:	Delhi Integrated Multi-Modal Transit System
DISCOMs:	Distribution Companies
DMRC:	Delhi Metro Rail Corporation
DPCC:	Delhi Pollution Control Committee
DSS:	Decision Support System
DTC:	Delhi Transport Corporation
ECC:	Environment Compensation Charge
ECD:	Emission Control Device
EESL:	Energy Efficiency Services Limited
EIA:	Environmental Impact Assessment
ELVs:	End-of-Life Vehicles
EPCA:	Environment Pollution (Prevention and Control) Authority
EPS:	Electric Power Survey
ESR:	Environmental Social Responsibility
ETA:	Estimated Time of Arrival
ETM:	Electronic Ticketing Machine
EVs:	Electric Vehicles
FAME:	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FGD:	Flue-gas Desulfurization
GAIL:	Gas Authority of India Limited
GAs:	Geographical Areas
GIDC:	Gujarat Industrial Development Corporation
GMCBL:	Gurugram Metropolitan City Bus Limited
GMOS:	Graded Merit Order System
GNCTD:	Government of NCT of Delhi
GPS:	Global Positioning System
GRAP:	Graded Response Action Plan
GST:	Goods and Service Tax
HGVs:	Heavy Goods Vehicles
HPCL:	Hindustan Petroleum Corporation Limited
IARI:	Indian Agricultural Research Institute
ICAT:	International Centre for Automotive Technology
ICDs:	Inland Container Depots
ICEs:	Internal Combustion Engines
ICMR:	Indian Council of Medical Research
IFCs:	Integrated Freight Complexes

IIT:	Indian Institute of Technology
IITK:	Indian Institute of Technology Kanpur
IITM:	Indian Institute of Tropical Meteorology
IMD:	India Meteorological Department
Indo-HCM:	Indian Highway Capacity Manual
IPDS:	Integrated Power Development Scheme
IPT:	Intermediate Public Transport
IRC:	Indian Roads Congress
ISBTs:	Inter-State Bus Terminals
ISRO:	Indian Space Research Organisation
ITMS:	Intelligent Traffic Management System
ITS:	Intelligent Transportation System
KVA:	Kilo Volt Ampere
kWh:	Kilo Watt Hour
LDO:	Light Diesel Oil
LMVs:	Light Motor Vehicles
LNG:	Liquefied Natural Gas
LPG:	Liquefied Petroleum Gas
LSHS:	Low Sulphur Heavy Stock
MCF:	Million-plus cities Challenge Fund
MDPE:	Medium-density Polyethylene
MGVs:	Medium Goods Vehicles
MIS:	Management Information System
MMI:	Multi-modal Integration
MMT:	Multi-modal Transport
MNRE:	Ministry of New and Renewable Energy
MoA&FW:	Ministry of Agriculture & Farmers Welfare
MoEFCC:	Ministry of Environment, Forest and Climate Change
MoF:	Ministry of Finance
MoHUA:	Ministry of Housing and Urban Affairs
MoP:	Ministry of Power
MoPNG:	Ministry of Petroleum and Natural Gas
MoRTH:	Ministry of Road Transport and Highways
MoU:	Memorandum of Understanding
MPD:	Master Plan for Delhi
MRSM:	Mechanical Road Sweeping Machine
MRTS:	Mass Rapid Transit System
MSMEs:	Micro, Small and Medium Enterprises
MSW:	Municipal Solid Waste
MUZ:	Multi-Utility Zone

MW:	Mega Watt
NAAQS:	National Ambient Air Quality Standards
NAMP:	National Air Quality Monitoring Programme
NCAP:	National Clean Air Programme
NCR:	National Capital Region
NCRPB:	National Capital Region Planning Board
NCT:	National Capital Territory
NDC:	Nationally Determined Contributions
NEERI:	National Environmental Engineering Research Institute
NGT:	National Green Tribunal
NHAI:	National Highways Authority of India
NHs:	National Highways
NITI:	National Institution for Transforming India
NMRC:	Noida Metro Rail Corporation
NMT:	Non-Motorised Transport
NOIDA:	New Okhla Industrial Development Authority
NPL:	National Physical Laboratory
NSGM:	National Smart Grid Mission
PAHAL:	Pratyaksh Hanstantrit Labh
PIS:	Passenger Information System
PM:	Particulate Matter
PMAP:	Parking Management Area Plan
PMUY:	Pradhan Mantri Ujjwala Yojana
PNG:	Piped Natural Gas
PPP:	Public Private Partnership
PPPI:	Power Plant Pollution Index
PTZ:	Pan-Tilt-Zoom
PUC:	Pollution under Control
RDF:	Refuse Derived Fuel
RECD:	Retrofitted Emission Controlled Device
RERA:	Real Estate Regulatory Authority
RFID:	Radio Frequency Identification
RoW:	Right of Way
RPM:	Revolutions per Minute
RRTS:	Regional Rapid Transit System.
SAFAR:	System of Air Quality and Weather Forecasting and Research
SAMARTH:	Sustainable Agrarian Mission on use of Agro Residue in Thermal Power Plants
SBM:	Swachh Bharat Mission
SDMC:	South Delhi Municipal Corporation

SEZ:	Special Economic Zones
SLB:	Service Level Benchmark
SLF:	Sanitary Landfill
SMS:	Short Message Service
SOP:	Standard Operating Procedure
SPCB:	State Pollution Control Board
SPV:	Special Purpose Vehicle
STU:	State Transport Undertakings
TERI:	The Energy and Resources Institute
TOD:	Transit-oriented Development
TPPs:	Thermal Power Plants
ULBs:	Urban Local Bodies
UOI:	Union of India
UPSRTC:	Uttar Pradesh State Road Transport Corporation
USEPA:	United States Environmental Protection Agency
UTTIPEC:	Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre
VKT:	Vehicle Kilometres Travelled
VOCs:	Volatile Organic Compounds
WFH:	Work from Home
WtE:	Waste to Energy
WP:	Writ Petition

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1. The mandate

The Hon'ble Supreme Court of India in its order dated 16.12.2021 in WP (Civil) No 1135 of 2020 in the matter of Aditya Dubey (minor) and Anr v/s UOI & Ors directed the Commission for Air Quality Management (CAQM) that with a view to "find permanent solution to the air pollution menace occurring every year in Delhi and NCR, suggestions may be invited from the general public as well as the experts in the field".

The Commission, through advertisements published on 24.12.2021 in three leading national dailies each in Hindi and English and also by uploading the same on the website of the Commission, invited suggestions within 14 days of publication to this effect. As per the order of the Hon'ble Supreme Court, suggestions received were to be examined by an Expert Group to be constituted by the Commission for the said purpose before finalization of the policy to curb air pollution.

Accordingly, the Commission for Air Quality Management (CAQM), vide order dated 7.1.2022, constituted an Expert Group with the following terms of reference:

- To consider the suggestions received from the general public and experts in the field with a view to finding out permanent solutions for the air pollution menace occurring every year in Delhi and NCR.
- To recommend suggestions for formulating permanent solutions for the air pollution menace.
- To suggest a policy to curb air pollution before finalization.

The Expert Group was also advised to interact with interveners, experts, and others as it deemed necessary and submit its report in this regard.

2. An overview of the approach

The approach followed by the Expert Group to formulate a suggestive policy to curb air pollution in the region is summarized below:

The Expert Group reviewed the suggestions received from the general public and experts. These were largely related to mitigation in the key sectors of air pollution, air quality management, monitoring framework and institutional strengthening for implementation. More than 115 submissions covering a wide gamut of suggestions have been received from civil society, research bodies, industry, experts, academia, individuals, etc.

The suggestions received in a series of stakeholder consultations have been incorporated appropriately in the relevant sections. This participatory approach has enriched the exercise of suggesting a policy to curb air pollution.

The Expert Group also reviewed and examined the existing scientific literature, relevant policies, regulations, programmes and funding strategies of the State and Central governments in various sectors; the current status of actions; and best practice approaches. The scope of this multi-sector assessment included industries, power plants, vehicles and transportation, diesel generator sets, dust sources like construction/demolition projects/roads and open areas, municipal solid waste/biomass burning, episodic events like stubble burning, firecrackers and other dispersed sources.

As primary research and independent estimation of the baseline and projected scenarios were not practical within the stipulated timeframe, data and evidences shared by the concerned departments and those from the available literature have been considered by the Expert Group. As the mandate of the Expert Group was to suggest "permanent solutions" to the problem of air pollution, efforts have been made to identify areas of improvement in infrastructure and systems, strengthening of regulatory and institutional capacity and strategies for compliance and enforcement, including enabling funding mechanisms.

The Hon'ble Supreme Court has passed a series of directions and orders in the past also taking into consideration the reports of the EPCA, which have contributed

towards improvement in air quality in Delhi-NCR. The policies and programmes of the Central government, the NCR State governments/GNCTD, directions of the Hon'ble NGT, steps taken by the Pollution Control Boards/Committee, including the Comprehensive Action Plan to abate Air Pollution in Delhi-NCR, have also contributed to the cause of abating air pollution in the region. Large numbers of statutory directions, orders, advisories and guidelines have also been issued from time to time by the CAQM since its inception. The Commission has interacted widely with a large number of industry associations/bodies, consortia, individuals and academic institutions, besides the State governments in NCR, the GNCTD and concerned pollution control authorities.

Extensive deliberations were held by the Expert Group during its nine different meetings, where presentations on promising proposals and ideas were delivered.

An interactive 'Dialogue towards Clean Air' was organized by the CAQM at Gurugram on 7th-8th March, 2022 involving all stakeholders, to garner opinions and suggestions for long-lasting solutions to the problem of poor air quality in NCR.

The Expert Group has duly taken cognizance of all such guidelines and programmes as above, has considered and assessed the current status and against this backdrop, further steps have been identified to address the gaps and newer challenges for improvement in air quality in the region.

The scope of this plan is to control air pollution primarily in Delhi and NCR. Owing to a deficit in infrastructure and systems across sub-regions of the NCR, wide variations in baseline actions, and varying levels of urbanisation, a differentiated approach and timelines have been suggested for various the sub-regions. These sub-regions include (*see Map 1*):

- The NCT of Delhi
- The NCR districts near Delhi — Gurugram, Faridabad, Sonipat, Jhajjar, Rohtak, Ghaziabad, Gautam Buddha Nagar and Baghpat
- Other NCR districts
- The entire state of Punjab and the non-NCR districts of Haryana, primarily for addressing episodic events of stubble burning

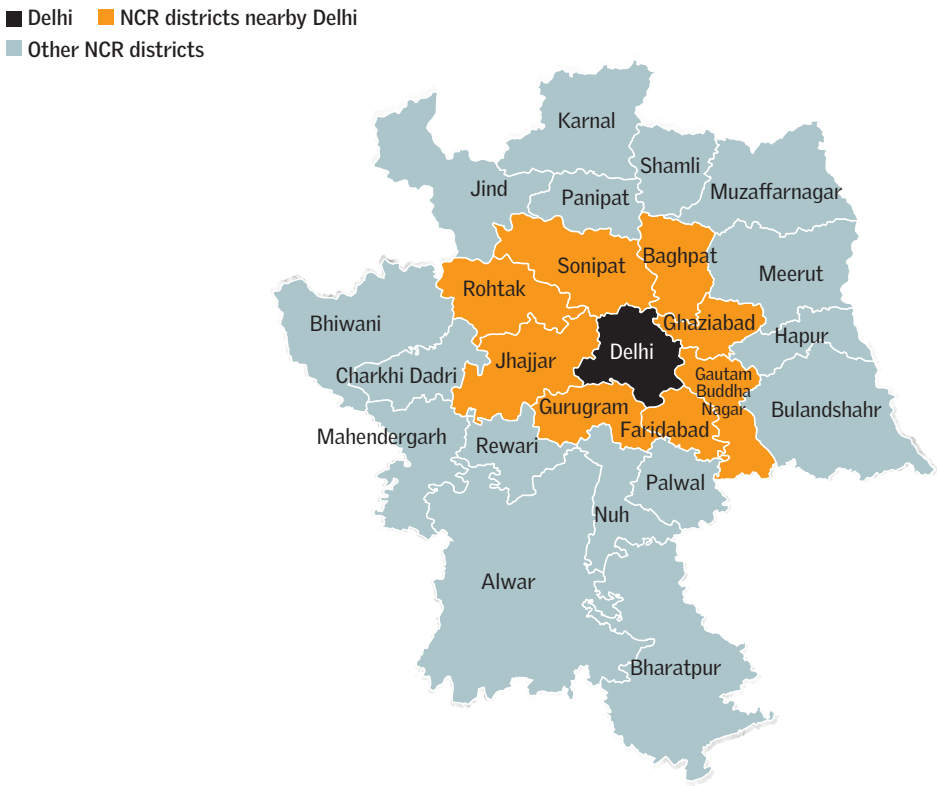
The Expert Group, considering the issues and complexities involved, suggests short-term (up to one year), medium term (one-three years), and long term (three-five years, preferably) actions. This timeframe is further differentiated for different sub-regions/areas/districts/cities to provide the space for all to transform to meet the common air quality goal.

Broadly, the critical areas of transformation aimed for meeting the national ambient air quality standards include –

- Widespread access to affordable clean fuels and technology in industry, transport and households
- Mobility transition including through mass transit, electrification of vehicles, building walking and cycling infrastructure and reducing personal vehicle usage etc
- Circular economy for material recovery from waste to prevent its dumping and burning
- Dust management from C&D activities, roads/right of ways and open areas with appropriate technology, infrastructure and greening measures
- Strict time-bound implementation, improved monitoring and compliance

Most of the available information relates to the NCT of Delhi and to some extent the four cities of Gurugram, Faridabad, Gautam Buddha Nagar and Ghaziabad. Information on the other NCR areas is not adequate for assessment of local issues. The problem of data limitation and funding requirements in the sub-regions, thus, need to be addressed.

Map 1: Delineation of areas in the NCR



3. The vision and the guiding principles

The policy to curb air pollution is primarily guided by the following principles:

- Clean air for all, good health, well-being and increased productivity.
- Action for clean air requires speed, scale and urgency.
- Equitous, inclusive, affordable, innovative approaches.
- Scientific, technical and behavioural solutions.
- Protect the vulnerable from the pollution risk.
- Multi-sector policy response and a systems-based approach.
- Air pollution management needs an airshed and a regional approach.

Health imperatives

Action to clean air is vital to reduce integrated exposures and protect public health. Studies have provided evidence of public health consequences of air pollution, and highlighted public health benefits of controlling air pollution. The Indian Council of Medical Research (ICMR) has found that the average life expectancy could be higher if air pollution levels were lowered.

Studies also show that air pollution risk is growing for major categories of diseases that include chronic obstructive pulmonary disease, lung cancer, heart disease, stroke and pneumonia, especially in the elderly and in children. Even in the case of episodic events like stubble burning, a study carried out by CPCB/TERI in 2021 found an increase in respiratory complaints triggered by these events across all age groups.[1]

Suggestions from the public and experts on the overall clean air action plan

- Need holistic, long-term regional approach – multi-sectoral strategy for the NCR and adjoining areas
- Multi-pronged measures to tackle air pollution throughout the year
- Reduce emissions from sources year-round and reduce reliance on emergency measures such as the Graded Response Action Plan
- Focus on rural and peri-urban areas
- Use modelling-based cost-benefit analysis to drive interventions
- Publish periodic reports on progress made against interim targets; assess why regulatory and enforcement measures succeeded or failed
- Develop sectoral action plans and solicit expert and public comments

4. Sector-wise action plans for abatement of air pollution

Strengthening air quality monitoring and source apportionment

SUGGESTIONS FROM PUBLIC AND EXPERTS ON AIR QUALITY MONITORING AND POLLUTION SOURCE ASSESSMENT

AIR QUALITY MONITORING

- Expand high resolution air quality forecasting across NCR
- Increase monitoring in rural and peri-urban areas for action plans to address rural and peri-urban air quality issues and household and localized sources
- Standardise and ensure transparency of air quality data
- Expand real time monitoring in the airshed and its reporting — widespread information dissemination through SMS, social media and other electronic means
- Ensure focus on the whole Indo-Gangetic Plain — adopt guidelines like the Regional Haze Programme of the US
- Put in place intensive airshed management, and availability of real time air quality data
- Pilot low-cost sensor-based technologies for air pollution measurement.
- Use Universal Air Pollution Monitoring Tool to comprehensively capture pollution sources and monitoring challenges.
- Ensure realistic monitoring of particulate matter, especially at traffic intersections
- Collect, inventorise, and publish monitoring data from various sources.
- Align all strategies with revised NCAP reduction targets; set annual interim targets to track progress and establish markers of success — interim targets should focus on ambient air pollution levels.

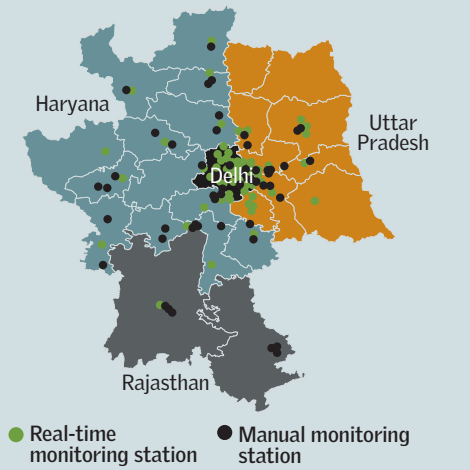
POLLUTION SOURCE ASSESSMENT

- Emission inventories required for each district of NCR — develop an up-to-date emissions inventory that can be revised periodically
- All policy frameworks and action plans for future development to be based on gridded source apportionment studies (diurnal/seasonal) and carrying capacity.
- Mandate the collection and reporting of data (collected through periodic field surveys).
- Institute a citizen task force to map out dispersed pollution sources in Delhi-NCR
- Integrated management of air pollution, modification of air quality management plan, promoting education and culture and public participation.

Since 2015, there has been considerable progress in expanding air quality monitoring in Delhi-NCR. The region has a total of 146 monitoring stations today, 65 of them manual and 81 real time (*see Table 1*). Nearly a quarter of all the real time monitors in the country are in Delhi-NCR. However, there is asymmetry in the distribution of monitors.

Table 1: Current distribution of air quality monitors in Delhi-NCR

District/ City	Manual stations	Real Time	Total stations
Delhi	10	40	50
Districts near Delhi			
Baghpat	2	2	4
Faridabad	0	5	5
Gautam Buddha Nagar	6	6	12
Ghaziabad	4	4	8
Gurugram	7	4	11
Jhajjar	2	1	3
Sonipat	2	1	3
Rohtak	2	1	3
Sub-total	**25**	**24**	**49**



Distribution of air quality monitors in NCR

District/City	Manual stations	Real Time	Total stations
Outer NCR			
Alwar	3	2	5
Bharatpur	3	0	3
Bhiwani	0	1	1
Bulandshahar	2	1	3
Charkhi Dadri	3	1	4
Hapur	2	1	3
Jind	1	1	2
Karnal	2	1	3
Mahendragarh	2	1	3
Meerut	2	3	5
Muzaffarnagar	2	1	3
Panipat	2	1	3
Rewari	2	1	3
Shamli	0	0	0
Mewat	2	1	3
Palwal	2	1	3
Sub-total	**30**	**17**	**47**
Total (NCR)	**65**	**81**	**146**

Source: Central Pollution Control Board and NCR State Pollution Control Boards

Most monitors are concentrated in urban centres. While 50 per cent of the real time monitors are located in Delhi, the remaining are distributed mainly in the four cities of Faridabad, Gautam Buddha Nagar, Ghaziabad and Gurugram. The other districts of NCR have only one real time monitor each. Till some time ago, several districts did not have any monitor at all, including manual ones. Of the total 65 manual stations presently in the NCR, only 20 have $PM_{2.5}$ monitors.

Further strengthening of the monitoring grid in the NCR region requires a roadmap. Delhi has a sufficient number of regulatory monitors and needs to focus on quality control of the data and its dissemination. The rest of NCR will require further strengthening of the grid.

The Central Pollution Control Board (CPCB) has adopted population-based criteria for estimating the number of monitors needed in an urban centre with a given population. The CPCB may further reform and rationalise the monitoring grid for the next phase of expansion in NCR. The multiple monitoring objectives include short and long-term air quality trends in different land-uses; air quality gradient in the urban area, regional scale and the background level; establishing compliance with the air quality target; assessing exposures in local environments and pollution hotspots; disseminating daily pollution alerts to general public and for emergency measures; and assessing transboundary movement of pollution.

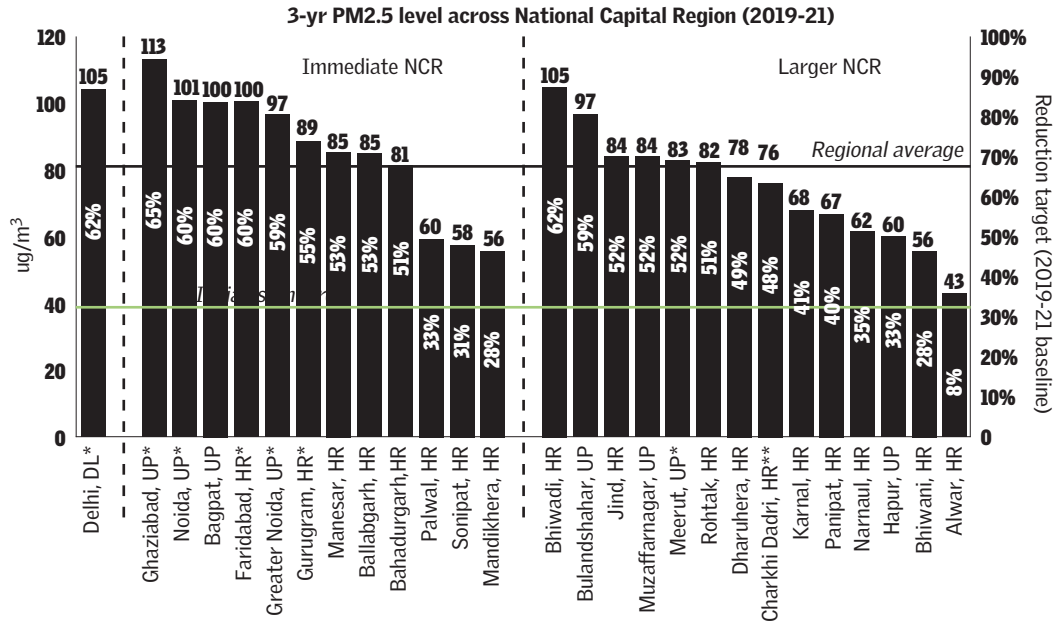
Currently, the CPCB reports the AQI for Delhi on a daily basis, primarily using real time data from CAAQMS. In addition, annual average levels are also computed based on data from manual stations under the National Air Quality Monitoring Programme (NAMP). While further strengthening the quality control and quality assurance of data, the CPCB may also need to develop a robust protocol for computing air quality trends to report compliance with NAAQS or NCAP targets. A standardised method will be needed for estimating short and long-term trends (for e.g., averaging time to be considered, data completeness to address data gaps, selection of monitoring stations for trend reporting etc).

Improvement in air quality – compliance of NAAQS

The suggestive policy for sustained improvement in air quality is primarily intended to enable compliance with the National Ambient Air Quality Standard (NAAQS) in the entire region as a first step.[i] The CPCB has initiated the process of a review of the NAAQS.

i. National ambient air quality standards SO_2, NO2, PM10, PM2.5, Ozone, Lead, CO, Ammonia, Benzene, Benzo(a)Pyrene, Arsenic and Nickel have been notified under the (Prevention and Control of Pollution) Act, 1981. Accordingly, "annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals" and "24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring". (Source: National Ambient Air Quality Standards, Central Pollution Control Board, Notification Dated, the 18th November, 2009, https://cpcb.nic.in/uploads/National Ambient Air Quality Standards.pdf)

Graph 1: $PM_{2.5}$ levels in Delhi-NCR: Three-year average, 2019-21



Note: Cities with multiple stations are represented by an average of stations which meet data adequacy requirement for all three years (2019, 2020 and 2021). *Cities with multiple stations. **Based on two-year data. Three-year averages are calculated using USEPA methodology and data completeness requirement, with median value substitution for the missing data

Source: Analysis of CPCB´s real-time data[2]

Review of the available real time data for cities indicates the current baseline level and the reduction needed to meet the NAAQS. Delhi, even after the stabilisation and a downward trend in $PM_{2.5}$ levels, requires about 60 per cent reduction to meet the NAAQS. Ghaziabad, Faridabad, Noida and Greater Noida, and Gurugram have levels higher than the regional average and need reduction in the range of 54-66 per cent. Smaller towns in the NCR, such as Ballabhgarh, Meerut, Bulandshahr and Rohtak, among others, have comparatively lower levels but require a reduction in the range of 48-58 per cent to meet the NAAQS (*see Graph 1*).

