bharat CLIMATE FORUM

Council for International Economic Understanding | Dalberg

Aironomics 2025

Unlocking India's Blue Skies Economy

Date: May 31, 2025 | **Location:** ITC Maurya, New Delhi

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Governing cum organizing team

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Rajnish Kumar
Former Chairman, State Bank of India

Sanjeev Bikhchandani
Co-Founder, Info Edge

Vijay Shekhar Sharma
Founder and CEO, Paytm

Executive Summary

Air pollution in India is a persistent national crisis with major health and economic consequences. In 2019, ~1.7 million deaths and ~54 million disability-adjusted life years (DALYs) in India were attributable to air pollution. Economic losses due to air pollution stand at USD 95 billion annually, about 3% of GDP, driven by lower workforce productivity, lost working days, reduced consumer spending, and shrinking tourism revenues.

Air quality management presents a multi-billion-dollar economic opportunity, along with the potential to unlock co-benefits. Scalable solutions across transport, waste, industry, and energy can cut pollution, create jobs, and unlock new capital. India's EV market could reach USD 250 billion by 2030, generating 50 million jobs. Biogas and waste-to-value solutions could mobilize USD 20 billion in investments and divert thousands of tonnes of waste daily, while improving health outcomes and reducing emissions. Clean air action also unlocks co-benefits at the intersection of climate, air pollution, and biodiversity, with interventions like clean cookstoves collectively reducing carbon emissions, PM2.5 emissions, and fuelwood burned.

While solutions to improve air quality exist, progress is impeded by challenges in governance, financing, and behavior change. Interventions such as vehicle electrification, waste processing, clean cookstoves, and emission controls are already being implemented across sectors and regions. However, governance remains fragmented, with overlapping mandates and poor coordination between central, state, and local agencies. Financing is limited, with underutilized public funds and low private investment due to unclear returns and weak financial architecture. Public engagement is low, as air pollution is often viewed as inevitable.

In this context, Aironomics 2025 was organized to translate ambition into action by aligning stakeholders to disseminate empirical evidence and formulate coordinated strategies. Aironomics 2025 convened over 200 participants across 20 plenary sessions and 6 roundtable sessions. More than 70 speakers

shaped the dialogue, including policy leaders such as Rekha Gupta, N K Singh, Manoj Tiwari, and Manoj Singh; institutional leaders like Dr. Virinder Sharma, Sanjiv Kumar, Dr. Adarsh Pal Vig, Auguste Tano Kouamé, and Shombi Sharp; and corporate leaders such as Vijay Shekhar Sharma, Ashwini Tewari, and Arun Duggal.

The summit spotlighted eight sector-specific actionable pathways for clean air, along with cross-sectoral themes. These included electric vehicles, clean cookstoves, flue gas desulfurization, industrial emission controls, compressed biogas plants, material recovery facilities, mechanized road sweepers, and low-cost sensors. The discussions also addressed cross-cutting enablers such as institutional coordination, innovative financing, citizen accountability, and technological innovation. Together, these areas represent over USD 4 billion (~₹35,000 crore) in investment opportunities and strong potential for green job creation across high-growth sectors.

The Paytm Foundation and UNEP jointly announced Phase 2 of the Air Quality Action Forum (AQAF) at the summit. The platform will help cities and innovators deploy local solutions by providing access to data, financing models, and tools. It aims to empower city-level officials, enable state action, and embed citizen-led approaches, including recognition and reward for cleaner industry practices through a proposed corporate certification system.

Dalberg and CIEU presented a high-impact action plan for Delhi, outlining both immediate and near-term interventions, alongside a bold national roadmap to enable systemic action across states. Delhi's plan includes immediate measures across vehicles, dust, construction, and biomass emissions. These include scrapping 33% of diesel and CNG trucks, deploying 500 mechanized sweepers, monitoring 2,000 construction sites via AI, providing LPG and cookstoves to slums, and creating a dedicated task force and SPV. The roadmap also lays out five additional steps for execution in six months, including 33,000 bus replacements, 20 waste collection centers, audit systems for urban dust, stronger control of open waste burning, and a targeted winter action plan. At the national level, the roadmap proposed three structural reforms: launching a National Mission for Shuddh Vayu to unify clean air mandates, building a Chief Ministers' Coalition for Clean Air to catalyze state leadership, and establishing a ~USD 6 billion (₹50,000 crore) National SPV to drive coordinated funding and unlock private investment at scale.

At Aironomics, the Hon'ble Chief Minister of Delhi, Rekha Gupta, committed to a clear set of actions focused on public transport, construction dust, private vehicle emissions, and enforcement. She announced the addition of 2,000 new DEVI electric buses by year-end, building on the 400 already on the road, with full fleet electrification targeted by 2028. To cut dust pollution, all high-rise buildings must now install sprinklers, while upgraded sweeping machines with integrated smog guns and water jets will be deployed across all 70 Assembly constituencies. For private vehicles, the government will introduce a new EV subsidy policy and launch a scrappage scheme for end-of-life vehicles.

Aironomics has benefited from feedback from its knowledge partners. Several leading research institutions have joined hands with Aironomics as knowledge partners, bringing in-depth sector-specific expertise to the summit.

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Plenary Discussions

INAUGURATION AND WELCOME ADDRESS

A Breath of Fresh Ambition: Aligning Clean Air, Climate Action, and Shared Prosperity

Dr. Ashwani Mahajan
Member, Board of Governors, Council For International Economic Understanding (CIEU)

Gopal Arya
National Convenor of RSS Paryavaran Vibhag

The session titled "***A Breath of Fresh Ambition: Aligning Clean Air, Climate Action, and Shared Prosperity***" opened Aironomics 2025 by framing India's air pollution crisis as a national development challenge, not just an environmental one. Featuring a welcome address by **Dr. Ashwani Mahajan** (Member, Board of Governors, Council for International Economic Understanding) and an inaugural address by **Gopal Arya** (National Convenor, RSS Paryavaran Vibhag), the session brought together political, institutional, and corporate

voices to call for urgent, unified action. It emphasized the need to integrate clean air, climate resilience, and economic development, highlighting health, equity, and productivity co-benefits, and positioned Aironomics as a platform to drive convergence, catalyze cross-sector investment, and advance mechanisms such as PPPs and SPVs for implementation at scale.

Key Insights from Dr. Ashwani Mahajan's address

Air pollution as a persistent and pan-India crisis

- **Air pollution affects the entire country, not just specific regions.** The inaugural address emphasized that air pollution is no longer limited to certain geographies but a pan-India crisis impacting states from Delhi to Haryana, Punjab, and beyond.
- **The problem persists year-round, not just seasonally.** Dr. Mahajan highlighted that it is not a seasonal issue but a chronic, continuous threat, with AQI levels regularly reaching hazardous thresholds and sometimes hitting 1000 or becoming unmeasurable even outside traditional "pollution months."

Growing impact on health, society, and India's global standing

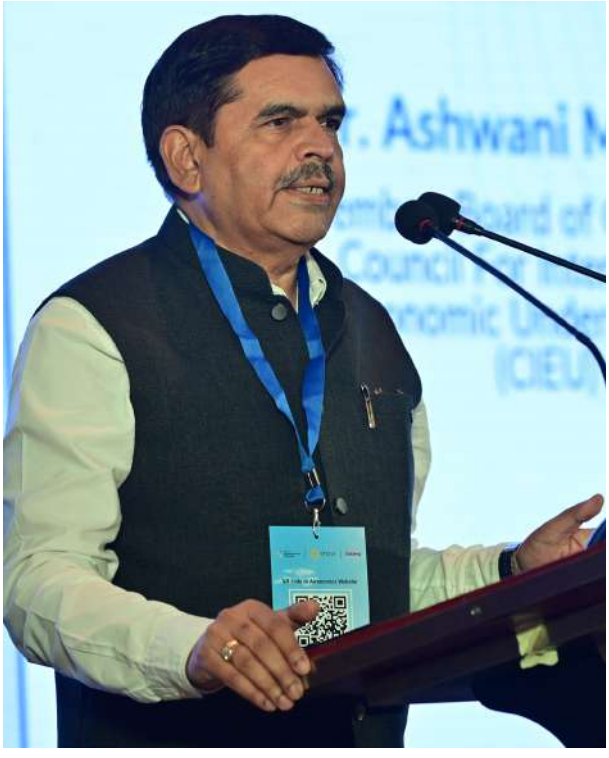
- **Air pollution is triggering a nationwide public health emergency.** The address highlighted that there is an alarming rise in non-communicable diseases, especially among youth, with cardiac surgeons now observing blackened lungs, indicating the severe physiological toll of polluted air on India's population.
- **Air quality is affecting the livability and global perception of Indian cities.** The address noted that many citizens are opting to leave Delhi due to health concerns, while foreign diplomats are increasingly reluctant to relocate their families—signaling reputational and economic risks for the capital.

Lack of coordination hinders progress despite active measures

- **Efforts remain fragmented across government, private, and civil society actors.** Dr. Mahajan pointed out that while initiatives like smog towers, EV promotion, and waste-to-wealth projects are underway, they lack integration. Corporate CSR activities and startup innovations run parallel rather than synergistically.
- **The pace of action is failing to match the scale of the crisis.** Although multiple actors are engaged, the overall response remains too slow and disjointed relative to the urgency of the challenge.

Aironomics as a catalyst for coordinated, scalable solutions

- **Aironomics was positioned as a convergence platform to break silos.** Dr. Mahajan emphasized the need to bring together public institutions like NGT and CAQM, private sector players, and civil society for collective action, with Aironomics as a space for aligning fragmented efforts



- **Institutional mechanisms like PPPs and an SPV were proposed to operationalize impact.** Dr. Mahajan outlined Aironomics' vision of creating scalable, accountable mechanisms such as public-private partnerships and a dedicated Special Purpose Vehicle to ensure long-term financing, implementation coherence, and accountability.

Key Insights from Gopal Arya's address

Clean air as a non-negotiable foundation for life

- **Air quality is essential for survival, not just wellbeing.** Gopal Arya reminded the audience that just 20 seconds of oxygen deprivation at birth can lead to brain damage, highlighting that clean air is not an abstract concept but a vital requirement for life.
- **India's urban air quality is consistently and dangerously poor.** Despite this urgency, cities like Delhi routinely report AQI levels above 400, far beyond health-safe limits. This chronic exposure contributes to a growing burden of pollution-linked illnesses.

India's ecological imbalance and the tree deficit crisis

- **India is facing a critical tree-to-human imbalance.** Referencing CPCB data, Gopal Arya revealed that Delhi has only three people per tree, compared to an ideal ratio of 422 trees per person. This stark gap underscores the urgent need for large-scale afforestation in urban India.
- **Urban green cover gains mask a decline in dense forests.** While green cover may have marginally increased, dense forest cover has declined, weakening urban ecological resilience and worsening air quality in the long term.

Community stewardship and indigenous approaches as powerful pathways forward

- **India has a rich legacy of collective ecological action.** The story of Amruta Devi and 360 villagers who gave their lives to protect trees was invoked as a powerful reminder of India's deep-rooted commitment to environmental protection.
- **Local, rooted, and indigenous approaches are key to sustainable solutions.** The discussion emphasized the importance of holistic, community-driven responses. Initiatives like HARIT Delhi (Holistic Action for Revitalizing Indigenous Techniques) were cited as promising models that draw on traditional knowledge, civic responsibility, and community ownership to foster sustainable urban ecosystems
- **Reframing environmentalism as ecopreneurship can unlock grassroots action.** A key insight was the need to shift from narratives of eco-terrorism to ecopreneurship, empowering communities to protect natural resources while also creating local livelihoods and economic opportunities.

SETTING THE STAGE

The Moment, the Mandate Framing India's Clean Air Opportunity

Jagjeet Singh Sareen
Area Chair, Climate Initiatives,
CIEU, Partner, Dalberg Advisors

The session titled, "***Setting the Stage: The Moment, the Mandate: Framing India's Clean Air Opportunity"***, commenced Aironomics 2025 by positioning the convening as a national platform to unlock clean air as both an economic and cross-sectoral opportunity, spanning climate action, public health, and ecological resilience. Delivered by **Jagjeet Singh Sareen** (Area Chair, Climate Initiatives, CIEU; Partner, Dalberg Advisors), the session emphasized that air pollution is a persistent, all-season challenge with massive human and economic costs. It set the agenda for scaling high-impact, made-in-India solutions across energy, transport, waste, and industry, and called for united political will, institutional alignment, and cross-sector collaboration, public, private, philanthropic, and civic, to launch a mission-mode response for clean air and shared prosperity.

Key Insights from Jagjeet Singh Sareen's address

Air pollution as a persistent national crisis

- **Air pollution is a year-round problem, not a seasonal anomaly.** The address emphasized that peak pollution is no longer restricted to winter months, with AQI levels during the monsoon season also registering dangerously high.
- **Poor air quality has health and economic consequences.** Jagjeet Sareen stressed that the persistent deterioration in air quality imposes both human and financial costs, reinforcing the need to treat clean air as a continuous national priority.

Shared responsibility as the only viable path to impact

- **Pollution sources are distributed, requiring solutions beyond city boundaries.** With only 30% of Delhi's pollution generated within the city, the address made clear that neither city-bound nor sector-specific strategies will suffice.
- **Fragmentation is undermining progress on clean air.** Jagjeet Sareen highlighted the current disjointed approach, where coordinated action among too many actors across jurisdictions facing challenges.
- **A unified, multi-stakeholder approach is essential.** The address emphasized that only a broad coalition of public, private, and civil society stakeholders can deliver the scale of change required.

India's readiness to scale homegrown clean air solutions

- **India has built strong domestic capabilities in clean technology.** Jagjeet Sareen

highlighted advancements in local manufacturing of electric vehicles, flue gas desulfurization units, and material recovery systems as proof of growing national capacity

- **The next step is scaled deployment and strategic innovation.** The address urged stakeholders to move beyond pilots, invest in domestic innovation for remaining gaps, and transition from capability demonstration to widespread implementation.

Operation Shudh Vayu as a national call-to-action

- **A mission-driven approach can unify stakeholders around clean air.** The address proposed 'Operation Shudh Vayu' as a collective effort modeled on Operation Sindoor, calling for similar levels of political, public, and institutional commitment.
- **The mission aims to align actors around measurable and systemic outcomes.** By bringing together government, industry, civil society, and philanthropy, the proposed mission seeks to create long-term, accountable structures for clean air delivery.

FIRESTARTER

Green Growth and Liveable Cities

Dr. Soumya Swaminathan
Chairperson, M S Swaminathan Research Foundation (MSSRF)

Shikhar Jain
Executive Director - CESD, Confederation of Indian Industry (CII)

Mikiko Tanaka
Director and Head of the UN ESCAP Subregional Office for South and South-West Asia (moderator)

The session titled, ***'Green Growth and Liveable Cities'***, moderated by **Mikiko Tanaka** (Director and Head of the UN ESCAP Subregional Office for South and South-West Asia), brought together **Dr. Soumya Swaminathan** (Chairperson, M S Swaminathan Research Foundation) and **Shikhar Jain** (Executive Director - CESD, Confederation of Indian Industry) to reframe air pollution as a year-round public health emergency with major economic consequences. The panel explored the deepening links between air quality, health outcomes, and economic productivity, calling for urgent, cross-sector action to protect vulnerable populations and unlock green growth.

Context for the Firestarter

Air pollution has emerged as one of the most critical public health and economic crises in South Asia, disproportionately impacting densely populated regions with already strained healthcare and infrastructure systems. The region is home to 37 of the world's 40 most polluted cities and over 60% of its population exposed to PM2.5 levels above WHO safe limits[52]. It contributes to nearly 2 million premature deaths annually, about 9% of total deaths in the region[53]. Beyond its health toll, the economic impact is staggering as air pollution costs are primarily manifested through lost labor productivity, increased healthcare expenditures, suppressed consumer demand, and weakened sectors like tourism and agriculture.

