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Multi-Sectoral Action Plan for Air Pollution Mitigation in Gurugram, India 2025-2030

Prepared by: **United Nations Development Programme (UNDP), India, December 2024**

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1. Introduction

Exposure to air pollution is linked to a wide range of illnesses, including respiratory and cardiovascular diseases, incident cases of stroke, lung cancer, type-2 diabetes mellitus, chronic obstructive pulmonary disease (COPD), ischemic heart disease (IHD), acute lower respiratory tract infection (ALRI), cancer, and neurological disorders, significantly impacting life expectancy and quality of life.

Air pollution has emerged as one of the most pressing environmental and public health challenges in India, with wide-ranging implications for health, economic productivity, and overall quality of life. Gurugram, designated as non-attainment cities under the National Clean Air Programme (NCAP), exemplifies this growing crisis as it consistently fails to meet the National Ambient Air Quality Standards (NAAQS). The persistent degradation of air quality in the city has led to a significant rise in respiratory ailments, cardiovascular diseases, and a general decline in well-being.

Gurugram, a major hub of urban development and information technology, faces critical air quality challenges stemming from high vehicular emissions, intense traffic congestion, widespread construction activities, and industrial pollution. The city's rapid urbanization, coupled with inadequate urban planning, has overwhelmed its infrastructure, making air quality management an urgent necessity. Despite the presence of national frameworks such as the NCAP and the Air (Prevention and Control of Pollution) Act, 1981, effective implementation remains a challenge. Institutional limitations, resource constraints, and fragmented coordination among stakeholders often hinder the enforcement of pollution control measures at state and municipal levels.

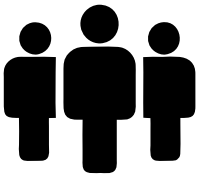
According to a UNDP investment case on ambient air pollution and health for Gurugram and Amritsar (2024), targeted interventions could significantly mitigate the burden of air pollution in Gurugram. For instance, developing roadside greenbelts could prevent approximately 477 deaths, while transitioning industries to cleaner fuels might avert an additional 223 deaths and Stricter emissions control measures might avert 160 deaths. These findings underscore the critical need for city-specific, multi-sectoral action plans to reduce pollution and protect the health and well-being of Gurugram's population.

The proposed Multi-Sectoral Action Plan on Air Pollution and Health for 2025-2030 (MSAP) outlines the challenges Gurugram faces in controlling air pollution and proposes action across key areas to mitigate the negative impacts. Extensive stakeholder engagement was undertaken to further understand the challenges and hindrances faced by authorities and other stakeholders in controlling air pollution. The existing coordination mechanisms for air pollution were also analyzed to examine how decision-making occurs and how data flows regarding air pollution management in the city. Based on these insights, a new coordination mechanism for air pollution is being proposed at city or district government level to bridge these gaps and enhance the efficiency of air quality management.

The development of this proposed MSAP is part of a wider global UNDP-European Union project *Advancing health and environmental sustainability through action on pollution* (2020-2024). The project developed two new global methodologies - for air pollution investment case and legal environment assessment for health and pollution – and piloted them in Ethiopia, India and Mongolia, and supported the development of action plans for health and pollution. The proposed MSAP is developed in consultation with the respective local government of Gurugram. The details of the consultation with the stakeholders involved is provided in Annexure 2.

2. The Need for a Multi-Sectoral Action Plan on Air Pollution for Gurugram

India's National Clean Air Program (NCAP) (Ministry of Environment, Forest and Climate Change, 2019) identifies non-attainment cities—those that fail to meet the National Ambient Air Quality Standards (NAAQS)—as critical areas for focused interventions. Among these, Gurugram, with its distinct geography and demographic characteristic, have been selected for the development and implementation of multi-sectoral action plan to address its air quality challenges.



Population (2011)
15 Lakh

Gurugram, located in Haryana and part of the National Capital Region (NCR), is a rapidly urbanizing city known for its industrial hubs, IT sector, and real estate development. The city faces severe air pollution, driven by vehicular emissions, construction dust, industrial activities, and seasonal biomass burning in surrounding rural areas. Gurugram's semi-arid climate and its proximity to Delhi further exacerbate its air quality issues, with transboundary pollution playing a significant role during the winter months. In terms of air quality data, Gurugram consistently records high levels of particulate matter ($PM_{2.5}$ and PM_{10}), often exceeding the NAAQS. During peak winter months, $PM_{2.5}$ levels can reach several times the World Health Organization's (WHO) 2021 Air Quality Guidelines, placing Gurugram among the most polluted cities globally. Additionally, ground-level ozone and nitrogen dioxide levels are rising, contributing to respiratory and cardiovascular diseases.

District's area
1253 Sq. Km.

As per **UNDP's Air Pollution Investment Case: Amritsar and Gurugram Cost of Illness Report** (United Nations Development Programme, 2024), the annual average PM2.5 level in Gurugram in 2021 was 100 µg/m^3, significantly exceeding the NAAQS of 40 µg/m^3 and the WHO's 2021 guideline of 5 µg/m^3. Adherence to NAAQS levels could have prevented 340 deaths and 19,447 incident cases, while meeting WHO-recommended levels could have averted 1,013 deaths and 42,885 cases. Acute lower respiratory infections (ALRI) had the highest incidence, followed by chronic obstructive pulmonary disease (COPD) and ischemic heart disease (IHD), with COPD and IHD causing the most deaths. These findings highlight the urgent need for stringent air quality measures to reduce the substantial health and economic burden on the city.

Gurugram encounters elevated levels of particulate matter, particularly PM10 and PM2.5, along with other hazardous pollutants. According to (Lancet Planet Health, 2019) study, air pollution resulted in economic losses equivalent to 1.36 percent of India's GDP, approximately US$36.8 billion underscoring its severe economic toll. The economic burden on Gurugram is particularly concerning. According to UNDP's investment case study for air pollution in Amritsar and Gurgaon, air pollution-related diseases cost Gurugram an estimated 695.4 million (US$ 8.4 million) per year. This highlights the urgent need for effective strategies to mitigate pollution, which affects not only human health but also economic productivity and urban resilience.

The Continuous Ambient Air Quality Monitoring System (CAAQMS) stations were conceptualized to meet the requirements of the 2009 National Ambient Air Quality Standards (NAAQS), which emphasized real-time monitoring for effective air quality management. While manual systems were used for a broader set of parameters, CAAQMS was designed to continuously monitor eight critical parameters, providing instantaneous data. This real-time data became essential for calculating the National Air Quality Index (NAQI), a public information tool introduced to disseminate actionable air quality information.

Gurugram is equipped with four CAAQMS stations located at **Vikas Sadan, Sector 51, TERI Gram**, and **NISE Gwal Pahari**, which continuously monitor air quality (Central Pollution Control Board, 2024). These

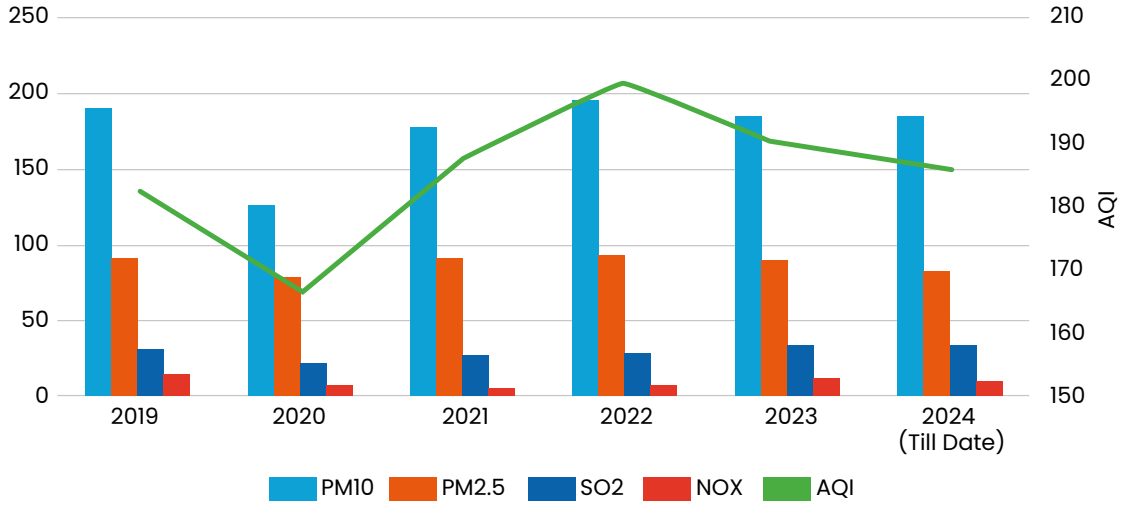
stations are vital for providing real-time data on various air pollutants, enabling the city to analyse pollution trends and implement targeted mitigation strategies. The table and figure below present averaged out data collected from these four stations over the past five years, offering insights into Gurugram's air quality status and its progression.