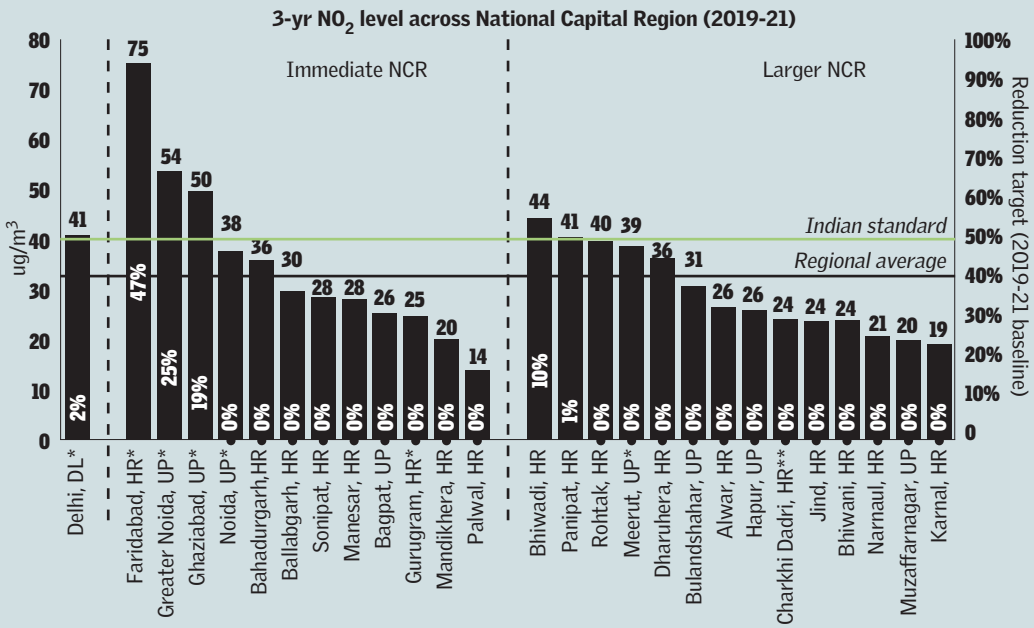
So far, the action in this region has primarily considered particulate pollution, which is a serious health threat. However, improved air quality monitoring and the emerging science indicate the importance of taking a multi-pollutant approach to control critical gases, including nitrogen dioxide and ozone. This is needed not only to reduce exposure to toxic gases but also to control the secondary particulate matters that are formed in the atmosphere. The existing source apportionment studies have shown that the share of secondary particulates in $PM_{2.5}$ can be more than a quarter during winter in Delhi. Therefore, the action plan will have to address both primary and secondary pollutants (*see Box: Addressing a multi-pollutant problem*).

ADDRESSING A MULTI-POLLUTANT PROBLEM

In addition to PM_{10} and $PM_{2.5}$ monitoring stations are also generating data on a range of pollutants including nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), ozone and volatile organic compounds (VOCs) like benzene, xylene, toluene etc. While local impacts of CO have been noticed in several locations of Delhi, NO_2 and ozone are also emerging concerns that need early action.

Nitrogen dioxide: The three-year NO_2 average exceeds the standard in Delhi, Faridabad, Greater Noida, Ghaziabad, Bhiwadi, Panipat and Rohtak (*see Graph 2*).

Graph 2: NO_2 levels in Delhi-NCR cities: Three-year average, 2019-21



Note: Cities with multiple stations are represented by an average of stations which meet data adequacy requirement for all three years (2019, 2020 and 2021). *Cities with multiple stations. **Based on two-year data. Three-year averages are calculated using USEPA methodology and data completeness requirement, with median value substitution for the missing data

Source: Analysis of CPCB´s real-time data[3]

Ground-level ozone: Ozone is a highly volatile and reactive gas. In 2021, ground ozone pollution exceeded the standard in the major cities of NCR. Delhi, with 231 days of exceedance, was the worst affected. Faridabad, Ghaziabad and Bulandshahr each recorded over 140 days of exceedance. Ozone data is not robust for smaller cities that have only one monitor each (*see Graph 3*).

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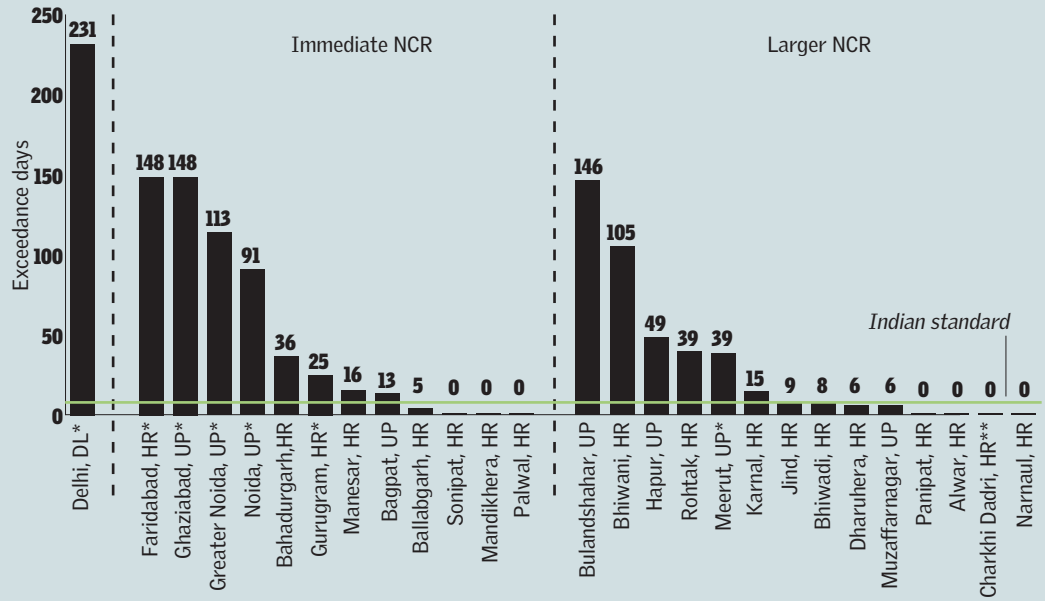
Graph 3: Ground level ozone exceedance days in Delhi-NCR cities: 2021



Note: Cities with multiple stations are represented by an average of stations which meet data adequacy requirement for all three years (2019, 2020 and 2021). *Cities with multiple stations. **Based on two-year data. Three-year averages are calculated using USEPA methodology and data completeness requirement, with median value substitution for the missing data

Source: Analysis of CPCB´s real time data[4]

The CPCB data indicates a general reduction in particulates in the region over a period of time as compared to levels in 2016, barring an exceptionally good air quality in 2020 owing to low level of anthropogenic and air pollution activities due to the COVID-19 pandemic. There has also been an increase in the number of good, satisfactory and moderate air quality days.

Air quality forecasting

Air quality forecasting has improved to inform policy action in Delhi – currently, it covers 19 districts of NCR. The Indian Institute of Tropical Meteorology (IITM) has recently developed and updated an 'Air Quality Early Warning System' (AQEWS) towards providing a dynamic daily air quality forecast for CAQM for Delhi-NCR.

This enables advance decision on emergency action during periods of anticipated adverse air quality. Recently, the AQEWS has been further integrated with a Decision Support System (DSS) for effective air quality management in Delhi-NCR. DSS provides both qualitative and quantitative information regarding contribution of different emission sectors in the region, including biomass-burning in neighboring states.

It is desirable that this system is further expanded for the entire NCR for better and informed decision making.

Contribution of different pollution sources to air quality

Scientific assessment of pollution sources and their relative contribution to the pollution load and concentration is available to inform action in some of the sub-regions of NCR – this should be viewed as an opportunity.

Multiple source apportionment and emissions inventory studies have been carried out in the period 2015-2018. These include pollution source apportionment and source inventory by the Indian Institute of Technology-Kanpur (IITK) for Delhi in 2015; by The Energy and Resources Institute (TERI) and the Automotive Research Association of India (ARAI)[5] in 2018 for Delhi-NCR; and by System of Air Quality and Weather Forecasting and Research (SAFAR), Delhi, IITM, in 2018.[6]

These studies show that there is considerable seasonal variation in the relative contribution of pollution sources between winter and summer. While during summer, the influence of dust increases to almost 31-34 per cent, its share during winter reduces to 6-15 per cent. The contribution of combustion sources (vehicles, industry, biomass burning among others) increases during winter to 85-94 per cent.

Notably, share of secondary particles (that form in the atmosphere from other gaseous pollutants from combustion sources, like sulfur dioxide, nitrogen oxides, ammonia, and volatile organic compounds etc) can be as high as 26-30 per cent during winter and about 15-17 per cent during summer (*see Tables 2 and 3*).

Updated emissions source inventory and source apportionment studies may be welcome with wider coverage in the NCR region. The available data, however, enables to initiate target-oriented strategies and actions to control and abate air pollution in the region and could be further aligned with specific source apportionment studies for particular regions, whenever conducted.

It is also important for the state pollution control boards to develop and maintain a live and independent inventory of pollution sources for proper planning and action. Efforts are also required for real time source apportionment for better decision making.

Table 2: Contribution of sources to $PM_{2.5}$ — winter and summer (using receptor modelling)

Sources	Winter		Summer	
	IITK 2015 (in %)	TERI-ARAI 2018 (in %)	IITK 2015 (in %)	TERI-ARAI 2018 (in %)
Secondary particles	30	26	15	17
Vehicles	25	23	9	18
Industry (coal)	5	10	26	11
Biomass burning	26	22	12	15
Dust and construction	6	15	31	34
Others	8	4	7	5

Source: Source apportionment study, 2018, Teri and ARAI; Comprehensive study on Air Pollution and GHGs in Delhi, 2016, IIT Kanpur

Table 3: Sector-wise contribution of $PM_{2.5}$ reported in three recent emission inventories in Delhi-NCR

Emission sectors	Delhi (2015)	Emission sectors	Delhi (2018)		NCR (2018)	
	IITK (in %)		SAFAR (in %)	TERI-ARAI (in %)	SAFAR (in %)	TERI-ARAI (in %)
Transport	20	Transport	41	39	39	12
Industrial-stack	11	Industry	19	3	22	23
Industrial area	2	Power plants	5	11	3	8
Domestic burning	12	Residential burning	3	6	6	24
Solid waste burning	3	Wind blown (includes construction)	21	26	18	7
Road dust	38					
Construction/ Demolition	2					
Hotels/ Restaurants	3	Others*	11	15	12	26
Others*	9					

Note: IITK-Others* — included DG sets, MSW burning, crematoria, aircraft, hotels/restaurants, medical incinerators.

SAFAR -Others* — included brick industry, hotels (dhabas), hospitals, malls, waste and biomedical waste burning, crematorium, DG sets, etc

TERI-ARAI-Others* — included DG sets, refuse burning, crematoria, airport, restaurants, incinerators, landfills, etc.

Source: Source apportionment study, 2018, Teri and ARAI; Comprehensive study on Air Pollution and GHGs in Delhi, 2016, IIT Kanpur

Minimise regional influence on air quality

There is growing evidence now of the regional influence on local pollution due to transboundary movements between upwind and downwind areas that require integrated and harmonised action across the region or the airshed. The 2018 joint

study by TERI and ARAI estimated the contribution of sources from within Delhi as also from 21 districts of the NCR to Delhi's air quality.

This shows that Delhi as well as other NCR areas collectively contribute to the overall adverse air quality scenario both in summer and winter seasons. The report by IIT Kanpur (2015) also shows more than 50 per cent of secondary particulates associated with coal and biomass burning are coming from outside Delhi. The DSS system of IITM further estimates and forecasts such regional influence on a dynamic basis.

The National Clean Air Programme (NCAP) has also highlighted that the need for a regional approach, and thus an integrated action plan, for the entire NCR based on a common airshed approach is a need of the hour.

Alternative methods for multi-dimensional air quality monitoring

It is now possible to have multi-dimensional air quality monitoring approaches as is evident globally, with countries combining alternative approaches to support conventional regulatory monitoring networks to address data gaps and map exposures. Accordingly, satellite-based monitoring and high-density sensor-based monitoring networks are being adopted increasingly across the world.

Satellite-based air quality assessment

Satellite remote sensing-based estimation of pollution from satellite retrievals of Aerosol Optical Depth (AOD) is a useful source of data for ground-level estimations with a potential for a wider regional coverage. The National Clean Air Programme (NCAP) of the MoEFCC has taken this approach on board. This can address spatial and temporal data gaps, ranging from hyper local to regional air quality. This, however, does not replace ground-based regulatory-grade measurements of air pollution but improves the accuracy of the estimates and calibration and validation of data.

Currently, independent research institutions including IITs have begun its application and are providing knowledge support to state pollution control boards. The CAQM has also coordinated with ISRO for satellite-based monitoring of stubble burning and fire counts in the region. The CPCB may create a framework for adoption and application of these new generation techniques.

Sensor-based monitoring

Sensor-based monitoring has created an opportunity to generate data to fill data gaps and map exposures where regulatory monitoring is inadequate. The NCAP has taken on board the application of sensor monitors that are much cheaper than regulatory monitors. Several state pollution control boards including

Maharashtra and Delhi among others, have joined hands with technical institutions to experiment and validate the data from low-cost sensors and assess the calibration requirements.

Additionally, under the ongoing Smart City programme of the Ministry of Housing and Urban Affairs (MoHUA), cities are required to install low-cost sensors for smart monitoring and digitization. However, the CPCB has given a clarification to all state pollution control boards and pollution control committees in its advisory on March 25, 2022 that air quality data generation using any technology including low-cost sensors other than that specified in NAAQS is not to be used for regulatory purposes as its accuracy, linearity, reliability and long-term performance are not yet fully established.

The CPCB has constituted a committee for development of network of air quality monitoring to frame operational guidelines, protocol for monitoring air quality and also to optimise the CAAQMS requirements. The CPCB is considering a pilot study to evaluate the efficacy of sensors.

The Bureau of Indian Standard (BIS) is currently developing a performance standard for sensors to address quality and validation of data from sensors. However, the SPCBs may explore and examine the use of low-cost sensors for other qualitative applications such as relative assessment and comparison of air quality owing to various dust control measures and interventions from time to time at construction sites, roads, right of ways, open spaces, hotspots etc. across the NCR.

The targeted action plan and timelines in this regard are in table 4 –

Table 4: Air quality monitoring and assessment: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible agency	Timeline		
			Up to 1 year	1-3 years	3-5 years
Develop a plan for air quality monitoring network, based on a revised criteria (based on land-use, population density, urban to regional scale, and background levels etc).	Delhi	CPCB/DPCC	More stations are not recommended at this stage. Focus needed on data quality control, and transparent dissemination		
Implement the plan for installation of identified new/ to be relocated monitoring stations.	Other NCR districts	CPCB/SPCB	Plan of action by 31.07.2022.	50% of identified new stations by 31.12.2023 and balance by 31.12.2024	

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Policy interventions	Sub-region	Responsible agency	Timeline		
			Up to 1 year	1-3 years	3-5 years
Updating emissions inventory and source apportionment studies in entire NCR and assessment of movement of regional pollution.	Delhi and all NCR states	CPCB/SPCB		By 31.12.2023 for Delhi/nearby districts and 31.12.2024 for other NCR districts.	
Critical review of the city / town / district action plans aligning with the present status of air quality, identified interventions and apportionment of financial resources for different sectors.		CPCB along with ULBs, Departments of Urban Affairs and Environment, SPCB/ DPCC			
Active involvement and lead role by the ULBs in monitoring of measures to abate air pollution.		ULBs			
Performance audits at frequent intervals.		CPCB along with Departments of Urban Affairs and Environment, SPCB/ DPCC.			

Abating industrial pollution

SUGGESTIONS FROM PUBLIC AND EXPERTS ON INDUSTRIAL AIR POLLUTION

- Mandate the use of PNG in areas adjoining Delhi, especially during winters
- Ban solid and liquid fuel and promote electricity and gaseous fuels
- Provide incentives and subsidies for MSMEs to switch to PNG
- Address pricing of natural gas and bring it under GST
- Ban polluting fuels including coal in entire NCR
- Issue a standard approved fuel list for NCR
- Encourage agro-residue based fuels with appropriate pollution control instruments
- Ban non-compliant industrial units and shift industries in non-conforming areas to industrial clusters
- Classify industries as per pollution control techniques and track through CEMS and/or low-cost app-based technology
- Fix emission limits on industries
- Ensure uninterrupted electricity to industries
- Close down unauthorised industries in residential areas
- Encourage retrofitting of factory chimneys, among other things
- Close brick kilns around Delhi-NCR

Industrial pollution control efforts have evolved in phases in Delhi-NCR. The significant earlier effort to curb industrial pollution in Delhi included shifting heavily polluting industries out of Delhi during the late '90s, pursuant to the Hon'ble Supreme Court's directions. Hazardous and heavily polluting industrial units were directed to be closed down and several units were directed to install adequate and appropriate pollution control devices.

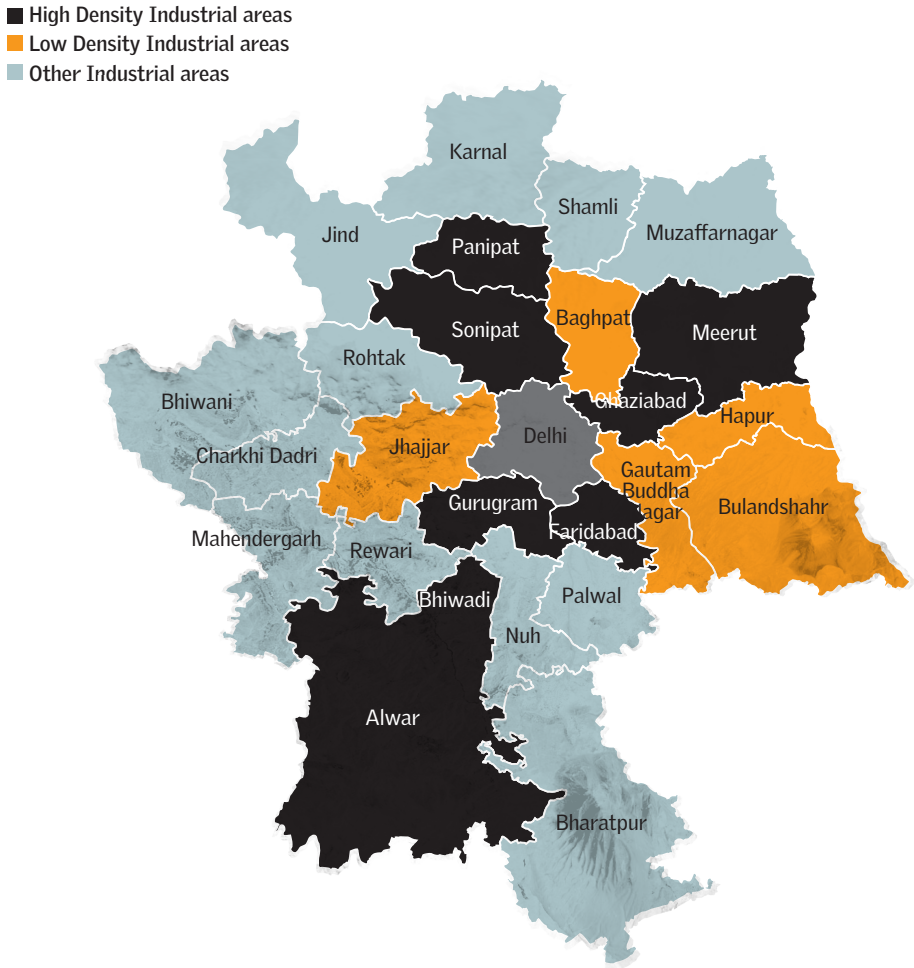
According to the Draft Regional Plan 2041 of the NCR Planning Board, prominent industries in NCR include automobile industry, metal industry (basic and fabricated), textiles, apparels and footwear industry, computer, consumer electronics and electric equipment, rubber and plastic industry. There are more than 42 lakh MSMEs in the region.[7] A large number of small unorganized units that include plastic recycling units are located outside the industrial estates or in unauthorized areas. A majority of the small industries have small boilers and some cupola furnaces.[8]

Currently, in the NCT of Delhi, more than 50 per cent of the industrial activities are within planned industrial areas/estates. These are mostly medium and small-scale units that include garment, furniture, electric machinery, metal/non-metal finishing, rubber, plastic, and packaging industries. However, polluting industries that were shifted outside Delhi or are located in the major industrial clusters in NCR districts of Sonipat, Panipat, Faridabad, Bahadurgarh, Gurugram, Ghaziabad, Alwar and Bhiwadi exert a substantial influence on the airshed of the region.

Map 2 provides an indicative spread of industrial activities in the NCR. Some of the dominant coal consumption sectors include textiles, food processing, chemicals, metal-based units, paper and pulp, rubber goods etc, among others. As the key industrial areas in NCR are likely to see further industrial growth, well-designed and appropriate strategies can minimize the contribution of this growth to air pollution. Currently, for instance, the NOIDA Authority allots industrial plots to non-polluting industries only,[9] while Delhi permits new industries as per the provisions of the MPD 2021.[10]

All industrial areas require special attention as they impact the airshed and downwind locations in the NCR. Industrial pollution control requires a multi-dimensional strategy to address primary stack emissions which depend on emission potential, level of emissions control technologies and the quality of fuels. Fugitive emissions from dust generating enterprises like stone crushers or mineral grinding etc; material handling and loading/unloading; open burning of

Map 2: Industrial areas in Delhi-NCR



industrial waste; heavy dependence on diesel generator sets; and dust pollution caused by the movement of heavy-duty trucks and goods vehicles, especially on unpaved roads in industrial areas etc are the other areas of concern in industrial set-ups.

It is necessary to further reform the industrial structure — modernise production capacity with improved emission control systems and adoption of clean fuels like natural gas and clean electricity for industrial applications. This will have to be supported by smart monitoring and deterrence for compliance and targeted improvement.

CAQM directives on industry during winter

During heavy smog episodes, particularly in winters, temporary closure notices were served on polluting industrial and other units as an emergency measure. The

CAQM has issued a series of advisories and directives related to industries during winter smog episodes of 2021-22. These included industries with gas connectivity to run on gas and those using unapproved fuels to be closed. Monitoring and compliance of the Action Plan for switching over of all identified industrial units to piped natural gas (PNG), where infrastructure and supply of gas are already available, was also directed by the Commission. This has, to an extent, sensitized industries in the region to move towards cleaner fuels.

Clean industrial fuels

The thrust of actions in the industrial sector has so far been to replace polluting fuels like coal, pet-coke and furnace oil. Under the directions of the Hon'ble Supreme Court, pet-coke and furnace oil have been completely banned as combustion fuels in the four states of NCR, except in industries like cement where these are used as feed stock. This requires stringent enforcement to prevent violation.

The other key strategy to promote clean fuels is the notification of approved fuel list by the respective state governments under the Air (Prevention and Control of Pollution) Act, 1981. The approved fuel list for Delhi bans the use of coal, pet-coke, furnace oil, other downstream and recycled fuels like tyre oil — consequently, all the identified industrial units in Delhi are now running on cleaner fuels like PNG.

However, the approved fuels lists in other NCR states, while banning pet coke and furnace oil, continue to rely upon polluting fuels like coal, LDO etc with no clearly defined targets for their replacement. Coal usage dominates the industrial districts in NCR that locks in a growing pollution. The State Government of Uttar Pradesh is yet to come out with an approved fuel list. The approved fuel lists of Rajasthan, Haryana and Delhi are, however, still widely varying: considering the central theme of a common airshed for NCR, it calls for a common approved fuel list for the entire region.

Clean fuel transition in the industrial sector is critical for finding a permanent solution to air pollution. This will require rapid transition to natural gas and reliable supply of electricity for industrial processes. Even with the current natural gas infrastructure in Delhi and the surrounding NCR districts, substantial transition is possible with targeted development

In Delhi, all the identified industries have converted to piped natural gas for their fuel requirements.[11] On 18 December 2018, the DERC notified a compensation policy to consumers for any electricity cut in Delhi. Directions have been issued

by the CAQM to DISCOMs for uninterrupted power supply and to discourage DG sets in Delhi. It has been submitted that during the winter of 2021-22, power availability was 98.82 per cent.[12]

Current status of natural gas availability in the region

According to the information shared by the Ministry of Petroleum and Natural Gas (MoPNG) with the CAQM, there are 11 city gas distribution entities in NCR[13] (*see Tables 5 and 6*).