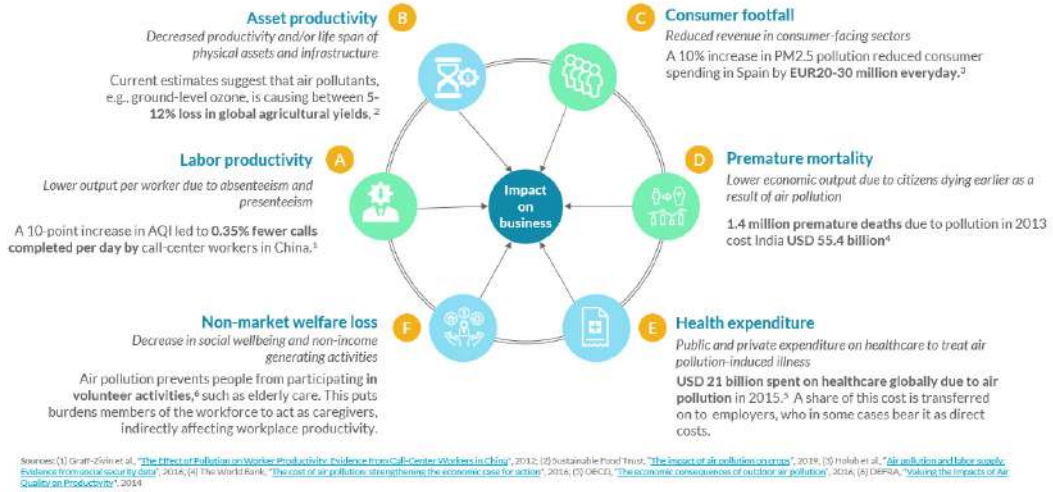
52.Science Direct, Air pollution and cardiovascular health in South Asia: A comprehensive review, 2024
53.World Bank, Striving for Clean Air, 2023

Notably, this challenge is disproportionately higher in middle-income countries, compounding population-level vulnerabilities. India exemplifies this challenge at scale. Major cities such as New Delhi, Mumbai, and Kolkata consistently rank among the most polluted globally, with Delhi's PM2.5 levels averaging 110 µg/m, making it the world's most polluted city in this respect. The primary contributors to this pollution include vehicular emissions, industrial activities, construction dust, and agricultural practices like crop burning. Seasonal variations further exacerbate the situation, with winter months witnessing increased pollution due to factors like crop burning and meteorological conditions that trap pollutants.

Exposure to elevated levels of particulate matter (PM2.5 and PM10) contributes to increased morbidity, mortality, absenteeism, and a higher incidence of respiratory and cardiovascular diseases such as asthma, bronchitis, COPD, lung cancer, and heart attacks. Health damages from air pollution in India are estimated to be ~1.36% ($36.8 billion) of the country's GDP[54]. Air pollution contributes to approximately 18% of all deaths in India, leading to an estimated 1.67 million premature deaths in 2019[55]. The health burden is particularly severe among vulnerable populations, including children, the elderly, and low-income communities, who often reside near major pollution sources and lack access to adequate healthcare.

The economic impact of air pollution is both extensive and multifaceted, touching nearly every sector of the economy. Businesses lose an estimated USD 95 billion annually, around 3% of India's GDP, due to pollution-related disruptions[56]. As illustrated in Figure 1, these costs manifest across six major pathways. Productivity loss is among the most direct impacts. The persistent air pollution crisis in India not only devastates public health but also stifles economic growth, creating a vicious cycle that demands urgent and comprehensive intervention. Addressing this issue is critical to safeguarding both the well-being of millions and the long-term prosperity of the nation.

Figure 1: Economic costs of air pollution manifest across 6 major pathways



Sources: (1) Graff-Zivin et al., "The Effect of Pollution on Worker Productivity: Evidence from Call-Center Workers in China", 2012; (2) Sustainable Food Trust, "The Impact of air pollution on crops", 2019; (3) Holub et al., "Air pollution and labor supply: Evidence from social security data", 2016; (4) The World Bank, "The cost of air pollution: strengthening the economic case for action", 2016; (5) OECD, "The economic consequences of outdoor air pollution", 2016; (6) DEFRA, "Valuing the Impacts of Air Quality on Productivity", 2014

54.World Bank, How is India Trying to Address Air Pollution?, 2024
55.The Economic Times, Mounting economic costs of India's killer smog, 2024
56.Dalberg Report, Air Pollution's Impact on the Indian Economy, 2021

Potential Opportunities and Challenges

The opportunities to mitigate the economic and health impact of air pollution include:

- **Increase in life expectancy by 5 years:** Reducing PM2.5 levels to meet WHO guidelines can increase average life expectancy in India by around 5 years[57]. Also, India could save about 150% of India's healthcare budget[11] by reducing pollution-induced health issues
- **$22 Billion higher revenues for consumer-facing businesses:** Bringing air quality up to safe levels in 2019 would have improved consumer footfall in commercial zones in Indian cities, unlocking $22 billion[58] higher revenues for consumer-facing businesses
- **Over $40 billion through workforce productivity gains[11]:** The economy stands to gain significantly from improved air quality through enhanced workforce productivity and reduced absenteeism. For example, the Indian IT sector, contributing 9% of GDP, could recover $1.3 billion (0.7% of its value) by 2030 through improved worker health and performance.
- **$20–30 billion market potential:** India's air quality management market could reach USD 20 billion annually by 2030[59]. Scalable solutions like EVs, projected to create 50 million jobs[60], and biogas expansion, which could reduce gas import bills by $29 billion through 2030[61], would be some factors driving this growth.

Key challenges would have to be overcome to leverage these opportunities.:

- **Weak institutional accountability dilutes health impact:** Even as evidence mounts on the health benefits of pollution reduction, fragmented responsibility across agencies and levels of government leads to patchy implementation of mitigation measures, such as vehicular emission controls, waste management reforms, and cleaner industrial practices, blunting public health outcomes.
- **Consumer-facing sectors remain vulnerable to seasonal volatility:** Poor and unpredictable air quality continues to suppress consistent commercial activity in urban centers, discouraging long-term investments in retail, hospitality, and tourism despite the latent demand potential.
- **Workplace environments are overlooked in productivity strategies:** Efforts to boost national productivity often ignore the direct impact of ambient and indoor air quality on worker performance, especially in informal and high-density work settings, leaving a key lever unaddressed.
- **Clean-tech job growth held back by weak enablers:** While sectors like EVs and bioenergy show high employment promise, enabling infrastructure, workforce skilling, and policy clarity are not keeping pace, resulting in a widening gap between potential and realized gains.

Key Insights from the Firestarter

Air pollution as a year-round health emergency with unequal impacts

- **Air pollution is India's leading health risk, with year-round consequences.** Panelists shared that it contributes to 18% of annual deaths and disproportionately affects pregnant women, infants, the elderly, and low-income communities.
- **Vulnerable groups bear the brunt of chronic exposure.** High PM2.5 levels were linked to premature births, impaired cognitive development, and chronic diseases such as

57.Nature India, Air pollution limits in India are too high to prevent deaths, study says, 2024
58.World Economic Forum, Solving India's Air Pollution Can Boost Economy and Business. Here's How, 2021
59.Globalnewswire, India Air Pollution Control Systems Market Report 2024-2030: Clean Air Initiatives Spurs Investments, Surge in Regulatory Mandates, Rising Environmental Awareness Fueling Developments, 2024
60.Invest UP, Economic Survey 2023: EV industry, 2023
61.IEEFA, Greater use of biogas can help India save US$29 billion in import bills between FY2025 and FY2030, 2023

diabetes, cardiovascular ailments, and dementia.

Air pollution as a drag on India's economic competitiveness

- **The economic cost of air pollution is substantial and structural.** Panelists cited estimates of a 2.5–3% GDP loss annually due to pollution, impacting national productivity and sectoral performance.
- **Pollution disrupts business continuity and raises operational costs.** Construction and manufacturing sectors were identified as especially affected, facing frequent shutdowns and project delays due to high pollution episodes.

The critical role of data in driving accountability and action

- **Granular and real-time data is essential to shape effective responses.** Panelists called for improved pollutant-level monitoring, rural air quality data, and more robust health and economic attribution systems.
- **Linking pollution to health and economic outcomes is key for policy traction.** The panel emphasized that quantifying the cost of inaction is critical for mobilizing political and institutional will across sectors.

Interventions across households, mobility, and industry as opportunities to scale

- **Clean cooking access must be expanded to address indoor pollution.** Panelists advocated for targeted LPG subsidies, particularly in North India, where biomass burning remains a dominant household practice.
- **Cleaner transport and urban design offer co-benefits for air and health**. Expanding electric public transport and investing in walkable infrastructure were seen as opportunities to improve air quality while reducing congestion and promoting physical health.
- **Green business models are emerging as viable solutions to urban emissions.** Panelists pointed to progress in last-mile EV deliveries, diesel generator retrofits, and alternative fuels as scalable industrial responses.
- **Voluntary industry action needs to be matched with enabling policy.** Industry associations like CII are developing charters and CEO forums, but panelists stressed the importance of clear regulatory signals and incentives to accelerate adoption.

Integrated governance and reframing the narrative as imperatives for impact

- **Lasting change depends on coordinated action across ministries and levels.** Panelists called for alignment among environment, health, finance, and industry portfolios, supported by local ambition and public engagement.
- **Clean air investments must be reframed as a catalyst for inclusive growth.** The panel concluded that cleaner air should be viewed not as a cost, but as essential infrastructure for public health, economic resilience, and equitable urban development.

FEATURED SPEECH

Blue Skies in Viksit Bharat

Arun Duggal
Chairman and Independent Director,
ICRA Limited

The session titled ***'Blue Skies in Viksit Bharat'*** featured a keynote address by **Arun Duggal**, Chairman and Independent Director at ICRA Ltd. Focused on strengthening inter-agency coordination and embedding accountability across jurisdictions, the session explored how India's public policy and administrative frameworks must be realigned to deliver sustained, year-round clean air governance. Drawing on global examples and India's persistent pollution challenge, the discussion called for systemic reforms to move beyond reactive measures and institutionalize long-term solutions.

Key Insights from Arun Duggal's address

The scale and severity of India's air pollution crisis

- **India is facing an unprecedented air pollution emergency.** Duggal recounted that on November 19, 2024, Delhi's AQI maxed out at 999, with actual levels likely higher, reinforcing the capital's position as the most polluted in the world.
- **Vulnerable populations face disproportionate health risks.** He highlighted the severe impacts on pregnant women, children, the elderly, and low-income communities, who bear the brunt of toxic air.

Air pollution as a year-round problem with seasonal intensification

- **Air quality remains poor throughout the year, not just in winter**. Drawing on IIT Delhi's four-year dataset, Duggal showed that even during the monsoon, AQI levels stay above 100, spiking again after September.
- **Winter conditions trap pollution, worsening the crisis**. He explained how temperature inversion in North Indian winters forms a dome of warm air that stalls atmospheric clearance, visibly darkening skies and locking in pollutants.

Limitations of current air quality management approaches

- **India's air pollution policy tends to be reactive.** Duggal noted that mechanisms like GRAP and NCAP are usually activated only after pollution worsens, instead of preventing it in advance.
- **NCAP targets are largely unmet or backsliding.** While the program aimed for a 40% pollution reduction in 131 cities, only half have met this goal and some cities have seen pollution levels increase.

A modern legislative through the proposed Air Act 2025

- **A modern legal framework is needed to address today's realities.** Duggal called existing environmental laws outdated and proposed the Air Act 2025 to enshrine clean air as a constitutional right and introduce polluter-pays principles.
- **Clear national targets must guide long-term ambition**. He proposed reducing Delhi NCR's annual average AQI to 15 by 2047, aligning with WHO standards and creating a national milestone for clean air.

Creating economic accountability through corporate contribution

- **Polluting industries must financially support clean air solutions**. Duggal proposed a Corporate Environmental Responsibility (CER) mandate requiring sectors like fossil fuels and cement to contribute 2% of their revenues to pollution reduction.
- **Industry contributions can fund R&D and community solutions.** These funds could be channeled toward sectoral innovation or initiatives such as electric buses, shifting the burden from the public to the private sector.

FIRESTARTER

Powering the Air Quality Action Forum (AQAF)

Dr. Balakrishna Pisupati
Head, United Nations Environment Programme (UNEP), India

Vijay Shekhar Sharma
CEO, Paytm

Atul Bagai
Former Country Head (India), UNEP (moderator)

The session titled '***Powering the Air Quality Action Forum'*** featured key voices including **Vijay Shekhar Sharma** (CEO, Paytm) and **Dr. Balakrishna Pisupati** (India Country Head, UNEP), moderated by **Atul Bagai** (Former Country Head (India), UNEP). It explored how cross-sector leadership, corporate commitment, and multilateral partnerships can drive scalable clean air solutions. The session also marked the formal announcement of Phase II of the AQAF initiative, jointly led by UNEP and Paytm Foundation, to institutionalize clean air action across India.

Context for the Firestarter

The session marked the formal announcement of **Phase II of the Air Quality Action Forum (AQAF)**, an initiative jointly led by UNEP and Paytm Foundation to institutionalize clean air

action across India. Building on the momentum of the first phase, which brought together over **140 organizations** spanning civil society, government, **academia, and industry, the new phase aims to move from convening to implementation. The forum's core ambition is to connect fragmented efforts, foster local ownership, and enable more targeted, data-driven responses at the city and state levels. By anchoring clean air in mainstream development and creating structures that** bridge public and private leadership, AQAF seeks to become a national platform that not only champions the clean air agenda but accelerates its delivery through shared accountability.

Key Insights from the Firestarter

Bridging the disconnect between data, policy, and implementation

- **India has the tools to address air pollution, but lacks integration.** Dr. Balakrishna Pisupati emphasized that the challenge lies not in a shortage of data, institutions, or legal frameworks, but in the failure to connect them effectively.
- **Actionable data and aligned governance are critical for outcomes.** He highlighted the need to translate available information into measurable impact by improving implementation and integrating governance across local levels.

Making clean air a people's movement, not an elite concern

- **Clean air must shift from conference rooms to the streets.** Vijay Shekhar Sharma shared that as Delhi became increasingly unliveable, it felt as though the city itself was pushing people out, underscoring the urgency for broader public engagement.
- **Citizen-led demand is key to sustaining momentum for change.** The speakers stressed that clean air should become a grassroots demand, not just an issue discussed by experts and policymakers

- **Technology and funding alone are not sufficient without behavioral change.** Speakers agreed that meaningful progress depends on shifts in everyday practices and norms, not just investments in innovation or infrastructure.

Announcing AQAF Phase II as a platform for implementation and industry accountability

- **Empowering local governments is central to the next phase of action.** The second phase of AQAF will prioritize municipal leadership and personal responsibility and focus on empowering city and state-level actors to drive results on the ground, taking inspiration from initiatives like the LIFE movement in India and Beijing's urban air strategy.
- **Corporate accountability and recognition will be embedded in the new phase**. Vijay Shekhar Sharma endorsed the idea for a Corporate Environmental Responsibility (CER) framework and proposed industry-led certification to reward cleaner practices and foster accountability.

IMMERSIVE DISCUSSION

Finding Facts: Cracking the Code on Pollution Sources

Dr. Sachchida Nand Tripathi
Professor, Indian Institute of Technology, Kanpur

Dr. Sumit Sharma
Programme Officer, United Nations Environment Programme (UNEP)

Dr. R. Subramanian
Sector Head Air Quality, Center of Study of Science, Technology and Policy

Dr. Sachin S Gunthe
Professor, Indian Institute of Technology, Madras (moderator)

The session titled "***Finding Facts: Cracking the Code on Pollution Sources***" focused on identifying and attributing the diverse, cross-sectoral, and cross-geographic contributors to air pollution in India. Moderated by **Dr. Sachin S Gunthe** (Professor, IIT Madras), the session featured insights from **Dr. Sachchida Nand Tripathi** (Professor, IIT Kanpur), **Dr. Sumit Sharma** (Program Officer, UNEP), and **Dr. R. Subramanian** (Sector Head Air Quality, CSTEP), highlighting the scientific, technological, and institutional challenges in conducting robust source apportionment and translating it into effective policy.

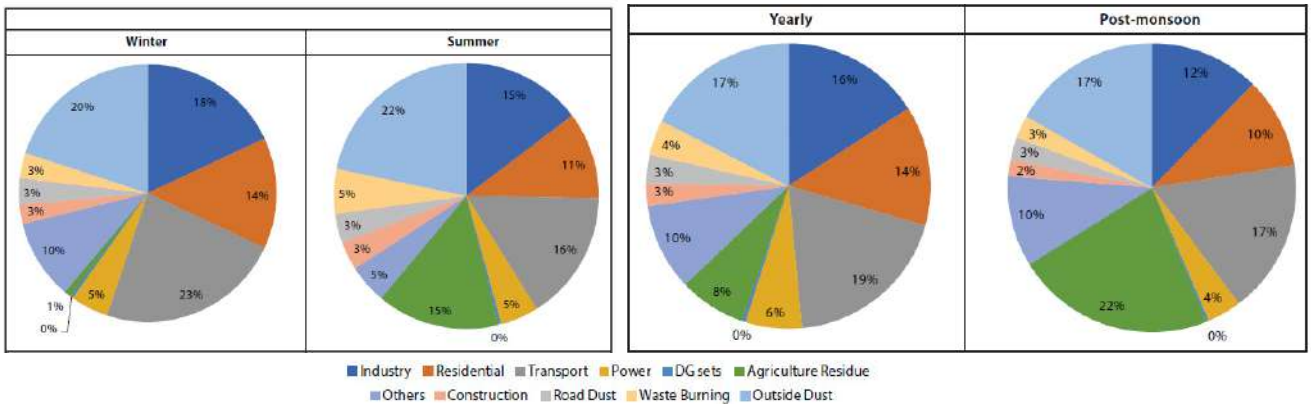
Context for the Panel Discussion

Air pollution in India is a complex and multi-dimensional challenge, primarily due to its transboundary nature, multi-sectoral sources, and seasonal variations. A major difficulty in measuring pollution is the movement of pollutants across borders, complicating the identification of their origin. On average, only about 20% of the pollution in Delhi originates within the city, with the rest being transported from surrounding areas. Delhi's air quality is influenced by the National Capital Region (NCR), contributing up to 48% of PM2.5 concentrations post monsoon (when open agriculture residue

burning is prevalent in the upwind states of NCR), 35% in summer and 30% in winter[52]. Additionally, sources outside Delhi-NCR, including neighboring states and countries, are responsible for 50-60% of PM2.5 concentrations on average.