Table 1: Gurugram's CAAQMS Data from Four Stations

Year	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	AQI
NAAQ Standard	60	40	50	40	—
2019	190	91	31	14	182
2020	127	77	22	8	167
2021	178	91	27	6	187
2022	195	93	29	8	199
2023	184	89	34	12	190
2024	185	82	34	11	186

*Data Collected from Central Control Room for Air Quality Management

Figure 1: Gurugram Past 5 Years CAAQMS Data



From the data above, it is evident that over the last five years, the concentrations of PM_{10} and $PM_{2.5}$ in Gurugram have remained consistently high, indicating a concerning trend. This data, averaged throughout the year, highlights persistent challenges in managing particulate matter pollution in the city. In contrast, the levels of SO_2 and NO_x have remained within the standards set by the NAAQS, reflecting better control over gaseous pollutants.

2.1 Sectoral Challenges in Managing Air Pollution in Gurugram

Several sectors are responsible for air pollution in Gurugram, and these are outlined below. In addition to specific sectors, transboundary pollution from neighbouring regions, especially during the stubble-burning season, contributes significantly to Gurugram's particulate matter burden. The city's semi-arid climate and meteorological conditions often trap pollutants, exacerbating the situation. Windblown dust from open areas is also a major source of air pollution.

Transport Sector

- **Vehicular emissions:** Vehicular emissions primarily come from private vehicles, commercial vehicles (including diesel trucks and buses), and two-wheelers, which run on fossil fuels. Gurugram's increasing population and rapid urbanization have led to a sharp rise in the number of vehicles on the roads, worsening air quality. These emissions consist of particulate matter ($PM_{2.5}$, PM_{10}), NO_x, and CO_2, all of which have adverse effects on human health, contributing to respiratory issues, heart diseases, and even premature mortality.

- **Insufficient availability of public transport**: The current public transport system in Gurugram is insufficient in terms of reach, frequency, and integration with the city's growing population. This lack of effective public transport options pushes residents toward personal vehicles, resulting in increased congestion, emissions, and overall traffic management challenges. A lack of comprehensive bus routes, absence of last-mile connectivity from metro stations, and limited non-motorized transport options contribute significantly to air pollution and traffic congestion.

- **Limited EV adoption:** The adoption of electric vehicles (EVs) has been slow due to the high upfront cost, limited availability of charging infrastructure, and range anxiety. People are reluctant to switch from petrol/diesel vehicles to EVs without the assurance of an adequate charging network. Without sufficient infrastructure or government incentives, the transition to EVs remains slow, despite the potential for reducing emissions from the transport sector.

- **Traffic congestion:** Cyber City, MG Road, and NH-8 are some of the most congested areas in Gurugram, where traffic jams are frequent. These hotspots not only contribute to higher fuel consumption and vehicle emissions but also delay public transport, creating a vicious cycle of traffic and air pollution. Prolonged idling of vehicles during traffic congestion increases emissions.

Energy Sector

- **High dependence on fossil fuels:** Gurugram relies heavily on diesel generators (DGs) for backup power, particularly in industrial and commercial areas, due to frequent power outages. This results in significant $PM_{2.5}$, NO_x, and CO_2 emissions. Diesel generators contribute directly to local air pollution, and their widespread use increases energy inefficiency, especially in high-demand sectors like IT parks, malls, and residential complexes.

- **Limited renewable energy integration:** While the potential for rooftop solar energy in Gurugram is high, adoption rates are low due to high installation costs, lack of awareness, and technical barriers such as grid compatibility issues. This limits Gurugram's ability to reduce its dependence on fossil fuels and undermines the state's renewable energy targets.

- **Inefficient energy use in buildings:** Most residential and commercial buildings in Gurugram are constructed without energy-efficient designs. Cooling systems, lighting, and appliances consume excessive electricity due to outdated technologies. This leads to increased greenhouse gas (GHG) emissions, higher utility costs, and overloading of power infrastructure.

Health Sector

- **Air quality related health issues:** Exposure to high levels of $PM_{2.5}$ and NO_x is causing a surge in respiratory issues, cardiovascular diseases, and mental health disorders. Vulnerable populations, such as children, the elderly, and those with pre-existing health conditions, are at greater risk. Additionally, prolonged exposure is associated with increased mortality rates, with a significant burden on the healthcare system.

- **Inadequate healthcare infrastructure:** While Gurugram has seen an expansion in its healthcare facilities, the rapid population growth and increased disease burden have placed pressure on healthcare infrastructure. There is a shortage of specialists, hospital beds, and emergency services to handle pollution-related illnesses effectively.

- **Lack of public awareness:** Many residents are unaware of the long-term health risks of air pollution. This lack of awareness limits public participation in efforts to reduce exposure to pollutants, such as avoiding outdoor activities during high pollution periods or adopting air purifiers at home.

Urban Development

- **Construction-related dust and emissions:** The construction boom in Gurugram, fuelled by both residential and commercial developments, produces a large amount of dust and particulate matter ($PM_{2.5}$). Construction machinery, excavation, demolition, and material transportation all contribute to airborne particulate pollution. This issue is exacerbated by the lack of dust control measures and unregulated construction practices.

- **Vehicular emissions from infrastructure expansion:** Urban development often leads to increased vehicular traffic, especially in developing sectors with commercial hubs and residential complexes. As the population increases, so does the reliance on private vehicles, leading to higher emissions of nitrogen oxides (NO_x), particulate matter, and carbon monoxide, all of which significantly degrade air quality.

- **Energy demand from buildings and infrastructure:** Increased energy consumption due to high-rise buildings, malls, office complexes, and IT parks places additional stress on power grids, leading to greater emissions from coal-based power plants in the region. Inefficiencies in building designs and outdated cooling and lighting systems further contribute to greenhouse gas (GHG) emissions.

- **Insufficient green spaces and urban heat island effect:** Gurugram's urban development has reduced its natural green cover. This not only limits the city's ability to combat pollution through natural filtration but also exacerbates the urban heat island effect, where built-up areas become significantly hotter than their rural surroundings, leading to increased energy demand for cooling and a rise in air pollutants.

Industrial Sector

- **Industrial emissions:** Industries in Gurugram, especially those involved in manufacturing, construction materials, and chemical production, are significant sources of air pollution. Many factories lack advanced pollution control equipment, and older technologies continue to emit high levels of particulate matter, NO_x, and sulphur compounds into the air.

- **Inefficient energy use and fossil fuel dependency:** Many industries in Gurugram are still reliant on fossil fuels like coal, diesel, and natural gas for power generation. The use of outdated energy systems leads to higher carbon emissions, contributing to climate change and deteriorating local air quality.

- **Lack of waste management systems:** A significant amount of industrial waste is not properly treated or disposed of, leading to additional air pollution from open burning of waste or the release of toxic fumes from landfills and waste dumps. Many industries do not have sufficient waste management infrastructure in place, resulting in further environmental degradation.

- **High transportation emissions:** Industries often rely on trucks and other heavy vehicles for the transport of goods, which contribute heavily to road congestion and air pollution. The emissions from these vehicles, especially from old and poorly maintained fleets, exacerbate the city's pollution levels.

Agriculture Sector

- **Stubble burning in neighbouring districts:** Crop residue burning in adjoining areas significantly contributes to $PM_{2.5}$ levels in Gurugram during the harvest season. Despite government bans, enforcement remains inconsistent, and farmers often resort to burning due to the lack of affordable alternatives.