Table 5: City gas distribution entities in the NCR

Name of entity	Authorized geographical areas (GAs)
HPCL	Sonipat and Jind
BPCL	Rohtak
Baghpat Green Energy Pvt Ltd	Baghpat
Torrent Gas Pvt Ltd	Alwar (other than Bhiwadi) & Jaipur
Haryana City Gas (KCE) Pvt Ltd	Jhajjar
Haryana City Gas Distribution Ltd	Gurugram
Haryana City Gas Distribution Ltd (Bhiwadi) Limited	Bhiwadi (in Alwar district)

Source: Ministry of Petroleum and Natural Gas

Table 6: City Gas Distribution (CGD) infrastructure in NCR vis-a-vis India

CGD infrastructure	All India (712 districts)	NCR (35 districts)	Percentage
CNG stations	3878	812	21%
PNG (domestic) connections	88,98,132	20,51,799	23%
PNG (commercial) connections	34,316	4,767	14%
PNG (industrial) connections	13,016	4,694	36%

Source: Ministry of Petroleum and Natural Gas, March 2022[14]

CNG stations and PNG infrastructure have expanded considerably in the NCR. There are 812 CNG stations now, with a total steel pipeline of 18,446 inch km, and 40,435 inch km of MDPE pipeline. This expansion of infrastructure has created the opportunity to replace coal with cleaner fuels in industrial, transport and domestic sectors in the region. As per MoPNG data, there are 198 industrial areas of which 148 are connected with natural gas and the rest are also expected to be connected in the time frame of March 2022 to September 2023 (*see Table 7*).

Table 7: Status of natural gas supply in industrial areas

District	CGD entity	Number of industrial areas	Status of connection to industrial areas
NCT of Delhi	Indraprastha Gas Ltd	51	50 areas connected (remaining 1 area will be connected by March 2022)
Baghpat	Baghpat Green Energy Pvt Ltd/Think Gas Pvt Ltd	3	1 connected (Remaining expected to be connected by June 2022)
Bulandshahr	Indian Oil Adani Gas Pvt Ltd/ Adani Gas Ltd	5	Partially connected (4 industrial areas are connected. Balance to be connected depending on gas demand)
Gautam Buddh Nagar	Indraprastha Gas Ltd	37	35 acres connected (Remaining 2 industrial area will be connected by March 2022)
Ghaziabad	Indraprastha Gas Ltd	19	10 areas connected (remaining industrial areas in Ghaziabad to be connected by June 2022 and in Hapur by September 2023)
Hapur			
Meerut	GAIL Gas Ltd/ Indraprastha Gas ltd	11	Partilly connected – 9 out of 11 industrial areas. Balance to be connected by March 2023
Meerut	Indraprastha Gas Ltd	7	Not connected (expected to be connected by June 2022)
Muzaffarnagar and Meerut (part)			
Shamli			
Bhiwani	Adani Gas ltd	3	Not connected. Expected to be connected by June 2022
Charkhi Dadri			
Mahendargarh			
Faridabad	Adani Gas ltd	8	6 connected. Remaining to be connected by 2022
Gurugram	Indraprastha Gas Ltd/Haryana City Gas Distribution Ltd	7	All areas connected
Jhajjar	Haryana City Gas KCE Pvt Ltd	6	5 connected. Remaining area to be connected by December 2022
Karnal	Indraprastha Gas Ltd	3	2 areas connected (1 industrial area will be connected by March 2022)
Nuh	Adani Gas Ltd	2	Not connected (to be connected by June 2023
Palwal	Adani Gas Ltd	2	Connected
Panipat	Indian Oil Adani Gas Pvt Ltd	6	Partially connected- 4 out of 6 industrial areas. Balance to be connected by December 2022
Rewari	Indraprastha Gas Ltd	3	All areas connected
Rohtak	BPCL	4	2 connected. Balance expected by December. 2022

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Sonipat	GAIL Gas Ltd	5	All areas connected
Jind	HPCL	2	Not connected. Work under progress. Expected by December 2022
Alwar	Torrent Gas Jaipur Private Ltd/Haryana City Gas Distribution (Bhiwadi) Limited	11	2 connected. Balance to be connected between March 2022 to March 2023
Bharatpur	GAIL Gas Ltd	3	1 connected. Balance to be connected based on gas demand
Total		198	148

Source: Ministry of Petroleum and Natural Gas, March 2022[15]

The key industrial districts of Ghaziabad, Panipat, Bhiwadi, Alwar, Gurugram, Gautam Budh Nagar, Faridabad, and the twin towns of Sonipat and Panipat that have access to natural gas, can plan a targeted transition. However, the districts that have access have not yet seen an efficient linkage of the pipeline with all concerned industrial units.

The NCR needs a district-wide mechanism for enforcement of a clean fuel policy to prevent entry and illegal use of banned fuels. A monitoring and surveillance system and a siting policy and visible display of CTO (Consent to Operate)' from pollution control boards by each unit is needed in this regard.

The longer-term energy vision envisages rapid adoption of reliable and clean fuels and electricity for industrial processes.

Need for a uniform natural gas pricing policy

It is evident that despite the availability of natural gas in several districts and industrial areas of NCR, there is hesitation to adopt gas on a large scale, mainly due to economic considerations. Given the current Central and state level fuel taxation policies, natural gas is more expensive than other competing mainstream and more polluting industrial fuels like coal. Currently, natural gas is outside the purview of GST and therefore attracts state taxes that have a cascading effect on gas prices. It is recommended that the tax structure be rationalized for the NCR sub-regions till the time GST reforms are possible to make gas more competitive and enable its rapid adoption to replace coal and other dirty fuels in the region.

Delhi has already reduced taxes on natural gas. This requires a uniform policy across all the sub-regions. In fact, the CAQM directive on restrictions on industries that do not operate on gas during adverse air quality scenario in winters, has created an opportunity for this transition.

As is evident from MoPNG data, significant investments are underway to expand the natural gas pipeline in the region. This investment will remain sub-optimal and wasteful if critical demand for gas is not tied up. Pricing of gas will therefore play an important role in scaling up demand for gas and the scale of change may also contribute towards offsetting some of the revenue losses due to fuel tax rationalization.

Reduce use of DG sets in industry

Use of diesel generator (DG) sets for captive power generation in industrial areas is a major source of pollution. The estimated annual diesel consumption for DG sets is a substantial part of the total annual consumption of diesel oil by industries in the region. DG sets cause enormous pollution with serious local toxic exposures with attended problem of contamination of water bodies and soil with waste oil. With increased availability of natural gas in the region and improvement in reliable electricity supply, use of DG sets can be curtailed significantly.

Uninterrupted power supply: To discourage use of DG sets the key focus has to be on uninterrupted power supply in the region and replacing DG sets with gas-based sets. While the new installation can be based on PNG based sets, the existing ones can be replaced in a phased manner. Continuous supply of gas must be ensured. It may be noted that while the capital cost of a diesel generator set is lower than that of the gas-based set, the operational cost of gas-based set is lower as CNG prices are much lower than the diesel prices.

The industrial associations in NCR have made submissions to CAQM stating that diesel-based power is much more expensive than the grid power and industry would prefer electricity and not DG sets if reliable electricity is available. But repeated breakdowns and tripping make use of DG sets necessary.

The CAQM has been emphasizing on uninterrupted power supply in NCR to minimize use of DG sets. CAQM direction dated February 22, 2022 has already mandated and directed the DISCOMS in NCR to ensure power availability 24x7, comprehensively assess the power demand and initiate adequate measures and plan sufficiently in advance towards ensuring uninterrupted power supply in the NCR, particularly for the period between October-February when the air quality index in the region generally remains in poor end category.

It has further directed that Government of NCT of Delhi and NCR State Governments should take up the matter effectively with the respective power distribution companies to ensure uninterrupted power supply, especially during the month of October to

February. Non-compliance of these Directions should lead to penal action against the power distribution companies / officials concerned under the relevant laws as well as imposition / levying of environmental compensation charges.

Gas-based captive power generation

During the GRAP period, use of conventional DG sets is totally restricted other than for emergency purposes as stipulated in the relevant CAQM directions. There is however a CAQM direction for permitting uninterrupted use of gas-based power generating sets for all applications even under the GRAP. The said direction also permits selective use of diesel generator sets even in the periods under GRAP period for up to 2 hours a day for industrial applications in areas where PNG infrastructure and supply is available, subject to such DG sets having been converted into a dual fuel mode (PNG and Diesel) as also retro-fitment of Emission Control Devices (ECD) in accordance with CPCB guidelines. The guidelines for retro-fitment of Emission Control Devices are however not presently available for DG sets of more than 800 KVA capacity and need to be taken up urgently by CPCB.

Use of biomass-based fuels

Industrial use of agro-residues is growing in NCR which has a co-benefit of lowering pollution in relation to coal combustion and also absorbing the biomass waste from agriculture that would otherwise burn in the open to cause enormous pollution. Pollution emergency action during winter that requires closure of industry on dirty fuel and the pressure to implement the comprehensive action plan is pushing this change. There is increasing trend towards adoption of biomass fuels in the region. There is also considerable policy thrust at the central level to use biomass for cofiring in power plants. It is expected to lower particulate and gaseous emissions and nearly eliminate SO_x emissions through use of biomass fuels in lieu of conventional fossil fuels for industrial applications.

There are concerns around the relatively relaxed emission standards for boilers under the Environment Protection Rules, 1986. The PM emissions standards for less than 2 (t/hr) capacity boilers is 1,200 mg/Nm^3; 2 to < 10 (t/hr) capacity 800 mg/Nm^3; 10 to <15 (t/hr) capacity 600 mg/Nm^3 and 15 and above (t/hr) capacity 150 mg/Nm^3 [16] respectively appear to be lenient and warrant a review by the CPCB and MoEFCC.

The CAQM has further issued a direction dated March 17, 2022 regarding permissible standards for emissions through use of biomass fuels in industrial processes. The maximum permissible emissions standards for particulate matter for biomass fueled boilers is 80 mg/Nm^3. However, such industries shall aim for an emission level of 50 mg/Nm^3 with emissions control systems through suitable technology upgrades

and installation of requisite air pollution control devices such as bag filters, cyclonic filters, wet scrubbers, ESPs etc. based on on-site technical parameters.

This directive has further stated that while switching to use of agro-residues/ biomass fuels on a regular basis all such industries in NCR must apply for and obtain a revised CTO from the PCBs concerned with added conditions to the effect viz permission to use bio fuels and prescribed level of emissions standards particularly for controlling particulate emissions. Also, the CAQM Direction No 53 (dated 4.2.2022) has further stated that where PNG infrastructure and supply is not available, such industry shall also work to completely switch over to biomass fuel as the earliest but not later than 31.12.2022. These directives are an important step forward.

Small-scale units and small boilers

Small-scale units dominate the industrial sector in the region and are largely dependent on polluting fossil fuels in their individual boilers. Such a system while being energy-inefficient on one hand, is also a source of high pollution from multiple sources. While several industry-specific interventions to improve processes may improve overall technical efficiency for resources and emissions savings, it is necessary to focus on two priority strategies — access to clean fuel and replacement of small individual industrial boilers with common boilers wherever possible.

More than 50 per cent of the boilers installed in industrial areas are of less than 2 tonne per hour (TPH) capacity. Another 35 per cent have a capacity in the range of 2-10 TPH.[17] These are used for generating steam for heating purposes. These boilers primarily consume coal and are presently not equipped with effective pollution control devices. Fuel feeding is mostly done manually without any automation and these have poor technical efficiency. Installation of any type of Continuous Emissions Monitoring Systems (CEMS) is not feasible. There are a large number of small boilers in several industrial clusters in Ghaziabad, Loni, Faridabad, Bhiwadi and Panipat, among other towns.

Replacement of small boilers with common boilers for steam generation in a cluster of industrial units is an important way forward. Community boilers are centralized systems that meet the collective demand of steam by a group of industrial units through a steam pipeline network in the industrial area. This approach can reduce particulate and gaseous NO_x and SO_2 emissions considerably. At present, Gujarat has piloted this in Ankleshwar GIDC, Sachin GIDC, and Vapi GIDC, with around 90 units connected to three common boiler facilities; this was included in Gujarat's

Industrial Policy of 2015 as a scheme of assistance for common environment infrastructure. In the NCR, Haryana has taken an initiative to set up a common boiler system in Panipat.

There are several advantages of switching from individual small boilers to common boilers. The individual industrial units can avoid a range of costs that include cost of installing small boilers and associated fuel cost, cost of air pollution control devices, operation and maintenance costs and can also avoid the need for getting environmental clearances for boilers. These costs and responsibilities can be borne by the manufacturers/installer and operator of common boilers. This can further reduce inspection requirements of numerous boilers by SPCBs. Common boilers can meet much tighter emissions standards, run on cleaner fuels including natural gas or biomass, adopt emissions control systems and CEMS monitoring and also obtain necessary environmental clearances.

Controlling emissions from furnaces: As efforts are being made to reduce pollution from boilers in industries, it is equally important to restrict the use of furnaces running on dirty fuels. Primarily manufacturing industries, especially metal based industries, use furnaces. Currently, these are largely operating on fuels like coal, wood and liquid fuel. However, several units in NCR have also adopted electric furnaces while a few are running on gas-based systems. While non-electric furnaces should not be allowed in new industries, a phase-out plan may be planned for the existing industries with some incentive support for small- and medium-scale units. Until then, it should be ensured that all industries using furnaces have installed well maintained air pollution control devices. As feasible, such furnaces and industrial processes could also be run on affordable electricity.

Fugitive emissions

There are several industrial enterprises that are responsible for huge amounts of fugitive emissions and dust generation from mining and different phases of crushing and storage. Stone crushers and mineral grinding are the most prominent among them. The National Green Tribunal (NGT) order on stone crushers ranges from acknowledging non-compliance to seeking carrying capacity studies and adequate remedial plans etc.[18] The Haryana government's 2016 notification requires stone crushers to adopt dust suppressant measures and establish crusher zones in Faridabad, Panchkula, Yamuna Nagar, Gurugram, Mewat and Bhiwani and those outside need to meet the siting guidelines for proper monitoring. This needs to include infrastructure for storage of the final product. Other requirements are installation of ambient air quality monitoring stations and online e-Rawaana system

to stop illegal mining. These require proper implementation and effective technical approach. Also, further mapping of all sources of fugitive emissions is important.

Industrial waste burning

Nearly all industrial areas are prone to open burning of industrial waste that includes plastic, packaging, rubber, textile, ceramic, slag etc. Industrial waste management – for both non-hazardous and hazardous waste - has emerged as an important issue in Delhi and the NCR states. There is an urgent need to streamline the collection and disposal of such waste to prevent burning. Make industries and industry associations liable for safe collection and disposal. There have been some initiatives as in Bhiwadi Industrial Area, Rajasthan, where authorities have tied up with an organization named 'Saarthak' to collect industrial waste and recycle and reuse it using a material recovery facility. Such initiatives need to be scaled up for the entire region.

Brick kilns

Brick kilns are small-scale and widely dispersed and are difficult to monitor. There have been several efforts to monitor their operation, set emission standards, mandate adoption of improved zigzag kiln technology and closure during winter. Subsequently, the NGT has directed closure of all brick kilns including those with zigzag technology based on a carrying capacity report submitted by the CPCB, which shows that the carrying capacity of the NCR airshed cannot sustain all the brick kilns in the region. Directions from NGT/the Hon'ble Supreme Court in this context are awaited.

The MoEFCC has issued a gazette notification on February 22, 2022, on emissions standards and kiln technology. This provides for tighter particulate emissions standards, and specification of stack height by capacity of brick kilns. All new brick kilns will be allowed only with zigzag technologies or vertical shaft or on piped natural gas. The existing ones will also have to follow the same provisions within one year if they are within 10-km radius of non-attainment cities, and two years for other areas.

All brick kilns will have to use approved fuel that include piped natural gas or agricultural residues. Use of pet-coke, tyre, plastic, hazardous waste etc are banned. Kilns will construct a permanent facility as per the prescribed design guidelines. They need to follow process emissions/fugitive dust emissions control guidelines. The ash needs to be fully re-utilised in brick making. Approach roads will have to be paved and transport vehicles covered. Also, minimum siting criteria have been established.

CEMS monitoring in industries

Smart monitoring with the help of continuous emission monitoring (CEMS) is required for effective surveillance and transparent monitoring of industrial stack emissions to assess performance. There is an urgent requirement to strengthen the CEMS regime so that it can be used as a compliance monitoring tool by the regulators. The concerns regarding CEMS installation is quality control of data generated from the system. Lack of proper calibration and wrong installation, inadequate knowledge and skills required for technology selection, installation, operation and maintenance, compromise the quality of data and this needs immediate attention and action. Also, vendors, industry, service providers lack proper knowledge/skills. Industries lack clarity on suitable technology selection. Suitability of technologies, according to type of stacks, issues related to auto drift, span check etc., or provision of remote calibration of equipment, quality assurance and periodical check of CEMS performance also need to be addressed. Quality data and robust management of data from CEMS is desirable to adopt market-based mechanism like emission trading system.

The targeted action plan and timelines in this regard are in table 8 —

Table 8: Industrial pollution: Targeted action plan and timelines

Policy interventions	Sub-region	Nodal/ responsible agency	Timeline		
			Up to 1 yr	1-3 yrs	3-5 yrs
Transition to clean fuels					
Commissioning of gas infrastructure and supply in the entire NCR.	All districts in NCR	MoPNG, SPCB, State Governments, CGD Agencies	As per target dates finalized by MoPNG		
Use of PNG as fuel in industrial operations in areas where infrastructure and supply is available.	Delhi	DPCC	Already implemented in industrial areas in GNCTD. Remaining industries in isolated areas, if any, running on fuels other than PNG / electricity to also convert to PNG by 30.09.2022.		
PNG as fuel in industrial operations in areas where infrastructure and supply is available. (Biomass and other approved fuels as per Common fuel list also permitted)	Other districts in NCR	NCR State Governments, SPCBs	All industries running partially on PNG and also on other fuels like coal, Diesel oil etc. to fully shift to PNG or biomass fuels or any other approved fuel in the proposed common fuel list for NCR, by 30.09.2022.		

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Policy interventions	Sub-region	Nodal/ responsible agency	Timeline		
			Up to 1 yr	1-3 yrs	3-5 yrs
Use of biomass fuels with appropriate pollution control systems in areas where PNG infrastructure and supply is not available	Delhi		Not to be permitted		
	Other NCR districts	NCR State Governments, SPCB	By 31.12.2022		
Imposing a complete ban on use of coal as fuel in industrial operations	Delhi		Already banned		
	Areas in NCR where gas infra and supply is available	NCR State Govts., SPCB.	By 30.09.2022		
	Other Areas where gas infra and supply is not available	NCR State Govts., SPCB.	By 31.12.2022 (Coal etc. to be permitted only during periods other than GRAP).		
Common boilers for small-scale units					
Formulate a plan for Common Boilers for Industrial Clusters	Delhi and all states of NCR	CPCB/NCR State Governments, SPCBs/ DPCC, ULBs	CPCB to formulate model guidelines by 30.09.2022. States & ULBs concerned to develop a plan for implementation by 31.12.2022.	Implementation as per the plan	
Control on Industrial waste burning					
Develop a comprehensive plan for industrial waste management and ensure zero burning.	All industrial areas in NCR	NCR State Govts., DPCC, SPCBs, ULBs and industry associations	By 30.09.2022		
Online reporting of industrial emissions through CEMS					
Certification system and performance standard for CEMs as per standards/ best practices.	Delhi and NCR states	National Physical Laboratory (NPL) CPCB and SPCBs to coordinate with NPL		By 31.03.2023	

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Policy interventions	Sub-region	Nodal/ responsible agency	Timeline		
			Up to 1 yr	1-3 yrs	3-5 yrs
Controlling fugitive emissions					
Formulate / revise and strengthen guidelines for fugitive emissions control in dust generating industries viz. stone crushers, mining, cement industries etc.	Delhi and all states in NCR	CPCB to formulate and circulate guidelines. SPCBs to implement.	By 31.12.2022		
Uniform and affordable PNG pricing policy: In view of much higher and escalating prices of PNG as compared to conventional fuels, there is a case for uniform and affordable pricing structure to make operations economically viable while also maintaining the imperatives of protecting the air quality. PNG could be considered under the ambit of lower slabs under the GST regime. Furthermore, region/state wise wide variations also act as a deterrent. There is a need to rationalise the pricing policy for the entire NCR for PNG and other cleaner fuels likewise.		MoPNG, MoF, NCR State Govts/ GNCTD.			
Developing an effective eco-system for processing biomass and agriculture residues into pellets / briquettes as fuel in various industrial applications in the NCR, along with PNG.		All NCR State Govts., Ministry of Agriculture and Farmers' Welfare			
Phasing out usage of heavily polluting fossil fuels like coal, diesel oil, light diesel oil (LDO), Pyrolysis oil, Naptha etc. in industries across NCR. To this end, the expert group recommended a "Standard" fuel list for NCR, incorporating cleaner fuels. (*See Standard list of approved fuels for entire NCR*). *		NCR State Govts., SPCBs/ DPCC, CPCB			
Increased vigilance and monitoring on compliance of standards for emissions from various categories of industries.		SPCBs/ DPCC, CPCB			
State governments to prepare a plan for replacing cupola and other furnaces using polluting fuels with electric furnaces through suitable incentives etc. for small and medium scale units.		All NCR State Govts			

STANDARD LIST OF APPROVED FUELS FOR ENTIRE NCR

- **Petrol** (BS VI with 10 ppm Sulphur) as per Notification of Government of India as amended from time to time — **Vehicular fuel**
- **Diesel** (BS VI with 10 ppm Sulphur) as per Notification of Government of India as amended from time to time — **Vehicular fuel**
- **Hydrogen/Methane** — Vehicular and Industrial purposes
- **Natural Gas (CNG/PNG/LNG) – Vehicular, Industrial and Domestic Purposes**
- **Liquefied Petroleum Gas (LPG)/**Propane/Butane **– Vehicular, Industrial and Domestic Purposes**
- **Electricity — Vehicular, Industrial, Commercial and Domestic Purposes**
- **Aviation turbine fuel**
- **Biofuels** (Bio-alcohols, Bio-diesel, Bio-gas, CBG, Bio-CNG) – for **industrial/vehicular/Domestic purposes as applicable**
- **Refuse Derived Fuel (RDF)** for Power plants, Cement plants, Waste to Energy plants
- **Firewood/**Biomass briquettes **for religious purposes**
- **Wood/Bamboo Charcoal** for Tandoors and Grills in Hotels/Restaurants/Banquet Halls (with emission channelization/control system) and in Open eateries/Dhabas.
- **Wood charcoal** for cloth ironing.
- **Electricity/CNG/Firewood and Biomass briquettes** for crematoria

FUELS PERMISIBLE ONLY BEYOND THE JURISDICTION OF GNCTD

- **Biomass/Agriculture refuse and Pellets/briquettes –** for Industrial Boilers, Power plants, Biofuel projects, Cement industry, Waste to Energy plants etc
- **Biomass Pellets/briquettes –** for Tandoors and Grills in Hotels/Restaurants/Banquet Halls (along with mandatory emission channelization/control system) and in Open eateries/Dhabas
- **Metallurgical coke –** For industrial purposes only in standalone Cupola based Foundries
- **"Low Sulphur Fuels" namely LSHS, Very Low Sulphur fuel oil and Ultra-Low Sulphur Fuel Oil –** for industrial purposes in metal smelting/melting/refining/heating furnaces and kilns.

NOTE:
1. Coal with low Sulphur shall be permitted as fuel only in Thermal Power Plants in the NCR.
2. Specific requirement of any other fuel(s), other than in the lists above, by a class/category of industries/other entities, owing to technical, technological and/or process requirements shall be considered by CAQM on merits.
3. Any other clean fuel notified by the Govt. of India, from time to time, shall be included in the list appropriately.
4. All other fuels will be deemed as "unapproved" in as far as the NCR is concerned.

Abatement of air pollution from Diesel Generator (DG) sets

SUGGESTIONS FROM PUBLIC AND EXPERTS: ABATEMENT OF AIR POLLUTION FROM DG SETS

DG SETS

- Small DG sets (less than 2 KVA) should not be permitted to operate
- Solar-powered generators and inverters should be promoted
- Pollution control measures from DG sets: Ensure the availability of gas-based generator sets at reasonable prices
- Ensure the retrofitting/conversion of DG sets to gas-based generators at reasonable prices
- Awareness of rules, regulations and standards for DG sets
- Ensure uninterrupted power supply

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RENEWABLE ENERGY

- Rooftop solar power mandatory for apartments and commercial offices
- Net metering for installing solar panels
- Solar power generators and inverters should be promoted
- Institute long-term action plan for non-conventional energy use
- Ban the use of generators in societies — make the use of solar energy compulsory

Dependence on DG sets is very high for captive power generation in this region. Frequent and long outages and unreliable supply of quality electricity is increasing this dependence in both residential and industrial/commercial areas. A number of buildings in NCR are operating without connected load from the grid and are dependent almost entirely on captive power generation. Stopping of DG set operations during winter is part of the Graded Response Action Plan.

During the winter of 2021-22, the CAQM had issued direction (Direction No. 44) on steps for effective control of air pollution in the wake of prevailing air quality scenario in Delhi-NCR – the direction (dt 16.11.2021)[19] had imposed a strict ban on DG sets in Delhi-NCR.