Moreover, air pollution stems from a variety of sectors, including transportation, industry, agriculture, and waste burning, each contributing differently across seasons. The overall contribution of these sectors to PM2.5 levels in urban areas like Delhi varies significantly (see figure 2 for details). Industries, including power plants, contribute around 22% of the annual PM2.5 load, followed by the transport sector at 19% and residential sources, which account for 14%[1]. Other sources, such as crematoria, ammonia, biogenic processes, airports, and restaurants, make up around 10%. Agricultural residue burning, while occurring only during certain months, accounts for 7% of the annual contribution, with this share significantly increasing during the post-monsoon period.

Figure 2: Yearly and seasonally averaged source contribution to prevailing PM2.5 concentration (which includes both primary and secondary particulates) in Delhi in 2019



The lack of standardized and comprehensive source apportionment studies hampers effective air quality management in India. While initiatives like the National Clean Air Programme (NCAP) have been launched to address this issue, aiming to reduce PM concentrations by 20-30% by 2024 through source apportionment studies in 102 cities, the progress has been uneven[53]. Many cities still lack robust data on pollution sources, leading to generic policies that may not address specific local challenges. This inconsistency underscores the need for mandated, standardized source apportionment studies to inform targeted interventions.

The absence of national policies mandating standardized source apportionment studies contributes to the fragmented understanding of air pollution sources. This policy gap not only leads to reliance on disparate studies, which use varying scopes and methodologies but also makes it difficult to compare results meaningfully. For example, some studies use receptor models like Chemical Mass Balance (CMB) or Positive Matrix Factorization (PMF), while others rely on satellite data or source-specific emission inventories. These methodological differences can lead to inconsistent findings, such as differing estimates of the contribution of vehicular emissions or industrial sources. Without standardized source apportionment studies, formulating effective and localized air quality management plans remains a challenge

52.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
53.PubMed Central, Addressing air pollution in India: Innovative strategies for sustainable solutions, 2024

India can learn from other countries where source apportionment studies have been successfully integrated into air quality management frameworks. For instance, the European Union has established standardized methodologies for source apportionment, facilitating comparability and consistency across member states. Implementing similar standardized approaches in India could enhance the reliability of data and inform more effective policymaking. Additionally, integrating advanced technologies such as satellite monitoring, artificial intelligence, and machine learning can aid in real-time tracking of pollution sources and forecasting air quality. Collaborative efforts, both within India and with international partners, are essential to share knowledge, harmonize methodologies, and develop region-specific solutions to air pollution. Strengthening regulatory frameworks and ensuring consistent enforcement are also crucial steps toward achieving sustainable air quality improvements.

Potential Opportunities and Challenges

The opportunities to streamline source appropriation for air pollution reduction include:

- **Establishing a National Research Center to conduct standardized source apportionment studies** annually will improve methodological consistency and generate high-quality, region-specific data to guide interventions.
- **Publishing an Annual Report on key polluting sources** will enable systematic tracking of major emission contributors, supporting data-driven air quality policies and public transparency.
- **Integrating technologies like satellite imaging and AI for real-time pollution tracking**, along with adopting best practices from international models (e.g., EU's PMF[54] and SHERPA[55]), will improve precision in source apportionment and air quality management policies
- **Enhancing cooperation between states, industries, and neighboring countries** can address transboundary pollution, such as the impact of crop residue burning from Punjab and Haryana on Delhi's air quality

Key challenges would have to be overcome to leverage these opportunities:

- **There is currently no single mandated agency or institutional mechanism** responsible for conducting source apportionment studies, leading to fragmented ownership and inconsistent accountability across central, state, and municipal levels.
- **Robust source apportionment studies require significant investment** in technology, modeling expertise, and field-level data collection, but budget allocations remain sparse and irregular, particularly in smaller cities and rural areas.
- **Many studies are conducted independently** by different academic institutions, government agencies, or NGOs, often without shared protocols or integration into a national framework, resulting in duplicative siloed efforts and incomparable datasets.
- **India's diverse climatic zones and variable atmospheric conditions complicate the modeling and standardization of source apportionment** across regions, necessitating highly localized approaches.

Key Insights from the Panel Discussion

Source apportionment as the foundation for effective action

- **Pinpointing pollution sources is essential for targeted interventions**. Panelists emphasized that without granular source-level data, policies risk being too generic or misaligned with the real drivers of pollution in different regions.
- **Source apportionment must lead to clear, cost-based action plans**. The group noted

54.European Union, An introduction to the chemometric evaluation of environmental monitoring data using PMF, 2009
55.Elsevier, A source apportionment and air quality planning methodology for NO2, 2024

that simply presenting sectoral pie charts is insufficient; decision-makers need actionable insights about which interventions work best, how much pollution they reduce, and at what cost.

Technological innovations enabling real-time, hyperlocal insights

- **Hybrid monitoring systems offer scale and precision**. The panel discussed how combining high-end instruments with well-calibrated low-cost sensors allows cities to monitor hyperlocal pollution in real time while maintaining data credibility.
- **AI-powered, real-time source attribution can transform decision-making**. New approaches that blend short-term co-location studies with AI models and sensor networks are enabling city-block-level resolution, supporting dynamic, source-specific responses**.**

Targeting pollution sources and systemic interventions

- **Solid fuel use and waste burning remain major year-round PM2.5 contributors**. Citing recent research, speakers noted that these sources account for 30–40% of Delhi's winter pollution and remain significant in other seasons, underscoring the need to improve residential energy access and waste systems.
- **Construction zones and informal burning must be captured by monitoring systems**. Panelists highlighted the importance of expanding monitoring to include emissions from rapidly growing construction activity and informal waste practices.

Governance, standardization, and accountability as system enablers

- **Standardized methodologies are needed for comparability and planning**. The panel called for harmonized emission assessment protocols across states to enable benchmarking, informed planning, and coordinated regional action.
- **State and airshed-level strategies are vital to bridge policy gaps**. While national and city-level plans exist, participants proposed stronger regional coordination backed by science-based, sector-specific strategies aligned with pollution transport patterns.
- **Integrated MRV (monitoring, reporting, and verification) systems and mission-mode governance can drive accountability**. The discussion concluded with a call for robust MRV frameworks, paired with real-time dashboards and a mission-mode update of NCAP to accelerate impact.

KEYNOTE ADDRESS

Capital for Clean Skies: Financing Clean Energy and Technology for Air Quality Action

Ashwini Tewari
MD and Board Member,
State Bank of India (SBI)

The session titled " ***Capital for Clean Skies: Financing Clean Energy and Technology for Air Quality Action***" focused on the role of India's financial institutions, especially public sector banks, in financing the transition to clean technologies that address both climate change and air pollution. It explored how banks can enable access to capital for solutions such as electric mobility, industrial pollution control, and green technology adoption among MSMEs. The session featured a keynote address by **Ashwini Tewari** (Managing Director and Board Member, State Bank of India).

Key Insights from Ashwini Tewari's address

The paradox of air pollution in policy and finance circles

» **Air pollution is widely discussed but rarely**

prioritized. Tewari opened by observing that despite growing public discourse, air quality remains low on the agenda in financial and policy domains when compared to climate action.

- **Funding exists, but deployment pathways are unclear**. He challenged the belief that banks aren't involved in clean air solutions, noting that while capital is available, mechanisms to channel it into specific air quality interventions are still missing.

The commercial gap in clean air solutions

- **Many air quality interventions are not yet bankable**. Tewari explained that unlike renewable energy, which became finance-ready through early public guarantees, clean air projects, especially those focused on monitoring and behavior change, still lack commercial viability.
- **Financing follows when technologies reach maturity**. He emphasized that funding naturally scales once technologies are proven and supported by strong policy, a threshold clean air solutions have yet to cross.

SBI's evolving clean technology investment strategy

- **SBI is leading climate finance but scale depends on ecosystem readiness**. With ~USD 9 billion (~₹77,000 crore) already invested in renewables, he said that SBI is the largest power sector financier and is expanding into electric vehicles and battery tech via SBI Capital's venture investments.
- **The transition from pilot to mainstream requires strong commercial support**. Tewari highlighted the role of SBI in helping startups move beyond equity to secure traditional lending, bridging the gap between innovation and scale.
- **Coal remains in the mix, but it must be made cleaner**. Rather than phasing out thermal power, SBI is funding cleaner technologies such as ultra-supercritical plants and retrofits like FGD, while warning of underused renewables without grid upgrades.

Institutional innovation, MSME financing, and shared responsibility for clean air

- **SBI is building institutional capacity for clean tech acceleration**. A new center of excellence is being established to focus on eight high-impact technologies, aiming to develop scalable financing models and convene key actors across sectors.
- **MSMEs remain underserved in the clean air transition**. Tewari flagged the lack of capital and awareness among small-scale industries, calling for cluster-based models and partnerships to scale replicable, low-cost technologies in high-polluting sectors like textiles and leather.
- **Air pollution must be tackled through collective effort**. Tewari closed by urging deeper collaboration, stating that clean air is not the government's burden alone, and SBI is committed to working with businesses, banks, and civil society to turn ambition into implementation.

OPPORTUNITY SHOWCASE

Clean Air + Green Gains: Synergizing India's Blue Sky – Green Growth Economy

Dr. Hanif Qureshi
Additional Secretary, Ministry of Heavy Industries (MHI)

Annupa Mattu Ahi
TOMRA

Ankit Mathur
Co-founder and CEO, Greenway Grameen Infra

Swapan Mehra
Founder and CEO, Iora Ecological Solutions

Sree Kumar Kumaraswamy
Program Director – Clean Air Action, Sustainable Cities & Transport, WRI India

Dr. R. Subramanian
Sector Head Air Quality, Center of Study of Science, Technology and Policy

The session titled "***Clean Air + Green Gains: Synergizing India's Blue Sky – Green Growth Economy***" showcased a range of scalable, market-ready clean air solutions across critical sectors of transport, solid waste, residential energy, agriculture, urban planning, and monitoring. It featured rapid-fire showcases by **Dr. Hanif Qureshi** (Additional Secretary, Ministry of Heavy Industries), **Annupa Mattu Ahi** (TOMRA), **Ankit Mathur** (Co-founder and CEO, Greenway Grameen Infra), **Swapan Mehra** (Founder and CEO, Iora Ecological Solutions),

Sree Kumar Kumaraswamy (Program Director – Clean Air Action, Sustainable Cities & Transport, WRI India), and **Dr. R Subramanian** (Sector Head Air Quality, CSTEP). Using a Pecha Kucha format, speakers highlighted innovations such as EV fleets, clean cookstoves, biogas and biochar systems, and data-driven monitoring tools, emphasizing how policy, finance, and technology must converge to deliver clean air at scale.

Key Insights from Dr. Hanif Qureshi's showcase

India's electric vehicle adoption remains far below potential

- **EV penetration is low across key vehicle segments.** Dr. Qureshi highlighted that electric vehicles make up just 6.1% of two-wheeler and 2% of passenger vehicle sales, underscoring the gap between India and global EV adoption trends.
- **Market growth is constrained by battery costs and technology dependence.** Despite India's large auto market and manufacturing strength, limited domestic production of advanced chemistry cells and high battery prices continue to hinder widespread adoption.

Manufacturing and infrastructure readiness as critical enablers

- **Domestic capacity is being built through targeted industrial policy.** The speaker emphasized PLI schemes for EV components and batteries as pivotal to localize production and reduce dependence on imports.
- **Public infrastructure targets are being expanded to support demand.** Government plans to install 72,000 public chargers and deploy 14,000 electric buses were cited as foundational to building a viable EV ecosystem.

Financial and policy incentives to unlock private investment

- **Strategic policy tools are designed to reduce investor risk.** Dr. Qureshi pointed to payment security mechanisms for e-buses as a way to de-risk procurement and attract private capital.
- **Incentives aim to make EV manufacturing more competitive.** Reduced import duties for EV makers were presented as part of a broader strategy to stimulate market activity and accelerate domestic EV deployment.

Key Insights from Annupa Mattu Ahi's showcase

Solid waste as an underrecognized driver of air pollution

- **Waste-related emissions remain overlooked in air quality discourse.** Annupa Mattu Ahi emphasized that open burning and poor segregation of solid waste release harmful pollutants, yet this source is rarely addressed in mainstream air pollution policy or public awareness.

Policy integration to enable waste-based air quality solutions

- **Robust regulatory frameworks can unlock scalable waste management impact.** The session highlighted that while waste sorting and material recovery technologies are available, their success depends on systems-level planning, enforcement, and enabling policies such as extended producer responsibility.

Air quality planning must explicitly incorporate solid waste systems

- **Designing waste systems with air outcomes in mind can deliver co-benefits.** Drawing on examples from India and abroad, the speaker called for solid waste management to be fully integrated into air quality strategies,

advocating for a paradigm shift: "design for air, not just for waste."

Key Insights from Ankit Mathur's showcase

Cleaner cookstoves offer a scalable solution to household air pollution

- **Biomass cooking remains a major contributor to indoor air pollution in rural India.** Ankit Mathur highlighted that household dependence on biomass fuels leads to significant PM2.5 and VOC emissions, directly affecting health and air quality.
- **The Greenway stove enables cleaner combustion through patented airflow technology.** This tier 3 wood-burning stove uses secondary combustion to dramatically reduce smoke emissions, offering a practical pathway to improve indoor environments.

Human-centered design and product usability are critical to adoption

- **Rural energy solutions must reflect the needs and preferences of primary users.** The session emphasized that factors like portability, ease of use, and intuitive design—particularly for rural women—are essential for product acceptance and sustained use.
- **Tier 3 cookstoves can serve as transitional technologies toward cleaner energy.** While advanced tier 4–5 technologies are available, scaling accessible, lower-tier models like Greenway's offers a near-term, high-impact approach for rural clean energy transitions.

Affordability and innovative finance are key to scaling access

- **Financing mechanisms are essential to make cleaner cookstoves widely accessible.** The discussion stressed that affordability remains a barrier, and highlighted the role of innovative financial tools—such as consumer financing or subsidies—to drive uptake at scale.

Key Insights from Swapan Mehra's showcase

Agri-waste valorization is a pivotal strategy for clean air and rural transformation

- **Crop residue burning contributes significantly to air pollution and public health risks.** Swapan Mehra highlighted that over 100 million tons of agri-waste are burned annually, driving PM2.5 pollution and respiratory illnesses across affected regions.
- **Turning agricultural waste into value-added products can generate co-benefits.** Technologies like Compressed Biogas (CBG) and biochar offer scalable solutions that reduce emissions, enhance soil quality, sequester carbon, and create green jobs in rural areas.

Supportive policies and financial innovation are critical to unlock scale

- **Government schemes and carbon markets are key enablers for adoption.** The discussion pointed to tools like the SATAT scheme, biochar-based carbon credits, and market development assistance as instrumental in incentivizing agri-waste utilization.
- **Blended finance and private investment can address capital constraints.** Access to finance remains a barrier, and the session emphasized the need for blended finance models and strong public-private partnerships to catalyze commercial viability.

Integrated planning can align air quality, climate, and development goals

- **Agri-waste solutions must be embedded in cross-sectoral strategies.** Mehra framed these interventions as a bridge between clean air action, climate resilience, and rural economic growth, calling for their integration into broader sustainability and development agendas.

Key Insights from Sree Kumar Kumaraswamy's showcase

Decentralized implementation and local tailoring drive clean air impact

- **City-specific interventions must follow a "test, learn, scale" approach.** Drawing on work across ten cities under the Accelerator for Cleaner Actions, Sree Kumar Kumaraswamy emphasized that clean air solutions must be locally designed, piloted, and adapted based on results.
- **Dust mitigation, low-emission zones, and C&D waste mapping must be context-specific.** The address highlighted that each intervention was grounded in local data and diagnostics, reinforcing the importance of tailored responses rather than uniform templates.

Collaborative governance and voluntary industry action can unlock scalable solutions

- **Shifting from enforcement to proactive industry leadership is showing early promise.** The India Alliance for Clean Construction was cited as an example of how industry can voluntarily align around clean air goals without relying solely on regulation.
- **Urban interventions like emission reduction in bakeries and traffic management in Indore show real-world results.** The speaker shared how city-specific, data-backed solutions have improved local outcomes, illustrating the value of integrated urban planning.

Institutional frameworks and partnerships are essential for mainstreaming air quality action

- **Clean air must be embedded into everyday governance through structured collaboration.** The speaker called for expanded institutional mechanisms and broader partnerships to ensure air quality becomes a routine part of municipal and sectoral decision-making processes.