- **Emissions from fertilizers:** The excessive use of nitrogen-based fertilizers in nearby districts leads to the release of ammonia (NH_3), worsening particulate pollution and contributing to smog formation in Gurugram.

- **Limited adoption of sustainable practices:** Low adoption rates of mechanized stubble removal technologies and bio-decomposers are barriers to reducing agricultural emissions. Farmers cite high costs and lack of awareness as key issues.

3. The Process of Developing the MSAP

UNDP, in its Investment Case (United Nations Development Programme, 2024), highlights the severe health and economic consequences of air pollution in these cities, primarily driven by PM2.5 exposure. This pollutant is linked to six major diseases, including stroke, IHD, COPD, lung cancer, type 2 diabetes, and ALRI. The report estimates that adherence to NAAQS and WHO's 2021 Air Quality Guidelines could prevent thousands of deaths and disease cases annually. To address these challenges, the report evaluates nine targeted interventions spanning transportation, industry, agriculture, and urban infrastructure, demonstrating their cost-effectiveness in delivering substantial health and economic benefits. Recommendations of the report include transitioning industries to cleaner fuels, enforcing stricter emission controls, and promoting electric and public transportation to reduce vehicular pollution. Urban infrastructure improvements, such as mechanized road cleaning, the development of greenbelts, and arterial road paving, are essential to curb dust emissions. In agriculture, integrated residue management is vital to eliminate stubble burning. Additionally, institutional reforms, such as enhancing air quality monitoring systems, building stakeholder capacity, and ensuring inter-departmental coordination, are critical for effective implementation. The findings also underscore the need for a comprehensive, multi-sectoral action plan to effectively tackle air pollution.

UNDP in its Legal Environment Assessment for Air Pollution and Health for India (United Nations Development Programme, 2025), highlights the urgent need to reform the country's air quality management framework. Despite robust regulatory structures like the Air Act, 1981, and programs like NCAP 2019, significant gaps persist due to outdated legislation, weak enforcement, insufficient public participation, and inadequate monitoring infrastructure. Key findings include the necessity to modernize the Air Act with civil penalties, strengthen air quality standards and their implementation, and adopt region-specific, multi-sectoral approaches. The report advocates integrating international best practices, enhancing inter-agency collaboration, promoting public engagement, and prioritizing sustainable solutions to mitigate public health risks and economic losses caused by air pollution.

By addressing them through a multi-sectoral approach, the proposed interventions from the investment case and legal environment assessment can collectively improve public health, reduce economic losses, and support sustainable urban growth in Gurugram. Collaboration among stakeholders is vital for the success of this integrated approach. Government agencies, private enterprises, community organizations, and citizens must work together to design, implement, and monitor air quality initiatives. Policy coherence, technological innovation, and active public participation are key pillars.

The development of the Multi-Sectoral Action Plan (MSAP) for air pollution mitigation in Gurugram began with an in-depth review of various reports and air quality data, particularly from the Continuous Ambient Air Quality Monitoring Stations (CAAQMS) (Central Pollution Control Board, 2024). This review was essential in understanding pollutant levels, trends, and sources, focusing on key pollutants such as $PM_{2.5}$, PM_{10}, SO_2, and NO_x. These pollutants were identified as primary contributors to the city's air pollution. Additionally, the Air Quality Index (AQI) was analysed to gauge the overall air quality and its potential health impacts, laying the foundation for the MSAP.

Simultaneously, an extensive study was conducted to evaluate the coordination mechanisms between various agencies involved in air quality management. The goal was to understand the flow of information, roles, and responsibilities of each entity in tackling air pollution. To understand the role and responsibilities of each stakeholder in the current policy framework an extensive study of mandates and powers of key stakeholders was conducted, the study included the stakeholders namely Gurugram Metropolitan Development Authority (GMDA), Municipal Corporation Gurugram (MCG), Haryana State Pollution Control

Board (HSPCB), the Agriculture Department, State Transport Department, and the Gurugram Metropolitan City Bus Limited (GMCBL), were identified as crucial players. The examination of their mandates, regulatory frameworks, and areas of jurisdiction revealed the importance of clearly defined responsibilities to prevent overlap and ensure effective coordination. These key stakeholders serve as the foundation for Air Pollution Control and Mitigation efforts in the city, playing a crucial role in policy implementation, monitoring, and sustainable interventions. Currently, significant initiatives for air quality improvement in the city are being carried out under the National Clean Air Programme (NCAP) (Ministry of Environment, Forest and Climate Change, 2019).

Next, stakeholder consultations were held to understand the current actions and challenges faced by each department for air pollution mitigation and control. The stakeholders were engaged in discussions to assess critical gaps in the existing processes related to air pollution control. Key areas of focus included the utilization of funds allocated under the NCAP, clarity on the responsible authorities, and the interpretation of powers across multiple agencies with shared jurisdiction. Additionally, the consultations examined the enforcement mechanisms in place, including penalization frameworks, compliance monitoring, and regulatory efficiency. Another crucial aspect reviewed was the financial flow, ensuring transparency and accountability in the allocation and disbursement of resources for air quality improvement initiatives. The insights gathered from these consultations proved instrumental in shaping the MSAP. For example, the MCG's role in dust control, waste burning prevention, and enforcing construction regulations was highlighted by stakeholders, with a focus on collaboration with bodies like CAQM and GMDA. The GMDA's efforts in managing urban infrastructure, deploying air quality sensors, and overseeing green space management emerged as an important area during the consultations. The Agriculture Department's role in addressing stubble burning through satellite monitoring and enforcement of penalties, along with promoting sustainable agricultural practices, was considered as a critical component. Furthermore, the State Transport Department and GMCBL's initiatives to transition to electric buses and reduce vehicular emissions were seen integral, alongside the Industries Department's focus on regulating industrial emissions and promoting cleaner technologies. These stakeholders were engaged to gather insights and recommendations on key parameters essential for developing the plan. Discussions focused on identifying effective strategies tailored to address the specific challenges faced by each department and governing body. Their inputs helped outline priority areas, ensuring that proposed measures align with the current regulatory framework, operational constraints, and practical implementation feasibility. This collaborative approach aims to create a well-informed, actionable, and sustainable roadmap for addressing air pollution and improving overall environmental governance.

A significant insight that emerged from the consultations was the need for a centralized entity and body to coordinate and oversee air pollution management at the state level. Such an entity would serve as the focal point for tracking, controlling, and guiding air quality initiatives across various sectors. This centralized body would have the jurisdiction and authority to spearhead the multi-sectoral action plan, ensuring seamless coordination, data integration, and resource optimization. By creating a unified approach, this entity would enable all involved stakeholders to align their efforts and work collectively towards a shared goal of improved air quality. This entity can work as an apex body to coordinate all the workings and plans. This suggestion emerged from the stakeholder consultation and the notion was supported by other stakeholders also.

The formulation of the MSAP was done by a combination of data analysis, stakeholder inputs, and international case studies of successful air pollution management models (details given in Annexure 1). The plan includes both immediate and long-term strategies to reduce pollutants like $PM_{2.5}$, PM_{10}, SO_2, and

NO_x. Proposed actions include stricter vehicular emission standards, the adoption of cleaner industrial technologies, and the promotion of cleaner fuels. Additionally, measures to control pollution from dust and construction activities, which contribute significantly to $PM_{2.5}$ and PM_{10} levels, are also a key part of the plan. The expansion of air quality monitoring infrastructure and enhanced public awareness through the AQI are vital components, enabling citizens to stay informed and make decisions based on real-time air quality data.

The MSAP also emphasizes community engagement through public awareness campaigns and digital platforms that provide live air quality updates. These strategies aim to prioritize high-risk areas and guide targeted interventions, such as expanding green spaces and promoting electric vehicles (EVs) to mitigate the harmful effects of pollution. By combining data-driven insights, stakeholder collaboration, and evidence-based actions, the MSAP seeks to create a sustainable and adaptive air quality management strategy that not only addresses current pollution levels but also ensures continuous improvement, contributing to a healthier and more sustainable environment in Gurugram.