The ongoing action includes compliance with emissions standards, replacing DG sets with gas-based generators, and introducing dual fuel (gas and diesel) mode in DG sets wherever natural gas is available. The existing DG sets are also required to be retrofitted with emission control devices to abate particulate matter pollution. The available data shows that upfront cost of DG sets is comparatively less than gas operated sets. But due to the lower operational costs, the additional cost incurred for gas-based sets can be recovered quickly.

Address reliable supply of electricity and clean electricity: Dependence on DG sets could be reduced by mandating targeted reduction in power disruptions and ensuring uninterrupted electricity supply. As the next generation strategies across all sectors require transformative changes in energy systems as well as reduce dependence/eliminate captive power generation like DG sets, it is necessary to have an explicit focus on the access to reliable, and affordable clean electricity. Thus, Delhi and NCR region requires to pay attention to reliable electricity supply within the framework of clean air action plan. This is urgently needed not only to replace DG sets but also to support massive access to electricity in nearly all sectors for clean air action — vehicle electrification, access to electricity in industry, and transition to induction stoves for clean cooking.

According to the Draft Regional Plan 2041 of the NCPRB, per-capita energy consumption in NCR is 1,694 kWh (2018-19), which is much higher than the

northern region (953 kWh). NCR energy demand density is 1.9 MU/km^2/year. As per the Report on 19th Electric Power Survey (19th EPS) of India (Volume-II) (NCR) prepared by the CEA, Ministry of Power, total electricity consumption of NCR in year 2018-19 was 83,849 MU (with 14.68 per cent T&D losses), against the requirement of 98,271 MU. During 2013-14 to 2017-18, NCR has observed annual growth rate of 4.87 per cent in terms of electrical energy requirement. Peak demand for the region was 15,430 MW in year 2018-19. The domestic sector was the biggest consumer of electricity (35 per cent) followed by industry and the commercial sector consuming about 22 per cent and 15 per cent, respectively of the total electricity consumption of NCR.

This needs to be reviewed at regional, ward and neighborhood scale across Delhi and NCR to assess the current deficit in transmission and distribution systems for immediate remedial action. Infrastructure to supply electricity must be strengthened to prevent power cuts and ensure supply of reliable electricity so that dependence on diesel generator sets can be reduced and minimized. DISCOM reforms have to be accelerated in a time bound manner to enable this quickly to minimize and eliminate power outages during summer and winter.

The industries and large establishments including big residential complexes in NCR are spending disproportionately high amount on inefficient captive power back-ups, gen-sets and Inverters. The cost of back-up power is much higher than the electricity tariff – that can be up to 15 times the tariff per kWh by the utilities. Leverage the Central government schemes and programmes (Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Integrated Power Development Scheme (IPDS), National Smart Grid Mission (NSGM) etc.) to provide 24x7 electricity to all households in next five years with smart technologies.

This strategy will have to be aligned with the renewable energy programmes – grid scale and rooftop solar — in the region. Delhi and NCR states have adopted renewable energy programmes including rooftop solar programmes. Rooftop solar power with enhanced grid capacity particularly in rural set-ups needs to be encouraged and supported. This needs targeted expansion to support clean air action. Sub-region-wise plans need to be created with targets for deployment that is measurable and monitorable for implementation.

The CAQM directive: In this regard, the CAQM has already issued a direction on February 22, 2022 to the DISCOMS to comprehensively assess the power demand and initiate adequate measures and plans sufficiently in advance towards ensuring uninterrupted power supply; and ensure uninterrupted power supply in the NCR,

particularly for period between October-February when the air quality index in the region generally remains in poor, very poor or severe category; further, it is directed that Government of NCT of Delhi and NCR State Governments shall take up the matter effectively with the respective power distribution companies to ensure uninterrupted power supply specially during the month of October to February.

Non-compliance of these Directions shall be construed as contravention of the provisions of Commission for Air Quality Management in NCR and Adjoining Areas Act 2021 and should lead to penal action against the power distribution companies/ officials concerned under the relevant laws as well as imposition and levying of environmental compensation charges.

The targeted action plan and timelines in this regard are in table 9 —

Table 9: Diesel generators sets: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline
DISCOMS to strengthen transmission and distribution systems and ensure 100% reliable power availability, especially during winter months.	Delhi and all sub-regions in NCR	DISCOMS, Power departments of NCR States	By 30.09.2022
Uninterrupted use of conventional DG Sets only for emergency purposes, during periods under the GRAP. There shall be no restrictions on Generator sets fully running on PNG/ LPG/BIO-GAS/PROPANE/ BUTANE for any application, even for periods under the GRAP.	Entire NCR		Implementation w.e.f. 01.10.2022. The emergency services for which DG set operations shall be permitted as exceptions in the entire NCR, whenever orders for banning the use of DG sets are enforced under the GRAP, shall be as under: Elevators / Escalators / Travelators etc. in various installations. Commercial entities / residential societies shall, however, ensure that DG set operation and supply therefrom is purely limited to operation of elevators / escalators / travelators etc. Medical Services (Hospital/Nursing Home/ Health care facilities) including units involved in manufacturing of life saving medical equipment/devices, drugs and medicines. Railway Services / Railway Stations. Metro Rail Corporation & MRTS Services, including trains and stations. Airports and Inter-State Bus Terminals (ISBTs). Sewage Treatment Plants. Water pumping Stations. Projects related to national security, defence & of national importance. Entities involved in telecommunications and IT/ data services.

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Policy interventions	Sub-region	Responsible authorities	Timeline
Limited use of DG sets under periods of restriction under the GRAP, for industrial operations in areas where PNG infrastructure and supply is available. There shall be no restrictions on use of Generator sets fully running on PNG/LPG/BIO-GAS/ PROPANE/BUTANE for industrial operations, even for periods under the GRAP.	All areas in NCR	SPCB, Industry department	Implementation w.e.f 01.10.2022. Diesel Gen sets shall be permitted to operate for a maximum of 2 hours on a per day basis, to take care of exigencies of power supply failures etc. provided that: The DG Sets have been suitably converted to run on dual fuel mode i.e., natural gas and diesel. AND Such DG Sets are also equipped with Retrofitted Emission Controlled Devices (RECD) in accordance with the CPCB guidelines towards a minimum PM capturing efficiency of 70% for in-use DG sets up to 800 KW gross power category, further subject to such a retro fitment carried out through an agency which has a valid certification from any of the 5 agencies authorized by CPCB in this context. A detailed log of the intervals / time durations for which the DG Sets have been used shall be maintained methodically, preferably such data being captured in an electronic mode in the DG Sets itself.
Limited use of DG sets under periods of restriction under the GRAP, for industrial operations in areas where PNG infrastructure and supply is not available.	All areas in NCR	SPCB, Industry department	Implementation w.e.f. 01.10.2022. Diesel Generator sets shall be permitted to operate for a maximum of 1 hour for a day, to take care of exigencies of power supply failures etc. provided that: Such DG Sets are equipped with Retrofitted Emission Controlled Devices (RECD) in accordance with the CPCB guidelines towards a minimum PM capturing efficiency of 70% for in-use DG sets up to 800 KW gross power category, further subject to such a retro fitment carried out through an agency which has a valid certification from any of the 5 agencies authorized by CPCB in this context. A detailed log of the intervals / time durations for which the DG Sets have been used shall be maintained methodically, preferably such data being captured in an electronic mode in the DG Sets itself.
Expeditious retro-fitment of all DG sets running in the NCR with Emission Control Devices as per CPCB guidelines for DG sets up to 800 KW capacity.	All areas in NCR	CPCB , SPCBs/ DPCC, Concerned industries/ units	-
Retro-fitment of dual fuel mode (gas / diesel) for DG sets in industrial areas where gas is readily available.	All areas in NCR		-
CPCB to develop suitable guidelines for Emission Control for DG sets of more than 800 KW capacity.		CPCB	By 31.12.2022

Abating air pollution from thermal power plants within 300 km of Delhi

SUGGESTIONS FROM PUBLIC AND EXPERTS ON THERMAL POWER PLANTS

- Adopt Graded Merit Order System (GMOS) for prioritizing TPPs as per the adoption of greener practices like bio-mass co-firing, etc.
- Monitoring of FGD installation in all TPPs in and around NCR.
- A road map and action plan for thermal power plants (especially for control of SOx and NOx) and formulation of a power plant pollution index (PPPI) and categorization of power plants accordingly
- Fly ash storage ponds/disposal sites to be constantly monitored by SPCBs and remediation through afforestation

There are 11 thermal power plants (TPPs) located within 300 km radius of Delhi that are required to meet the emissions standards of 2015 in the time frame of 2022-2024, as per the latest notification of the MoEFCC in this regard.

CAQM directives were issued related to emergency action related to TPPs during the winter of 2021 whereby of the 11 TPPs, only five were allowed to operate until 30 November 2021. Electricity load requirements after the closure, were to be fulfilled by the plants situated beyond 300 km. This was combined with a ban on DG sets.

According to the MoEFCC classification, TPPs whose stacks are within an aerial distance of a 10-km radius of the NCR or cities with a million-plus population are in Category A[i]; these TPPs (5,350 MW) are the Panipat, Dadri, Indira Gandhi and the Mahatma Gandhi TPS in NCR[ii]. The remaining 7,545 MW of capacity belongs to Category C TPPs – that are beyond the 10-km radius of the NCR or cities with a million-plus population, critically polluted areas or non-attainment cities.[iii] These include the Yamuna Nagar, Rajiv Gandhi, GH TPS, Harduaganj, Nabha and Talwandi Sabo TPPs.

Information from the Central Electricity Authority on the current status of implementation of emissions standards shows that all the 35 units in the 11 plants claim compliance with particulate matter and nitrogen oxides norms in the NCR. About 710 MW of power generating units have to comply by the end of 2022, while units generating about 1,865 MW are required to comply by 2024.

i. MoEF&CC, Notification GSR 243(E) dated March 31, 2021
ii. CPCB Letter no. B-33014/7/2021/IPC-II/TPP/ dated December 13, 2021
iii. CPCB Letter no. B-33014/7/2021/IPC-II/TPP/ dated December 13, 2021

According to the CEA, the "Guidelines for Renovation & Modernisation/Life Extension Works" states that the equipment is designed for a given fatigue life of about 25–30 years of operation[iv]. There is a need for a plan to schedule phased retiring of the old plants. The Union Budget of 2021-22 has also recommended shutting down of old thermal power plants nationally and has included the offer of central incentives to states if they plan to disinvest in idle and stranded assets in power sector. Such a plan may be developed for the sub-regions of the NCR for phased implementation.

Simultaneously, it will also be helpful to develop a plan for promoting firing of biomass with coal in TPPs as a co-benefit strategy. The CAQM, through a statutory direction has mandated 5-10 per cent co-firing of biomass including paddy straw in each of the identified 11 thermal power plants located within a radius of 300 km of Delhi. The Union Budget of 2022–23 has also provided for 5-7 per cent of biomass pellets to be co-fired in the thermal plants nationally. This is part of the scheme - SAMARTH (Sustainable Agrarian Mission on use of Agro- Residue in Thermal Power Plants), which is under implementation. It is reported that 50 per cent of the thermal power plants identified by CAQM have started cofiring biomass pellets with coal.

The targeted action plan and timelines in this regard are in table 10 —

Table 10: Thermal power plants: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline		
			Upto 1 yr	1-3 years	3-5 years
Comply with CPCB / MoEFCC emission standards including Fly Ash Notification.	NCR States and Punjab	Ministry of Power, all 11 TPPs located within 300 km radius of Delhi	As per target dates stipulated in the relevant MoEFCC notifications.		
Compliance checks for TPPs by CPCB and uploading emission data in public domain			Within two months of the targeted date for respective power plants, to comply with the MoEFCC standards		
Compliance of direction to co-fire 5-10% Biomass in identified TPPs	NCR States & Punjab	Ministry of Power, all 11 TPPs located within 300 km of Delhi	At least 5% co-firing by 30.09.2022. Target 10% by 31.03.2023.		

iv. CEA in its "Guidelines for Renovation & Modernisation/Life Extension works" report in its section (4.2) on "R&M Programme with Life Extension (LE) and uprating (U) that in a coal/lignite based thermal power plant, "the equipment subjected to fatigue stresses and creep due to high temperatures such as turbine rotor and casings, HP piping, boiler headers, Boiler drum, main steam piping etc. are designed for a given fatigue life of about 25-30 years of operation".

Abating air pollution from vehicles and the transport sector

SUGGESTIONS FROM PUBLIC AND EXPERTS ON VEHICLE TECHNOLOGY, ON-ROAD EMISSIONS MONITORING AND OLD HEAVY VEHICLES

- Improve fuel and combustion technology and convert vehicles to CNG/PNG/EVs
- Develop automated PUC checking of all vehicles
- Regular checking of cars for pollution
- Remote sensing-based monitoring of polluted vehicles on road
- Scrapping policy for overaged vehicles for the entire NCR
- Ensure complete ban on old autos in adjoining states of Delhi
- Ban old two wheelers, autos and vans etc
- Re-registration of overaged petrol vehicles after conversion to CNG/hybrid
- Fitness to be the norm, not the age of the vehicle
- Banning of trucks that are non-destined for Delhi
- No diesel engines in Delhi after 2035, limit registrations of cars, introduce odd-even
- Compulsory fitness certificate for vehicles by independent fitness centres
- Machine learning solution tested at NEERI to assess the impact of vehicles on the overall pollution in a specific area

This region is in a grip of rapid motorization. The available source inventory and apportionment studies show that vehicles are the second highest contributors to particulate pollution in the region. The Vahan Database of Ministry of Road Transport and Highways (MoRTH) shows that as of March 2022, Delhi's cumulative vehicle registration was 135 lakh vehicles — Faridabad had 9.4 lakh, Gurugram 11.7 lakh, Ghaziabad 12.85 lakh, and Gautam Buddha Nagar 9.5 lakh. Delhi's vehicle stock, several times more than the neighboring cities, overpowers the region. During 2016-2022, Delhi registered about 5.4 lakh vehicles annually: the figures for the rest were Faridabad (43,000), Gurugram (58,000), Ghaziabad (67,000) and Gautam Buddha Nagar (70,000). In 2021-22, 63 per cent of the vehicles registered in Delhi were two-wheelers and 30 per cent were cars.

Even though the number of vehicles is growing rapidly, majority of the population in the region still use sustainable modes of public transport, walk and cycle. The 2011 census for work trips shows a substantial share of travel trips by public transport, walking, cycling, autos and trains — about 71 per cent in Delhi and 73 per cent in the immediate NCR. This baseline for sustainable modes creates a significant opportunity for clean air gains in the region.

Moreover, lack of adequate integrated regional public transport and its low frequency and multiple interchanges have increased traffic intensity in the region. Five National Highways (NH-44, NH-48, NH-9 and NE3) converge on Ring Road of Delhi and one Highway (NH-34) meets NE3 at Ghaziabad; also, the erstwhile NH-703, NH-709, NH-919 and NH-34 pass through the region. This leads to enormous influx of traffic in the absence of adequate regional public transport connectivity. Additionally, industrial growth and economic activities have intensified freight traffic in the region that contributes hugely to pollution.

According to the Automotive Research Association of India, due to the progressive tightening of the emissions standards for vehicles there has been substantive improvement in tailpipe emissions from new vehicles. With graduating from Bharat Stage-I (BS-I) to Bharat Stage-VI (BS-VI) emissions standards, particulate emissions from diesel cars have reduced 31 times and from heavy duty vehicles by 36 times. Similarly, NOx emissions from diesel cars have reduced by 6.25 times and from heavy commercial vehicles by 20 times.[20]

While new vehicle technology and emissions control systems have significantly improved and will continue to improve to reduce tailpipe emissions in the driving conditions, equally stringent focus is needed on management of on-road vehicles. The objective is to keep on-road vehicles low emitting during their useful life on the road and to reduce direct exposure to toxic emissions; accelerate fleet renewal to leverage emissions gains from the technology advancement with introduction of BS-VI emissions standards; and accelerate zero emissions transition with rapid electrification of targeted vehicle fleet to meet clean air target. Simultaneously, transportation and mobility strategies will be implemented to reduce vehicle miles travelled and achieve at least 80-85 per cent modal share by public transport systems.

On-road emissions inspection and monitoring

Currently, the only vehicle inspection and maintenance programme is the pollution under control (PUC) certificate that includes a set of idling emissions tests. Petrol vehicles are tested for two-speed idle testing of carbon monoxide and hydrocarbons and the lambda test to maintain optimal conditions for proper functioning of catalytic converters. Diesel vehicles are tested for smoke density along with RPM, oil temperature etc. PUC norms are linked to different generation of mass emissions standard for vehicles. There is also an advisory from the Ministry of Road Transport and Highways for checking of the malfunctioning light of on-board diagnostic systems at the time of inspection and to return the vehicle for repair if the light is found on indicating technical problem.

This highly decentralized programme is very difficult to monitor for quality control and credible testing. The Hon'ble Supreme Court directed audit of the PUC centres in Delhi-NCR in 2017 had shown low level of compliance, lack of qualified and skilled PUC operators, inadequate calibration of machines, lack of knowledge of proper testing procedures, and improper testing and manual data reporting. The NCR had additional problem of non-functioning equipment, and fake software and certificate. Even though the PUC centres have been linked with the central server PUC database is mostly not usable due to lack of uniform protocol for recording of data (vehicle/fuel type-wise, age-wise etc.) and the central server not amenable for remote monitoring.

There has been some improvement in enforcement systems since then that include linking of updated PUC and Vahan database, automatic alert to vehicle owners for renewal of PUC certificates, compliance strategy like linking refueling with valid PUC certificate in Delhi and higher penalty. Linking of PUC with annual vehicle insurance has not happened yet. Information on the status of action in all NCR cities and towns is not equally adequate. The programme requires uniform strengthening; quality control at a scale and effective fleet screening still remains a daunting challenge. This requires introduction of more advanced inspection and monitoring systems.

In addition, all commercial vehicles require annual roadworthiness and fitness tests under Central Motor Vehicle Rules (CMVR). In most part of NCR these tests are done manually without adequate testing facilities. There is a need to set up more fully automated high-capacity centralized testing centres for the region. There are two centralised centres in Delhi – Jhuljhuli and Burari. Jhuljhuli is modern and fully automated with high-capacity testing facility. There is scope for better capacity utilisation of these testing centres.

Advancement of on-road emissions monitoring

Given the advancement in new vehicle technologies under the regime of BS-IV and BSVI emissions standards, it is necessary to introduce more advanced and efficient screening of fleet to overcome the limitation of the PUC testing. Delhi and bigger cities of NCR – Gurugram, Faridabad, Gautam Budhh Nagar and Ghaziabad — need to operationalise remote sensing measurements of vehicles. Remote sensing is absorption spectroscopy to measure exhaust emissions remotely as vehicles cross the light path on the road. It can detect CO, NO, NO_2, and HC. This allows large scale fleet screening without the vehicles being taken for physical tests; determines average emissions of the fleet and effectively identifies high emitters based on threshold limit for worst polluters and also detects vehicles with systemic flaws in vehicle batches that cause high excess emissions.

The Hon'ble Supreme Court directive of July 29, 2019[21] has taken on board the recommendations on remote sensing for on-road emission monitoring that require the Ministry of Road Transport and Highways (MoRTH) to frame rules for its implementation and Delhi government to implement the programme. The MoRTH has framed draft AIS 170 rules to define the scope of the programme. This directive came after the pilot programme by ICAT on remote sensing in Delhi in 2018 that had aimed to – (a) develop 'gross threshold points' to identify high emitters, and (b) correlate remote sensing techniques and PUC results. It included data analysis, processing and reporting and planning and operations. Plan for its implementation may be developed for Delhi and the key cities in the immediate NCR including Gurugram, Faridabad, Gautam Buddh Nagar and Ghaziabad for time bound implementation for advanced monitoring and surveillance. Globally, on-road emissions surveillance has advanced considerably.

Phase-out of old vehicles and scrappage of end-of-life vehicles

Fleet renewal and fleet modernisation are needed to benefit from the technology advancement in new vehicles. From time to time a series of directives from the Hon'ble Supreme Court and the NGT have regulated the age of vehicles in this region. The NGT order of April 2015 has banned diesel vehicles older than 10 years and petrol vehicles older than 15 years in Delhi-NCR. This needs to be strictly implemented.

To maximise the emissions gains from this strategy and to reduce environmental impact from the unsafe disposal of junk vehicles, the state governments may additionally implement state level scrappage policy for the end-of-life vehicles that cannot be used any more. Old and poorly maintained vehicles consume more fuel and cause more pollution. End-of-life vehicles also generate toxic and hazardous waste. Without a scrappage policy material and metal cannot be recovered. Moreover, effective linking of the old vehicle phase out programme with at least three-year incentive programme to replace targeted old vehicles with electric vehicles can further contribute towards electrification target and help to maximise emissions gains.

This region will also require a targeted phase out plan for the diesel run autos that are responsible for high toxic exposures. Even under BS-VI emissions standards, a diesel three-wheeler will emit substantially higher particulate matter and nitrogen oxide as compared to a BS-VI diesel car.

The Ministry of Road Transport and Highways on 15 March 2021 has issued

- G.S.R. 653(E) regarding the Motor Vehicles (Registration and Functions

of Vehicle Scrapping Facility) Rules, 2021, dated 23-09-2021
- G.S.R 220(E) regarding Concession in Motor Vehicle Taxes against submission of Certificate of Vehicle Scrapping, dated 26-03-2021
- Sec 59 of the CMV(A) Act, 2019 that provides for fixing age and restricting plying of unfit vehicles
- AIS 129 that defines the standards for manufacturers on reuse, recycling and material recovery from vehicles.

The CPCB has issued Guidelines for Environmentally Sound Facilities for Handling, Processing and Recycling of End-of-Life Vehicles in 2019. Delhi has issued state-level guidelines for scrapping of end-of-life vehicles (ELVs) on 24 August 2018. Accordingly, only authorized scrapping centres can issue dismantling certificates. As per the Delhi policy, a recycling unit has been set up in Greater Noida. NGT orders dated May 2015, October 2018, January 2019, and April 2019, have scrapped recycling units in Mayapuri to address public health and environmental concerns from unsafe disposal. Government of NCT of Delhi has issued guidelines for scrapping of motor vehicles in Delhi in August, 2018.

A Scrappage Centre has been set up as part of the Delhi Government's policy with private sector participation. More such centres are needed to serve clusters of NCR districts.

Organised scrappage is also an important strategy for recovering material – steel, aluminium and plastics — to bring it back to production for a circular economy while preventing environmental contamination. The NCR Planning Board in its Draft Regional Plan 2041 has proposed setting up of such regional scrappage centres in the surrounding NCR districts with land availability.

Controlling emissions from heavy duty vehicles – trucks

The intensity of road-based freight traffic is responsible for high toxic exposure and source of ambient particulate and nitrogen oxide concentrations. IIT Kanpur's pollution source inventory study of 2015 in Delhi had shown that heavy duty trucks were responsible for 46 per cent of the particulate load and 21 per cent of the NOx load from all vehicles. This segment requires strategies for fleet renewal, clean fuel and energy saving strategies and reduction in heavy duty traffic intensity in densely populated areas to reduce toxic exposures.

Since 2001, a series of directives from the Hon'ble Supreme Court have set a roadmap for addressing diesel emissions from heavy duty trucks in Delhi, which include:
- 6.12.2001 and 16.12.2015 directives banning entry of non-destined commercial traffic from entry into Delhi.

- 11.2.2005, 11.3.2005, 1.8.2005 directives to build Western and Eastern Peripheral Expressway to provide alternative routes to trucks.
- 9.10.2015 directive imposing environment compensation charge (ECC) on all commercial light duty vehicles and trucks entering Delhi.
- 16.12.2015 directive banning entry of vehicles registered in 2005 or earlier.
- 5.1.2016 directive on weigh in motion bridges and machines at the entry points of Delhi to check overloading.
- 22.8.2016 directive to SDMC to set up RFID based collection system at 13 entry points that cover 80 per cent of the commercial traffic.

As part of the Graded Response Action Plan, emergency restrictions on trucks are imposed during smog episodes in winter.

As a combined impact of all these measures the real time data on truck entry monitored by SDMC has shown substantial reduction in truck numbers in Delhi. Currently out of 124 entry points into Delhi, hand-held RFID technology for cashless collection of ECC and toll tax have been introduced at all locations, including 13 border points being equipped with fully automated RFID systems.

The CAQM directive of November 9, 2021 has asked SDMC to install automated infrastructure at additional 10 entry points – Noida Major, Loni Main, Dhansa border, Kundli II, New Seemapuri, Bajghera, New Kondli, Chander Nagar, Jharoda and Pul Prahladpur. Though handheld RFID is available at these locations, these are not as efficient and lead to congestion and pollution. The RFID system may be introduced in more entry points in the future depending on the volume of traffic.