Key Insights from Dr. R. Subramanian's showcase

Expanded and localized monitoring is essential for targeted air quality action

- **India's current monitoring networks lack sufficient spatial resolution in urban areas.** Dr. Subramanian emphasized that despite national-level growth, many large cities still have inadequate coverage, limiting the precision of localized interventions.
- **Low-cost sensors can map city-wide PM variations and pollution hotspots.** These technologies help identify localized issues such as traffic corridors and construction sites, but must be complemented by high-end instruments to monitor regional or background pollution accurately.

Real-time source apportionment and speciation frameworks are urgently needed

- **India lacks a national framework for continuous, city-level chemical speciation.** The address stressed the need for real-time data to distinguish between local emissions and pollutants transported from outside a given city.
- **Building infrastructure for PM composition monitoring is a critical priority.** Dr. Subramanian called for investments in indigenous sensor manufacturing and enhanced technical capacity to enable long-term source-specific air quality management.

Scientific benchmarking of AI tools is key to credible forecasting

- **AI-based attribution systems must be validated against conventional models.** To ensure scientific rigour, he advocated benchmarking AI-enabled source identification tools with traditional approaches before integrating them into forecasting and planning systems.

KEYNOTE ADDRESS

Blueprint in Action: Clean Air Model from Uttar Pradesh

Manoj Singh
Former Additional Chief Secretary, Environment and Climate Change, Uttar Pradesh

The session titled "***Blueprint in Action: Clean Air Model from Uttar Pradesh***" focused on the state's efforts to operationalize clean air strategies through coordinated planning and implementation. It featured a keynote address by **Manoj Singh** (Former Additional Chief Secretary, Environment and Climate Change, Government of Uttar Pradesh) and examined key interventions such as city-level air quality action plans, brick kiln reforms, and the transition toward electrification in transport and industry.

Key Insights from Manoj Singh's address

Aligning air pollution and climate strategies requires nuance and precision

- **Air quality and climate interventions must be differentiated and carefully integrated.** Manoj Singh emphasized that while measures like railway electrification serve both air pollution and climate goals, others—such as EV adoption—primarily affect air quality, and some pollution control strategies may worsen climate outcomes if not properly calibrated.

City-level results in Uttar Pradesh demonstrate the power of localized action

- **UP's multi-pronged municipal approach has delivered significant air quality improvements.** During his tenure, cities like Varanasi and Bareilly achieved over 66% PM reductions, while Moradabad, Lucknow, Kanpur, and Agra saw reductions ranging from 28–48%, driven by empowered commissioners and coordinated departmental efforts.

- **Local infrastructure interventions have shown measurable impact.** In Gorakhpur, targeted actions such as full road paving and roadside greening led to a 30% reduction in PM10, highlighting the value of city-specific strategiesovergenerictop-downapproaches.
- **Evidence-based planning has guided UP's clean air strategy.** Singh referenced IIT Kanpur's source apportionment studies, which identified household cooking and heating as the leading contributors to pollution, prompting a recalibrated response that deprioritized transport and agriculture.

The UP Clean Air Programme exemplifies integrated investment and governance

- **The ~USD 130 million (₹1,100 crore) programme is built on cross-sectoral convergence and local ownership.** Developed with World Bank support, the UP Clean Air Programme aligns departments from transport to education and relies on weekly district magistrate reviews to maintain momentum.
- **City-specific planning and enforcement have reduced stubble burning.** Singh noted that the programme emphasized locally tailored interventions, supported by coordinated governance rather than one-size-fits-all mandates.

Air quality improvement also requires cultural change and behavioral shifts

- **Societal normalization of high AQI must be challenged.** He warned against "learned helplessness," citing rising SUV ownership in Delhi and reluctance to use public transit as symptoms of public complacency.
- **Citizen action, business responsibility, and constructive media narratives are essential.** Clean air, Singh argued, cannot be achieved by governments alone—public behavior, corporate accountability, and media focus on ground-level issues are equally critical.

Environmental ethics and long-term values must guide clean air efforts

- **Institutional and cultural investments are needed to sustain progress.** Citing UP's success in planting 175 crore trees and increasing forest cover by 550 sq. km, Singh urged a deeper societal commitment to environmental stewardship.
- **Neglecting the environment carries moral and generational consequences.** Concluding with a parable, he reminded the audience that environmental irresponsibility is not just a policy failure but a collective moral lapse that must be corrected through shared values and ethical action.

KEYNOTE ADDRESS

From the Ground Up: A Public Mandate for Clean Air

Manoj Tiwari
Member of Parliament – Delhi (North-East)

The session titled "***From the Ground Up: A Public Mandate for Clean Air***" featured a keynote address by **Manoj Tiwari** (Member of Parliament – Delhi North-East), who underscored the critical role of political leadership, responsive governance, and local solutions in addressing Delhi's persistent air pollution crisis. Drawing from his experience in Parliament, he highlighted efforts ranging from shutting down coal-based power plants to creating truck bypass routes and managing landfill emissions. The session reinforced the need for collective ownership, across citizens, governments, and institutions, to move from fragmented interventions to sustained, city-wide air quality outcomes.

Key Insights from Manoj Tiwari's address

Grounded political leadership and collaborative problem-solving

- **Effective leadership on air pollution requires humility, listening, and collaboration.** Tiwari reflected on over a decade of representing Delhi in Parliament, emphasizing that addressing complex challenges like air pollution demands close partnership between political leaders and technical experts.
- **Firsthand engagement with ground realities shapes responsive governance.** He offered candid insights into Delhi's air

crisis, based on direct experience with both systemic constraints and the practical steps already taken to tackle them.

Targeted interventions have delivered measurable air quality improvements

- **The closure of the Okhla coal plant was a major pollution reduction milestone.** Tiwari explained that expert assessments equated its emissions to over 100,000 trucks daily, and that political leadership enabled its replacement with a gas-based facility that meets energy needs while reducing pollution.

- **Peripheral expressways have helped divert truck traffic and reduce vehicular emissions.** He credited the Eastern and Western Peripheral Expressways with removing 1.25 lakh trucks per day from Delhi roads—formerly a major source of unnecessary intracity pollution—thanks to central government-led infrastructure.

Legacy issues like landfills and crop burning require scalable, practical solutions

- **Delhi's landfill mountains remain a major source of pollution requiring urgent action.** Tiwari acknowledged some progress, including talks with NHAI to repurpose decomposed waste for roads, but called for a comprehensive, technology-backed plan and welcomed policy ideas from the forum.

- **Crop residue burning must be addressed through farmer-centered incentives.** Speaking as both policymaker and farmer, he explained that stubble burning stems from mechanized harvesting and limited alternatives, and highlighted the promise of buy-back schemes like Haryana's, while calling for wider adoption and awareness.

Geographic constraints and regulatory action shape Delhi's clean air strategy

- **Delhi's topography exacerbates pollution retention and calls for regional cooperation.** Tiwari noted that the city's basin-like geography traps pollutants from surrounding states, making relief dependent on wind and rain, and reinforcing the need for coordinated airshed-level planning.

- **Strict enforcement against outdated vehicles is underway and must continue.** He highlighted steps already taken to deregister older high-emission vehicles and expressed openness to evidence-based proposals for stronger regulatory action.

Unified political will is essential to achieving clean air outcomes

- **Delhi's waste legacy will be addressed through clear political commitment and new infrastructure.** Tiwari announced the goal of transforming landfill sites into public parks within two and a half years, supported by new waste-to-energy plants and decentralized waste management policies.

- **Cross-party coordination is critical to move beyond past political fragmentation.** He closed with a call for unified, science-based governance, noting that previous political divisions had hampered progress, and affirming that clean air requires shared responsibility and collective commitment from all sides.

KEYNOTE & IMMERSIVE DISCUSSION

One Air, Many Bosses: Building Institutions for Integrated Climate and Clean Air Action

Dr. Virinder Sharma
Member (Technical), Commission for Air Quality Management

Justice Adarsh Kumar Goel
Former Chairperson, National Green Tribunal (NGT) India

Arvind Nautiyal
Member Secretary, Commission for Air Quality Management

Dr. Prashant Gargaya
Former Member Secretary, Central Pollution Control Board (CPCB)

Sutapa Choudhury
Deputy Head, Indo Pacific Regional Department (IPRD

Shirish Sinha
Executive Director of Global Programmes, Clean Air Fund (moderator)

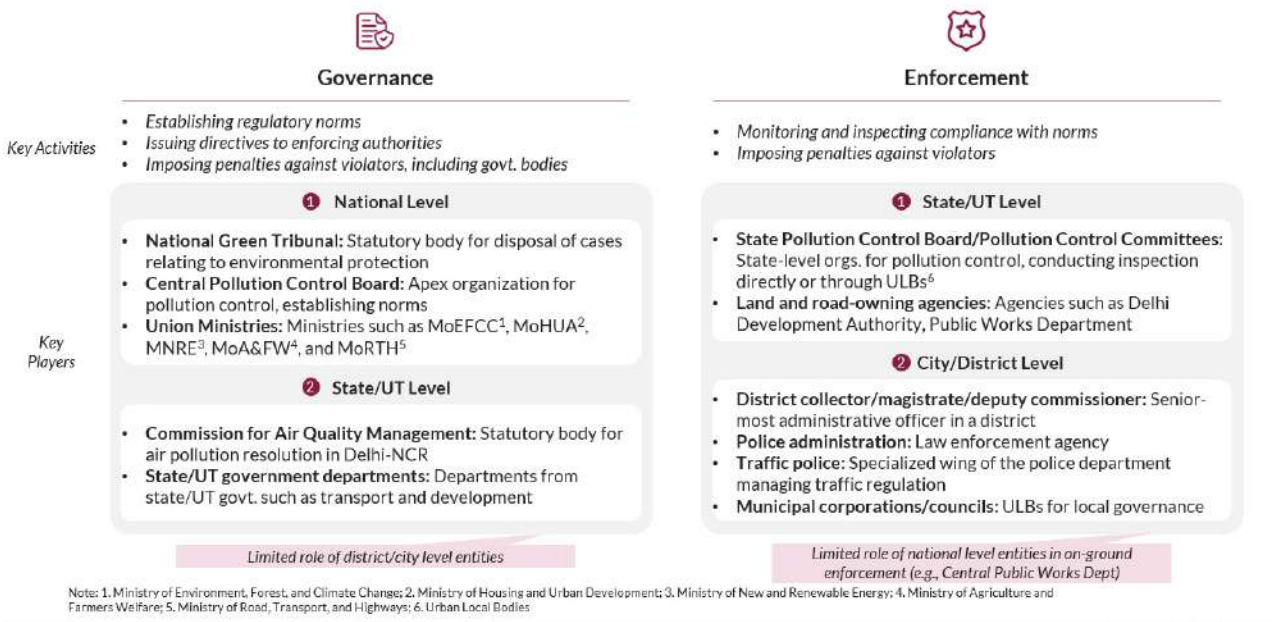
The session titled "***One Air, Many Bosses: Building Institutions for Integrated Climate and Clean Air Action***" explored the governance, institutional reforms, and inter-agency coordination required to align climate, air quality, and development goals in India. It featured a keynote address by **Dr. Virinder Sharma** (Member Technical, CAQM) followed by a panel discussion moderated by **Shirish Sinha** (Executive Director of Global Programmes, Clean Air Fund), with panelists including **Justice A.K.**

Goel (former Chairperson, NGT), **Arvind Nautiyal** (Member Secretary, CAQM), **Dr. Prashant Gargava** (former Member Secretary, CPCB), and **Sutapa Choudhury** (Deputy Head, Indo Pacific Regional Department).

Context for the Keynote and the Panel Discussion

India has established a broad architecture of governance and enforcement mechanisms to tackle air pollution, spanning national, state, and local levels. At the national level, the National Clean Air Programme (NCAP) serves as a central strategy, with targets for reducing PM concentrations and supporting 131 non-attainment cities through action plans and capacity building. On a state level, regulatory norms like the Graded Response Action Plan (GRAP) in Delhi-NCR provide tiered, real-time responses to rising pollution levels. Complementing these are sector-specific regulations, from the Construction and Demolition Waste Rules (2016) and Solid Waste Management Rules (2016) to Bharat Stage Emission Standards for vehicles and emission caps on thermal power plants. Multiple agencies including the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), the Commission for Air Quality Management (CAQM), and urban local bodies are tasked with regulation and enforcement across these domains (refer to figure 3).

Figure 3: Key governance and enforcement entities in India for air pollution norms

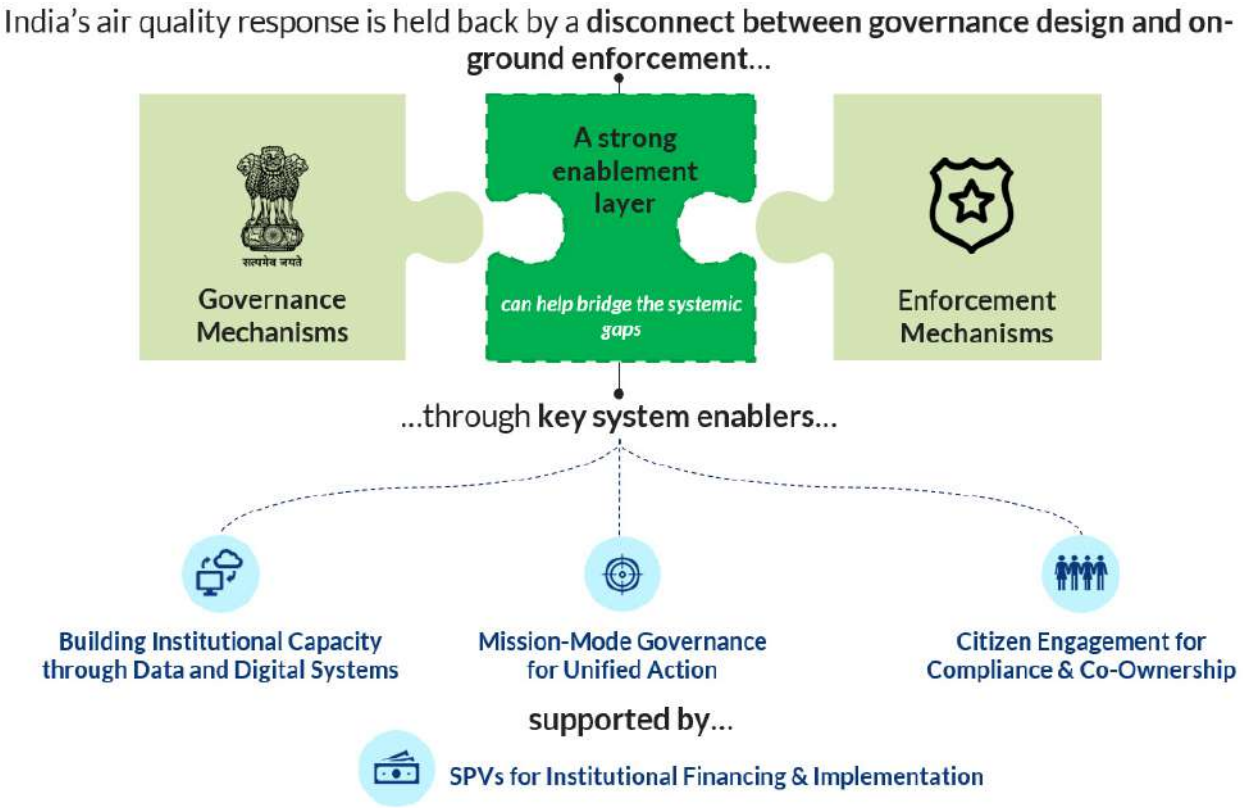


Despite the institutional architecture for air quality management in India, three interlinked challenges continue to undermine impact on the ground: fragmented governance structures, limited institutional capacity, and weak citizen engagement. The fragmentation of responsibilities across government tiers results in overlapping mandates, inconsistent enforcement, and delayed action. In Delhi, enforcement involves a maze of actors, from the Ministry of Environment, CAQM, CPCB, and DPCC to municipal bodies and police, each with intersecting roles but no unified accountability. Sector-specific regulations further complicate matters; for example, transport emissions are governed by MoRTH, Supreme Court rulings, and CAQM's GRAP, but enforced by

disparate state and local authorities. These structural issues are compounded by a lack of technical capacity and trained personnel: only 1,296 air quality monitoring stations cover just 12% of India's cities[52], and local bodies often lack resources to enforce compliance on sources like construction dust or industrial emissions. Civic participation is also limited, over 20% of Delhi vehicles lacked valid PUC certificates in 2022, and open waste burning remains rampant despite bans, highlighting a widespread gap in public accountability that undermines even well-designed interventions.

To move from fragmented action to lasting impact, India must activate a new class of solutions that go beyond piecemeal interventions. These solutions must be systemic, scalable, and anchored in three mutually reinforcing levers: **building institutional capacity, effective mission-mode governance and active citizen engagement** (see figure 4). Underpinning and enabling these levers are robust financing mechanisms that can mobilize and align resources across sectors and scales. Together, they form the foundation of a more responsive, accountable, and future-ready air quality management ecosystem.