The MSAP will be primarily funded under the National Clean Air Programme (NCAP) and implemented under its framework. However, for Gurgaon to benefit from NCAP funding and initiatives, it must first be included in the list of non-attainment cities. This list, established in 2019, initially excluded Gurgaon due to the absence of baseline air pollution data at that time. Given the current environmental challenges, it is imperative to expedite the process of enlisting Gurgaon in the NCAP non-attainment cities list to facilitate targeted interventions and funding.

Furthermore, beyond NCAP, several initiatives outlined in the action plan can be supported through various other government schemes and programs. The details of these alternative funding opportunities are provided in the corresponding table, ensuring a multi-faceted approach to addressing air quality concerns in Gurgaon.

4. The Multi-Sectoral Action Plan for Air Pollution Mitigation in Gurugram

The MSAP outlines activities focused on reducing air pollution and particulate matter across different sectors. The below tables provide information on activity, target, baseline, stakeholders across sectors, timeline for implementation, and required budget. The tentative total budget to implement the activities of the proposed plan is estimated to be INR 484 Crores (US$ 56.8 million)

Table 2: Proposed Activities under Multi Sector Action Plan

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
1	Electric Vehicle Promotion	Achieve 10% of total registered vehicles as EVs by 2026 and 30% by 2030.	In 2024, EVs account for only 5.8% of total vehicle registrations in Gurugram.	Haryana Transport Department	EV Manufacturers, Municipal Corporation of Gurugram (MCG), Private Sector	2026-2030	₹ 200 to 300 Crores (₹ 10,000/kWh of battery with cap of maximum ₹4,00,000 per vehicle).	Ministry of Heavy Industries (MHI) to provide subsidies under FAME-II and PM E-Drive schemes.
2	EV Charging Infrastructure Expansion	Install 500 EV charging stations, including at least 100 of 22.5 kW capacity.	Gurugram has only 250 public EV charging points, mostly located in malls and IT parks (International Council on Clean Transportation, 2024)	Municipal Corporation of Gurugram (MCG)	Private Partners, Charge Point Operators	By 2028	₹ 50 to 75 Crores (10-15 lakh per charging station	Ministry of Power to support power distribution agreements and grid upgrades.
3	Zero-emission vehicle (ZEV) sales mandate	Implement a 15-20% ZEV sales target.	No existing ZEV sales mandate, a baseline assessment is required for scenario analysis and yearly target ramp ups.	Ministry of Road Transport and Highways (MoRTH)	Haryana Transport Department, Automotive Manufacturers	6-8 years post baseline analysis	Not applicable	MoRTH to introduce ZEV mandates aligned with international best practices.
4	Electrification of Public Transport	Convert 50% of public bus fleet to electric.	Gurugram Metropolitan City Bus Limited (GMCBL) operates 200 diesel buses, with only 25 electric buses as of 2024 ((The Economic Times, 2024)	Gurugram Metropolitan City Bus Limited (GMCBL)	Haryana Transport Department, Private Sector	By 2028	Approximately ₹ 100 Crores (₹ 1 to 2 Crores per Bus)	MHI to allocate subsidies for EV buses under central schemes.
5	Vehicle Scrappage Policy Implementation	Phase out all polluting vehicles per national scrapping policy.	Approximately 20% of vehicles on Gurugram's roads are over 15 years old, contributing disproportionately to emissions ((The Real Urban Emissions Initiative, 2024)	Haryana Transport Department	RTOs, Vehicle Owners, Private Scrappage Facilities	By 2026	No budgetary allotment required. All scrapping facility will be third party as mentioned in the national scrapping policy and notification GSR 653(E) and 212(E).	MoRTH to oversee scrappage enforcement and incentivize compliance.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
6	Intelligent Traffic Management Systems (ITMS)	Deploy ITMS at 100 intersections to reduce emissions.	Only 15 intersections in Gurugram have functional ITMS systems, limited to central business areas ((Hhindustan Times, 2024)	Gurugram Traffic Police	Gurugram Metropolitan Development Authority (GMDA), MCG	By 2026	₹ 15 to 20 Lakhs per Station	Ministry of Home Affairs to support urban transport digitalization.
7	Automatic Number Plate Recognition (ANPR) in LEZs	Implement ANPR in Low-Emission Zones (LEZs).	No ANPR systems currently in use for LEZ enforcement in Gurugram.	Gurugram Traffic Police	Haryana State Pollution Control Board (HSPCB)	By 2028	₹ 0.75 to 5 Lakhs per ANPR system depending upon the capacity	MoHUA to integrate LEZ policies within Smart Cities Mission.
8	Develop cycling and pedestrian infrastructure	Construct 200 km of cycling tracks and pedestrian walkways	Less than 20 km of cycling tracks, mostly fragmented and poorly maintained pedestrian track.	GMDA, MCG	Urban Planning Departments,	By 2027	₹ 8 Cr for 200 kilometres	N/A
9	Public Bicycle Sharing Programs	Establish public bicycle-sharing schemes in high-density areas and LEZs	No active bicycle-sharing program in Gurugram as of 2024; pilot programs were discontinued	GMDA	Private Bicycle-Sharing Companies	By 2025	No Cost implication	Ministry of Urban Affairs to offer guidelines for successful public-private partnerships.
10	Expansion of Metro Network	Develop at least two new metro routes connecting congested parts of the City. (Ex: Bhondsi village to Gurugram railway station and Golf Course Extension Road to Sector 5).	Current metro network covers 29.7 km; extensions required to reach underserved areas. HMRT has approved two new metro routs of 30 km. ((The Times of India, 2019)	Haryana Mass Rapid Transport Corporation Limited (HMRTC)	Gurugram Metropolitan Development Authority (GMDA), Gurugram Metro Rail Limited, private contractors	Approval and Project Inception by 2030	As per the state budget approved for this activity	Ministry of Housing and Urban Affairs (MoHUA) to initiate the process.
11	Subsidy for Diesel Generator Replacement	Provide incentives for BESS or solar-based power solutions. (CAQM banned the use of large diesel generators in Delhi-NCR starting October 1, 2023)	Baseline study and cost analysis is required for replacement and sizing of DGs.	Haryana State Renewable Energy Development Agency (HAREDA)	Private Sector, State Government	Till 2030	Estimation needs to be done on the basis of baseline study and government approvals.	Ministry of New and Renewable Energy (MNRE) to fund subsidy programs.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
12	Rooftop Solar Expansion	Install an additional 100 MW of rooftop solar capacity.	As per Centre for Science and Environment Report of 2018, the Gurugram district has installed a total of 24 MW solar rooftop systems. (Centre for Science and Environment, 2018)	Haryana Renewable Energy Development Agency (HAREDA)	State Power Distribution Company, Private Developers	By 2028	No additional funding required as Chief Minister in Jan 2025 approved a project worth Rs 36 crore to install rooftop solar power plants on 290 government buildings in Haryana.	Ministry of Power and MNRE to support solar adoption through national schemes.
13	Energy Efficiency in Buildings	Ensure 100% compliance with ECBC for new buildings from 2026; retrofit 30% of existing buildings by 2030.	There are 265 certified green buildings (GBCI, IGBC & GRIHA) in the state. About 52% of the buildings are ECBC compliant out of the buildings approved in the reporting period for construction. (Ministry of Power, 2022)	Municipal Corporation of Gurugram (MCG)	Ministry of Housing and Urban Affairs (MoHUA), Private Developers	By 2030	Case-by-case retrofitting cost	Bureau of Energy Efficiency (BEE) to support compliance enforcement.
14	Solarization of Public Buildings	100% solar rooftop installation on government buildings.	Under the PM Surya Ghar Yojana, the Haryana Renewable Energy Development Agency (HREDA) will install rooftop solar power plants in all government buildings across Gurugram, aiming to bolster clean energy adoption was announced. (Economic Times, 2024)	Haryana Renewable Energy Development Agency (HAREDA)	State Government, MCG	By 2030	Already under state budget	Ministry of New and Renewable Energy (MNRE) to provide implementation guidelines.
15	Smart Metering and Demand-Side Management	Install smart meters in all commercial and residential buildings.	Smart meters are installed in only 25% of buildings	Haryana State Distribution Company	Private Sector, Residents' Associations	By 2027	Cost to be determined by State Power Distribution Company	Ministry of Power to issue smart metering mandates and financial support.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
16	Monitoring Pollution-Health Impact	Develop Sentinel surveillance and real-time surveillance system for respiratory and cardio-vascular illnesses, hospital admission as well as Enhance vaccination programs for respiratory disease.	Limited tracking of pollution-related health impacts	Gurugram Health Department (GHD)	Indian Council of Medical Research (ICMR), GMDA	By 2026	Not applicable (Activities covered under Haryana SAPCCHH)	MoHFW to mandate real-time health impact assessments in polluted zones.
17	Public Awareness on Health and Pollution	Reach 80% of Gurugram's population with awareness campaigns.	Most of the people is n ot aware of pollution-health links, with limited use of preventive measures like masks and purifiers.	Gurugram Health Department (GHD)	HPCB, NGOs, Local Media	By 2027	No separate budget required, achieved through existing health funding under Haryana SAPCCHH	Ministry of Environment, Forest and Climate Change (MoEFCC) to support nationwide health-pollution awareness programs.
18	Strengthening Healthcare Infrastructure for Pollution-Related Diseases and knowledge about air pollution related health conditions	Train primary healthcare workers to manage pollution-aggravated conditions. Ensure adequate logistic support, including equipment's and other treatment modalities and supplies for case management	Specific pollution-related healthcare infrastructure and training is not provided.	Gurugram Health Department	GMDA, MCG, Private Hospitals	By 2026	No separate budget required, as the activity is covered under State action plan for Climate change and Human Health	N/A
19	Introduction of Low-Emission Zones (LEZs)	Establish LEZs in 5 hotspots.	As of 2024, Gurugram has no LEZs. Baseline study and scenario analysis are required.	GMDA	HSPCB, MoEFCC, Local Authorities	2-3 years post-baseline analysis	Implementation budget from the state to be allocated.	MoEFCC to assist in policy formulation and air quality monitoring.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
20	Mandatory Dust Control Measures in Construction	Mandatory application of dust control screens and green construction methodology and heavy penalization for violators.	Only applicable under the Graded Response Action Plan (GRAP) enforcement.	GMDA	HSPCB, Real Estate Developers, Private Sector	Immediate enforcement	No budgetary allocation required	MoEFCC to integrate dust control into national construction guidelines.
21	Increase Urban Green Spaces	20-30% increase in urban green space and façade greening with climate resilient fauna.	No mandatory implementation, only ECBC notification exists	GMDA	MCG, Haryana Forest Department, Civil Society Organizations	Immediate enforcement	Budget assessment required from the state exchequer	MoHUA to provide funding and integration under Smart Cities Mission.
22	Deployment of Mobile Pollution Monitoring Devices	Deploy 20 to 30 mobile pollution monitoring systems to complement the CAAQMS stationary data for active data management and accuracy and better hotspot identification.	No provision currently exists	GMDA	HSPCB, Private Technology Firms	Immediate implementation	₹ 20-40 Lakhs	CPCB to facilitate real-time air quality data integration into urban planning.
23	Promote Adoption of Cleaner Production Technologies	Ensure 80% of industries adopt advanced pollution control equipment.	In 2023, 60% of industries in Gurugram used outdated pollution control technology, contributing to excessive PM and NOx emissions. (Haryana State Pollution Control Board, 2023)	Haryana State Pollution Control Board (HSPCB)	Ministry of Heavy Industries, Industrial Associations, Private Sector	By 2028	Not applicable as only enforcement	MoEFCC to enforce national pollution control standards and incentivize clean technology adoption.
24	Transition Industries to Renewable Energy Sources	40% of industrial energy consumption to be from renewable sources.	Fossil fuels (coal, diesel, natural gas) account for 80% of industrial energy use. (Global Edge, 2024)	Bureau of Energy Efficiency (BEE)	Ministry of New and Renewable Energy (MNRE), Private Energy Providers	By 2030	Not applicable as only enforcement	MNRE to provide subsidies for industrial renewable energy adoption.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
25	Encourage Energy Efficiency Through Audits and Upgrades	Conduct energy audits in all industrial units and implement efficiency measures to achieve a 20% reduction in energy use.	Energy audits are conducted in only 15% of industries in Gurugram as of 2023, with minimal adoption of efficiency measures.	Bureau of Energy Efficiency (BEE)	Private Sector, Industrial Associations	By 2028	Not applicable as only enforcement, audits are already under the purview of Bureau of Energy Efficiency and State Nodal Agencies.	BEE to implement mandatory industrial energy audits and provide efficiency incentives.
26	Establish Public-Private Partnerships for Pollution Control	Create PPPs to fund and operate at least 10 large-scale renewable energy or waste-to-energy projects.	Gurugram lacks structured PPP frameworks	MoEFCC	HSPCB, Private Sector Investors, Local Authorities	Start by 2028	Case-by-case basis depending on project DPRs	MoEFCC to create policy frameworks and financial incentives for PPP projects.
27	Implement Stricter Enforcement for Industrial Pollution	Limit emissions of particulate matter, volatile organic compounds (VOCs), and nitrogen oxides (NOx) by 30%.	PM levels continuously exceed the permissible limit during peak industrial activity. Penalization is not severe, and political interventions hinder justice and effective penalties.	Gurugram Metropolitan Development Authority (GMDA)	HSPCB, Municipal Corporation of Gurugram (MCG), Industrial Associations	Immediate	Not applicable as only enforcement	MoEFCC to strengthen penalties and ensure stricter industrial compliance.
28	Promote Alternatives to Stubble Burning	Achieve a 75% reduction in stubble burning incidents in neighbouring districts.	In 2023, Haryana contributed to 40% of the PM2.5 from crop burning during harvest. Neighbouring districts like Jhajjar reported over 300 cases annually	Haryana Agriculture Department	Local Farmers, MoEFCC, NGOs, Local Government Bodies	By 2027	Not applicable as only enforcement	MoEFCC to enforce bans on stubble burning and promote alternatives.
29	Reduce Fertilizer-Driven Emissions	Decrease NH3 emissions from fertilizer use by 30% in adjacent agricultural zones.	Fertilizer-driven ammonia emissions contributed to 15% of the region's air pollution mix. Excessive nitrogen use recorded in Jhajjar and Rewari	Haryana Agriculture Department	ICAR, Local Farmer Cooperatives, Private Sector	By 2030	Not applicable as only enforcement	Ministry of Agriculture to promote balanced fertilizer usage and bio-fertilizers.