The cordoning of Delhi for regulated entry of trucks and payment of ECC is a step towards treating Delhi as a low emissions zone. It needs to be examined if this kind of regulated and restricted entry can be broad based for the larger NCR and to treat this also as a low emissions zone to gradually allow only BS-IV and BS-VI trucks. As the trucks largely operate under national permit, there are limited strategies available at the state level other than regulating their entry and overloading and rationalising logistical centres for trade. This segment requires attention.

Trucking on clean fuels: In addition to the local regulations of truck entry and intra-city movement, the ongoing initiative of expanding highway-based CNG/LNG refuelling systems and charging infrastructure for electric vehicles need to be accelerated to encourage shifting a substantial segment of long-haul trucking and other commercial vehicles to gas and electricity over the next five years.

This plan may be developed for route clusters for implementation in NCR. This requires highway-based refuelling plans for both natural gas and electric charging and preferential incentives to encourage their usage. A targeted plan needs to be developed with the fleet operators for upgrading the fleet.

Modernise and rationalise logistic infrastructure to reduce intensity of heavy-duty traffic in cities: The Delhi MPD 2041 has recommended improving the capacity of freight movement through rail-based transport and developing efficient interlinkages with the regional Integrated Freight Complexes proposed by NCRPB under the Functional Plan 2031. New Integrated Freight Complexes (IFCs) are to be developed as multi-functional spaces integrating various logistics, warehousing and freight-related needs. Modernisation of existing IFCs, their siting need to be incentivized through appropriate incentives for regeneration. New IFCs, if any, are to be preferably located on the National Highways (NHs) and align with the freight distribution network of the city.

The NCRPB 2041 has recommended that logistics infrastructure such as Inland Container Depots (ICDs), Container Freight Stations (CFS), Integrated Freight Complexes and multi-modal logistics hubs be set up in the sub-regions at strategic locations. The key targeted districts and locations are Jhajjar, Sonipat, Gurugram, Charkhi-Dadari, Ghaziabad, GB Nagar, Bulandshahr, Baghpat and Alwar. But this will require very careful spatial and locational planning to mitigate pressure from truck traffic, pollution and exposure for the local population. More efficient linking with regional rail-based freight systems and increasing share of rail-based freight will provide more sustainable solutions. An integrated plan needs to be developed for implementation.

The targeted action plan and timelines in this regard are in table 11 —

Table 11: Vehicular pollution: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline		
			Upto 1 yr	1-3 years	3-5 years
Emission Monitoring					
PUC — Ensure 100% compliance of all vehicles: refueling subject to valid PUC certificate	Delhi and all NCR States	NCR State Govts, Transport department and Oil Companies	100 % by 31.12.2022		
Mandatory half yearly audits of all PUC centres	Delhi and all NCR States	Transport department		100 % by 31.03.2023	

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Policy interventions	Sub-region	Responsible authorities	Timeline		
			Upto 1 yr	1-3 years	3-5 years
On–road vehicle emission monitoring systems					
Formulate norms for monitoring of on-road vehicles with remote sensing devices for advanced emissions surveilance		Ministry of Road Transport and Highwaysw	By 31.12.2022		
Implementation of remote monitoring mechanism for enforcement (%)	Delhi, Gurugram, Faridabad, Ghaziabad, Gautam Buddha Nagar	NCR State Governments including Traffic Police		25% of the planned network by 31.12.2024	50% of the planned network by 31.12.2025 and 100% by 31.12.2026
Phasing out overaged vehicles and scrappage policy					
Develop/amend vehicle scrappage policy to provide incentives	Delhi and all NCR states		Policy by 31.10.2022	Implementation as per policy plan.	
Implement Scrapping policy and relocate all overaged vehicles of NCR	Delhi and all NCR states	NCR State Govts. and GNCTD	Legacy stock by 31.12.2022	On regular basis thereafter	
Implement scrappage policy and set up infrastructure for material recovery and disposal of end-of-life vehicles.	Delhi and all NCR states	NCR State Govts. and GNCTD		Develop at least 50% of the planned infrastructure	Develop 100% of the planned infra -structure
Controlling emissions from heavy duty vehicles – trucks					
Automated RFID enabled Toll/Cess collection at Border Entry Points of Delhi (Total 124) 13 points Fully automated, 111 with handheld RFID readers)	Delhi	Municipal Corporation of Delhi	Additional 4 Border Entry points in Delhi to be fully automated by 31.12.2022.	Additional 6 Border Entry points in Delhi to be fully automated by 31.12.2023.	Other identified entry points, as per traffic growth to be also fully automated by 31.12.2026
Develop a plan for CNG/LNG fuelling network in NCR and on highways to shift long haul trucking and other commercial vehicles to gas.	Delhi and all NCR states	MoRTH / MoPNG GAIL/IGL	Plan by 31.12.2022	Build 50% of the infrastructure as per plan	100%
Expeditious expansion of natural gas network.	Delhi and all NCR States	MoPNG, CGD agencies	As per plan of MoPNG		

Clean fuels and electric mobility

SUGGESTIONS FROM PUBLIC AND EXPERTS ON E-MOBILITY

- Policies on e-mobility for all the NCR states — priority sectors must be targeted first
- Rs 1,016 crore green cess fund lying with GNCTD should be utilized for purchasing electric buses for Delhi's public transport, among other things
- Faster EV adoption in intra-city commercial transport and in 2/3 wheeler segments
- Commercial vehicles/cabs of OLA/UBER/private should run only on gas/electricity
- Promote electric vehicles and increase the charging infrastructure
- Encourage electric vehicles, no sale of petrol and diesel vehicles in Delhi
- One car per family norm — if required, the second should be EV/CNG only
- EV vehicles should be exempted from relevant taxes
- Creating timelines and targets for long-term strategy for incentivising EVs
- Electric/CNG/hybrid diesel buses for public transport, EV for private vehicles
- Retrofitting of old and overaged petrol/diesel vehicles into electric vehicles
- Complete ban on area-specific vehicle movements except cycle/EVs and others

Delhi and the key cities of NCR have taken the lead to incentivise and expand vehicle fleet on compressed natural gas (CNG) in public transport fleets including buses, autos, taxis and local commercial vehicles. This transition is more advanced in Delhi. This strategy that has largely replaced diesel fleet has contributed significantly to the reduction of toxic emissions from vehicles.

The new generation transformation that awaits the vehicle sector is the large-scale electrification to achieve zero tailpipe emissions with battery operated vehicles. Given the scale and pace of motorization zero emissions targets has become necessary to reduce toxic exposure to exhaust emissions and prevent lock in of more pollution in the rapidly growing fleet. On the basis of lifecycle emissions, it is estimated that tailpipe emissions account for as much as 65-80 per cent of the automobile emissions.[22] According to an estimate of NITI Aayog, despite India's current energy mix, lifetime emissions from electric vehicles today are 19-34 per cent lower than internal combustion engines.

As per NITI Aayog,[23] more stringent emissions targets and regulations through 2025 and 2030 along with incentives will create opportunities for electric vehicles. Advancement in technology and reduction in battery prices, charging time and increased driving will increase its attractiveness. Easy access to fast

charging infrastructure will reduce downtime for electric vehicles customers. Battery prices have already dropped faster than expected and is improving costs for mass adoption. Availability of high-performance electric vehicles will create more market demand. At the central government level, production linked incentives for advanced chemistry battery, automobile and semiconductor can help to build the industry and incentives under the FAME scheme can enable faster adoption.

All the NCR states have drafted electric vehicle policies to set targets, adopt demand incentive programme, frame incentive for charging, industrial promotion, recycling, and funding strategy. The policies vary in scope and approaches. A quick gap analysis can be carried out for further amendment and the targeted roll-out. It is necessary for all state programmes to set time-bound quantifiable targets for overall electrification and vehicle segment-wise electrification target, define strategies for creating dedicated fund to support the incentive programme and adopt a cross subsidy model in a revenue neutral manner and detail out the scope of action that is verifiable and measurable.

Delhi, for instance, is funding its EV programme with the dedicated fund created from Air Ambience Fund from an environment cess on every litre of diesel fuel sold in Delhi and also the ECC imposed on incoming trucks. Their policy has further proposed to increase registration and road tax on petrol and diesel vehicles. This will require timebound implementation for targeted transformation of the fleet. This strategy may priorities two and three-wheelers, public transport buses, delivery fleet and aggregators and government owned vehicle fleet.

Nearly 80-90 per cent of the new three-wheeler fleet has the potential to be electrified by the end of the plan period as their annual registration numbers are small. Scaling up of the charging infrastructure will incentivize other segments as well. With battery costs reducing and with both central and state level incentives, price parity is expected to improve further to reduce capex while the opex will remain attractive vis-à-vis IC engines. A combination of incentives, mandates and targets is needed to achieve significant shift to zero-emission vehicles and bring more confidence in the market.

Vehicle electrification targets for NCR by each of the states/GNCTD need to be set in terms of percentage of the new vehicle sales to be achieved by the end of the

plan period as also targeting total e-vehicles in particular categories. However, currently the electric vehicle policies of the state governments in the NCR sub-regions have adopted the following approaches:

Delhi: The electric vehicle policy of Delhi notified in 2020 has set a target of 25 per cent electrification of all new vehicle registrations by 2024. This policy also aims to register a minimum 50 percent of all new stage carriage buses as e-buses, including both city fleet and fleet for last mile connectivity. All delivery service providers shall convert 50 per cent of their fleet operating in Delhi to electric by 2023 and 100 percent by 2025.

Haryana: The draft policy does not have an overall electrification target for the state; however, it has set targets for converting its total commercial fleet and public transport fleet into electric. The policy aims to convert 100 per cent of bus fleet owned by State Transport Undertakings in the state into electric buses (Battery Electric Vehicles or Fuel Cell Electric Vehicles) by 2029, with the first phase of 100 per cent conversion of bus fleet in Gurugram and Faridabad by 2024. Fossil fuel commercial fleet and logistics vehicles in Gurugram and Faridabad are to be phased out by 2024 and in all cities by 2030. All government vehicles shall be converted to electric by 2024.

Rajasthan: Electric vehicle policy notified in 2021 does not give electrification targets, either for the overall fleet or for vehicle segments. The policy has asked for only a lump sum incentive amount to be given to EV buyers during the time of purchase, which will depend on the battery capacity of the vehicle.

Uttar Pradesh: Electric vehicle policy notified in 2019 has set a number target — "nearly 10 lakh EVs, combined across all segments of vehicles, by 2024". There is no vehicle segment-wise target for the state to support this roll-out. However, the state aims to achieve "70 per cent EV public transportation on identified green routes in identified 10 EV cities by 2030". The policy gives a target to launch 1,000 new buses in the state and asks for phasing out of all conventional commercial fleets and logistics vehicles and achieve 50 percent EV mobility in goods transportation in identified 10 EV cities by 2024 and all cities by 2030.

Key features of the electric vehicle policy of Delhi and states of NCR are provided in table 12.

Table 12: Key features of the electric vehicle policy of Delhi and states of NCR

State	Target & mandate	Demand incentive	Charging incentive	Industry incentive	Recycling	EV fund
NCTD (7th August 2020)	1. 25% EV registration by 2024 2. 100% electrification of last-mile delivery service fleets in Delhi by 2030.	1. e- 2W: Rs 5000/ kWh (<Rs30,000), scrappage: Rs 5000 2. e-Autos: Rs 5000/ kWh (<Rs30,000), open permit and Interest subvention (5%), scrappage: Rs 7500 3. e-rlck/cart: Rs 30000, Interest subvention (5%), 4. Goods carrier. Rs 30000 to first 10,000 units, Interest subvention (5%), scrappage: Rs 7500 5. Subsidy for electric cars stopped in November 2021 6. Passenger e-cycles: max Rs 5500 per vehicle + 2000 per vehicle for first 10000 vehicles; scrappage: Rs 3000 7. Cargo e-cycles: max Rs 15000 per vehicle for first 5000 buyers, scrappage: Rs 3000 8. Road and registration tax exemption 9. Public awareness	1. Free EV charging from 12 pm to 3 pm at 40 charging stations 2. Grant of up to Rs 6000 for first charging point for the first 30,000 charging points 3. Amendment in Building Bye Laws mandating 20% of parking capacity to be EV ready 4. Favourable tariff 5. Digital database of charging network	—	Will encourage re-use and recycle	1. Disincentivize ICEs 2. Environment Compensation Charge pending order from Hon'ble Supreme Court 3. Budgetary allocation
Haryana EV Policy (Draft)	1. Charging station and battery banks at all petrol pumps 2. Conversion of all STU bus fleet to EV by 2029, in Gurugram, Faridabad by 2024 3. Phase out all ICE commercial and logistics fleet by 2024 in Gurugram and Faridabad, all cities by 2030	1. All category of vehicles supported 2. 30% subsidy on road price of vehicle 3. Haryana will offer extra Incentive In form of coupons during first 6 months of policy (Rs 25000 (e- rick/cart), Rs 50000 (LMV), Rs 75000 (e-car < 10 lakh), Rs 100000 e-car> 10 lakh)) 4. Road tax exempted 5. 100% Interest free loan to govt employees 6. Net SGST reimbursement to service sector 7. No toll 8. Priority registration 9. Green zones and public awareness	1. 25% cap subsidy 2. Building bye laws 3. 100% SGST reimbursements 4. Promotional discounted tariff	1. Capital Subsidy (Micro: 25%, Small/ Medium: 20%, Large: 10%) 2. Stamp duty reimbursement (100%) 3. No electricity duty for 10 years 4. SGST (100%} reimbursements 5. Fixed power cost reimbursement @ Rs 3.00 per unit for 5 years 6. Rs 10000/- stipend per employee 7. Water Supply tariff will be reduced to 50% of the existing industrial supply tariff for the initial 3 years	—	Disincentivise ICE
Rajasthan (July 2021)	—	1. e-2W: Rs 5000 upto 2 kWh, Rs 7000 upto 4kWh, Rs 9000 upto 5 kWh, Rs 10000 for more than 5 kWh 2. e-3W: Rs 10000 upto 3 kWh, Rs 15000 upto 4 kWh, Rs 17000 upto 5 kWh, Rs 20000 for more than 5 kWh 3. 100% SGST reimbursement	—	—	—	—
Uttar Pradesh	1. 10 lakh EVs by 2024 2. 2 lakh chargers by 2024, 3. Rs 40000 Cr Investment and employment potential for 50,000 people 4. Launch 1000 electric buses; 70% of public transport to be electric by 2024 in 10 EV cities; 5. Conversion of all commercial fleets and logistics vehicles to EV and 50% of goods transportation to EV in 10 cities by 2024 and all cities by 2030 6, Manufacture EV batteries with at least 5GWh capacity by 2024	1. Road and registration exemption 2. Green Zones	1. 25" cap subsidy 2. Special Power tariff 3. Building Bye laws 4. 50% capital Interest subsidy on fixed capital Investment to set up hydrogen enabled refuelling Infrastructure	1. Land subsidy. 25% 2. Ultra-mega battery plant (50%) 3. Private EV Park (SEZ) 4. Capital interest, infrastructure interest, industrial quality, Stamp duty and electricity duty exemption, SGST reimbursement subsidies	1. capital Interest Subsidy @50% per annum for 5 years for battery recycling plants 2. Subsidy of 50% on annual Interest on loan to set up waste Treatment Plant	NA

Source: EV policies of respective NCR states

Retro-fitment strategy for electrification of on-road older vehicle fleet

Several representations have been received proposing retro-fitment of older vehicles with electric power train and battery to make them zero emission. There is interest in this strategy as Delhi and NCR have to comply with the mandate of phasing out of 10-year-old petrol and 15-year-old diesel vehicles and retro fitment may allow them to extend life of the vehicle by at least another five years.

At this stage, the predominant interest is in smaller vehicles two/three wheelers, small commercial vehicles, though retro-fitment of bigger vehicle is also possible. While technically and principally this is possible and feasible, several safeguards and preparedness are needed for its conditional implementation for safe and reliable conversion.

Retro-fitment may be allowed subject to some key conditions. Any retro-fitment strategy needs certification of retro-fitment kits of specified make and model of vehicles by the Automotive Research Association of India (ARAI) and as per the standards and provisions being notified under Central Motor Vehicle Rules (CMVR). This needs to be performance linked. Based on the central government rules, the state governments need to further define and notify the implementation mechanism for retro-fitment. The Ministry of Road Transport and Highways may reform the CMVR and AIS rules related to certification and verification of retro-fitment as needed and notify the makes and models that qualify for retro-fitment.

Moreover, given the fact that old vehicles are to be targeted for retro-fitment, it is also necessary to incentivize replacement of the end-of-life vehicles with new electric vehicles with scrappage incentives. This may bring more parity in cost of new electric vehicles and discourage retrofitted vehicles. Delhi electric vehicle policy has adopted this strategy. This may be extended across the region.

The targeted action plan and timelines in this regard are in table 13 —

Table 13: Electric mobility: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline		
			Up to 1 yr	1-3 years	3-5 years
Amend/notify EV policy in all NCR states stating target, mandate, incentives, funding strategy, network plan for public charging and making buildings ready for EV charging.	Delhi and all NCR States	NCR State Govts.	By 30.9.2022		

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Policy interventions	Sub-region	Responsible authorities	Timeline		
			Up to 1 yr	1-3 years	3-5 years
Set targets for electrification of overall vehicle fleet as well as targets for individual priority vehicle segments namely 2/3 wheelers, electric buses, delivery fleet of e-retail, aggregators for ride-hailing / government owned vehicle fleet (Four wheelers) by 31.12.2022.	Delhi and all NCR States	NCR State Govts /GNCTD. Transport department and designated nodal authority for EV policy	Implement as per targets and timelines in the policies and plans of respective State Govts. and GNCTD. Target for new procurements of EVs as % of the total new vehicles to be met		
Develop charging network and infrastructure including swappable battery stations	Delhi and all NCR States	NCR State Govts /GNCTD Transport Department, ULBs, Power department, urban development authority	As per targets and timelines in the policies and plans of State Govts. and GNCTD. (Criteria for network - at least one station in every 3 km x 3 km grid - mix of DC fast and slow and every 10 km DC fast on highways).		
Policy formulation on retro fitment of vehicles to EV – certification by ARAI. System for collection of used batteries and IC engines for disposal; Scrappage incentive for replacement of old vehicles with electric vehicles.	Delhi and all NCR States	NCR State Govts/ GNCTD Transport Department, Ministry of Road Transport and Highways ARAI	By 31.12.2022		
Develop plan for expansion of battery charging infrastructure including battery swapping.		Transport Deptt. of State Govts.	Implementation as per the plan		
Feasibility study for retro fitment of fossil fuel based 2-wheelers into electric mode.		ARAI in association with DHI, ICAT etc.	—		

Abating air pollution through effective public transportation services

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON TRANSPORT IMPROVEMENT

PUBLIC TRANSPORT

- Improve city transport services — bus and metro services
- Bring the Metro and DTC under one authority
- Promote public transport, traffic-free routes, avoid diesel vehicles, introduce odd-even to reduce congestion etc.
- Public transport can be made cheaper than two-wheeler cost
- Improve public transport and promote cycling
- Increase price and running cost of cars to encourage the public to walk and use public transport
- Reduce emissions from fossil fuel vehicles. Track fuel sales and VKT as real indicators.

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- Electric vehicles will not substantially reduce fossil fuel VKT — more buses are the key to reducing pollution; metro may not be effective
- Interventions aimed to reduce congestion as opposed to reducing the use of vehicles are counterproductive and will only serve to increase air pollution

NON-MOTORISED TRANSPORT

- Promote cycling and develop proper infrastructure such as dedicated lanes
- Footpath and adjoining open spaces may be covered with grass or paving
- Promote cycling for shorter distances
- For last mile connectivity, cycles must be promoted and be allowed in the metro.
- Develop free walkways and cycle paths to facilitate free flow of traffic
- Road encroachment by shopkeepers to be replaced by cycling track

PARKING AND VEHICLE RESTRAINT MEASURES

Parking policy

- Inclusion of guidelines for "proof of owning/renting a parking space for the vehicle under registration" under the "Guidelines for Registration of Vehicle"
- An online portal could be created where plot owners can rent their spaces for parking purposes
- Registration of new vehicles only if parking facility available
- Conversion of heavy parking zones into no-motor zones and unauthorized settlements into parks/forests.

Other vehicle restraint measures

- Transport Demand Management measures to include steep rise in parking fees, pedestrianization of certain parts of the city, banning of single occupancy cars at peak hours or areas of peak congestion and high levels of enforcement of all traffic rules – driving without a licence, illegal parking, non-use of helmets and seat-belts, breaking traffic signals etc
- Decrease the number of kilometres travelled by automobiles
- Observe CAR-Free Days. Discourage the use of private vehicles.
- Registration of new vehicles based on carrying capacity estimations
- Road tax on cars be hiked and taxis and buses be exempted and incentivised.
- Ban parking on side of roads.
- Blanket ban on registration of new vehicles (two/three/four wheelers) for a period of two years. Promote car-pooling.
- Encourage public to not use their vehicles for at least two days in a week
- Ensure lesser vehicles on roads — offices (private/public) to have dedicated cab/bus service and staggered office timings.
- Apply odd and even rule for vehicles. Initiate public awareness campaigns and judicious use of personal vehicles.
- Encouragement of public participation, Sweden pattern, parking policy and re-development of colonies etc.

Vehicular pollution control will require transformative changes in the transportation and mobility patterns in the region to reduce number and usage of vehicles, travel distances and traffic intensity.

Even though the Clean Air Action Plan that was notified under the Environment Protection Act, 1986 under the direction of the Hon'ble Supreme Court in 2018, had mandated several improvements in public transport systems, the progress has been very limited. The 2018 plan had asked for improvement in bus numbers and services, reforming bus operations, improving availability of buses, enforcement of bus lanes to keep them free from obstruction and encroachment, improving NCR connectivity with buses and metro, implementing multi modal integration plan for bus-metro IPT, NMT at key/all interchange points; demarcation and development of influence zones around Metro stations as per MPD-2021 to improve access to the public transport system; implementation of multi modal integration plan for bus- metro IPT NMT at key/all interchange points; integrated passenger terminals to be created with mixed use and multi modal facilities for passenger comfort, integrating regional and local public transit systems. But this could not be implemented at a desired scale as the target, design, scope of action, and funding strategy could not be planned and implemented as needed in the targeted cities and sub regions. In the next phase the barriers to implementing these strategies will have to be addressed diligently.

This plan targets to achieve modal share of public transport of at least 80-85 per cent of motorised trips in five years. In Delhi, the MPD 2021 and MPD 2041 have set the same target of modal split of 80:20 in favour of public and shared transport. The system and infrastructure plan for service provisioning, complete street management for all road users (public transport, walking and cycling), vehicle restraint policies including low emissions zones and funding strategy need to be according to the requirements of service level benchmark of the Ministry of Housing and Urban Affairs (MoHUA). This needs to be supported by measures to restrain growing dependence on personal vehicles to reduce congestion, pollution and energy intensity of travel.

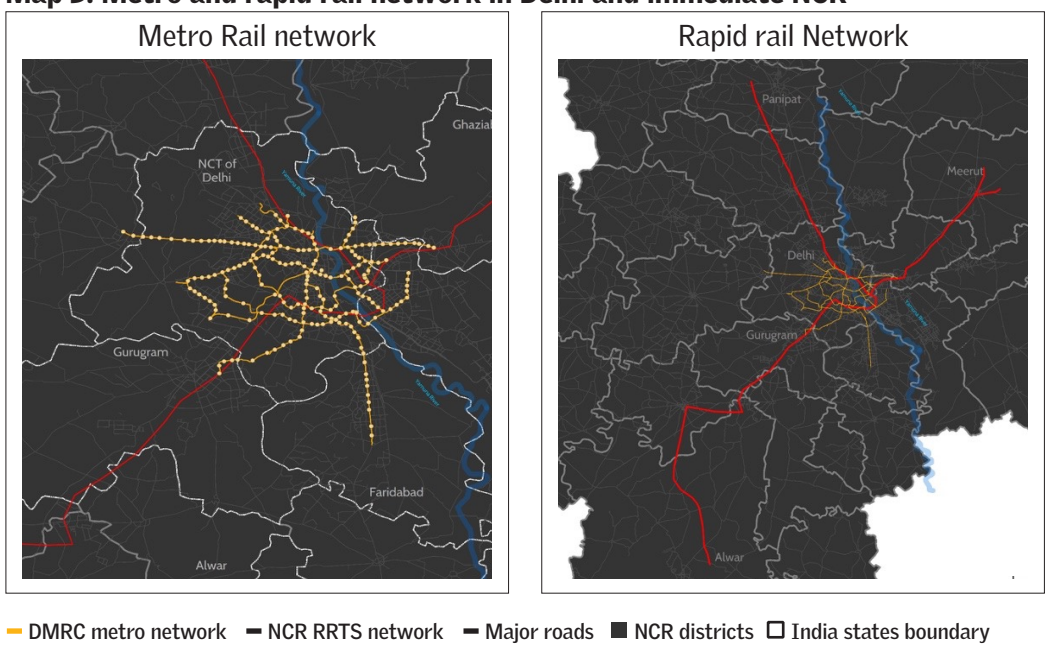
Implementation of transit-oriented development policy already framed by MoHUA and also integrated with the Master Plan in Delhi are needed to build compact, accessible mixed land-use and mixed income areas close to the mass transit nodes. Simultaneously, establishing special mobility zones to promote walking, cycling and electric mobility in cities, as also envisaged in the Union Budget of 2022-23. The potential of this change is significant especially in big cities like Delhi that are served by different mass transport systems. For example, the MPD 2041 has estimated that as much as 50 per cent[24] of urban area will be within 15-minute walking distance from the MRTS stations. Earlier UTTIPEC had estimated that after the full implementation of Delhi metro network about 80 per cent of Delhiites will be within 400 meters of some metro station. This requires strong leveraging to bring people to live closer to the MRTS stations and provide highly

accessible walkable and cyclable neighborhood for easy access to these stations while reducing parking requirements for personal vehicles.