Figure 4: Key enablers to deliver a systemic and scalable response to India's air quality crisis



52.India Today, AQI 101: Decoding how India's monitoring systems track the air we breathe, 2024

One of the first steps in operationalizing this shift is to strengthen institutional capacity through data and digital systems. Expanding low-cost sensor networks, as seen in pilots across Bengaluru and Ahmedabad, can provide granular, hyperlocal data to identify pollution hotspots and guide timely interventions. Advanced tools like satellite-based emissions tracking, AI-powered violation detection, and GIS-enabled mapping can support regulators in prioritizing inspections, automating alerts, and improving compliance workflows. Beijing and São Paulo offer powerful examples. Beijing uses satellite data and 1,000+ sensors for real-time pollution tracking, while São Paulo combines mobile network and sensor data to predict pollution spikes 48 hours in advance. Integrating these technologies with centralized dashboards can enhance transparency, improve inter-agency coordination, and bridge the gap between policy and execution in India.

Furthermore, to address India's fragmented air quality governance there's a need to adopt a mission-mode approach that unifies air quality efforts across sectors and levels of government. This approach reframes clean air not as a stand-alone environmental issue, but as a national development priority with clear goals, defined timelines, and shared accountability across ministries and states. Mission-mode programs enable alignment of regulatory, financial, and operational frameworks, ensuring that air quality actions are not ad hoc. They work because they are rooted in formal mandates, backed by strong political leadership, and reinforced through dedicated funding and robust monitoring mechanisms.

Lastly, alongside institutional and technological solutions, engaging citizens and shifting everyday behaviors is equally vital to sustaining clean air outcomes. Initiatives such as Earth5R's citizen-led monitoring programs show how awareness campaigns, hyperlocal data sharing, and community stewardship can drive greater accountability and behavior change at scale. Building a culture of shared responsibility is essential to bridge the gap between state action and societal outcomes.

To effectively implement these multifaceted strategies, spanning technology, governance, and citizen engagement, India requires robust institutional mechanisms to mobilize and manage resources at scale. Establishing Special Purpose Vehicles (SPVs) can serve as a pivotal solution, providing dedicated structures to coordinate cross-sectoral initiatives and attract diverse funding sources. For instance, Uttar Pradesh has launched the Uttar Pradesh Clean Air Management Project Authority (UP CAMPA) as an SPV to execute its airshed-based pollution control programs, securing substantial financing from the World Bank and carbon credit mechanisms. Internationally, Ulaanbaatar's Air Quality Program offers a compelling parallel, leveraging multi-source funding from the Asian Development Bank and World Bank to invest in clean heating, monitoring, and green tech through an SPV-like model.

Potential Opportunities and Challenges

There is an opportunity to strengthen India's institutional architecture for air quality management by building on existing regulatory frameworks and expanding coordination mechanisms:

- **Anchoring air quality efforts in a mission-mode institutional architecture can accelerate systemic impact:** By building on existing regulatory frameworks and introducing a high-level coordinating authority, India has the chance to shift from fragmented mandates to unified, accountable governance. A Cabinet Secretariat–anchored entity with formal MoUs, joint action plans, and clear KPIs can institutionalize coordination across ministries and states, ensuring sustained momentum.

- **Integrated financing, monitoring, and technology systems can unlock scale and accountability:** With the right enablers, performance-based allocations, AI-powered monitoring, and market-based incentives, India can transform its air quality management from reactive spending to outcome-oriented investment. For instance, Gujarat's emissions trading scheme, supported by real-time monitoring, led to significant pollution reductions in participating factories.
- **Embedding citizen engagement and transparency into the ecosystem can strengthen compliance and trust:** Community-led monitoring, behavior-focused interventions, and real-time data access can help bridge the gap between top-down policies and ground-level action. These elements not only drive compliance but also foster a sense of ownership, making clean air a shared public value rather than a regulatory obligation.

At the same time, several challenges undermine effective enforcement and accountability for air pollution control:

- **Institutional resistance and mandate protectionism may delay cross-ministerial alignment:** Existing ministries and departments may be reluctant to cede control or align under a central coordinating body due to jurisdictional turf, legacy systems, and political sensitivities. Without high-level political backing and formal accountability mechanisms, a mission-mode structure may remain symbolic rather than operationally transformative.
- **Weak incentive design and fragmented funding flows could limit impact and adoption:** While performance-based and market-linked tools (like emissions trading) show promise, their success hinges on robust baseline data, trust in enforcement, and clarity on financial flows. Many states may lack the institutional maturity or digital infrastructure to manage and disburse funds linked to measurable environmental outcomes, risking token compliance rather than genuine improvement.
- **Citizen fatigue, misinformation, and lack of localized platforms may dilute engagement:** Sustained public participation depends on timely, actionable, and hyperlocal information. Without adequate investments in awareness-building, feedback loops, and trust-building with communities, engagement efforts may stagnate or become performative. There's also the risk of citizen-led data being disregarded by authorities or misused in political conflicts.

Key Insights from Dr. Virinder Sharma's address

Institutional reform is more critical than institutional expansion

- **New institutions alone will not guarantee cleaner air without fixing existing systems.** Dr. Virinder Sharma emphasized that in a multisectoral and multijurisdictional context like air quality governance, the focus must be on re-engineering current agencies with clear mandates, roles, and accountability structures rather than creating new entities.

CAQM as a model for cross-sector statutory coordination

- **CAQM demonstrates how unified regulatory bodies can integrate diverse stakeholders.** He described how the Commission brings together central ministries, state governments, local authorities, scientific institutions, and civil society to act under a single statutory framework, having issued over 90 directions and 17 advisories to coordinate action.

Regulatory compliance must be backed by enforcement and incentives

- **Performance penalties and accountability mechanisms drive real-world compliance.** Citing enforcement examples in Punjab and Haryana, Dr. Sharma outlined how tools like penalties, show-cause notices, and complaint tracking systems were used to ensure nodal officers and district collectors delivered tangible results.

Data systems are foundational to effective planning and reporting

- **Air quality governance must be grounded in real-time, localized data.** He showcased how dense monitoring networks, early warning systems, and audits of dispersed pollution sources—especially in the NCR—have become essential to both policy planning and transparent reporting.

Public understanding and engagement are essential to systems change

- **Air quality data must be made relevant to people's health and daily lives.** Dr. Sharma concluded by calling for communication strategies that translate technical data into health-based messaging, particularly for vulnerable populations, to foster long-term behavioral and institutional shifts.

Key Insights from the Panel Discussion

Institutional fragmentation continues to limit integrated air quality governance

- **Overlapping mandates and weak coordination pose challenges in effective implementation.** Panelists noted that despite the existence of multiple institutions and legal frameworks in India, unclear lines of accountability and limited inter-agency coordination can pose challenges to cohesive air quality action.

Localized leadership and community engagement are essential for impact

- **Air quality solutions must center municipal leaders and people's participation.** The

panel emphasized that technical and regulatory approaches alone are insufficient, especially in non-attainment cities, where tailored, community-responsive governance is needed to drive real progress.

National frameworks must allow for local adaptation and flexibility

- **One-size-fits-all policies are inadequate for diverse regional contexts.** Panelists argued for a balanced model where cities and states have flexibility to adapt standard operating procedures and implementation timelines while still aligning with national clean air goals.

Judicial interventions must be followed by stronger implementation mechanisms

- **The courts have played a catalytic role, but enforcement faces challenges.** While legal directions on air pollution are extensive, panelists pointed out the challenges in effective on-ground implementation, highlighting the importance of carrying capacity studies and enforceable regulatory limits in high-pollution zones.

Clean air is not just an environmental issue but a development opportunity

- **Air quality action can unlock economic and public health benefits.** Drawing from both Indian and international examples, panelists framed clean air as a lever for green jobs, resilient growth, and healthier communities, stressing the need for long-term institutional alignment and sectoral convergence to achieve these outcomes.

OPPORTUNITY SHOWCASE

Clearing the Air: Transforming Power and Industry

Ujjwal Bhattacharya
Former Director (Projects & Technical), NTPC Limited

The session titled ***"Clearing the Air: Transforming Power and Industry"*** featured a keynote showcase by **Ujjwal Bhattacharya** (Former Director, Projects & Technical, NTPC). The session focused on the evolution of air pollution control measures in India's thermal power sector, spotlighting retrofits like Flue Gas Desulfurization (FGD) and advanced emission control systems. It unpacked the challenges, costs, and regulatory pathways that are reshaping how legacy coal-based power plants comply with new environmental norms.

Key Insights from Ujjwal Bhattacharya's address

Balancing energy security and environmental responsibility in the power sector

- **Coal-fired power remains central to India's energy needs but carries major pollution burdens.** Bhattacharya emphasized that while coal is vital and affordable for base load

generation, it contributes significantly to SOx, NOx, SPM, and mercury emissions that require urgent mitigation.

- **Retrofitting thermal plants with FGDs is critical for pollution control.** He argued that Flue Gas Desulfurization systems are essential to reduce emissions without compromising energy reliability, particularly as India expands its power infrastructure.

Evolution of regulatory norms and India's graded compliance regime

- **Emission standards have tightened over time, but implementation remains staggered.** Since 2015, thermal power plants have faced increasingly stringent SOx norms, but compliance deadlines have been repeatedly adjusted due to limited suppliers, retrofitting complexities, and COVID-related delays.
- **A penalty-based regime now incentivizes compliance while allowing transitional flexibility.** The current framework applies graded penalties based on plant size, location, and regional air quality, while offering conditional exemptions for units scheduled for retirement by 2030.

Techno-economic rationale for India's FGD strategy

- **India's FGD choices are grounded in technical testing and economic pragmatism.** Bhattacharya shared that NTPC has awarded FGDs for over 68 GW of capacity, with ~22 GW already commissioned, prioritizing wet limestone FGDs for high-PLF plants due to long-term cost efficiency and ~90% SO2 reduction.
- **Technology selection is tailored to plant performance and site context.** Dry sorbent injection, while cheaper in upfront cost, has higher operating expenses and is more suited for low-PLF plants. Despite low sulphur content in Indian coal, its high calorific value

still results in high SO2 emissions, making FGD adoption essential.

Dispelling myths about the cost of emission controls

- **FGDs are far more affordable than commonly believed.** Bhattacharya refuted claims that FGDs would raise tariffs by ₹2–3/kWh, presenting NTPC data that shows an actual average cost impact of just ₹0.23/kWh—comprising ₹0.18 in capital expenditure and ₹0.05 in operational cost.
- **Emission control systems offer significant co-benefits for air quality.** Beyond SO2 reduction, FGDs also cut SPM, mercury, and secondary PM2.5 by ~50% through SO4 conversion, thus delivering substantial improvements in ambient air conditions.

Urgency of implementation and sectoral responsibility

- **Delays must be resisted.** Bhattacharya urged the sector to avoid delays and focus on evidence-based, timely implementation of emission controls.
- **The power sector must lead with calibrated investments and commitment to norms.** He concluded that India's environmental credibility hinges on the power industry's ability to adopt proven technologies and uphold its responsibility through science-backed compliance.

IMMERSIVE DISCUSSION

Turning the Tide: Delhi's Moment to Lead on Clean Air

Bhupinder Bhalla
Former Secretary, Ministry of New and Renewable Energy (MNRE)

Sanjiv Kumar
Chairman, Delhi Pollution Control Committee

Ambuj Sagar
Deputy Director (Strategy & Planning), IIT Delhi (moderator)

The session titled "***Turning the Tide: Delhi's Moment to Lead on Clean Air***" brought together key leaders including **Bhupinder Singh Bhalla** (Former Secretary, MNRE) and **Sanjiv Kumar** (Chairman, Delhi Pollution Control Committee), and was moderated by **Ambuj Sagar** (Deputy Director, Strategy & Planning, IIT Delhi). The discussion unpacked Delhi's unique governance challenges and opportunities in tackling air pollution. While reaffirming Delhi's political resolve, the panel reflected on the complex, multi-agency landscape that often hinders progress and emphasized the need for a coordinated airshed approach to combat shared pollution sources across NCR. The session underlined that Delhi's leadership moment lies in making governance seamless, science-led, and responsive across jurisdictions.

Context for the Panel Discussion

Delhi's air pollution is a regional public health crisis that imposes a significant economic burden and requires an airshed approach. Despite some gains, Delhi remains India's most polluted megacity, with annual PM2.5 levels 20 times the WHO guideline.[52] In winter, up to 40%

52.Urban Emissions, What Is Polluting Delhi's Air?, 2023

of its pollution originates outside Delhi's boundaries, driven by stubble burning and regional emissions.[53] Within city limits, sources like transport, construction, and residential combustion compound the crisis, leading to complex, overlapping pollution patterns. The impact is severe, with air pollution raising health expenditure to ~USD 17 (₹1,403) per person,[54] incurring a productivity loss of ~ USD 430 million over three months and costing the city nearly 6% of its GDP each year through health expenses and productivity losses.[55]

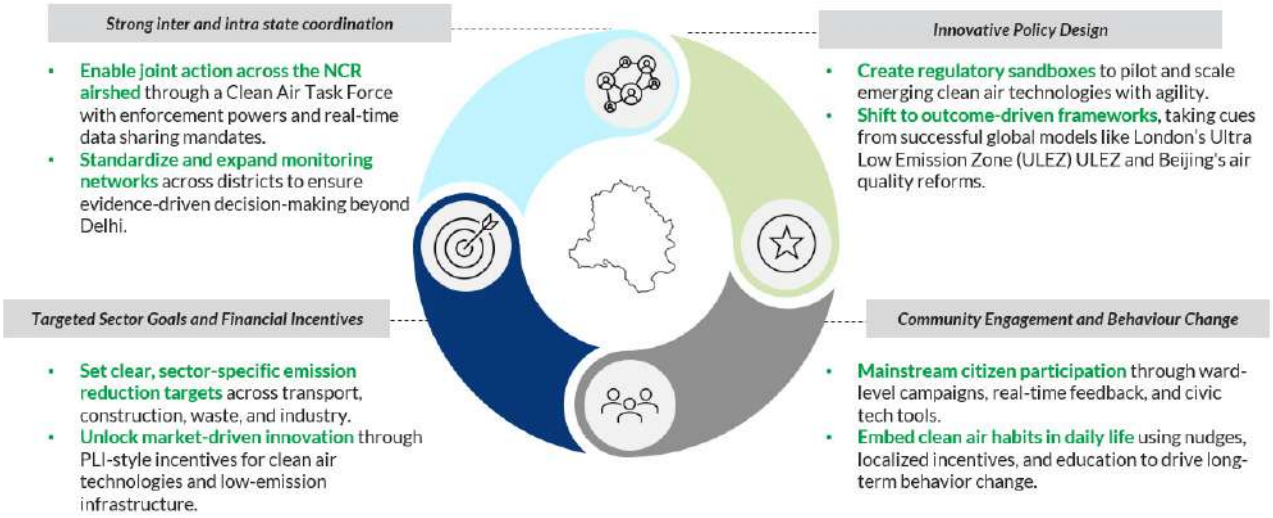
Despite high-profile policy interventions, progress has been incremental and uneven. While Delhi's PM2.5 levels declined from 115.8 µgg/m³ in 2018 to 100.9 µg/m³ in 2023, the rate of improvement remains slow.[56] Initiatives like GRAP, the Odd-Even scheme, and the 2020 EV policy have shown localized benefits, but sustained gains remain elusive. Broader efforts across NCR have also lagged, despite the extension of several policies beyond city borders.

Delhi's clean air efforts are constrained by institutional fragmentation, weak regional coordination, and a short-term crisis response mindset. Multiple agencies, including DPCC, SDMC, DDA, PWD, and the Transport Department, hold overlapping mandates, which leads to unclear accountability and fragmented implementation. Sectoral enforcement is uneven: PUC compliance remains below 30%, construction dust norms are routinely violated, and informal industries continue to burn coal and biomass due to lack of oversight. Despite CAQM's mandate to coordinate regional action, enforcement across NCR varies by state, with inconsistent application of GRAP measures, fuel bans, and vehicular emission norms. Clean air planning often focuses on reactive measures during peak pollution months, with limited year-round action. Programs are siloed from other urban systems like transport, planning, and health, and funding streams remain fragmented across state, municipal, and central agencies. Moreover, tools like the Air Quality Early Warning System and Decision Support System are not fully integrated into operational protocols, limiting their impact on day-to-day decision-making.

A future-ready solution framework must integrate coordination, innovative policy, sectoral reform, and citizen engagement. Establishing a Delhi-NCR Clean Air Task Force, with pooled funding, clear mandates, and shared monitoring, can drive coordinated implementation across city and state boundaries. Innovative policies like low emission zones and tools like regulatory sandboxes can enable rapid testing of new approaches, from dynamic emission norms to outcome-based incentives. Sector-specific emissions targets, for example under NCAP, combined with incentive-based programs like production-linked incentives (PLI) or tax rebates, can spur private investment. Digital tools can support compliance monitoring and data-driven planning across sectors. Equally important is embedding citizen engagement in program design: integrating waste segregation into municipal service delivery, expanding hyperlocal air quality monitoring with communities, and enabling participatory budgeting for clean air can help build trust and accountability.