S. No.	Activity	Target	Baseline	Lead Stakeholder	Other Stakeholders	Timeline	Budget	Ministerial Action
30	Distribute Residue Management Equipment	Set up 100 machinery distribution centres and provide subsidized Happy Seeders.	As of 2023, only 18 machinery distribution points existed in Haryana, covering less than 30% of the farming population in Jhajjar and Rewari.	Haryana State Agriculture Department	MoAFW, Private Vendors, Farmer Cooperatives	By 2026	No separate budget required, covered under “Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue” scheme.	MoAFW to subsidize agricultural equipment for residue management.
31	Integrate Agricultural Data into Air Quality Monitoring	Use real-time agricultural emissions data to improve air quality management by setting up low-cost mobile monitoring devices at strategic locations.	Gurugram’s air quality monitoring system does not include emissions data from agricultural zones as of 2023.	GMDA	HSPCB, Local Farmers, Technology Firms	Immediate	Approximately 20,000 per monitoring device (2,00,000 for 10 devices)	MoEFCC to support air quality data integration with agricultural emissions.
32	Farmer Training on Precision Agriculture	Train 50,000 farmers in adjacent districts on precision agriculture via National Skill Training Institute.	Precision farming methods had a penetration rate below 10% in Haryana as of 2023, with limited adoption of technology like drones	ICAR	Haryana Agriculture Department, Local Training Institutes, Farmer Organizations	By 2027	Covered under the scope of National Skill Development Fund	Ministry of Agriculture to implement large-scale precision agriculture training.
33	Launch Financial Incentives for Eco-Friendly Practices	Provide financial assistance for crop diversification and organic farming to 40% of farmers.	In 2023, less than 15% of farmers practiced crop diversification, citing market and financial barriers.	Haryana State Government	Banks, Financial Institutions, MoEFCC, Private Agri-Tech Firms	2026-2027	Cost discovery needed for incentive design	Ministry of Agriculture to allocate funds for sustainable agriculture programs.