At a regional scale in the NCR, more integrated rail-bus based networks need to be expanded for inter-city movement to be able to reduce the influx of personal vehicles. This will require modernization of the infrastructure and also rationalisation of border taxes that impose costs on public transport systems. The NCR-wide reciprocal agreement needs to address this to make intercity road-based mass transport affordable for all. Developing strategies for affordable usage of mass transport across NCR cities will be critical.

Metro and rapid rail network in Delhi and immediate NCR is indicated in **Map 3**

Map 3: Metro and rapid rail network in Delhi and immediate NCR



Improve bus systems

Buses will remain the prime mover in the NCR cities and need urgent modernisation and upscaling. The July 28, 1998 directive of the Hon'ble Supreme Court while directing the CNG programme in Delhi, had also set a target of 10,000 buses in the capital. This was again reinforced in the directive of January 5, 2016. The Hon'ble Supreme Court order dated October 9, 2015, had also directed utilization of funds deposited with the Delhi government under the Environment Compensation Charge (ECC) to induct 1,000 low-floor electric buses in Delhi to mitigate pollution.

The Delhi Master plan 2021 has estimated the bus requirement in Delhi at 15,000 buses. The Hon'ble Supreme Court directive dated February 16, 2016 had also

directed optimum utilization of bus depots for parking and advised construction of multilevel parking for buses to optimize use of land and reduce external dependency on more land in future to limit bus augmentation.

As per Delhi Economic Survey 2020-21, Delhi has 6672 buses (DTC- 3762 buses and DIMTS – 2910 buses). Delhi Budget for 2022-23 states that the number of buses has reached 6693.[25] Moreover, Delhi EV policy, 2019, has set a target of 50 per cent electrification in bus services by 2022 for its bus procurement policy.

In the surrounding NCR, Gurugram has set up a dedicated bus service and GMCBL is operating the bus service. 50 e-buses[26] were allocated to Gurugram under the FAME-II. But the city has not tendered on time. Faridabad has created an SPV but has not initiated the intra-city bus services. Noida does not have any public city bus services on their own. However, NMRC operates 50 buses for last mile connectivity for their metro services. Ghaziabad has just started city bus services with electric buses and are currently operating 25 e-buses. On January 2022, UPSRTC have started city bus services for Ghaziabad on limited routes. Ghaziabad was allotted 50 buses[27] under FAME-II funding.

According to the Service Level Benchmark (SLB) of the MoHUA, a city size of Delhi with more than four million population needs 60 buses per lakh population. Delhi currently has about 43 buses per lakh population [as per the 2011 census). The actual requirement would be much more considering population has increased substantially in the past 10 years.

On the other hand, a city with less than four million population (that includes cities like Gurugram) needs 40 buses per lakh population. But smaller towns in NCR are largely served by intermediate public transport (IPT - autos and shuttle services) or privately managed bus services. IPT needs targeted improvement in reorganization. Smaller towns like Alwar, Panipat, Muzaffarnagar, Karnal, Hapur and Bharatpur with population of more than two lakh as per the census of 2011 are too small to support their own dedicated systems. They need cluster bus systems that serve key routes in multiple contiguous towns.

It is desirable to review NCR reciprocal agreements to rationalise and lower inter-state taxes on public transport bus services to reduce tax burden on buses.

Transition to electric buses: All buses in Delhi and the new buses in big cities of immediate NCR are currently running on CNG. However, moving forward, electrification of the bus fleet will become critical to phase in zero emissions

mass transport. Already, the FAME-II programme of the central government is incentivising e-bus programmes. At the regional level, the Delhi EV policy has set a target of 50 per cent electrification of bus services by 2022. All state governments need to set ambitious target for bus electrification.

New procurement policy related to e-buses needs to be planned in bigger cities that will be augmenting and modernising their bus fleets. National experience with e-bus deployment shows that e-bus procurement is increasingly specifying the service needs instead of only vehicle details. The majority of tenders are focusing on service range per single charge, defined routes and depots for electrification, driving condition during peak and non-peak hours, headways during peak and non-peak periods to decide scheduling, battery capacity or energy consumption ratio etc. While manufacturers are improving battery capacity, sizing, range etc., operational parameters are becoming important to address real-world range, ageing and degradation of batteries. The incentives and subsidies may be linked with the operability of buses.

Cities need to come up with detailed route plans and other infrastructure requirements. Under FAME-II, the EESL is developing such a framework for nine cities and the central government is working towards a standardised tendering process. An incentive structure can create more opportunities for more diverse charging options including conduction charging facilities, opportunity charging, battery swapping etc. E-buses will require day-to-day monitoring to track battery performance etc. Build the basics related to guidelines, regulations, skilling and training to build capacity of the bus transit agencies. Eventually, a strategy will be required to develop common infrastructure to incentivise private operations of e-buses that meet the maximum travel needs in the region.

Modernization of bus infrastructure for improvement in services and ridership

The provision of public transport strategies in clean air action plans often fail to deliver as the scope of action is not aligned with the existing policies and service level benchmarks to plan the infrastructure and to provide funding support. Improvement in bus service and ridership requires improvement in critical parameters including bus numbers procured annually, passenger km per bus per day, bus network length for every square km of city/town's habitable or built-up area, ITS policy for operation and service delivery, and fare policy among others. Application based bus aggregator services also need to be encouraged. Service delivery need to be upgraded to meet the SLB benchmarks and MPD requirements related to service coverage, average waiting time to be less than 4 min at bus stops and level of comfort in the bus services among others.

Delhi has begun implementation of automatic vehicle location system, electronic ticketing system, passenger information system, command control facilities, CCTV surveillance, on-board/off-board PIS systems, a common mobility card for both metro and bus services, and a payment app. Gurugram is also improving these systems. This will have to be scaled up with targets and milestones.

Intermediate public transport (IPT)

Intermediate public transport (IPT) plays an important role in providing connectivity between modes and last mile services in big cities and are the prime movers in smaller towns. As per the Census 2011, the modal share of work trips using IPT in NCR districts ranged from 6-9 per cent. The comprehensive clean air plan of 2018 has provided for implementation of electro-mobility for three wheelers to make them zero emission and be an efficient feeder system for interchange points and integration with bigger public transport systems. These need to be organised for efficient deployment and require city-wise planning.

Clean fuel strategy will be critical for this segment. The current fleet of diesel autos need to be phased out and be replaced with electric vehicles. In fact, this segment can have a higher level of ambition for electrification. This is consistent with Niti Aayog's estimation that nearly 70 per cent electrification of both two-three-wheeler fleets is possible by 2030. Moreover, ride hailing services and taxi aggregators will require targeted electrification. Total cost of ownership parity is expected quicker in this segment compared to the bigger vehicles.

It is possible to mandate electrification of this low volume, high frequency and short haul transport system. This segment has limited access to capital given the unique challenges of daily rentals/lease for operations makes financing and monthly repayment a challenge. A fiscal and funding strategy will be useful. Several state EV policies including Delhi's have provided for (in varying combination) subsidy, interest subventions, open permit system, scrappage and purchase incentives, waiving road tax, registration fees, permit fees for a targeted number of units. NCR needs to adopt a comprehensive policy for this segment.

Multi-modal integration

To enhance and optimise usage of diverse public transport systems – buses, and metro - multi-modal integration (MMI) is necessary for easy transfers and utilisation. This requires physical integration of different modes; fare integration of modes; and time Integration of services.

Currently, there is a mandate for developing 59 metro stations as MMI hubs. In 2019, DMRC in consultation with GNCTD had identified 14 out of 59 metro stations to

be developed as multi-modal integration hubs. MMI hubs are being developed with pedestrian zones, dedicated pick-up and drop off locations for all types of services, improved traffic circulation plans etc. DMRC is implementing bus feeder systems, metro lite, electric mini buses and organising services of e-rickshaws and Yulu e-bikes as a pilot. This strategy will have to be scaled up covering the entire transit network.

In addition, as per the 2017 TOD guidelines and regulations amended as Chapter 12 of Delhi MPD 2021 in 2019 and as per directions of the MoHUA, five metro stations have been identified by UTTIPEC to be developed as TOD nodes. These are the opportunities in the region that need to be planned for scale with time-bound implementation in Delhi, Gurugram, Faridabad, Noida and Ghaziabad. The TOD principle of building compact, accessible, mixed income neighbourhoods within a 400-m radius of metro stations needs to guide all new and redevelopment projects in the region.

Inter-city rail-based connectivity: Leverage implementation of on-going rail-based projects for inter-regional connectivity to reduce commuting needs by personal vehicles for inter-city transport. The Regional Rapid Transit System (RRTS) network includes eight corridors in NCR covering the areas – i) Delhi-Ghaziabad-Meerut (ii) Delhi-Gurugram-Rewari-Alwar and (iii) Delhi-Panipat. There are several potential TOD sites located on the corridors. It has been estimated that the corridors are expected to improve public transport modal share in the region from 37 per cent to 63 per cent.

Simultaneously, Orbital Rail Corridors (ORCs) need to be completed by 2023. Five more RRTS corridors are planned — Delhi-Shahdara-Baraut; Delhi-Hapur; Delhi-Khurja; Delhi-Ballabgarh-Palwal; and Delhi-Rohtak. The Hon'ble Supreme Court in its order dated January 18, 2019 has stated that completion of RRTS Phase I is crucial and it should be considered an integral part of the notified Comprehensive Air Action Plan for Air Pollution Control. Accordingly, implementation of Phase I was directed.

Non-motorized transport (walking and cycling)

Under the notified 2018 clean air plan Delhi-NCR is mandated to prepare and implement zonal plans for developing and NMT network. This requires expediting ward-wise network plans and not as small stretches of corridors.

Delhi has a plan for development of footpaths and cycle tracks on a few hundred kilometres of road stretches. The draft Master Plan Delhi (MPD) 2041[vi] provides for Active Travel Areas and Walk Plans, City level Active Travel

networks, and micro-mobility. Only Ajmal Khan Road and Shahjahanabad have been pedestrianised so far.

In the cities of immediate NCR, footpaths and cycle tracks have been implemented as part of the overall road infrastructure in Noida; about 10 km stretch has been redeveloped in Gurugram among others. But these projects require a network approach and targeted pedestrianisation and low emissions zones approach. Review of all current projects in Delhi and NCR shows that the scale of these interventions is very limited and not scalable and these often face resistance. This will require a mandate and stringent compliance strategy supported by community-oriented education and awareness programmes.

Even though considerable road construction is underway in this region, these are largely oriented towards making wider and high-speed corridors for vehicles; they are not aligned with the requirements of current policies, regulations and road design related to other road users like public transport users, walkers and cyclists. Street design guidelines are given in multiple standards that iterate similar guidelines for development for urban roads. These are IRC 103, UTTIPEC-DDA Street Design Guidelines (2010), Indo HCM (CRRI, 2018) and the draft MPD 2041. These prescribe need for continuous footpath, safe crossing, access to public transport, earmarking Multi-Utility Zone (MUZ) of 1.8 mts minimum width on all collector and arterial roads. The most recent draft MPD 2041 on its Annexure 7.3(d) states that if any street with ROW equal or less than <18 mts witnesses pedestrian traffic of equal or more than 8000 pedestrians per hour (including for the direction) to be notified for pedestrianisation. It also states that streets may be considered for pedestrianization even if pedestrian traffic is lower than 8000 per hour (including for the direction) depending on the potential to improve economic activity and/or safety and convenience.

Roads and public space development and redevelopment in all cities and towns of Delhi NCR require a network plan municipal ward-wise that is consistent with street design standards and guidelines for all road users. Identify key commercial areas for targeted pedestrianization to move towards low emissions zones to regulate traffic entry and promote zero emissions streets in cities. In addition to establishing infrastructure enforcement and complete street management, targeting all road uses will become important.

Travel demand management and vehicle restraint measures

While augmentation of public transport services is expected to reduce dependence on personal modes, this also needs to be supported by explicit demand management

and restraint measures to reduce usage and vehicles killometers travelled.

As part of the pollution control effort, parking policy as a demand management measure has been prioritized. GNCTD has notified the Delhi Maintenance and Management of Parking Rules, 2017' and guidelines as a demand management measure. On March 6, 2019 the Hon'ble Supreme Court directed[28] the land holding agencies in Delhi to prepare Parking Management Area Plans (PMAP) for residential and commercial areas as pilot. On July 8, 2019 the Hon'ble Supreme Court[29] directed submission of pilot plans on draft parking rules for review. Accordingly, status of the plans was submitted by East Delhi Municipal Corporation, North Delhi Municipal Corporation and South Delhi Municipal Corporation. On September 2, 2019 the Hon'ble Supreme Court directed[30] submission of a detailed working report on Lajpat Nagar, Krishna Nagar and Kamala Nagar by 30.12.2019. On August 10, 2020, the Hon'ble Supreme Court directed[31] five corporations of Delhi and concerned authorities of NCR to form a detailed comprehensive parking plan for the NCR region. But the progress has been very limited.

Going forward, the municipal ward-wise PMAPs are required to demarcate the legal parking areas after considering requirements of all street level activities, notify areas where parking cannot be allowed like parks and green areas, footpaths, traffic intersections, emergency vehicle routes, etc; introduce variable parking pricing based on duration and user pay principle; impose penalty on illegal parking; proof of parking for purchase of vehicles; promote shared, priced and public parking to optimize use of assets; IT based parking area management and parking linked to EV charging; earmarking of parking revenue for local area development and organised parking for buses and commercial vehicles. Multi-level parking needs to be decided by the PMAP of an area and not be a stand-alone project. This approach can improve management of parking and simultaneously reduce parking demand and vehicle usage. MPD 2041 has further recommended to cap and reduce parking spaces in areas that perform well on public transport accessibility index. Similarly, TOD policy has provided for reducing and capping parking provisions in TOD areas near MRTS stations. Despite the policies and rules implementation of PMAPs across wards has remained very slow.

More steps are needed to restrain personal vehicle usage. It is necessary to learn from global experience and implement low emissions zones to promote walking, cycling, public transport usage, clean and zero emissions vehicles while restraining entry of polluting vehicles. Design and implement congestion charges in targeted areas, among others.

In the next phase this mandate will have to be made enforceable. Currently, the temporary vehicle restraint measures implemented as pollution emergency measures include odd and even scheme and temporary hike in parking charges during the smog episodes in winters, but more sustainable solutions are needed while augmenting the public transport infrastructure and services in the region.

The targeted action plan and timelines in this regard are in table 14 —

Table 14: Transportation strategy: Targeted action plan and timelines

Policy interventions	Sub-region	Nodal/ responsible authorities	Timeline		
			Up to 1 yr	1-3 years	3-5 years
Augmentation of city public bus service through CNG / e-buses.	Delhi	GNCTD Transport department	As per targets already laid down /orders of the Hon'ble Supreme Court. Align with targets as per EV policy.		
Augmentation of city public bus service through CNG / e-buses as per model yardsticks and service level benchmark of MoHUA based on population.	Cities of Gurugram, Faridabad, Gautam Budh Nagar, Ghaziabad	NCR State Govts.		50% of the planned fleet augmentation by 31.12.2024	100% of the planned fleet augmentation by 31.12.2026
Augmentation of city public bus service through CNG / e-buses as per model yardsticks of MoHUA based on population.	Other NCR cities	NCR State Govts.		25% of the planned fleet augmentation by 31.12.2024	50% of the planned fleet augmentation by 31.12.2025 and 100% by 31.12.2026.
New procurement of electric buses for NCR cities	Delhi and NCR States	Transport department	As per targets in the EV policy		
New registration of only CNG/Electric autos in NCR.	NCR States	Transport department	w.e.f. 01.01.2023		
Phasing out diesel auto rickshaws	Delhi	Transport department	Already banned in Delhi		
	Cities of Gurugram, Faridabad, Gautam Budh Nagar, Ghaziabad	NCR State Govt. Transport department		By 31.12.2024	
	Other areas in NCR	State Govt. Transport department			By 31.12.2026
Modernizing transit infrastructure in Delhi	Delhi	GNCTD and Transport department	Further strengthen advance ITS facilities, including AVLS for vehicle tracking, ETM for fare collection, Transit app for route details, ETA etc that have been implemented. Further modernise depot and terminal infrastructure with advance IT features for passenger information, asset management system etc.		
Modernizing transit infrastructure in NCR	Other NCR states	NCR State govt.	To implement advance ITS facilities, including AVLS for vehicle tracking, ETM for fare collection, Transit app for route details, ETA etc. for better passenger convenience.		
Cluster city bus operations in smaller towns (with more than 2 lakh population)	Other NCR states	NCR State govt.	Prepare operational plan for cluster city bus services for smaller cities		
Integrated transit service application	Delhi and all NCR States	NCRPB	Develop an integrated transit app including all modes. To include integrated ticketing facilities for public transit services.		
Implementation of multi-modal integration (MMI) plan in metro stations — all stations in Delhi as per the plan	Delhi	DMRC	To be implemented as per plan developed and to be augmented.		
Implementation of multi-modal integration (MMI) along metro/RRTS routes in NCR cities	Gurugram, Faridabad, Ghaziabad and Gautam Buddh Nagar	NCRPB	To be implemented as per plan. New metro/ RRTS stations to be developed following MMI principle.		
Developing NMT infrastructure and special mobility zones in Delhi	Delhi	Municipal Corporation of Delhi	- New development or redevelopment of road network to be based on complete street management and IRC street design guidelines		
Developing NMT infrastructure and special mobility zones in NCR	Delhi and all NCR States	NCR State govt. - ULBs	New development or redevelopment of road network to be based on complete street management and IRC street design guidelines		
Implementing Parking area management plan in Delhi	Delhi	Municipal Corporation of Delhi	As per the notified Parking rules, 2019, developed and implement ward-wise, parking area management plan along with parking pricing strategy.		
Implementing Parking area management plan in NCR	Delhi and all NCR States	NCR State govt. - ULBs	As per the plan to be developed, implement parking area management plan and parking pricing strategy.		

Abating air pollution through effective road traffic management

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON TRAFFIC MANAGEMENT

- Introduce Adaptive Intelligent Transport Systems for addressing traffic congestion
- Use of traffic control cameras for monitoring real time traffic.
- Removal of encroachments on National Highways and roads.
- Synchronise traffic lights to facilitate free flow of traffic.

Congestion hotspots and gridlocks are seen as source of hotspot pollution leading to demand for traffic management. While the fundamental solution to this problem will emerge from the improvement in public transport and restraint measures of vehicle usage, reduced vehicle miles travelled, local congestion hotspots may require attention and local management solutions. But this intervention needs to be applied with caution and not to encourage signal free corridors, flyovers and road widening as a standard practice that disrupts public transport accessibility, impedes walking–cycling infrastructure and induce more motorized travel.

However, several traffic management strategies are possible including periodic audit of intersections, intelligent traffic signaling etc. It is also important to adopt and mandate traffic impact assessment and mitigation strategies for new developments.

The targeted action plan and timelines in this regard are in table 15 —

Table 15: Traffic management: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline
Development and Commissioning of early warning systems (like ITMS etc.) to inform commuters and plan route diversions, in Delhi, Gurugram, Faridabad, Gautam Buddh Nagar and Ghaziabad districts to start with.	Delhi and all NCR States	State Govts. Traffic police	As per plan to be developed
Development of Intelligent Traffic Signals and synchronizing of electronic monitoring of traffic violations and penal actions therefor	Delhi and all NCR States	State Govts. Traffic police.	As per plan to be developed

Abatement of air pollution through control on municipal solid waste burning

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON MUNICIPAL SOLID WASTE MANAGEMENT

- Ensure mandatory segregation of MSW at source – there is a need for a block-wise decentralised waste management and recycling approach
- Opt for a 'no landfill policy' approach — eliminate landfills
- Increase the house tax for those not providing segregated waste to solid waste collecting agencies
- Ensure biomining of waste and trapping methane at SLFs
- Shut down the Okhla Waste to Energy Plant
- Ensure management and minimization of moist municipal wastes through the waste to energy plant and cooperation with industrial units for burning such wastes
- Stop burning of all kind of wastes; stop scrap dumping/burning on road sides with the help of police.
- Manage the packing material/dry wastes generated from local shops
- Strictly ban use of single use plastic
- Monitor open burning of MSW strictly
- Ban MSW burning; promote compost plants and ensure covered transport of building material
- Create collection centres for e-waste in every town
- Generate awareness regarding the ill effects of open-burning (even for warming purposes)
- Depute cleanliness volunteers by all civic authorities

Open burning of waste as well as spontaneous fires in landfills contribute substantially to air pollution and are a source of high toxic exposure for local communities. The enforcement measures that include ground inspection and penalty and emergency response to public complaints have limited impacts. The effective solution lies in proper waste management. However, infrastructure for waste collection, transfer, material recovery and safe disposal is not adequate. As a result, waste accumulates in the open that is burnt for easy disposal.

Waste management has to ensure proper quantification of waste generation, 100 per cent door-to-door collection of segregated waste, material recovery and recycling and minimize fresh dumping of waste in landfills and full remediation of legacy waste.

Sub-regions in NCR have yet to scale up infrastructure adequately to meet these objectives. Delhi has the capacity to process half of the waste generated daily. It has three dumpsites (Okhla, Ghazipur and Bhalaswa) that together cover an area of 152 acre with a legacy waste of 28 million tonne. The MoHUA has shared information with regard to the status of legacy waste in Delhi dumpsites (*see Table 16*). On the other hand, Gurugram and Faridabad share Bandhwari dumpsite of

30 acre with 3.5 million metric tonne of legacy waste. Ghaziabad's dumpsite in Indirapuram is on 27 acre with 0.6 million metric tonne of legacy waste. Status of remediation of legacy waste dumpsites in Delhi is provided in table 16.

Table 16: Status of remediation of legacy waste dumpsites in Delhi

ULB	Ghazipur dumpsite - EDMC	Okhla dumpsite - SDMC	Bhalswa dumpsite – NDMC
Status of SWM	2600 TPD generated, 1300 TPD processed, 1300 TPD sent to landfill as fresh waste	3600 TPD generated, 2000 TPD processed, 1600 TPD sent to landfill as fresh waste	2200-2500TPD fresh waste received
Area of dumpsite	Approx. 70 acres	Approx. 46 acres	Approx. 60 acres
ULB	**Ghazipur dumpsite - EDMC**	**Okhla dumpsite - SDMC**	**Bhalswa dumpsite – NDMC**
Legacy waste quantity	140 lakh tons	55-60 lakh tons	80 lakh tons
Remediated quantity	9 lakh tonnes	11 lakh tones	20.3 tons (25.4%)
Area cleared	-	20 acres	15 acres, 11m height
Current status	18 number trommels operational; 8 to be installed; capacity to be increased to 7000 TPD. RFP issued for bio mining of 50 lakh tons legacy waste.	25 trommels operational; capacity proposed to be increased to 7000 TPD by March 2022	36 trommels + 04 Kleeman machines operational; 7 more to be installed; proposed capacity of 9500-10,000 TPD by March 2022
Plan of action	To clear 140 lakh MT by December 2024	To remediate 100% by Oct 2023	To remediate 100% waste by July 2023
Funding required for 100% remediation	Rs 775 Crore	Rs 315 Crore	Rs 774 Crore
Material from remediation	C&D waste (12.5-15%), RDF (17.5-20%) Inert/soil (65-70%)	C&D waste (20%), RDF (5-10%) Inert/soil (70-75%)	C&D waste (10%), RDF (15%) Inert/soil (60%); moisture (15%)

Source: MoHUA, Urban Solid Waste Management and Addressing Legacy Waste at Dumpsites, Presentation in Dialogue Towards Clean Air, March 7-8, CAQM

The review has highlighted several issues with respect to the current system of waste management. These include:

- Quantification and characterization of waste and need for proactive public disclosure for proper system design for waste management.
- Trommel-based processing of mixed waste at the dumpsites cannot ensure segregation of wet and dry waste at the disposal site. While these energy intensive and expensive trommels can be used for legacy waste, other technologies need to be standardized for dealing with fresh waste.
- **Enforcement of the ban on single use plastics and material recovery through segregation:** As per current practices, most of the non-recyclable plastic waste is dealt with in incineration-based technology at cement industries and waste to energy plants. There are serious concerns around mixed / plastic waste reaching the WtE plants, causing huge toxic exposure and thus a need for effective implementation of the ban on single use plastics.