53.PubMed Central, Stubble-burning activities in north-western India in 2021: Contribution to air pollution in Delhi, 2023
54.NCAER, Health and Economic Impact of Air Pollution in Delhi, 2023
55.CREA, Revealing the Cost of Air Pollution in World's Cities – in Real Time, 2020
56.Energy Policy Institute, Odd-even scheme makes a comeback as Delhi chokes on pollution, experts question efficacy, 2023

Figure 5: An illustrative four-pronged strategy to address Delhi's clean air challenge



Potential Opportunities and Challenges

The opportunities that can be realized by effectively combatting Delhi's air pollution crisis include:

- **Unlocking $4-5 billion in annual economic gains through a binding airshed governance model:** Formalizing a legally backed regional framework, anchored in joint emission targets, pooled funding, and synchronized action plans, could reduce the ~$4-5 billion[57] in annual economic losses Delhi NCR faces from air pollution-linked productivity and health costs.
- **Catalyzing a $2.5–3 billion investment opportunity through structural sectoral reforms:** Transport electrification, fuel switching, decentralized waste systems, and green infrastructure can drive multi-year investments in Delhi, with $2.5–3 billion in Delhi's transport sector alone over the next decade.
- **Unlocking private sector participation in regional clean air initiatives:** Mandating ESG-linked disclosures, enabling green procurement, and using blended finance can mobilize private capital for clean air efforts.
- **Establishing Delhi as a national sandbox for air pollution solution pilots:** By formalizing Delhi as a regulatory sandbox for pollution mitigation technologies and behavioral interventions, the city can accelerate the deployment, validation, and scaling of high-potential solutions.
- **Positioning Delhi as a national leader in regional airshed governance:** Early success through joint planning, pooled funding, and aligned enforcement can establish Delhi as a model for managing transboundary pollution.

Key challenges would have to be overcome to leverage these opportunities:

- **Fragmented political mandates and weak inter-state accountability mechanisms stall regional action:** Without binding

57.NCAER, Health and Economic Impact of Air Pollution in Delhi, 2023

targets or shared accountability, the influence of institutions like CAQM remains limited across divergent state priorities.

- **Lack of catalytic financing structures to de-risk and scale structural sectoral investments:** Sectoral investments remain underfunded, with minimal use of blended finance or green bonds to attract private capital.
- **Absence of integrated, legally binding early warning-to-action protocols across key pollution sectors:** Despite robust 48–72 hour air quality forecasts, Delhi lacks enforceable sector-specific protocols (e.g., construction curbs, transport restrictions, power plant operational limits) that automatically trigger preventive actions before pollution spikes.
- **Inadequate regulatory frameworks to link corporate ESG ambition with regional clean air outcomes:** Despite growing ESG disclosure, there is no clear mechanism tying corporate action to regional air quality goals, such as emissions-linked incentives or procurement preferences.
- **Weak innovation governance and fragmented research-to-market pathways for clean air technologies:** Clean air innovation efforts in Delhi are isolated across multiple institutions, with no dedicated funding mechanisms, incubators, or scale-up pathways to systematically nurture startups, R&D programs, and deployment pilots in air quality management technologies.

Key Insights from the Panel Discussion

Delhi's leadership potential hinges on inter-agency coherence and airshed thinking

- **Delhi has made regulatory progress, but fragmented governance limits impact.** Panelists emphasized that despite policy advances, the challenges in coordination across institutions continues to hinder the full implementation of air quality measures.

Multiplicity of authorities slows basic air quality interventions

- **Overlapping mandates obstruct execution of even simple pollution controls.** Speakers

pointed out that more than five agencies manage Delhi's roads, complicating efforts like street sweeping or enforcement of dust-control norms due to unclear or competing responsibilities.

Political leadership is essential to overcome institutional silos

- **High-level coordination is needed to align departments and drive accountability.** The discussion proposed regular reviews led by the Chief Minister or Lieutenant Governor to break through bureaucratic fragmentation and ensure consistent implementation of clean air strategies.

Monitoring infrastructure must be paired with real-time source attribution

- **Delhi's extensive monitoring systems are under-leveraged without regional context.** While the city operates over 40 continuous monitoring stations, speakers noted that the limited availability of comparable data from surrounding regions can constrain a fuller understanding of regional air quality dynamics and make coordinated enforcement more challenging.

Technology can enhance compliance, but gaps in transparency and automation persist

- **Advanced tools are being used, but broader systemic improvements are still needed.** Panelists shared examples such as AI-based site monitoring and vehicle tracking, but underscored the ongoing need for cost-effective sensors, open data systems, and timely public alerts to ensure effective compliance and citizen engagement.

An NCR-wide airshed strategy is essential for long-term impact

- **Delhi cannot solve its air crisis without coordinated regional action.** The panel stressed that with major contributors like farm fires and regional power plants located outside Delhi, shared data systems, institutional mechanisms, and joint action with NCR states are the only viable path forward.

KEYNOTE ADDRESS

Beyond the Borders: Advancing Airshed Action for Clean Skies

Auguste Tano Kouamé
Country Director for India, World Bank

The session titled "***Beyond the Borders: Advancing Airshed Action for Clean Skies***" featured a keynote address by **Auguste Tano Kouamé** (Country Director for India, World Bank), who reinforced the urgency and opportunity of integrating airshed-based approaches into India's national development priorities. Drawing on global lessons and regional modeling, he emphasized that clean air is both achievable and economically beneficial, with India well-positioned to lead the charge through coordinated action, targeted investment, and institutional reform. The session called for deeper collaboration across states and sectors in the Indo-Gangetic Plain, framing clean air not just as a health and environmental priority, but as a pillar of economic growth and regional cooperation.

Key Insights from Auguste Tano Kouamé's address

Air pollution as a global health, economic, and development crisis

- **Air pollution is both a massive public health threat and economic burden.** Kouamé noted that over 90% of the world's population lives in areas exceeding WHO pollution standards, with PM2.5 contributing to 5.7 million global deaths annually and costing 5–6% of global GDP.
- **India faces particularly severe impacts**

from air pollution. With half its population exposed to hazardous PM2.5 levels, India loses an estimated $95 billion annually—roughly 3% of its GDP—making clean air not just an environmental concern but a pressing national development priority.

- **Clean air is a fundamental right and development imperative.** He emphasized that the World Bank's new mission, "ending poverty on a liveable planet," places clean air at the heart of development, framing it as a cornerstone for sustainable progress.

The Indo-Gangetic Plain as the epicenter for coordinated airshed action

- **Pollution in the Indo-Gangetic Plain crosses borders and defies isolated efforts.** Kouamé stressed that over 50% of PM2.5 in any given location in this region often originates elsewhere, making cross-state collaboration essential for effective action.
- **Without coordination, even the most proactive states will fall short.** He warned that state-level initiatives must be complemented by a shared airshed strategy to address transboundary pollution flows and avoid undermining local efforts.

A clear target and actionable roadmap for clean air

- **"35 by 35" is a bold but feasible goal for India's clean air transition.** Kouamé proposed reducing average PM2.5 to 35µg/m³ by 2035, supported by World Bank modelling and a mix of targeted actions, state capacity building, and coordinated policy across airsheds.
- **India already has strong policy tools to build on.** He cited the National Clean Air Programme, finance commission incentives, PM eBus SEWA, and Swachh Bharat as foundational programs to drive clean air progress.
- **A three-pronged strategy of capacity, targeted action, and cooperation is critical.** He called for strengthening state institutions, addressing major pollution sources like transport, agriculture, and industry, and fostering cross-sector, cross-border collaboration—while stressing that implementation should not be delayed by coordination gaps.

Clean air as a catalyst for economic growth and job creation

- **Lower pollution levels will drive higher productivity and investor confidence.** Kouamé emphasized that clean air will enhance labor efficiency and contribute to economic dynamism, advancing India's vision for a "blue skies economy."
- **Clean air action can create millions of new jobs.** He stated that implementing the NCAP alone could generate two million jobs, positioning clean air as a central pillar of India's ambition to become Viksit Bharat by 2047.

World Bank support for India's clean air transformation

- **The World Bank is ready to support India through finance and technical expertise.** Kouamé outlined support for state-level air quality management projects and broader climate investments in areas like solar, green hydrogen, freight corridors, cooling, and methane mitigation.
- **The Bank is helping build shared commitment and regional platforms.** He highlighted partnerships to convene states and scale knowledge platforms like ICIMOD, and reaffirmed the value of forums like Aironomics in aligning stakeholders.
- **A hopeful future with clean air is within reach.** In closing, he envisioned a day when children across the Indo-Gangetic Plain can "see through the clean air a brighter future," affirming the World Bank's strong commitment to partnering with India on this journey.

IMMERSIVE DISCUSSION

AirGPT: Data & Technology at the Heart of Air Quality Management

Rajan Handa
Managing Director,
OK Play

Rai Mahimapat Ray
Senior Digital Specialist, South Asia Region, The World Bank

Ronak Sutaria
Founder & CEO, Respirer Living Sciences

Suwarn Pant
Head Product Planning, EV, Tata Motors

Nishant Idnani
Managing Director, Vaultus Green Funding (moderator)

The session titled "***AirGPT: Data & Technology at the Heart of Air Quality Management***" featured a dynamic discussion on the role of emerging technologies in transforming how India monitors, manages, and mitigates air pollution. Moderated by **Nishant Idnani** (Managing Director, Vaultus Green Funding), the panel included **Rajan Handa** (Managing Director, OK Play), **Rai Mahimapat Ray** (Senior Digital Specialist, South Asia Region, The World Bank), **Ronak Sutaria** (Founder & CEO, Respirer Living Sciences), and **Suwarn Pant** (Head Product Planning, EV, Tata Motors). Panelists showcased innovations across AI-enabled enforcement, smart

filtration systems, EV ecosystem planning, and low-cost sensor networks, highlighting how tech-led approaches can enhance institutional capacity, enable real-time action, and build scalable, citizen-centric solutions for clean air across cities and sectors.

Context for the Panel Discussion

Data and technology are reshaping air quality management in India. Since the launch of NCAP, India has rapidly expanded its monitoring infrastructure, deploying over 400 CAAQMS stations,[52] mobile monitors, low-cost IoT sensors, and public tools like SAMEER and SAFAR. Technologies like AI, satellite analytics, and smog-control devices are being piloted to enhance monitoring, enforcement, and abatement. For instance, the Delhi government's Green War Room integrates camera feeds, air quality data, and on-ground patrols to identify and penalize violators.

Figure 6: Harnessing Tech, Data and AI Across AQM Pillars

Low-cost sensors and mobile monitoring systems are enabling hyperlocal data and bridging critical gaps. Under projects like AMRIT, LCS networks are expanding across underserved areas. Cities like Mumbai and Hyderabad are building dense, real-time pollution maps by integrating satellite, mobile, and ground data, supporting evidence-based planning and action.

Citizen-facing platforms are enhancing awareness and accountability. Platforms like SAFAR deliver 1–3 day air quality forecasts along with health advisories. the SAMEER app, developed by CPCB, provides real-time air quality data and violation reporting, with over 1 million downloads to date. In Delhi, the Green Delhi app has enabled citizens to file over 84,000 pollution complaints, achieving an 87% resolution rate through geotagged reporting and digital tracking systems[53]. There is potential to further deepen engagement by expanding wearable alerts, integrating citizen data into dashboards, and enabling two-way feedback systems.

Digital enforcement is enabling smarter compliance. Tools like drones, CEMS, and satellite imagery

52.Urban Lab - Centre for Science and Environment Analysis, Status of air quality monitoring in India: Spatial spread, population coverage and data completeness, 2023
53.The New Indian Express, Government records over 84K pollution complaints via Green Delhi App this year, 2024

are being used to detect violations in real time. Gujarat's particulate matter trading scheme and Jaipur's NB-IoT deployment show how technology can enable automated compliance systems. India can build on its early pilots by scaling up IoT-based real-time monitoring across high-emission sectors such as construction, small-scale industry, and transport, with China's "Blue Sky" program, which deploys AI-enabled video analytics and satellite surveillance, offering a compelling model.

Technology-driven abatement solutions offer promising but nascent options. Smog guns, air purifiers, and building-integrated filtration systems are being piloted in high-exposure zones like traffic corridors and construction sites. While evidence on their long-term effectiveness remains limited, these solutions can help manage hyperlocal pollution peaks. Embedding such technologies into urban infrastructure plans, and optimizing their use through AI-enabled deployment and performance tracking, can support more responsive and targeted abatement in dense city environments.

Potential Opportunities and Challenges

The opportunities that can be realized through the effective integration of data and technology in India's air quality management include:

- **Unlocking a ~$380 million domestic market for air quality monitoring and data solutions:** Rising demand from NCAP, smart cities, and ESG-linked reporting can catalyze a domestic market estimated at $380 million by 2030 for sensors, data platforms, and analytics services.[54]
- **Enabling real-time regulatory action through digital enforcement infrastructure:** Scaling tools like CEMS and IoT sensors can reduce enforcement delays, as seen in Rajasthan's NB-IoT pilots.
- **Activating neighborhood-level clean air governance through hyperlocal sensor networks:** Localized monitoring, like Hyderabad's ward-level dashboard, can empower communities and drive targeted interventions in high-risk zones.
- **Partnering with private players and platforms to integrate air quality information into everyday services:** Collaborations with major tech players like Google and Apple can embed real-time air quality data into widely used platforms such as Google Maps and search engines, encouraging behavior change and supporting citizen awareness.
- **Positioning India as a testbed for AI-driven pollution abatement technologies in dense urban zones:** With over 63 Indian cities exceeding national PM2.5 standards by more than 200%, there is a strong case to scale air-sucking towers, smog guns, and building-integrated systems in pollution hotspots.

Key challenges would have to be overcome to leverage these opportunities:

- **High costs and limited financing options hinder the scale-up of emerging AQM technologies:** Expensive technologies lack funding instruments and MRV (Monitoring, Reporting and Verification) frameworks to attract climate finance.
- **Fragmented digital infrastructure weakens real-time enforcement:** Absence of a national digital backbone and reliance on siloed systems limit coordinated action.
- **Limited sensor coverage and data quality hinder hyperlocal interventions:** Many cities, especially smaller non-attainment ones, lack dense, calibrated sensor networks. Where LCS exist, maintenance, validation, and data reliability issues prevent from full integration.
- **Institutional capacity gaps stall sector-specific digital compliance:** SPCBs and ULBs often lack lack the skilled staff and IT systems needed for digital compliance tools like CEMS, e-logbooks, or automated inspection systems.

54.Grand View Research, India air quality monitoring system market size & forecast

- **Citizen-facing tools remain underutilized due to poor design and low trust:** Citizen engagement platforms or portals suffer from low uptake and limited two-way communication. Without visible government responsiveness to complaints, trust in these tools remains weak.

Key Insights from the Panel Discussion

Digital technologies as enablers of smarter air quality management

- **AI, sensors, and real-time platforms are transforming air governance.** Panelists highlighted that digital tools are supporting more accurate data collection, targeted enforcement, and multi-level coordination—from schools and industrial sites to state policy interventions.

Credible, integrated data systems are essential to drive action

- **Fragmented and unreliable data remains a core governance barrier.** Despite wide knowledge of pollution sources, speakers noted that the absence of unified and trusted data systems limits the effectiveness of both institutional responses and community participation.
- **AI platforms are helping integrate diverse data sources into insights.** These systems combine inputs like images, sensor readings, and satellite data to generate actionable intelligence for regulators and citizens alike.

AI and sensors are enabling predictive enforcement and hyperlocal interventions

- **Smarter systems are making enforcement proactive, not reactive.** Examples included Haryana's proposed $500M SPV using AI to flag construction violations and low-cost sensor networks identifying micro-level hotspots for targeted mitigation.
- **Digital monitoring enables preemptive responses to pollution peaks.** Speakers shared interventions such as halting construction activity or rerouting school buses in advance, based on predictive insights from AI and sensor data.

Real-time purification as a near-term safeguard for vulnerable populations

- **Air purification deployments are providing measurable short-term relief.** In schools and other high-priority sites, panelists cited examples where real-time purification led to up to 80% reductions in PM2.5 levels, offering protection as long-term solutions are scaled.

Citizen-centric, interoperable data systems are key to accountability

- **Air quality data must function as trusted public infrastructure.** Panelists argued for data systems that are accessible, interoperable, and co-owned by institutions and citizens, with analogies drawn to platforms like ONDC.
- **Proposals included decentralized sensors and localized integration.** Suggested models included open networks for air quality, community-owned sensors, and linking air data to public services and real estate indicators to drive transparency and action.

Technology must be matched with collaborative governance to scale impact

- **The challenge is no longer technology, but societal coordination.** Panelists emphasized that platforms enabling collaboration across public, private, and citizen stakeholders are now critical to move from pilots to large-scale clean air outcomes.