5. Monitoring and Evaluation of the MSAP Implementation

Effective implementation of the MSAP requires a robust monitoring and evaluation framework which ensures accountability, measures progress, and guides decision-making by providing actionable insights into the effectiveness of implemented interventions. It aims to track progress against predefined targets, ensure transparency among stakeholders, enable course correction through evidence-based adjustments, and foster collaboration through shared data and performance insights. The framework aligns with national and international standards, such as the National Clean Air Programme (NCAP) and Sustainable Development Goals (SDGs), making it a cornerstone for achieving sustainable urban development in Gurugram.

5.1 Components of the Monitoring Framework

To ensure effective oversight and accountability, the monitoring and reporting mechanisms are designed to provide real-time insights and structured feedback loops:

- **Real-time monitoring systems**: Continuous Ambient Air Quality Monitoring Systems (CAAQMS) track pollutants like $PM_{2.5}$, PM_{10}, NO_x, and SO_2, offering instant data on air quality levels.
- **Mobile monitoring units**: Deploy mobile units to identify and analyse pollution hotspots across the city, ensuring localized insights.
- **Health surveillance**: Hospitals and clinics provide regular updates on pollution-related health trends, aiding in the assessment of public health impacts.
- **Citizen reporting tools:** Digital platforms enable residents to report violations such as illegal waste burning or excessive emissions, fostering community involvement.
- **Monthly progress reports**: Implementing agencies submit updates on sectoral activities, highlighting achievements and challenges.
- **Quarterly cross-sectoral reviews**: Led by the Gurugram Metropolitan Development Authority (GMDA), these reviews assess progress and inter-agency coordination.
- **Annual impact assessments**: Comprehensive evaluations of the MSAP's outcomes are published for transparency and stakeholder engagement.

5.2 Evaluation Matrix Framework and Markers

The Evaluation Matrix categorizes indicators by sector and measures progress based on predefined benchmarks. It includes the following components:

- **Input Indicators:** Resources allocated (e.g., budget for EV subsidies, number of solar panels installed).
- **Process Indicators:** Actions taken (e.g., policies implemented, awareness campaigns conducted).
- **Outcome Indicators**: Immediate effects (e.g., reduction in PM2.5 levels, increase in green spaces).
- **Impact Indicators:** Long-term changes (e.g., improved health outcomes, enhanced quality of life).

The evaluation markers are measuring points for effectively measure the potency of the action plan. The markers are listed below:

- **Reduction in PM2.5 and PM10 levels**: Annual average concentrations of $PM_{2.5}$ and PM_{10} will be measured and compared against baseline values to track progress toward achieving national air quality standards. Seasonal variations and trends in pollution hotspots will be analysed to identify areas requiring targeted interventions. This metric ensures that mitigation efforts lead to tangible improvements in air quality over time.
- **Decrease in the number of air quality "severe" days**: The frequency of "severe" air quality index (AQI) days will be monitored throughout the year to assess the effectiveness of implemented measures. A year-on-year reduction in such days will serve as a key indicator of success. Additionally, efforts will be made to correlate these improvements with specific interventions, such as stricter emission controls or enhanced public awareness campaigns, ensuring a comprehensive understanding of impact.
- **Increased compliance rates among polluting industries**: Compliance with emission norms by polluting industries will be tracked through regular inspections and mandatory self-reporting mechanisms. Reports will be analysed to identify patterns and areas of non-compliance, with penalties enforced where necessary. Simultaneously, incentive programs will be introduced to encourage industries to adopt cleaner technologies, ensuring sustained reductions in emissions and better overall compliance.
- **Periodic Reviews:** Quarterly reviews will be conducted to evaluate progress on key performance indicators (KPIs) and recalibrate strategies as needed. These assessments will involve all relevant stakeholders, including policymakers, industrial representatives, and community groups, to ensure transparency and inclusivity. The findings from these reviews will guide the refinement of action plans, addressing any gaps and adapting to evolving challenges.

- **Vehicular Pollution**: Regular inspections and enforcement of vehicular emission standards will be prioritized to reduce transportation-related pollution. Efforts will include ensuring adherence to Pollution Under Control (PUC) certifications, phasing out old and non-compliant vehicles, and promoting the use of cleaner fuels and electric vehicles. Public awareness campaigns will emphasize the importance of vehicle maintenance and responsible commuting habits. Additionally, data on vehicular emissions will be collected and analysed to identify high-impact areas, enabling targeted measures such as stricter enforcement zones and traffic management solutions.

5.3 Adaptive Management and Tools

To address unforeseen challenges and optimize interventions, the framework integrates advanced tools and an adaptive approach to ensure sustained progress.

- **Data-Driven Decisions:** Leverage AI and predictive analytics for real-time adjustments.
- **Stakeholder Feedback:** Conduct regular consultations with citizens and stakeholders.
- **Scenario Planning:** Develop alternative strategies based on monitoring results.
- **Geospatial Analytics:** Map pollution hotspots and monitor land-use changes.
- **AI-Powered Dashboards**: Integrate data from CAAQMS, health records, and citizen reports.
- **IoT Sensors:** Enhance data collection at micro-levels for localized insights.

By fostering accountability, transparency, and adaptability, this framework ensures the sustained impact of interventions and supports Gurugram's transition to a healthier and more sustainable urban environment.

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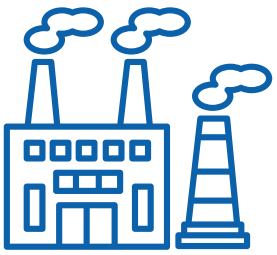
Annexure 1: International Case Studies on Addressing Air Pollution

Air Pollution Reductions in the New York/New Jersey Harbor Deepening Project



The EPA's case study highlights significant air pollution reductions achieved during the 20-year New York/New Jersey Harbor Deepening Project, completed in 2016. This project aimed to deepen navigation channels to accommodate larger vessels, boosting regional economic activity while incorporating advanced environmental safeguards.

In collaboration with the Port Authority of New York and New Jersey and the U.S. Army Corps of Engineers, contractors adopted cleaner technologies. These included Tier 2 and Tier 3 compliant engines, retrofitted equipment, and the use of cleaner fuels. These efforts led to substantial emissions reductions, including a 44% drop in nitrogen oxides and significant decreases in particulate matter.

EPA releases case study on air pollution reductions from New York/New Jersey Harbor Deepening Project, 2021

Fresh Air for Progress: Lessons from Beijing-Tianjin

The Beijing-Tianjin-Hebei (BTH) region, a hub of industrial activity and urbanization in China, has long faced severe air pollution challenges. To address this, the region implemented a comprehensive set of air-cleaning policies aimed at reducing pollution from key sources, including industries, vehicles, and residential energy use.

The policies emphasized stricter industrial emission standards, promoted the adoption of clean energy vehicles, and phased out coal burning in residential areas. Additionally, coordinated efforts across the region ensured uniform policy enforcement and facilitated collaborative governance. These measures were supported by enhanced monitoring systems to track progress and compliance.

The results of these efforts were significant, with marked improvements in air quality. Concentrations of particulate matter (PM2.5) and other harmful pollutants declined, benefiting public health and the environment.

Integrated assessment of cleaning air policy in China: A case study for Beijing-Tianjin-Hebei region. Journal of Cleaner Production.

New Jersey's Clean Air Journey: A Case Study of Pollution Reduction

From the 1950s to 2010, New Jersey faced severe air pollution due to rapid industrialization and increasing vehicle emissions. The state's poor air quality, which posed serious health risks, prompted a shift toward environmental action.

In the 1970s, New Jersey began enforcing stricter air quality regulations, including the Clean Air Act. These measures targeted industrial emissions, vehicle exhaust, and coal use. Over the years, the state adopted cleaner technologies and promoted the use of low-emission vehicles, significantly reducing pollutants like sulfur dioxide, nitrogen oxides, and particulate matter. By 2010, New Jersey saw dramatic improvements in air quality, contributing to better public health outcomes.