- **Rationalize waste to energy plants and use them as shared facilities for cluster of cities/towns:** Contaminated wastes affect the efficiency of WtE and inappropriate technology and poor pollution control/ monitoring mechanism further cause toxic emissions from such plants. Poor rate of segregation and use of mixed waste also reduce calorific value of waste. There is a need for optimal utilisation of the existing facilities through shared usage between contiguous cities and towns. WtE plants must strictly adhere to the laid down siting criteria, effectively away from habitation and vulnerable communities.
- **Protocol for management of dumpsites and reclamation of land:** Under SBM 2.0, about 30 per cent of funding is for remediation of legacy waste.[32] This requires proper quantification and characterization of waste towards optimal utilization of funds for waste remediation measures.
- **Integrate the informal sector in MSW value chain** which would protect livelihoods as well as improve efficiency of collection, pre-processing, secondary segregation at the material recovery facilities.
- **E-waste and bio-medical waste management system** requires stringent implementation.

Effective implementation of Swachh Bharat Mission Urban 2.0

It is noted that the Swachh Bharat Mission Urban 2.0 (SBM 2.0) has mandated remediation of legacy dumpsite through bio-mining, enforcement and incentivization for segregation through extensive bye-laws levels interventions, augmentation of capacity for treatment-processing-recycle-recovery to meet existing and projected generation of municipal solid waste and divert maximum waste from reaching the landfill. The ULBs have been given targets to reduce landfilling of solid waste to a maximum of 20 per cent by 2025.[33]

This is to be achieved through 100 per cent source segregation (wet and dry, including domestic hazardous waste and sanitary); 100 per cent door-to-door collection of segregated waste from each household; 100 per cent scientific management of all fraction of waste; moving towards a minimal use of single use plastics; and digital tracking and monitoring of waste management operations. This further requires integration of the informal sector. This requires performance monitoring and real time tracking of services.[34] The focus is also on phased reduction in single use plastic. Time-bound implementation of SBM 2.0 would minimize the problem of waste burning.

Performance based funding of SBM 2.0: As dedicated funding is available for waste management and the ULBs can avail performance-linked Additional Central Assistance (ACA) for managing legacy waste and creating additional treatment

infrastructure, this may be leveraged for clean air action. Disbursement of ACA requires cities with less than 10 lakh population to complete bio-remediation by March 2023 and cities with more than 10 lakh population, by March 2024. The funding is linked with creation of additional facilities for treatment and waste management performance. If cities do not achieve at least 60 per cent segregation by 2023, cities would not be entitled to receive further additional central assistance.[35] This policy and funding strategy needs to be leveraged for Delhi and NCR to meet zero waste target to exit from landfill approach for waste disposal.

Key strategies

To prevent/eliminate open burning and controlling landfill fires that cause enormous pollution the following strategies can be implemented at a scale:

- Divert and prevent fresh wet (bio-degradable) waste from reaching the dumpsites. Adopt decentralized model in collaboration with private agencies in PPP mode
- Remediation of legacy dumpsite as per the requirements of SBM 2.0 timeline
- For segregation of waste, collect wet waste daily and designate days for collection of dry and other streams of non-recyclable waste
- Incentivize source segregation through property tax rebate
- Map bulk waste generators and enforce *in-situ* management
- Set up material recovery facility-cum-micro composting site and engage informal sector to channelize recyclables to the local level aggregators.
- Scientific landfill to be used only for a negligible amount of residual wastes (rejects)
- Redesign concessionaire agreement to pay on the basis of treated quantity
- Create a business model around the waste ecosystem to ensure maximum resource recovery. For example, bio-CNG plant based on segregated wet waste can augment annual revenue of the municipalities.

The targeted action plan and timelines in this regard are in table 17 —

Table 17: Control on open burning of MSW and landfill fires: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline
Concrete and time bound plan for liquidating legacy solid waste at sanitary landfill sites through decentralised segregation, waste processing plants and by preventing dumping of fresh waste.	Delhi and all NCR States	Departments of the State Govt. dealing with Urban Affairs & ULBs	As per the plan developed/to be developed. (Align with the timelines under SBM2.0)

Contd on next page...

Policy interventions	Sub-region	Responsible authorities	Timeline
Expediting the timelines for completion of infrastructure works and capacity enhancement related to waste processing facilities in cities based on proper estimation of waste generation and by aiming for 100% source segregation.	Delhi and all NCR States	Departments of the State Govt. dealing with Urban Affairs & ULBs	As per the plan developed/to be developed. (Align with the timelines under SBM2.0)
Effective management and control on waste segregation at source (separating out days for collection of wet and dry waste, incentivise collection and transportation of segregated waste, bulk waste generators to be liable for segregation and processing etc.	Delhi and all NCR States	ULBs	As per the plan developed/to be developed. (Align with the timelines under SBM2.0)
Expansion of waste recycling capabilities, material recovery centres, composting sites and timely completion of ongoing and planned infrastructure works.	Delhi and all NCR States	Departments of the State Govt. dealing with Urban Affairs & ULBs	As per the plan developed/to be developed. (Align with the timelines under SBM2.0)

Management of Construction and Demolition (C&D) activities to reduce dust

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON C&D ACTIVITIES

- Halt construction from September to January every year
- Blanket ban on construction in Delhi-NCR
- Better use of building materials in NCR
- Construction dust mitigation
- Remote monitoring of C&D sites through PTZ cameras.
- Use of dust-suppressants over piled up C&D materials and open areas
- Real time monitoring of particulate matter at C&D sites
- Use of adequate numbers of standardized anti-smog guns
- Accurate estimation of C&D waste by ULBs
- Ensure that the cost of recycled C&D waste products is at par or lower than the cost of conventional and virgin building material
- Increased penalty on C&D sites for violation

Rapidly urbanizing regions and construction activities in Delhi and NCR generate enormous dust pollution and also cause environmental damages. A significant portion of construction and demolition waste (C&D) can be recycled and reused to substitute a part of the naturally sourced material. Bureau of Indian Standard has already amended rules to allow use of concrete made from recycled material and processed C&D waste as an alternative to natural aggregates.

C&D Rules and Regulations 2016 are in place that need to be integrated with the municipal bye-laws in all cities. Swachh Sarvekshan 2021 of MoHUA has accorded more weightage to waste management infrastructure and waste processing efficiency. This requires waste collection system, notified charges for C&D services, segregation of waste, and collection, processing and reuse of waste. The ULBs need to be more performance oriented. Infrastructure design will require a proper estimation of waste generation.

The current level of action varies across the sub-regions. According to the available information from the Government of NCT Delhi, C&D waste generation is approx. 6,000-7,000 TPD in Delhi. There are four C&D waste processing facilities with a total capacity of 4,150 TPD. Three more facilities are proposed by March 2023 with a total capacity of 2,500 TPD at Ranikhera (1,000 TPD), Tehkhand (1,000 TPD) and Libaspur (500 TPD).

Efforts are being made to create demand for C&D waste and its utilisation. For example, the NHAI has reformed its contract agreement for projects in NCT Delhi for compulsory utilisation of C&D waste (minimum 20 per cent). The DDA is utilising products from recycled C&D waste for its development works. Local bodies are also mandated to use processed C&D material. There were 255 designated C&D waste dump points in Delhi till 2021. Bulk generators are required to deliver C&D waste directly to the waste processing plant. Construction sites of 500 sq.m. or more are required to be listed on DPCC portal.[36]

Unsegregated waste continues to remain a challenge. Waste reaching C&D recycling plants is often not segregated. GST on recycled products is higher — GST on C&D recycled products is 18 per cent as opposed to 5 per cent on virgin materials. This impedes effective utilisation of recycled products.

Gurugram and NOIDA have C&D waste processing facilities. The C&D recycling plant in Basai, Gurugram has an expandable capacity of 1,800 TPD that needs to be fully utilized. Charges levied on the waste generator need to be rationalised to provide an incentive for segregation and prevent illegal dumping. Noida's C&D recycling plant has the capacity of 300 TPD. Noida has 20 collection points for C&D waste. Charges have been fixed in a way that the bulk waste generators are incentivised to collect and transport their waste to the recycling plant.

While recycling capacity is being augmented in the region, it is necessary to encourage sharing of these facilities by a cluster of towns and cities to maximise asset utilization and to make investments more efficient.

The sub-regions require comprehensive assessment and quantification of C&D waste generation, utilization, and disposal to plan adequate infrastructure and system for management. Accordingly, cities and town need to implement network of collection points and GPS enabled transportation system linked to recycling facilities. Integrating the informal sector may help to improve efficiency of the system and make the process more cost effective. There is also a need to incentivise the construction industry to manage their own waste and for onsite reuse and recycling. EIA and RERA projects should be encouraged to adopt forecasting and designing of waste generation during the pre-construction stage for mitigation.

Dust control in construction sites: The CPCB has issued guidelines for dust management and control in 2018 for project areas more than 20,000 sq m that require EIA clearance. In addition, the CAQM has directed a series of actions for dust control in hotspot areas and for monitoring. This will require stringent surveillance to ensure proper and effective implementation and adoption of appropriate technologies and strategies for dust control. There is a need to further strengthen the 2018 CPCB notification related to implementation of dust mitigation measures.

Standards/guidelines related to C&D waste and road dust management have been adopted by the concerned departments in NCT Delhi and NCR sub-regions. Web portal has been launched for C&D sites of 500 sq m and above plot areas for uploading of self-audits of dust pollution control. As in Uttar Pradesh, this includes registration, uploading of self-declaration, generation data for physical audit and the physical audit; based on all this, a revised score is generated and is followed by direction compliance and compliance reporting.[37] Stringent enforcement of dust control measures, adoption of appropriate technical approaches, monitoring and compliance is necessary across all sub-regions and such web portals have also been developed / are under development for other NCR States.

Moreover, construction agencies need to renew their fleet of construction machinery to meet the current BS-IV emissions standards notified by MoRTH in 2021. The BS-VI standards are due for implementation in 2024.

The targeted action plan and timelines in this regard are in table 18 —

Table 18: Management of dust from C&D projects: Targeted Action Plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline		
			Up to 1 yr	1-3 years	3-5 years
Monitoring of C&D sites i) Operationalize and refine "Web portal" for on line monitoring of dust mitigation in C&D sites. ii) Registration of all projects for Construction and Demolition activities, on the web portal (All Projects with Plot Area>500sqm)	Delhi and all districts in NCR	NCR State Govts. / GNCTD Urban development department and ULBs	30.06.2022 30.08.2022		
iii) All Projects to: Adopt effective dust control measures (wind breakers, dust screens, water sprinkling, dust suppressing and soil stabilisation measures etc.) Deployment of adequate numbers of anti-smog guns, in proportion to the area of the construction sites: **At least 1** for a total construction area between **5000 - 10000 sqm:** **At least 2** for a total construction area between **10001- 15000 sqm:** **At least 3** for a total construction area between **15001- 20000 sqm:** **At least 4** for a total construction Area **> 20,000 sqm:**	Delhi and all districts in NCR	Urban development department and ULBs	By 30.09.2022 By 30.09.2022 By 30.09.2022 By 30.09.2022 By 30.09.2022		
Segregation of C&D wastes at site and transportation to notified collection centres and processing plants.	Delhi and all districts in NCR	SPCBs/ DPCC & ULBs	As per the existing rule and guidelines.		
Plan and develop infrastructure for C&D waste processing facility (consider cluster approach for multiple urban centres)	Delhi and all districts in NCR	SPCBs/ DPCC, CPCB & ULBs	To be implemented as per the plan / to be developed		
Sensitize and enforce CPCB / MoEFCC guidelines on dust mitigation measures at C&D sites and the C&D Waste Management Rules.	Delhi and all districts in NCR	SPCBs/ DPCC, CPCB & ULBs	Ensure implementation and enforcement		
Rationalisation of taxes to control cost of recycled C&D waste materials.		Ministry of Finance, NCR State Govts., and GNCTD			

Abatement of air pollution caused by crop residue burning

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON CROP RESIDUE BURNING

- Biomass agricultural residue as an acceptable fuel for industries in Delhi-NCR
- Direct bank transfer to farmers to purchase crop residue
- Regulate agricultural burning through geotagging, satellite imaging etc
- Modification and development of harvesting machines in view of old manual technique, in which paddy would be collected and straw will be harvested
- Saguna rice agricultural technique as in Maharashtra, to obviate stubble burning

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-
- Development of CBG and bio-manure plant
- Development of infrastructure including collection, storage, logistics and transport of stubble
- Blanket ban on farm fires in NCR, Punjab and Haryana
- Pradhans of village/panchayat should be made accountable for parali burning
- Convert stubble into manure by bio-decomposer – at government's cost
- Collect and transport stubble to TPPs – at government's cost
- The Punjab Preservation of Sub Soil Water Act, 2009 and The Haryana Preservation of Sub Soil Water Act, 2009, have caused delayed paddy harvesting, near winter season.
- Commercial use of and agricultural machinery development to dispose of crop residue, promoting animal husbandry in Delhi Lal-Dora areas
- Sensitizing farmers against crop residue burning
- Use agricultural wastes in paper industry along with other industries.
- Robust biomass supply chain to scale up *ex-situ* crop residue management.
- Railways to shift massive crop residue from Punjab and Haryana to other states.
- Bringing bio-decomposer application under Corporate Social Responsibility (CSR) and Environmental Social Responsibility (ESR) — use of bio-decomposer technology in conjunction with CRM machines
- Ensure no stubble is burnt between 0800 hrs and 1400 hrs during the months from September to February
- Residual crops can be harvested and utilized in energy production, biogas generation, commercial feed stock for cattle, composting or conversion in biochar or as a raw material.

Crop residue burning is episodic pollution that contributes significantly to the regional air quality. Every winter, the large-scale burning of residues from paddy crops in October-November in the neighbouring states, primarily Punjab and Haryana, contributes significantly to the region's air pollution challenge. As is already well understood, mechanization of crops that leave behind smaller stubble on the ground that is tedious and uneconomical to remove, delayed rice sowing in Punjab and Haryana in June because of concerns of groundwater depletion, small window between the harvesting seasons of rice and sowing of wheat among other reasons, make burning of residues the easiest option for disposal. Winter inversion and wind patterns further aggravates its effect on the northern Gangetic plains and the highly populated region of Delhi and NCR.

Estimates indicate that stubble burning contributes to up to 15 per cent of air pollution on an average in Delhi during post-monsoon and winter air pollution. But daily contribution may vary from 4 per cent to more than 35 per cent depending on the direction and speed of wind. Review of information submitted to the CAQM[38] brings out the baseline status and action plan.

Series of directives from the Hon'ble Supreme Court, NGT and the programmes and funding schemes of the central and state governments have evolved over the last few years to control this problem. These have focused on *in-situ* solutions to provide farmers subsidized agricultural machines to plough back the straw into the ground; or composted on the land itself. Small and marginal farmers access to machines need to be assured.

Ex-situ straw management includes straw-based power generation plants, bio-CNG/bio-ethanol plants, use for co-generation, fuel in industrial boilers, brick kilns, coal based thermal power plants (co-firing of biomass pellets/torrefied pellets with coal). Other end products include biomass pellets and briquettes for miscellaneous applications, bio-ethanol, biofuel, compressed biogas, paper / particle board/ compressed agriculture panel furniture/ packaging material industries etc. This has the potential to create economic value for the farmer and incentive to not to burn it. Transportation of straw requires balers and storage space to enable collection from fields. This remains a challenge.

The sustainable long-term solution will emerge from diversification of crops and reduction in non-basmati paddy. Currently, area under paddy continues to dominate Punjab's Kharif crop mix leading to enormous paddy residue generation. Setting of targets for eliminating incidents of fire count due to stubble burning shall help to guide the performance planning of *in-situ* and *ex-situ* measures.

Government interventions to mitigate crop residue burning: Apart from various directions from NGT, and former EPCA, there have been multiple advisories / directions from CAQM in 2021. There are policies and schemes from central government, which include National policy for management of crop residue (2014), Central scheme on promotion of agricultural mechanisation for *in-situ* management of crop residue in the states of Punjab, Haryana, UP and NCT of Delhi (2018 onward) – in this scheme a total amount of Rs 1,726.67 crore (2018-2021) has been provided to state.

Another scheme – the Sustainable Agrarian Mission on Use of Agro Residue in Thermal Power Plants (SAMARTH) – has been initiated in 2022.[39] Plans and schemes to reduce the generation of paddy straw aim to promote basmati variety; short duration and early maturing varieties; and crop diversification. It is planned to totally suspend certification and use of the PUSA 44 variety of paddy seeds.[40]

Management of paddy straw through different *in-situ* measures

By 2021, more than 13,100 happy seeders and 17,600 super seeders were available in Punjab, besides other categories of CRM machinery including combine harvesters and super SMS. Non-basmati farms can be managed by existing stock of happy and super seeders, if deployed in full numbers and to their full capacity. There is, however, a concern around under-utilisation of crop residue management machines. The CHC rental model and FARMS app are plagued by inefficient logistical management.[41]

Bio-decomposer for *in-situ* crop residue management: Application of bio-decomposers like the one developed by PUSA is one of the vital *in-situ* stubble management option. To make the bio-decomposer application successful and effective, it is to be ensured that application is carried out in conjunction with appropriate CRM machinery for adequately mixing the same with the soil as well as light irrigation to facilitate faster and effective bio-decomposition of the stubble.

The conventional PUSA bio-decomposer was earlier in the form of capsules which had to be further processed through a series of preparatory actions, mixing with jaggery and gram dust (besan) over a long duration. This was seen as a cumbersome exercise and posed logistical issues towards preparation of the bio-decomposer solution by the farmers on site. To ease the process, M/s Nurture Farms has partnered with IARI for licensing and enhancing the PUSA bio-decomposer technology in a powder form which is readily sprayable with water solution.

During the paddy harvesting season 2021, bio-decomposer application was carried out in around 9,20,000 acre in U.P, including 1,01,000 acre in NCR districts of the state; in 4,104 acre in Delhi; 7,413 acre in Punjab; and 81,356 acre in Haryana. M/s Nurture Farms, through their CSR initiative, carried out bio-decomposer application in around 171,449 acre in Punjab and 2,36,109 acre in Haryana.

There is a need to upscale bio-decomposer application during paddy harvest season 2022, through various agencies in the state governments and the public and private sectors.

Management of agricultural residue through different *ex-situ* measures

Ex-situ management is one of the best options for utilizing agricultural residue as a resource and deriving economic value through products and services. Suitable policies need to be in place towards availability of paddy straw to various sectors viz. as fuel in industrial boilers, WtE plants, brick kilns, TPPs and other applications like composting, bio-fuel/biogas production, bio-mass power, paper/packaging industry etc. There is however a need for a robust supply chain to ensure uninterrupted availability of biomass fuels perennially for industries and other applications.

The Commission, in this regard, has issued advisories to State Governments of Punjab, Haryana and Uttar Pradesh on "*Ex-situ* Stubble Management for tackling the problem of Stubble Burning". Based on successful trials by NTPC and utilization in its various thermal power plants, it has been established that biomass pellets (torrefied/non-torrefied) can be successfully co-fired with coal in thermal power plants up to a blend ratio of 5-10 per cent, without any boiler design modifications.

The Commission, vide Direction dated 17.09.2021, has directed the coal-based thermal power plants located within 300 km radius of Delhi to initiate immediate steps to co-fire biomass-based pellets, torrefied pellets/briquettes (with the focus on paddy straw) with coal (up to 5-10 per cent) in the power plants through a continuous and uninterrupted supply chain. So far, biomass co-firing has been started in 7 out of 11 identified TPPs and action is underway for such co-firing in remaining power plants as well.

State governments have also been advised by CAQM to develop a mechanism / policy for assured availability/supply of paddy straw; map the districts and villages for the agricultural straw availability and demand from various industries for optimum quantity allocation and utilization; establish institutions / aggregators at village/ block/district level; develop appropriate decentralized mechanism for the collection, storage and transportation for industrial use of crop; ensure quality of agricultural straw, primarily the moisture content in it; and ensure requisite infrastructure at the industrial sites for proper utilization of straw etc.

Around 11.85 lakh tonne of paddy straw in Punjab and 4.78 lakh tonne in Haryana respectively was utilized in various *ex-situ* applications viz industrial boilers, biomass power projects, bio-CNG plants, bio-ethanol plants, CBG projects etc during 2021. As per projected utilization by 2023, approximately 27 lakh tonne of biomass in Punjab and 18 lakh tonne in Haryana respectively shall be utilized in different *ex-situ* applications.

The targeted action plan and timelines in this regard are in table 19 —

Table 19: Crop residue burning: Targeted action plan and timelines

Policy interventions	Sub-regions	Responsible agencies	Timeline		
			1 year (by 31.12.22)	3 years (by 31.12.24)	5 years (by 31.12.26)
Paddy straw management through various *in-situ* and measures.	Punjab, Haryana & NCR districts of Uttar Pradesh	State govt. of Punjab, Haryana, Uttar Pradesh and MoA&FW	60% of total straw generated	80% of total straw generated	100% of total straw generated
Ex-situ utilisation of paddy straw for industrial applications, thermal power plants, biomass power and production of bio-fuels and misc. applications etc.	Departments of Agriculture, Power, Renewable Energy, Industry in the States of Punjab and Haryana		Punjab: 1.25 million Tonnes Haryana: 0.48 million Tonnes	3 million Tonnes 1 million Tonnes	6 million Tonnes 2 million Tonnes
Update and refine action plan by the respective states based on framework developed by the CAQM with following Fundamental Pillars *In-situ* Crop Residue Management *Ex-situ* Crop Residue Management Plans / Schemes to reduce generation of paddy straw through crop diversification and diversification to short duration paddy varieties Prohibition of Stubble/Crop Residue Burning. Effective monitoring/enforcement. IEC activities for the Plan of Action	Delhi, Punjab, Haryana and NCR districts of Uttar Pradesh and Rajasthan	NCR State Govts., State Govt. of Punjab and GNCTD	As per the plan to be developed		
Promotion of biomass for various *ex-situ* applications through suitable policies towards availability of paddy straw to various sectors (viz. as fuel in industrial boilers, WTE plants, brick kilns, TPPs) and other applications like composting, bio-fuel/biogas production, bio-mass power, paper / packaging industry etc.		NCR State Govts., State Govt. of Punjab . MoA&FW	As per state specific plans and policies of the NCR states		
Consideration of a VGF towards cost of generation and distribution of biomass-based power vis-à-vis conventional power generation and distribution mechanism.		MNRE, MoF, NCR State Govts. and State Govt. of Punjab	-		
Establishment of robust supply chain to ensure uninterrupted availability of biomass fuels perennially for industries.		NCR State Govts. and State Govt. of Punjab	-		
Consideration by MoA&FW to provide subsidies for balers and rakers even for industrialists / entrepreneurs / aggregators involved in processing of agricultural straw (pelletisation / briquetting etc.) under CRM or similar schemes of the Ministry.		MoA&FW			
Enhanced utilization of biomass for co-firing with coal in thermal power plants as per statutory directions in this context.	11 TPPs within 300 kms of Delhi.	Ministry of Power, and TPPs within 300 kms of Delhi.	-		
Expanding application coverage of PUSA biodecomposer through CSR / CER initiatives of private/ public sector and financial incentives by the State Governments.	Delhi, Punjab, Haryana and NCR districts of Uttar Pradesh and Rajasthan	NCR State Govts, MoA&FW, IARI and State Govt. of Punjab	-		
Bringing the 'boom sprayers' for application of bio-decomposer solution under the ambit of CRM or similar scheme of the MoA&FW.		MoA&FW	-		

Abating air and dust pollution from roads and open areas

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON ROAD DUST CONTROL

- Proper cleaning of road dust and building good quality roads
- Plug the sources of dust such as vacant land, dirty roads etc
- Ensure regular cleaning and repairing of roads
- Road dust management and dust removal system
- Metalled roads at construction sites, removing road dust and sludge, green buffer zone, end to end footpaths and water sprinkling
- Stabilization of un-metalled roads
- Sweeping of roads only through mechanical vacuum sweepers
- Paving of roads, mechanical cleaning and plantation
- Field trials with various equipment/ technologies proposed by individuals/ organisations towards abatement of outdoor air/ dust pollution.

All source apportionment and inventory studies in the region show overwhelming impact of dust especially during summer that is inevitable in these geo-climatic conditions. Loose crustal soil and high wind effect in the Indo-Gangetic Plain contribute to this phenomenon. Dry winters/summers add to the problem. Re-suspension of road dust due to vehicular traffic is of special concern. Dust is a carrier of toxins from combustion sources and therefore can be harmful. However, the strategy to address this problem has to be diverse and not limited to only road cleaning and sweeping. A lot of this problem is also created by mismanaged urban construction and roads.