KEYNOTE ADDRESS

Cultivating Change: Punjab's Path to Clean Air

Adarsh Pal Vig
Former Chairman, Punjab
Pollution Control Board

The session titled "***Cultivating Change: Punjab's Path to Clean Air***" featured a keynote address by **Dr. Adarsh Pal Vig** (Former Chairman, Punjab Pollution Control Board). The session spotlighted Punjab's multi-pronged strategy to combat air pollution, particularly from stubble burning, through a combination of in-situ and ex-situ crop residue management, industrial fuel transitions, and farmer-centered behavioral change. Dr. Vig highlighted the state's shift toward systems-level approaches that integrate environmental stewardship with economic opportunity, positioning Punjab as a national leader in agricultural emissions reduction and clean air innovation.

Key Insights from Dr. Adarsh Pal Vig's address

Systemic approaches over superficial fixes in Punjab's clean air journey

- **Punjab has prioritized systemic, people-centric solutions over techno-centric fixes.** Dr. Vig called for environmental ethics, indigenous practices, and self-regulation, while discouraging blame games and overreliance on monitoring technologies.

- **The state has achieved an 84% reduction in stubble burning over four years.** He cited this progress as a national benchmark, driven by a mix of in-situ practices like mulching and biomass incorporation, and ex-situ strategies such as the expansion of pelletization plants and industrial substitution of coal with crop residue.

Behavior change and farmer recognition as levers for crop residue management

- **Punjab's approach focused on behavioral incentives rather than penalties.** Instead of punishing farmers who burned residue, the state honored non-burning farmers as "heroes" and scaled recognition at the district level to promote voluntary adoption.
- **Targeted investment and CER funding enabled machinery access and adoption.** Dr. Vig noted that ~USD 6.5 million (₹55 crore) was invested in farm equipment, supported by Corporate Environmental Responsibility funds, contributing to the goal of managing 8 million tonnes of crop residue ex-situ in the upcoming season.

Scaling industrial transitions through cleaner fuel use

- **Industrial zones like Mandi Gobindgarh are shifting away from coal.** Dr. Vig highlighted that hundreds of units have already transitioned to cleaner fuels such as natural gas, even under economic pressure, illustrating that large-scale industrial change is feasible.

Reclaiming traditional practices and cultural introspection

- **"Modern" air solutions must be complemented by indigenous methods.** Dr. Vig critiqued the overuse of technologies like air purifiers and advocated for long-standing Indian practices such as tree planting, water sprinkling, and natural zoning as enduring solutions.
- **Pollution is a matter of behavior and cultural priorities, not just economics.** He argued for institutional convergence and a societal reorientation that places environmental values at the core of decision-making and everyday habits.

A call for collective, non-partisan environmental ownership

- **Air belongs to no one and must be protected by all.** Dr. Vig concluded by affirming that the environment, like Punjab and Delhi, is a shared responsibility. "Environment first," he said, "everything else can follow."

IMMERSIVE DISCUSSION

Clean Air Starts with Us: People-Led Pathways to Cleaner Air

Bharati Chaturvedi
Founder and Director, Chintan

Indrajit Chaudhuri
CEO and Country Director, PCI

Emani Kumar
Deputy Secretary-General of ICLEI and Executive Director, ICLEI South Asia

Rakesh Thukral
CEO APAC, Edelman (moderator)

The session titled "***Clean Air Starts with Us: People-Led Pathways to Cleaner Air***" brought together voices from civil society, local governance, and development organizations to explore how citizen engagement and local leadership can drive lasting air quality improvements. Moderated by **Rakesh Thukral** (CEO, APAC, Edelman), the panel featured **Bharati Chaturvedi** (Founder & Director, Chintan), **Indrajit Chaudhuri** (CEO & Country Director, PCI), and **Emani Kumar** (Deputy Secretary-General, ICLEI and Executive

Director, ICLEI South Asia). The conversation focused on community-led behavior change, trust-based program design, and institutional strategies for scaling clean air initiatives through people-first approaches.

Context for the Panel Discussion

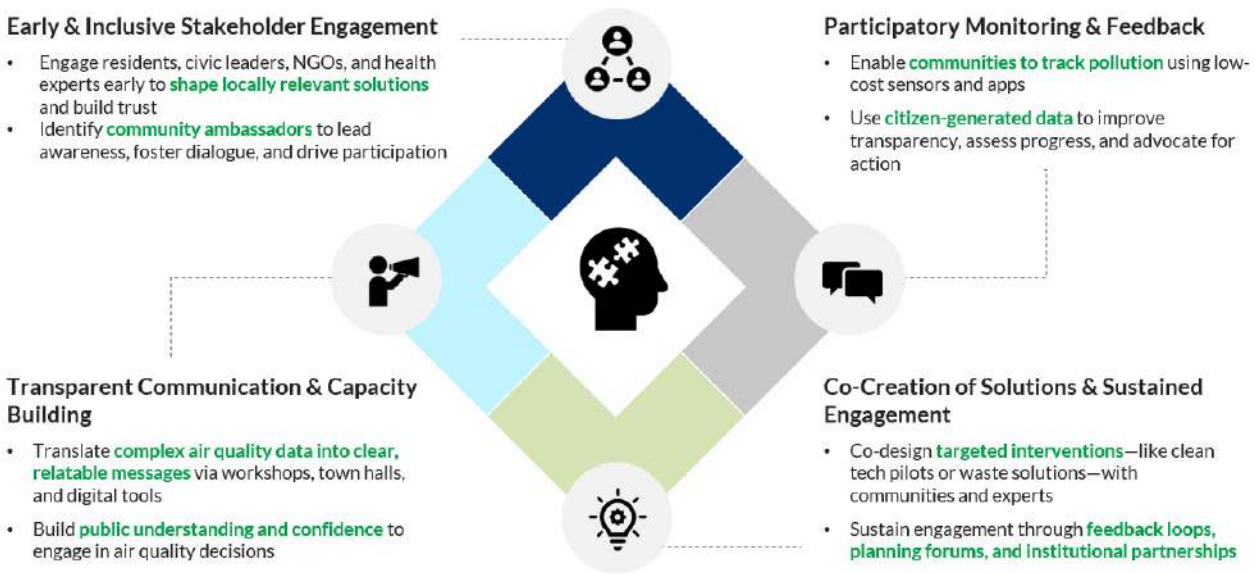
Clean air is unachievable without people-led action. India's air pollution crisis is shaped not just by policy or technology gaps, but by everyday behaviors such as crop burning, biomass cooking, and waste mismanagement. While programs like NCAP and PMUY have expanded clean air infrastructure, adoption is uneven. Many households return to traditional fuels due to cost or habit, and farmers hesitate to adopt stubble solutions given low trust and inadequate incentives.

Community-led models across India show that behavior change is possible when driven by trust and local ownership. In cities like Bengaluru, Indore, and Patna, citizen groups have used air quality monitors and sensor networks to generate local data and drive change. In Bengaluru, citizen groups installed 30 air quality monitors in schools and hospitals to inform local advocacy. In Indore and Patna, community sensor networks led to hyperlocal data and targeted interventions.

Global examples underscore how civic engagement can shift systems and policy. In cities like Jakarta, a citizen-led lawsuit involving 31 residents, backed by over 26,000 public signatures and support from health professionals and parents, compelled the government to commit to air quality reforms.[52] In Belgium, a parent-driven movement used air quality monitoring across 200+ schools to advocate for street closures during school hours, prompting municipalities to adopt traffic restrictions near schools as official policy.

A robust behavior change framework must anchor clean air efforts in four core pillars: early engagement, transparent communication, participatory monitoring, and co-created solutions. Early engagement fosters trust and ensures that interventions reflect community needs. Transparent communication makes technical information understandable, through town halls, community facilitators, and localized campaigns. Participatory monitoring, such as citizen-led air sensors or visual audits, builds awareness and accountability. Most importantly, co-created solutions, developed in partnership with local actors, ensure sustained ownership and practical relevance.

Figure 7: An illustrative community engagement and behavior change framework to reduce air pollution



52.Greenpeace, Here's how people power is tackling air pollution, 2020

To translate behavior change frameworks into action, India must address a core barrier: the limited capacity of local governments to lead and sustain community-led clean air efforts. Municipalities face staff shortages, limited participatory structures, and fragmented funding. National programs like NCAP offer guidance but cannot substitute for grassroots engagement. Cross-sector partnerships with civil society, academia, and community networks are essential to embed this framework into local systems. Models like Earth5R's community-led advocacy efforts show how citizen engagement can be institutionalized and scaled.

Potential Opportunities and Challenges

The opportunities for citizen engagement for clean air solutions in India include:

- **Scalable emissions reduction through behavior change:** Shifts in everyday practices like clean cooking, public transport use, and dust control can drive measurable emissions cuts.
- **Lower cost of implementation through community stewardship:** Citizen-led initiatives in waste and green space management, as seen in Pune and Indore, can reduce municipal costs by 15–50%.[53]
- **Improved monitoring density and data granularity:** Community sensor networks, like Bengaluru's 50+ low-cost monitors, supplement official systems and enable faster, localized action.[54]
- **Economic uplift through green livelihoods:** Community roles in waste collection, awareness, and monitoring create income opportunities, as demonstrated by the NGO's Hasiru Dala's support to over 5,000 waste workers.
- **Strengthened policy compliance through participatory governance:** Citizen monitoring and reporting, as seen in Delhi's civil society groups like Help Delhi Breather and Jhatkaa.org, improve enforcement and public accountability.

Key challenges would have to be overcome to leverage these opportunities:

- **Awareness is broad, but actionability is low:** Citizens often lack clear, local guidance on what actions to take or how their efforts create impact.
- **Social norms and affordability slow adoption:** Practices like biomass burning persist due to habit and cost, requiring alternatives or incentives to shift behavior.
- **Policies lack room for grassroots leadership:** Top-down approaches limit community participation, weakening trust and long-term ownership.
- **Community access to data remains limited:** Air quality information is often too centralized or technical for use in local decision-making or advocacy.
- **Grassroots initiatives struggle to scale:** Many successful pilots remain isolated due to short-term funding, lack of institutional support, or weak integration with city and state programs.

Key Insights from the Panel Discussion

Citizen action is rooted in dignity, data access, and participation

- **Collective movements succeed when communities are treated with dignity and engaged repeatedly.** Panelists shared examples like clean air efforts in Ayodhya and waste picker networks, where local data, collaboration with schools and doctors, and sustained engagement were key enablers of action.

Public awareness is uneven and shaped by socioeconomic context

- **Vulnerable populations often struggle to link pollution with health.** Speakers noted that rural and informal communities frequently normalize pollution or view it as unavoidable, while informal workers sometimes fear clean technologies may threaten their livelihoods.

53.Godrej, Scaling our Waste Mountains: Fixing Solid Waste Management in Indian Cities, 2023
54.Citizen matters, PM2.5 pollution: Why Bengaluru urgently needs hyperlocal air quality monitoring, 2025

- **Urban youth demonstrate higher awareness but gaps remain.** The panel observed that while some groups, like urban students, show better understanding of air quality issues, many others are left behind by standard awareness approaches.

Community data tools can catalyze participation and accountability

- **Accessible and hyperlocal air quality data activates local action.** When data is made actionable, citizens are more likely to report violations, adopt safer practices, and hold institutions accountable, as seen in models like Ahmedabad's grievance redressal system and Chintan's youth-led monitoring efforts.

Empowerment through health messaging is more effective than fear

- **Fear-based communication fails to drive long-term change.** The discussion emphasized that campaigns grounded in relatable, health-oriented messaging and practical solutions have greater success than those driven by alarm or anxiety.
- **Health data can motivate behavior change when delivered respectfully.** Panelists highlighted that uptake increased when workers saw personal lung health results and received actionable protective guidance, demonstrating the value of dignity-driven outreach.

Institutional alignment is essential for scaling citizen-led models

- **Partnerships with government unlock scale and legitimacy.** The panel emphasized that programs like the expansion of 'Namaste' to waste pickers or co-developed school waste guides succeeded because of collaboration with government bodies.
- **Reducing bureaucratic friction is key to sustaining progress.** While institutional support is vital, speakers also flagged the need to streamline collaboration pathways and ease administrative barriers to fully enable community-led solutions.

CLOSING REMARKS

One Air, One Agenda: The Power of Partnership for Clean Skies

Shombi Sharp
UN Resident Coordinator, India

The session titled "***One Air, One Agenda: The Power of Partnership for Clean Skies***" featured a keynote address by **Shombi Sharp** (UN Resident Coordinator in India). Sharp emphasized the urgency of system-wide collaboration to combat air pollution, an issue that cuts across boundaries, sectors, and social divides. He outlined the UN's support to India through initiatives like the Air Quality Action Forum and highlighted how partnerships across government, private sector, civil society, and multilateral institutions can unlock the financing, innovation, and political resolve needed to deliver blue skies and meet sustainable development goals.

Key Insights from Shombi Sharp's address

Air pollution as the defining environmental and development challenge of our time

- **Air pollution is the greatest environmental health risk today and a drag on development.** Shombi Sharp highlighted that air pollution causes over seven million premature deaths each year and contributes to India's economic losses of up to 1.4% of GDP due to health and crop-related impacts.

- **The crisis is rooted in unsustainable development and "business as usual" models.** Framing air pollution within a larger planetary emergency, he warned that 83% of SDGs are off track and current consumption patterns would require the resources of two Earths, underscoring the urgency for systemic change.

Capital exists, but is misdirected away from clean air solutions

- **The problem is not lack of capital, but poor allocation.** Despite the high costs of inaction, only 1–2% of public climate and development finance is currently directed toward clean air, revealing a serious gap in priorities.
- **The private sector must lead by integrating sustainability into core business models.** Sharp called on companies to embed pollution reduction and sustainability into their operations and supply chains, stressing that "we must pair sustainability with profit" and urging industry to lead from the front.

India's leadership and multilateral support offer a strong foundation

- **India's climate and air quality initiatives reflect global leadership.** He praised India's progress through the National Clean Air Programme, ambitious renewable energy targets, and household LPG adoption as significant national-level actions.
- **Multilateral institutions, including the UN system, are enabling collaborative solutions.** Sharp pointed to platforms like the Air Quality Action Forum as critical convening spaces bringing together policymakers, civil society, researchers, and businesses to drive joint efforts on clean air.

Innovation, entrepreneurship, and youth leadership as drivers of change

- **India's innovators are transforming waste into climate solutions.** He celebrated Indian entrepreneurs who are turning crop waste into bioCNG, sustainable packaging, and wood alternatives, showcasing the potential of local innovation.
- **Young changemakers are essential to accelerating climate action.** Sharp acknowledged the growing role of youth in leading solutions, particularly through technology and community-based initiatives, as part of a broader shift toward sustainable futures.

A shared purpose to unite national development and planetary goals

- **India's future must align SDG 2030 and Viksit Bharat 2047 into one unified vision.** He described these agendas as "two stepping stones on the same path" and called for stakeholders to move beyond planning and toward concrete delivery.
- **Delivering blue skies requires collective resolve and moral ambition.** Closing with a call to action, Sharp urged all to "reclaim Delhi" and build a prosperous, fair, and sustainable future grounded in clean air for all.

KEYNOTE & IMMERSIVE DISCUSSION

Air Is Free, Cleaning It Isn't: Making Clean Air Investable

N K Singh
Chairman, 15th Finance Commission

Ann Jeannette Glauber
South Asia Head - Environment, World Bank

Shirish Sinha
Executive Director of Global Programmes, Clean Air Fund

Satyendra Kumar
Director, NITI Aayog

Jagjeet Singh Sareen
Area Chair, Climate Initiatives, CIEU, Partner, Dalberg Advisors (moderator)

The session titled "***Air Is Free, Cleaning It Isn't: Making Clean Air Investable***" brought together a high-powered panel to unpack how India can bridge the financing gap for clean air action. Moderated by **Jagjeet Singh Sareen** (Area Chair, Climate Initiatives, CIEU; Partner, Dalberg Advisors), the conversation featured a keynote address by **N. K. Singh** (Chairman, 15th Finance Commission), followed by a panel discussion with **N. K. Singh** (Chairman, 15th Finance Commission), **Ann Jeannette Glauber** (South Asia Head - Environment, World Bank), **Shirish Sinha** (Executive Director, Global Programmes, Clean Air Fund), and **Satyendra Kumar** (Director, NITI Aayog). Together, they explored the limits of current funding structures, emerging financing innovations, and the need to

convert climate-health co-benefits into investable propositions that attract both public and private capital at scale.

Context for the Keynote and the Panel Discussion

Air quality management (AQM) funding remains limited and poorly targeted, undermining the fight against India's escalating pollution crisis. Between 2018 and 2022, India received just $16.2 billion in air quality finance i.e., only 14% of global flows. Most of this (~60%) went to transport, while key sectors like waste, construction, and agriculture were heavily underfunded and less than 1% supported data systems,[52] skewing interventions and hampering integrated action in multi-source airsheds like the Indo-Gangetic Plain.

India's air quality financing ecosystem is characterized by a growing diversity of players, each operating with distinct mandates, capacities, and incentives. Public funding flows through government budgets, philanthropic grants, and MDB/DFI programs. Private capital, led by banks, PE-VC funds, and corporate CSR, is growing but still nascent, often channelled through climate-linked sectors where air quality is a co-benefit.