New Jersey: A case study of the reduction in urban and suburban air pollution from the 1950s to 2010

Bogotá's Green Revolution: A Story of Air Quality Improvement

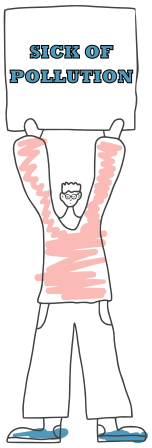
In the 1990s, Bogotá, Colombia, struggled with severe air pollution from increasing vehicle emissions and industrial activity. The city's air quality was worsening, with significant impacts on public health. One of the first major steps was the "Pico y Placa" program in 1998, which restricted vehicles from driving during peak hours based on their license plates. This helped reduce traffic congestion and air pollution. Simultaneously, the city introduced the TransMilenio Bus Rapid Transit (BRT) system in 2000, which offered a fast, efficient, and eco- friendly alternative to private cars.

Bogotá also focused on green urban planning, planting more trees and creating green spaces to absorb pollutants. These efforts combined to significantly reduce air pollution and improve public health outcomes in the city.

Case studies in improving air quality. Climate and Clean Air Coalition

Nature-Based Solutions: Plovdiv's Green Strategy to Tackle Air Pollution

In Plovdiv, Bulgaria, a city struggling with significant air pollution, nature-based solutions have been at the heart of efforts to improve air quality and public health. Rather than relying solely on technological fixes, Plovdiv's strategy incorporates trees, herbs, mosses, and lichens to help mitigate the impact of harmful air pollutants.

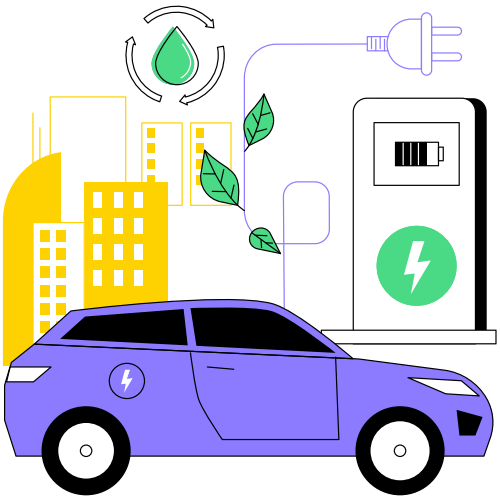


The city began by strategically planting trees in urban areas, recognizing the ability of trees to absorb pollutants, particularly particulate matter (PM), nitrogen oxides, and carbon dioxide. In addition to trees, the use of herbs, mosses, and lichens has been explored as a complementary approach. These plants are known for their high capacity to trap airborne pollutants, contributing to cleaner air in local neighborhoods. Research in Plovdiv has shown that certain species, such as mosses and lichens, are particularly effective in absorbing pollutants from the surrounding air.

This approach not only reduces pollution but also enhances the urban environment, providing green spaces that promote better mental and physical well-being. Additionally, the initiative helps reduce the urban heat island effect, improving overall climate resilience.

Nature-based solutions to reduce air pollution: A case study from Plovdiv, Bulgaria, using trees, herbs, mosses, and lichens, 2023

California Zero-Emission Vehicle Mandate: Pioneering Clean Transportation



The California Zero-Emission Vehicle (ZEV) Mandate, established by the California Air Resources Board (CARB) in 1990, is a groundbreaking policy aimed at reducing greenhouse gas emissions and fostering clean transportation. It requires automakers to produce a specific percentage of zero-emission vehicles, such as battery-electric, hydrogen fuel cell, and plug-in hybrid cars, for sale in California. The mandate operates on a credit-based system where manufacturers earn credits based on the type and number of ZEVS sold, ensuring compliance with annual targets.

This policy has been pivotal in driving innovation and investment in clean vehicle technology, making California a leader in the adoption of sustainable transportation. The mandate has significantly impacted the market, with California now accounting for over 40% of electric vehicle (EV) sales in the United States. It has spurred the growth of EV infrastructure, including charging stations and hydrogen refueling networks. Additionally, 15 other states have adopted similar policies under Section 177 of the Clean Air Act, amplifying its influence nationwide. By setting ambitious standards and fostering collaboration between regulators and industry, the ZEV Mandate has laid the foundation for a cleaner, more sustainable transportation future while helping California meet its climate goals.

California Air Resources Board. (2019). Zero-Emission Vehicle regulation fact sheet

Annexure 2: Meeting Records with Various Stakeholders

Minutes of the Meeting with Municipal Corporation Gurugram (MCG)

18th November 2024, Venue: Online

Item	Details
Attendee	Sh. Mukesh Kumar, Chief Engineer, Horticulture Wing, Municipal Corporation Gurugram (MCG)
Meeting Agenda	To understand the coordination mechanism, roles, and responsibilities of the Municipal Corporation Gurugram (MCG) in the implementation and regulation of air pollution control policies.
About MCG	MCG was established in 2008 under the Haryana Municipal Corporation Act, 1994, to manage and oversee the responsibilities include maintaining roads, managing solid waste, ensuring water supply and drainage systems, developing parks, and regulating construction and urban planning. It plays a vital role in environmental sustainability and public health by implementing programs to improve air quality, green spaces, and waste management practices.

Meeting Highlights

The key points discussed during the meeting with the Municipal Corporation Gurugram (MCG) on November 18, 2024, are outlined below:

1. **Organizational Structure and Responsibilities of MCG:**

The MCG has three main operational wings that play distinct roles in managing air pollution:

- **Horticulture Wing**: Responsible for dust control measures, including the regular sprinkling of water along roads and the watering of roadside plants to minimize airborne particulates.
- **Action Headquarters**: Manages incidents related to smog, particularly focusing on mitigating pollution caused by open waste burning.
- **Sanitation Wing**: Monitors construction activities to ensure compliance with air quality standards. This includes supervising the transportation and storage of construction materials. These tasks are overseen by sanitary supervisors who work to enforce regulations effectively.

2. **Regulatory Oversight and Coordination**

- The National Green Tribunal (NGT) and the Supreme Court actively monitor air pollution control policies through the Commission for Air Quality Management (CAQM) in Delhi-NCR and Haryana State Pollution Control Board (HSPCB), they are instrumental in regulating and implementing air quality measures in Gurugram.
- The CAQM coordinates with both the MCG and the Gurugram Metropolitan Development Authority (GMDA) to maintain consistent and effective air quality management across the region.

3. **Implementation of Graded Response Action Plan (GRAP)**

- MCG is tasked with executing GRAP Stage IV measures when air pollution levels severely deteriorate. These measures include imposing bans on truck entry, prohibiting the use of chimneys, restricting the burning of wood, and halting construction activities. Such actions are critical to curbing pollution spikes in the Delhi-NCR area.

Meeting Highlights

4. **Administrative Structure and Monitoring**
   - The MCG's operations are divided into four zones, each managed by a commissioner with comprehensive regulatory and administrative authority. The Commissioner is supported by two Additional Commissioners and four Joint Commissioners, ensuring robust governance.
   - Chief Engineers oversee all technical operations, including quality assurance and adherence to specifications.

5. **Jurisdictional Division of Responsibilities**
   - Water supply and sewerage lines along main sector-dividing roads fall under the jurisdiction of GMDA, whereas the MCG manages internal sector roads and associated infrastructure. This delineation helps streamline responsibilities and enhance the efficiency of urban management efforts.

The meeting underscored the collaborative and multi-sectoral approach required to address air pollution in Gurugram, with MCG playing a pivotal role in the implementation of policies and mitigation measures.

Minutes of the Meeting with Haryana State Pollution Control Board (HSPCB)

19th November 2024, Venue: Vikas Sadan, Sector-11, Gurugram

Item	Details
Attendee	• Mr. Kamesh, Assistant Environmental Engineer (AEE), Air Cell, Gurugram North, Haryana State Pollution Control Board (HSPCB)
Meeting Agenda	• To understand the coordination mechanism, roles, and responsibilities of the Haryana State Pollution Control Board (HSPCB) in the implementation and regulation of air pollution control policies.
About HSPCB	• HSPCB established in 1974, enforces environmental laws in Haryana, focusing on pollution control under the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981. It regulates and monitors air and water quality, ensuring compliance by industries and promoting sustainable development.