The 2018 Clean Air Action Plan had provided for repair and building of pavements and vacuum cleaning of roads; implementation of street design guidelines for footpaths and cycle tracks with adequate vegetative buffers and paving of roads; blacktopping/pavement of road shoulders; phase-in of mechanical/vacuum based street sweeping; introduce wet/mechanized sweeping of roads; implementation of truck loading guidelines; use of appropriate enclosures for haul trucks; gravel paving for all haul routes; sprinkling of recycled water; water fountains at major intersections; maintenance of pothole free roads; increase in green cover on central verges and on the road sides along the right of ways; and enforcement of air pollution control in concrete batching (use of water spray and wind breakers, bag filters at silos and enclosures, hoods, curtains etc).

During the winter of 2021-22, the CAQM has issued further directives and advisories for dust control during smog episodes. These include:

- Advisory on Abatement of Dust from Roads and Open Areas dated 12.02.2021[42] for regular sweeping of roads and mechanized sweeping, sprinkling of water on roads and open areas, paving of non-paved roads, making the roads pot hole free, greening of central verges and open areas, plantation of trees etc.
- Advisory to NHAI and DDA on Abatement of Dust Pollution from Roads and Open Areas dated 22.02.2021[43] — all road owning/road construction agencies of the State Governments/GNCTD have been advised to set up Dust Control & Management Cells for road projects in NCR for effective monitoring and implementation of dust control measures.
- Direction (No 19-28) on Setting up of Dust Control and Management Cells (DCMCs) dated 11.06.2021[44] by all road owning/maintaining/ construction agencies for effective monitoring and implementation of road dust control measures in NCR, including optimum utilization of road sweeping machines, scientific disposal of dust collected in landfills, sprinkling of water on roads, maintenance of roads, identification of hot spots of road dust, conversion of non-paved road sides into paved one or into green area, greening of central verges etc
- Direction (No. 44) on Steps for Effective Control of Air Pollution in the wake of prevailing air quality scenario in Delhi-NCR dated 16.11.2021[45] — incorporates dust control measures, to stop construction activities, water sprinklers, road sweeping machines and heavy penalty on the organizations responsible for C&D waste.

Towards dust management on roads and road construction projects, several municipal corporations have also adopted road dust control measures. The focus is largely on the maintenance of roads, identification of hotspots for road dust, mechanical sweeping, sprinkling and scientific disposal of collected waste. The longer-term systemic changes will require more broad-based approaches such as:

- Municipal ward-wise street network redevelopment plans for paving and greening as per IRC guidelines, without impeding the needs of other road users including pedestrians.
- Hotspot action for road cleaning with GPS enabled mechanical sweepers; desilting of canals/nullah's side roads brick lining, dedicated helpline with MIS support and citizen interface to enable geo-tagging for complaints
- Urban greening agenda with greening of open areas, gardens, plantation for green walling and protection of all forest areas in NCR.

Various technological suggestions to suppress or purify indoor / outdoor pollution levels have been received by the Commission, including some IAs filed by the

proponents of the respective technological solutions before the Hon'ble Supreme Court during hearings in the matter (Civil) No 1135 - Aditya Dubey (minor) and Anr v/s UOI & Ors. Most of these have however been tried out only under controlled laboratory conditions and need a field level validation for the efficacy of the technology and results as envisaged. It, therefore, seems appropriate to conduct technology agnostic pilot field trials in outdoor dust hotspots to ascertain efficacy of the technology proposed to improve air quality. State Govts. in NCR/ GNCTD, in due association with reputed technical / scientific / academic institutes and the technology partners concerned may conduct at least one such pilot field demonstration project in Delhi, Ghaziabad, GB Nagar, Faridabad and Gurugram respectively by 31.03.2023.

The targeted action plan and timelines in this regard are in table 20 —

Table 20: Dust control from roads and RoW: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline		
			Up to 1 yr	1-3 years	3-5 years
Paving/Greening of Central Verges	Delhi and all NCR districts	NCR State Govts / GNCTDs ULBs and all road construction/ maintenance and infrastructure development agencies.	At least 50% by 31.12.2022	100% by 31.12.2023	
Paving/Greening of sidewalks and open areas along roads and right of ways including in industrial areas as per the appropriate IRC street design guidelines	Delhi and all NCR districts	ULBs and all road construction/ maintenance and infrastructure development agencies	At least 20% by 31.12.2022	50% by 31.12.2024	100% by 31.12.2026
Scientific study on use of dust suppressants.	Delhi and all NCR districts	NHAI	30.06.2022		
Procurement of additional mechanical sweeping and sprinkling machines (@ one MRSM for every 40 km identified roads to be cleaned / sprinkled per day).	Delhi and all NCR districts	State Govts. GNCTDs ULBs and all road construction/ maintenance and infrastructure development agencies	25% by 31.12.2022	50% by 31.12.2023 75% by 31.12.2024	100% by 31.12.2026
Use of Dust-suppressants (in addition to water) in mechanized road sweeping activities.	Delhi and all NCR districts	State Govts. GNCTDs ULBs and all road construction/ maintenance and infrastructure development agencies	30.09.2022		
Use of Anti-smog guns at Road construction/ redevelopment sites, preferably with Dust-suppressants.	Delhi and all NCR districts	All Road construction/ owning and maintenance agencies in NCR			

Abating air pollution through greening and plantation programmes

Dust and pollution mitigation through forest sinks is important to control pollution. This green walling is needed against desertification and ingress of dust and cleansing of toxic gases. High level protection will have to be accorded to the entire stretch of Aravalli range in Haryana and Delhi and its different categories of forest areas.

At the national level, the National Mission for a Green India has been revised in line with the Nationally Determined Contributions (NDC) target. Afforestation of over 24 million hectare is targeted in convergence with ongoing central and state government schemes and funds available under CAMPA.[46] Currently, a central level MIS for tracking scheme-wise and state-wise outcomes is being developed. This can be further refined for the entire NCR region. Also, the Nagar Van scheme is an opportunity for greening in the NCR sub-regions. Under central government funding, urban local bodies and others can help to establish Nagar Vans in 10-50 hectare of land and vaatikas in 1-10 ha land.

Several sub-regions have begun to implement this scheme. While Haryana has a clear plan, Ghaziabad has implemented two afforestation projects – the Miyawaki forest that includes Sai Upvan in an area of 96 x 16 sq m, with 5,000 trees planted (more than 25 species) and a 6,000 sq m area in Pratap Vihar with 20,000 trees planted (approximately 40 species). Such efforts need to continue to augment the per-capita green cover in cities.[47] Owing to space constraints in urban landscapes, vertical gardens along metro rail pillars and other such structures etc should also be promoted.

The targeted action plan and timelines in this regard are in table 21 and 22 —

Table 21: Greening and plantations: Targeted action plan and timelines

Policy interventions	Sub-region	Responsible authorities	Timeline as per plan period
Expanding the net of "Nagar Van" and "Nagar Vatika", wherever feasible, in urban agglomerations and cities in NCR, including adoption of MIYAWAKI technique for dense plantation in limited urban spaces.	Delhi and all NCR districts	Forest Deptt. And Urban Affairs Deptt., NCR State Govts.	As per plan to be developed
Mass plantation drives focusing on proper nurturing and better survival rate, prioritising native species and protection of all categories of forest areas.	Delhi and all NCR districts	NCR State Govts.	As per plan to be developed
Target oriented action plans for greening / paving of central verges and sidewalks along the entire road network.		Road owning agencies, urban affairs Deptt. in NCR State Govts.	As per plan to be developed.

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Table 22: Targets/achievements for greening and plantation (No of saplings)

States	2021-22 (Achievement)	2022-23 (Target)
Delhi	28,81,145	31,89,191
Uttar Pradesh (NCR districts)	1,64,07,023	1,69,29,310
Haryana (NCR districts)	53,63,820	85,06,999
Rajasthan (NCR districts)	7,28,908	9,84,992

Abating air pollution owing to bursting of crackers

Episodic events of bursting fire crackers during festivals and celebratory events cause enormous air pollution and such incidences are a particular cause of concern during the winter months which are already faced with an adverse air quality scenario. The Hon'ble NGT, Hon'ble Supreme Court and the state governments in this regard have passed a series of orders and directions regulating the sales, use / bursting of fire crackers in the NCR and these need to be strictly implemented.

5. Review of the Graded Response Action Plan (GRAP)

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON GRAP

- Strengthen implementation of GRAP
- Proactively implement GRAP measures based on air quality forecasts, rather than retroactively implementing them once acceptable levels are breached
- Measures under GRAP to be invoked at least two-three days in advance based on the prediction of air quality forecasting models.
- Develop enforcement protocols and grievance redressal mechanisms

The directive of the Hon'ble Supreme Court in 2016 had led to the notification of the Graded Response Action Plan (GRAP) for graded and emergency response in January 2017. This was linked with the National Air Quality Index that was notified by the MoEFCC in 2015 for daily relay of information to the public and to inform emergency measures. Several measures have been graded according to the severity of daily air quality, these include temporary closure of industries, brick kilns and stone crushers; stopping of trucks and construction; and introduction of the odd-and-even scheme to reduce vehicle numbers during smog episodes.

As mentioned earlier, during the winter of 2021, the CAQM initiated a series of emergency measures directing industries using polluting fuel to close, temporarily shutting the thermal power plants (except five), banning DG sets, imposing restrictions on old vehicles, augmenting CNG buses, stopping entry of trucks and banning construction, enforcing intense dust control measures and shutting down schools and colleges. Earlier, additional measures such as the odd-and-even scheme for vehicles were also taken.

Emergency action is designed to arrest the peaking of extreme pollution during smog episodes when pollution is trapped due to atmospheric inversion and cool and calm winds during cold winters. These measures help prevent adding of more pollution when the natural ventilation index is low and pollution cannot disperse. These are drastic but temporary measures. These measures need to be refined from time to time according to the exigency. However, the scope of application of these measures also remains limited if the systemic and infrastructure-level changes are inadequate in pollution sectors. For instance, vehicle restraint measures are difficult to implement during smog episodes if public transport infrastructure is inadequate in the region.

It is also evident that temporary closure orders on industry, construction etc and other restraint measures have the potential to catalyse more systemic changes as polluters want to avoid temporary disruptions. It is important to underscore that only more sustained and systemic solutions can reduce the requirement for emergency action.

Revision of GRAP

The Commission has comprehensively revisited the contours of the GRAP in vogue, towards an effective implementation mechanism and control on the adverse air quality scenario that generally persists in the entire NCR during the peak winter months. Salient features of the revised GRAP are as under:

- The GRAP for NCR has now been classified under four different stages of adverse air quality in Delhi, reflected through the Air Quality Index (AQI) — Stage I - 'Poor' (AQI 201-300); Stage II - 'Very Poor' (AQI 301-400); Stage III - 'Severe' (AQI 401-450); Stage IV - 'Severe+' (AQI >450).
- Actions under Stages II, III and IV shall be invoked at least three days in advance of the AQI reaching to the projected levels of that stage, based on the dynamic model and weather/ meteorological forecast to be provided to the Commission by IMD / IITM on a day-to-day basis.
- Proposed restrictions are to be progressive from a lower stage to higher stage i.e., restrictive actions undertaken as per previous stages shall be continued, in addition to the air pollution stage under which the restrictive actions are envisaged to be taken. For example, restrictive actions under the Stage III category, whenever invoked, shall be in addition to those under Stage I and II respectively and so on and so forth.
- The Sub-Committee on GRAP constituted by the Commission shall meet frequently to plan for advance action and issue necessary orders for invoking various provisions of the GRAP, based on the prevalent air quality and the AQI forecast to be provided by IMD from time to time. The Sub-Committee shall also review the actions taken by various agencies responsible towards effective implementation of the GRAP.

Key restrictions / regulations of activities during the revised GRAP are as under:

Stage II - 'Very Poor' AQI category (AQI 301-400)

- Banning diesel generator sets except for emergent and essential services
- Ban on coal / firewood including in tandoors in hotels / restaurants / open eateries

Stage III - 'Severe' AQI category (AQI 401-450)

- Ban on C&D activities in NCR, except emergent and essential projects (like railways, metros, airports, ISBTs, national security/ defence related / projects of national importance) and non-polluting / non-dust generating activities such as plumbing works, interior decoration, electrical works and carpentry related works
- Regulate operations of industries in NCR not running on PNG / cleaner fuels / biomass fuels to maximum five days per week (staggering 'off days' for different sets of industries in the entire week)
- Shutting down of brick kilns, hot mix plants, stone crushers not operating on clean fuels like PNG and biomass-based fuels
- Ban on mining and associated activities in NCR
- State governments in NCR/GNCTD may impose restrictions on BS III petrol and BS IV diesel LMVs (4-wheeled vehicles)

Stage IV - 'Severe+' AQI category (AQI > 450)

- Stop entry of truck traffic into Delhi, except trucks carrying essential commodities / providing essential services and CNG / electric trucks
- Ban on plying of Delhi registered diesel run Medium Goods Vehicles (MGVs) and Heavy Goods Vehicles (HGVs) in Delhi except those carrying essential commodities / providing essential services
- Ban on plying of 4wheeler diesel LMVs in NCT of Delhi and districts of NCR bordering Delhi, except for BS-VI vehicles and vehicles used for essential / emergency services
- Ban on industries in NCR, which are running on fuels other than PNG/ cleaner fuels, electricity and biomass, except industries like milk and dairy units, industrial units involved in manufacturing of life saving medical equipment / devices, drugs and medicines.
- Ban on C&D activities in linear public projects such as highways, roads, flyovers, over bridges, power transmission and pipelines
- State governments to decide on allowing 50 per cent staff strength to work from home (WFH) in public, municipal and private offices
- State governments may consider additional emergency measures like closure of schools/ colleges/ educational institutions, plying of vehicles on odd-even basis etc.

6. Household energy and air pollution

SUGGESTIONS FROM THE PUBLIC AND EXPERTS ON HOUSEHOLD AIR POLLUTION

- Recognise indoor air quality and indoor air pollution as a part of the scope of work of CAQM and Air (Prevention & Control of Pollution) Act, 1981
- Address household air pollution in low-income and slum areas
- Encourage use of smokeless chulhas on streets
- Stop use of coal by carts and presswalas.
- Prevent the unorganised sector from using unauthorised fuel in Delhi-NCR
- Completely stop coal burning either for use of presswala or tandoor anywhere in Delhi — convert them to electric or gas based
- BPL families to be provided solar cookers
- Institute a plan for slum redevelopment and rehabilitation for promoting use of clean fuels
- Hotels, restaurants and eateries should be restricted from using coal and shift to electric and gas-based modes
- LPG/piped gas supply could be made available to all households

The Global Burden of Disease estimates attribute close to a million deaths due to household air pollution, largely affecting women and children. The 2015 Report of the Steering Committee on Air Pollution and Health Related Issues of the Ministry of Health and Family Welfare has estimated that household air pollution due to widespread use of solid fuels is responsible for 25-30 per cent of the outdoor air pollution. Mitigation of household air pollution needs to be integrated with outdoor air quality management across urban and rural landscapes.

Even though there has been substantial expansion of LPG connection and piped natural gas network in the region, the problem has not been eliminated. Central government schemes include Pradhan Mantri Ujjwala Yojana (PMUY) and direct benefit transfer to LPG consumers (PAHAL) combined with state government initiatives has widened the coverage. In Delhi, for instance, LPG penetration has increased after the implementation of 'Kerosene Free City' scheme during the last decade. District and ward-wise data is not yet available to assess the gap in NCR. Though the official data from Petroleum Planning & Analysis Cell of Ministry of Petroleum & Natural Gas as on 1.1.2020 shows legal LPG coverage of households in Delhi and NCR states to be near 100 per cent (LPG coverage is estimated on the basis of domestic LPG consumers by dividing estimated number of households), but there are issues of supply, use of mixed

fuels by households, and delayed refill that push households to fall back on dirty fuels in the semi-urban and rural areas.

The bigger challenge is that of the migrant and floating population in the low-income categories and below poverty line who do not have access to clean fuels.

The new affordable housing typologies including rental and dormitories need to be equipped with clean cooking systems preferably induction stoves for the migrant or floating population to use. Overall, expansion of PNG and electric cooking can help to improve access. Induction cooking has better thermal efficiency, and comparable cost effectiveness. Such provisioning may be integrated with the affordable housing programme, especially the vertical related to the rental housing.

In addition to household cooking, it is necessary to address use of solid fuels in open eateries and restaurants. With implementation of approved fuel list in Delhi, use of fire wood and coal in hotels and eateries have been stopped. Only wood charcoal is allowed for use in tandoors and grills of hotels/restaurants with adequate controls.

7. Air quality management and compliance framework

The Clean Air Action Plan underscores the importance of strengthening institutional process and systems for aligned and harmonised action with strong accountability and transparent monitoring for compliance. All actions will have to add up for verifiable air pollution reduction and improvement in air quality to meet the clean air target and the national ambient air quality standards for particulate and all other criteria pollutants by the end of the plan period.

- This requires high level coordination and oversight that the CAQM provides.
- At the state level, there is need for strong alignment of multi-sector action plans with the state governments' own programmes, funding strategies and priorities in each sector. The targets and indicators for change need to be mainstreamed and integrated with the departments' programmes and strategies for implementation. Review of programmatic reforms and schemes are needed to align with the requirements of the Clean Air Action Plan.
- Sectoral policies and regulations have evolved considerably in each sector of mitigation to set the regulatory standards, compliance strategy and deterrence frameworks. These set the sectoral mandate and need to be fully leveraged. Policy reforms can be further strengthened as needed. But strategic policy alignment can create considerable opportunity for change.
- This also requires convergence and alignment of different lines for funding in each sector and gap financing through central and state level funding and other financing means. This needs to be planned and quantified for advanced planning. Funding strategies in different sectors need to be consistent with the objective of clean air action and not lock in more pollution in misconceived infrastructure that leads to leakages.
- Even though Programme Monitoring Units or Air Pollution Cells are evolving at the state level, this requires strong monitoring methods for tracking compliance against targets, detailed standard operating procedures (SOP) and management information systems (MIS) within each department. This requires deeper understanding of the scope of action at the departmental level for adequate detailing and funding.
- There is need for capacity building within departments to understand the

full scope of action based on the Clean Air Action Plan, guiding principles and new generation policy principles like preventive action, polluter pay and demand management principles, circularity etc, for strategy development and implementation. Strengthen institutional, regulatory and technical capacity of the departments to enable planning and implementation.

- In different sectors, smart monitoring and digitisation are becoming common creating enormous opportunity for big data that can be leveraged for remote monitoring and policy feedback. Adopt appropriate protocol for data recording and reporting to leverage the dataset monitoring implementation. Build transparency and public disclosures systems.
- Action to clean the air at the state and regional levels will require strong central government interventions to provide strategic funding support and strategic policy, regulatory and relevant taxation reforms to support local and regional action on clean energy, transportation development, waste management among others. This will require both enhanced sectoral funding as well as enhanced dedicated funding for clean air action under National Clean Air Programme and Finance Commission funding for the region.

Recommendations for institutional strengthening

- Capacity building and strengthening of institutional capabilities of enforcement agencies and SPCBs including stricter compliance of all statutory directions
- Developing enforcement protocols and grievance redressal mechanisms
- Encouraging informed public consultations
- Proper use of Green Fund / tax by Delhi government and similar funding mechanisms in NCR states
- Graded enforcement and penalty as per nature of offence.

8. Funding strategies

Adequate and timely resource mobilization for meeting the cost of mitigation will be critical for the success of the respective action plans under the suggestive policy framework. Once the multi-sector strategies are detailed out at the state level, it will be possible to have granular view of the total funding requirements at the sub-region level. It has not been possible to do this exercise at this stage. But implementation of this plan will require a detailed funding strategy.

The Ministry of Environment, Forest and Climate Change (MoEFCC) has already indicated that all state and central funding schemes in different sectors require convergence and leveraging for clean air action and has identified all the central government schemes and programmes with their budgetary allocation that can contribute to this effort. However, these different streams of funding will have to be clearly earmarked according to the key indicators of spending in the sub-regions of NCR. At the same time identify the funding gaps to augment allocation depending on the priorities and detailing of the strategies in each sector. This plan can also leverage private sector investments to deliver on clean air goals and prevent locking in of more pollution.

Nationally, dedicated funding for clean air action is available from two sources – the National Clean Air Programme (NCAP) that is routed through SPCBs, and the 15th Finance Commission Grant for clean air that is routed through ULBs. But availability of this funding is very limited in the NCR region as only three cities have qualified for each of these funding lines.

Under NCAP, Delhi, Alwar, and Noida have received funds and under the 15th Finance Commission Grant for clean air action, Faridabad, Ghaziabad and Meerut have received funds. The MoEFCC has indicated the status of fund released under two key funded programme NCAP and the 15th Finance Commission Grant in NCR. It is stated that this funding is targeted at some core functions of the action plans. At this stage, there is no assessment of the adequacy of this funding and how further augmentation is planned for this entire region (*see Table 23*), but the multi-sector and multi-layered actions require substantial augmentation of resources.

Table 23: Funds released to NCR cities (in Rs crore)

Funds released under NCAP till 2021-22	
Delhi	11.25
Alwar	1.96
Noida	6.67
Funds released till 2021-22 under XV Finance Commission	
Faridabad	48
Ghaziabad	121
Meerut	72

Source: Ministry of Environment, Forest and Climate Change

While direct allocation of funds can be further augmented, this region also needs more innovative fiscal instruments to generate additional revenue. This is needed not only to augment resources, but also to make incentive/subsidy and cross subsidisation in different sectors more revenue neutral. Several sectoral policies have already provided for fiscal strategies but these have not been adopted for implementation. For instance, electric vehicle policy will require a funding strategy to support incentive programme in a revenue neutral manner. This will require 'tax the bad to fund the good approach' and polluter pays principle. Similarly, clean fuel strategy will require fuel tax rationalisation, uniform taxation and favourable taxation policy to make clean fuel more competitive and affordable across all sectors in the region. Market based mechanism can augment industrial investments to support the transition.

There is also considerable scope of influencing private sector investments to deliver on clean air indicators. While tighter regulations, standards and compliance mechanism can ensure widespread adoption of emissions control systems in the industry sector, integration of urban planning and urban design mandates can leverage infrastructure spending of the private sector including that of construction bodies, developers and transport providers. For instance, continuous process of constructing road and infrastructure in the sub-regions need to follow the urban design mandates for sustainability, accessibility, dust control and circularity. Similarly, urban renewal or urban redevelopment projects that are designed for private sector investments can be mandatorily linked with the requirements of TOD and compact urban form-based codes.

The funding for pollution abatement measures needs to be performance linked. This trend has already started. The 15th Finance Commission grant of Rs 4,400 crore that was sanctioned for improvement of air quality in 42 million-plus cities for 2020-21 and an additional grant of Rs 12,139 crore provided to improve air quality in these 42 cities for the period of 2021-22 to 2025-26 are performance linked grants. In the coming years, this grant will be performance linked through Million-plus cities Challenge Fund (MCF) and will be governed by a Tripartite Memorandum of Understanding (MoU) between MoEFCC, the State Government and the concerned ULB for a year-wise action plan. Responsibility of the nodal entity will be to achieve performance indicators.

Performance will be judged based on a range of criteria that include strengthening of pollution monitoring mechanism; source-wise cause analysis for air pollution; progress on action plans and compliance with statutory guidelines; quantification and evaluation of air quality improvements; reduction in air pollution level (particulate matter) and frequency of exceedance in AQI levels. These parameters will be weighted for the release of grants in FY 2021-22. But for the release of grants from FY 2022-23 onwards, 100 per cent weightage will be given to the quantification and evaluation of air quality improvements.

Moreover, if cities do not meet the air quality target and the NAAQS, MoEFCC may consider incentivizing cities/urban agglomerates differently. Fifty per cent of the fund will be distributed as follows – the top performers (10 per cent improvement in air quality) will get 20 per cent of the fund; those reporting 8-10 per cent improvement will get 17.5 per cent; and those reporting 6-8 per cent improvement, 12.5 per cent of the fund. Such a framework for funding can be internalised and adopted for sectoral funding in Delhi-NCR.

Similarly, as noted earlier, SBM 2.0 grant for waste management is also performance linked. Thus, informing and influencing the scope of action and strategy development for implementation are critical for efficient use of the available and augmented funds.

It is also recommended that more inclusive dedicated funding may be established for the Delhi-NCR region for wider coverage of cities and sub-regions and sub sectors based on the principle of incentive and disincentives and for direct mitigation of pollution at source. This needs to be worked out at both central and state level.

In addition, necessary reforms may be carried out to rationalise the taxes and prices to encourage clean products and activities, energy efficiency and resource savings, and change behaviour. Funding needs to be more deliberately designed for mitigation that is verifiable and measurable.

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