Meeting Highlights

The key points discussed during the meeting with the Haryana State Pollution Control Board (HSPCB) on November 19, 2024, are outlined below:

1. **Policy Formation and Implementation**
   - Policies and programs related to air quality management in Haryana are developed under the direction of the Member Secretary of HSPCB.
   - The Commission for Air Quality Management (CAQM) and the Central Pollution Control Board (CPCB) issue directives and guidelines to HSPCB. These are communicated to regional air cells (North and South) via email and other official channels for district-wise implementation.

Meeting Highlights

2. Roles and Responsibilities of Regional Air Cells

- Regional air cells are tasked with disseminating guidelines to relevant departments within their districts.
- Air cells work in coordination with District Commissioners (DCs), municipal corporations (MCs), and local bodies to ensure compliance and effective implementation of air pollution control measures.
- Daily compliance monitoring is conducted by air cells, and reports are compiled and forwarded to HSPCB headquarters.

3. Guidelines Enforcement and Dust Control

- HSPCB regulates the implementation of the Graded Response Action Plan (GRAP) guidelines in Gurugram.
- Municipal Corporations receive directives from HSPCB to enforce dust control measures. This includes instructing builders and industries, registered on the Dust Control Portal, to adhere to construction regulations or halt activities contributing to air pollution.
- HSPCB conducts physical inspections, while municipal corporations manage activities like road dust suppression and mechanized street sweeping.

4. Monitoring and Reporting

- Daily monitoring of air pollution control measures is a primary responsibility of the air cells.
- Regional air cells also oversee GRAP committees and ensure adherence to the established guidelines.
- Local bodies are required to provide daily compliance reports to the air cells, which compile and forward the information to the central office.

5. Coordination with Other Agencies

- District-level monitoring of National Highways Authority of India (NHAI) construction activities is overseen by District Commissioners.
- The Central Pollution Control Board collects pollution data from HSPCB for national-level analysis and planning.

6. Transition of Sectoral Services

- The Haryana Shahari Vikas Pradhikaran (HSVP) allocates land to developers. After five years when 80 percent occupancy is achieved services such as road maintenance, water supply, sewerage, stormwater drainage, streetlights, and park maintenance are handed over to municipal corporations.
- With the establishment of the Gurugram Metropolitan Development Authority (GMDA), these sectoral services have now been transitioned from municipal corporations to GMDA.

Minutes of the Meeting with Gurugram Metropolitan Development Authority (GMDA)

21st November 2024, Venue: GMDA Office, Gurugram

Item	Details
Attendee	• Mr. Satyavir Singh, Metropolitan Green Planner, Gurugram Metropolitan Development Authority (GMDA)
Meeting Agenda	• To understand the coordination mechanism, roles, and responsibilities of the Gurugram Metropolitan Development Authority (GMDA) in the implementation and regulation of air pollution control policies.
About GMDA	• GMDA was established in 2017 to serve as the planning and development agency for the Gurugram metropolitan area. It aims to ensure sustainable urban development by integrating infrastructure planning, governance, and service delivery. GMDA is responsible for managing urban services such as mobility, water supply, sewage systems, and urban greenery.

Meeting Highlights

The key points discussed during the meeting with the Gurugram Metropolitan Development Authority (GMDA) on November 21, 2024, are outlined below:

1. **Air Quality Monitoring and Data Management**
   - GMDA deploys both low-cost and high-cost air quality sensors through outsourced research-based agencies.
   - These agencies also provide research-driven solutions for air pollution mitigation.
   - GMDA collects, stores, and monitors air quality data and reports it to the Haryana State Pollution Control Board (HSPCB).
2. **Jurisdictional Responsibilities**
   - GMDA is responsible for major infrastructure such as roads wider than 30 meters, green belts, leisure valleys, and major parks.
   - Internal roads and parks within sectors fall under the jurisdiction of the Municipal Corporation of Gurugram (MCG).
   - Key responsibilities of GMDA include:
     - Infrastructure development and maintenance (flyovers, roads, etc.)
     - Dust control on major roads.
     - Tree plantation and management of green belts
     - Rainwater harvesting and flood control.
     - Sewerage management
     - Air quality hotspot monitoring
3. **Coordination Mechanism**
   - Implementation of Graded Response Action Plan (GRAP) directives comes under the purview of the Deputy Commissioner (DC), who acts as the nodal authority.
   - There is no formal or established coordination framework between GMDA and MCG for air pollution management.

4. **Challenges and Limitations**
   - GMDA lacks a specialized department, or experts dedicated exclusively to air pollution monitoring and mitigation.
   - The roles related to air quality are distributed among personnel without specific qualifications in environmental science or air quality management.

Minutes of the Meeting with Gurugram Metropolitan City Bus Limited, Gurugram (GMCBL)

05th December 2025, Venue: Online

Item	Details
Attendee	• Mr. Rajiv Nagpal, Depot Manager, Gurugram Metropolitan City Bus Limited, Gurugram
Meeting Agenda	• To understand the coordination mechanism, roles, and responsibilities of the Gurugram Metropolitan City Bus Limited in the implementation and regulation of air pollution control policies.
About GMCBL	• GMCBL was incorporated under the provisions of the Companies Act, 2013 on 5th September 2017 as a Special Purpose Vehicle with the joint collaboration of GMDA (50 percent), MCG (40 percent) and Haryana State Industrial and Infrastructure Development Corporation Limited (HSIIDC) (10 percent) with the objective to set up, manage, operate a city bus transport system in Gurugram metropolitan area as declared under section 3 of Gurugram Metropolitan Development Authority Act, 2017.

Meeting Highlights

The key points discussed during the meeting with the Gurugram Metropolitan City Bus Limited on December 05, 2024, are outlined below:

1. **Transition to Electric Buses**
   - GMCBL has committed to replacing all operational CNG buses with electric buses by the end of 2025.
   - The transition aligns with state and national-level goals for reducing vehicular emissions and mitigating air pollution.
2. **Infrastructure Development**
   - Charging stations will be strategically installed at bus depots and designated locations across the city to ensure seamless operations.
3. **Coordination with Local Authorities**
   - GMCBL will coordinate with GMDA, MCG, and HSIIDC to ensure proper execution of the electric bus transition plan.
4. **Operational Challenges and Solutions**
   - **Challenges Identified:**
     - High initial capital costs for electric buses and infrastructure.
     - Potential disruptions during the transition phase.
     - Training of drivers and technical staff for electric bus operations.

Minutes of the Meeting with Agriculture Department

10th December 2025, Venue: Online

Item	Details
Attendee	• Mr. Anil Singh, Climate Data Scientist,
Meeting Agenda	• To understand the coordination mechanism, roles, and responsibilities of the agriculture sector in the implementation and regulation of air pollution control policies.

Meeting Highlights

The key points discussed during the meeting on December 10, 2024, are outlined below:

- Satellite imaging is used to monitor stubble-burning activities in real-time, with a resolution of 500 meters helping to pinpoint areas for enforcement. This data is shared with the police and other authorities for immediate action.
- Penalties and FIRs have been registered against offenders to deter stubble burning. However, challenges persist due to limited enforcement resources and economic pressures on farmers.
- Air pollution from stubble burning is largely a winter issue, with a critical 15–20-day period causing sharp spikes in pollution. The government often struggles with preparedness and lacks adequate infrastructure to address this short yet impactful window effectively.
- Companies are working on converting stubble waste into bio-fertilizers through chemical processes, offering a sustainable alternative. However, these solutions are not yet financially competitive for most farmers.
- Farmers currently find stubble burning more economically beneficial than selling the residue, highlighting the need for economic incentives or subsidies to make alternative methods attractive.
- The government has introduced funding programs for startups addressing stubble management and has established ethanol plants to use agricultural waste, aiming to create a profitable market for stubble-based products.
- Immediate deployment of manpower at the field level after harvest was suggested. This would involve collecting stubble directly from farms, reducing the need for farmers to manage waste themselves and significantly lowering the likelihood of burning.
- Effective inter-departmental coordination, enhanced communication with stakeholders, and community-level engagement were emphasized as critical to achieving success in stubble management and pollution control.
- Raising awareness among farmers about the environmental and health impacts of stubble burning, combined with training in sustainable practices, is essential for creating long-term behaviour change. A multi-faceted approach combining technological innovation, economic incentives, and grassroots action was seen as vital to reducing the air pollution caused by stubble burning in the region.

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