Figure 8: A list of illustrative sources for air quality financing in India

Public capital is underutilized due to institutional constraints. Nearly 60% of NCAP funds remain unspent[53] due to poor execution capacity, staffing gaps, and weak inter-agency coordination. India's green bond market also faces challenges: high hedging costs, weak demand, and limited guarantees.

Private capital remains scarce due to perceived risks and weak monetization models. Regulatory uncertainty, fragmented projects, and limited revenue streams restrict investor interest. Most global air quality finance is loan-based, often at commercial rates. The social and economic returns from

52.CPI, The State of Global Air Quality Funding 2024, 2024
53.CREA, Tracing the Hazy Air 2024: Progress Report on National Clean Air Programme (NCAP), 2024

pollution reduction are high, but not easily monetized, making the sector less investable for private capital.

Blended finance and results-based financing can unlock private capital and improve effectiveness. Blended finance uses concessional or philanthropic capital to de-risk early-stage or high-impact clean air investments. Instruments like guarantees, concessional debt, and technical assistance have gained traction in India's $1.3 billion blended finance market.[54] Results-based financing links disbursements to outcomes like PM2.5 reduction or clean tech adoption. Though the leverage ratio is modest, RBF strengthens accountability, encourages innovation, and supports ecosystem development. Global case studies, from Vietnam's Emission Reduction-Linked Bond to Indonesia's Plastic Credit Bond, show the potential of RBF to crowd in capital and scale impact.

Figure 9: Ways in which results-based financing instruments can de-risk capital and strengthen ecosystem delivery

Potential Opportunities and Challenges

The opportunities for mobilizing private capital into clean air solutions in India include:

- **$18 billion market opportunity in Indian air pollution control systems market by 2030:**[55] Urbanization and industrial growth are driving demand for clean technologies like e-mobility, cookstoves, and emission controls, creating a sizable investable market.
- **Results-based and blended finance can de-risk $170 billion in near-term investments for climate change sectors (including air pollution) in India:**[56] These instruments can mobilize private capital by reducing risk in early-stage, high-impact sectors.
- **Up to 3% GDP gain from improved air quality will be a macro incentive for capital flows:** Meeting WHO air quality standards could boost GDP by 3%, reinforcing the economic case for public and private investment in pollution reduction.[57]
- **Investment-ready pipeline emerging across transport, waste, and clean energy sectors:** Sub-national and private actors are developing projects like e-buses, CBG plants, and green construction that can attract capital if structured and aggregated effectively.

54.Asha Impact, The Blended Finance India Narrative, 2023
55.Research and Markets, India Air Pollution Control Systems Market Report 2024-2030: Clean Air Initiatives Spurs Investments, Surge in Regulatory Mandates, Rising Environmental Awareness Fueling Developments, 2024
56.IFC, Blended Finance for Climate Investments in India, 2023
57.World Economic Forum, Solving India's Air Pollution Can Boost Economy and Business. Here's How, 2021

Key challenges would have to be overcome to leverage these opportunities:

- **Fragmented and small-scale project landscape:** Projects are often hyper-local and cross-sectoral but too small and disaggregated for institutional investors or consistent returns.
- **Weak revenue models for private investors:** Unlike sectors such as renewable energy, most air pollution solutions lack direct user-payment models or monetizable revenue streams, making them less commercially viable and heavily dependent on public or philanthropic funding.
- **Uncertainty around policy and outcome visibility:** Weak enforcement, shifting policies, and unclear long-term commitments raise investor risk and reduce confidence in returns.
- **Limited measurement and attribution infrastructure:** The absence of reliable, intervention-linked air quality hampers both risk assessment and impact verification, deterring outcome-based investments like results-based financing or ESG-linked bonds.
- **Institutional gaps in local governments and project design:** Urban local bodies and state agencies often lack the technical and financial capacity to design, structure, and implement bankable clean air projects, resulting in a weak pipeline of investment-ready opportunities.

Key Insights from N K Singh's address

Clean air as a public good requiring private capital and financial innovation

- **Clean air must be financed like a public good, with private capital playing a central role.** N. K. Singh emphasized that while air is free, the process of cleaning it is costly, and achieving clean air at scale will require significantly more financing than currently available.
- **Innovative financing tools are needed to unlock commercial viability.** He called for new public-private financing models, including special purpose vehicles and regulatory de-risking instruments, to make clean air interventions not only viable but also commercially attractive to private investors.

Global financial reform is essential, but current progress remains limited

- **The international financial architecture is evolving slowly and remains risk-averse.** Reflecting on the G20 Independent Expert Group recommendations he co-chaired, he observed that while multilateral development banks (MDBs) claim to be reforming, their ability to act boldly, collaborate across institutions, and catalyze private capital remains inadequate.
- **Low-income countries face an unfair choice between clean air and basic energy access.** He cautioned against the "false choice" of expecting poorer nations to leapfrog fossil fuels without first securing affordable capital and energy access, highlighting the need for a more equitable global financing framework.

Country platforms and project pipelines as instruments of effective implementation

- **Bankable project pipelines are critical to translating ambition into outcomes.** Drawing from his experience with the 15th Finance Commission and ongoing work, he emphasized the need for technically sound, locally informed, and properly diligenced pipelines to ensure funds lead to real-world results.
- **Even allocated clean air funds are being underutilized.** He noted with concern that in both Delhi and neighboring states, disbursement of already earmarked funds for clean air has been slow, with significant underutilization due to weak implementation systems and capacity gaps.

Airshed-level governance and financing must replace city-centric approaches

- **Air pollution is a regional issue that cannot be solved by city-level actions alone.** Singh highlighted that only 20% of Delhi's pollution originates within its borders, underscoring

the need for airshed-based strategies that take into account pollution flows across state lines.

- **Adjacent states are failing to act and spend available resources.** He stressed that neighboring states, despite receiving central funds, have failed to use them effectively, making cross-border cooperation and shared accountability essential to any future clean air strategy for Delhi.

Clean air requires collective resolve, institutional reform, and financial ambition

- **Public-private partnerships must go beyond slogans to enable real financing leverage.** Singh argued that calibrated public investment is essential to unlock larger private inflows, especially in capital-rich metropolitan regions like Delhi where investor interest exists.
- **Clean air must be seen as both a health and economic imperative.** He concluded that structural reforms, institutional alignment, and bold financial ambition are necessary to treat clean air not merely as an environmental goal but as a shared national priority that protects both lives and livelihoods.

Key Insights from the Panel Discussion

Financing clean air requires systemic reform, not just capital

- **The core constraint is project bankability, not capital availability.** Panelists agreed that while both public and private capital exist in India, the challenge lies in translating urgency into implementable, financially viable projects.
- **Financial viability demands better project preparation and coordination.** The discussion highlighted the need for improved pipeline development, administrative convergence, and technical readiness across sectors to unlock financing.

A strong enabling environment is essential to scale financing

- **Governance systems must be strengthened to catalyze finance.** Representatives from the World Bank and Clean Air Fund emphasized the importance of credible air quality data, cross-sectoral regulatory frameworks, enforcement mechanisms, and institutional accountability as foundational prerequisites for unlocking both concessional and private finance.
- **India must shift from towards a coordinated airshed-wide strategy.** The panel stressed the importance of focusing on cost-effective, health-aligned interventions across industry, transport, waste, and agriculture, moving beyond city-specific grants.

Philanthropy can play a catalytic role in unlocking capital

- **Philanthropic funding is small in volume but high in strategic impact.** Panelists noted that while the majority of resources come from public and private sectors, philanthropic capital can de-risk innovations, enable capacity-building, and unlock blended and results-based finance programs
- **Clean air remains severely underfunded in**

global aid flows. The panel highlighted that only around 1% of international aid currently goes to clean air, pointing to a significant gap in global prioritization and the need for recalibrated funding commitments.

Making projects bankable is the missing link between ambition and action

- **Project-specific financing pathways are essential to overcome structural barriers.** Drawing from experience, panelists emphasized that some interventions—like clean cookstoves or decentralized waste—require concessional capital, while others need aggregation platforms or better coordination to achieve scale.
- **Mechanisms like SPVs and pooled procurement can reduce friction and build scale.** The discussion pointed to tools such as special purpose vehicles, credit enhancement, and procurement pooling as effective ways to improve project readiness and attract investment.

Mission-mode execution and institutional alignment are critical to impact

- **The clean air agenda suffers more from coordination gaps than funding shortfalls.** Panelists acknowledged the government's strong commitment, including from NITI Aayog, but emphasized that outcomes remain constrained by fragmented implementation.
- **Impact requires faster alignment across ministries, MDBs, and state actors.** The discussion concluded with a call for mission-mode action, stressing that the health, climate, and productivity costs of inaction must be internalized in policymaking to translate intent into meaningful results.

MINISTERIAL VALEDICTORY ADDRESS

A New Air Agenda: Pathways for Scale and Systemic Impact

Rekha Gupta
Chief Minister, Delhi

The session titled "***A New Air Agenda: Pathways for Scale and Systemic Impact***" featured the valedictory keynote address by **Rekha Gupta, Hon'ble Chief Minister of Delhi**. Reflecting on the urgency of clean air as a fundamental right, she emphasized the importance of public participation, systemic solutions, and long-term political vision to tackle air pollution. As Delhi completes the first 100 days under her leadership, the Chief Minister used this platform to announce a comprehensive clean air roadmap, anchored in rapid EV transition, decommissioning polluting vehicles, and building institutional and civic ownership. Framing clean air as a shared responsibility, she invited citizens, businesses, and civil society to co-own this transformation and invest in a greener Delhi.

Key Insights from Rekha Gupta's address

Public participation and collective responsibility as the foundation of clean air governance

- **Good governance must be co-owned by society.** The Hon'ble Chief Minister emphasized that policy alignment, regulatory clarity, and inter-agency coordination can be achieved with minimal cost if there is collective will and civic commitment.
- **Air pollution is the responsibility of both the government and the people.** She stated that no single government action is solely responsible for Delhi's air, pointing instead to outdated practices, individual behavior, and systemic disregard as root causes.
- **Civic responsibility must precede coercive governance.** She argued that citizens must act voluntarily before the situation necessitates government enforcement, noting that the state intervenes only when civic duty breaks down.

A values-based shift in how society treats natural resources

- **Natural assets are least valued until they become scarce.** In a candid moment, she stated that no government policy alone is responsible for Delhi's polluted air; rather, it is the cumulative result of individual behaviors, outdated practices, and systemic neglect. Citizens, she argued, must shoulder equal responsibility and act before the situation necessitates alarm or coercive action from authorities. The government steps in, she noted, only when civic responsibility falls short.

Decisive action on vehicular emissions and public transport electrification

- **Polluting vehicles will face strict enforcement and removal.** She announced that vehicles beyond their legal lifespan are being issued notices, denied fuel, and aggressively scrapped in line with court orders and supporting policies.
- **Delhi's public bus fleet is undergoing rapid electrification.** Within the first 100 days, 400 "DEVI" electric buses were deployed, with plans to reach 2,000 by year-end and complete fleet electrification by 2028.

Building EV infrastructure and enabling a clean mobility economy

- **Massive EV charging infrastructure is being rolled out across the city.** The government has set a target of 4,30,000 charging stations to support both public and private electric vehicle adoption.
- **A new EV policy will promote widespread adoption and industry growth.** The policy will include direct subsidies for personal and two-wheeler EVs, while incentivizing private sector participation in manufacturing, dealership, and services.

Clean air transition as an inclusive economic opportunity

- **The public is invited to be a co-creator in Delhi's clean air journey.** In her closing remarks, the Chief Minister urged citizens, entrepreneurs, and industry to actively contribute—through manufacturing, trading, or adopting EVs—positioning clean air as both an environmental goal and an economic opportunity.
- **The state is ready to act, but public engagement will determine success.** She affirmed the government's commitment to building the necessary systems and infrastructure, while stressing that long-term progress depends on shared ownership and civic participation.

Technical Roundtables

Roadblocks & Runways: Steering India's Mobility Toward Clean Air

Context for the Roundtable

Transport is a major driver of air pollution and greenhouse gas emissions, with two-wheelers, three-wheelers, and trucks being the largest contributors. It contributes to 40% of India's air pollution,[52] over 40% of NOx emissions, and around 7% of combustion-related PM2.5 emissions.[53],[54] In Delhi alone, transport accounts for 43% of PM2.5.[55] Two-wheelers, three-wheelers, and trucks are the primary culprits, together contributing 80% of transport-related pollution in Delhi.[56] Nationally, heavy-duty vehicles account for the largest share of CO_2 emissions at ~45%.[57]

While the government has taken significant steps, penetration of electric buses and electric trucks remain low. India has set an ambitious EV target of 30% penetration by 2030,

52.Economic Times, Transport sector accounts for 40 per cent of air pollution; need to develop greener fuels, 2023
53.IEA, Air quality and climate policy integration in India, 2021
54.IEA, Transitioning India's Road Transport Sector, 2023
55.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
56.CSE, 2024. Retrieved from: Business Standard, 'Vehicular emissions major cause of Delhi's winter pollution, says CSE', 2024, and Dalberg analysis
57.WRI, Pathways to decarbonize India's transport sector: Scenario analysis using the Energy Policy Simulator, 2021

Figure 10: Breakdown of contribution to transport-linked air pollution in Delhi by vehicle type

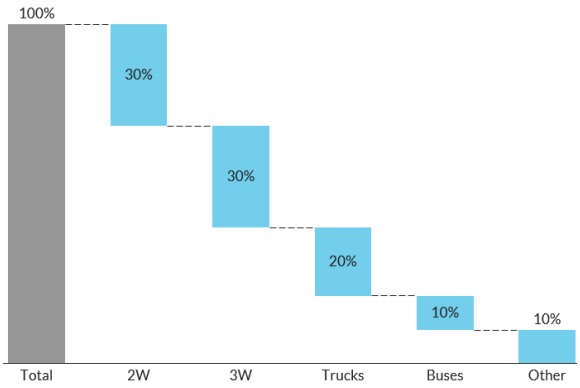
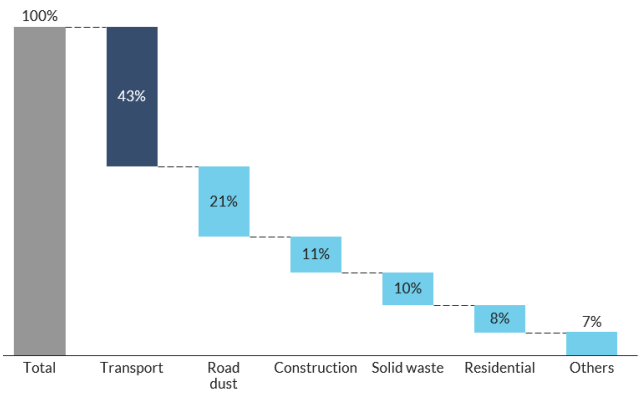


Figure 11: Sources of air pollution in Delhi



backed by national schemes such as FAME and PLI, and complemented by state-level policies like Delhi's purchase incentives. Newer programs like PM e-Bus Sewa and PM e-Drive aim to expand adoption. These efforts have helped develop a relatively mature market for two-, three-, and four-wheelers. However, electric buses accounted for less than 1% of total EV sales in FY25,[58] and e-truck sales only began in 2023, with limited commercial uptake so far.

State-owned buses have seen early success through leasing models, but private operators face challenges. The Gross Cost Contracting model, used by State Transport Undertakings (STUs) with support from entities like CESL, has enabled cost-effective bus electrification by eliminating upfront capital needs. However, this model is hard to replicate in the private sector due to fragmented demand, limited aggregation, and weaker institutional support. Industry associations have not yet played a significant role in enabling scale or access to finance for private fleet operators.

E-trucks face technological and financial barriers, making lower-emission BS-6 trucks a feasible short-term solution. E-truck models are still in early development, with limited availability and performance challenges under heavy loads. Battery costs remain high, and there are few financing options in the market. In response, several states have introduced scrappage incentives and tax waivers to promote a shift from older diesel trucks to BS-6 vehicles. These interim solutions are seen as critical to cutting emissions from freight while the e-truck ecosystem matures.

Innovative financing and private sector pilots are paving the way for scalable solutions and unlocking a massive economic opportunity. Blended finance initiatives, like ADB's $40 million investment in GreenCell for e-buses,[59] are beginning to unlock private capital. Logistics companies such as Amazon India are piloting e-truck adoption through strategic partnerships. With e-bus and e-truck markets expected to grow significantly, India has an opportunity to align electric mobility with job creation and economic growth, with the Indian EV market estimated at $240 billion and 5 crore jobs by 2030.[60]

58.Vahan, 2025. Retrieved from: Autocar, 'EV sales grow 17% to 1.96 million in FY2025, 2- and 3Ws, cars and SUVs hit new highs', 2025
59.ADB, ADB, GreenCell Sign $40 Million Financing for Safer E-Buses in India, Especially for Women Commuters, 2022
60.NDTV, Nitin Gadkari Expects India's EV Industry To Create Five Crore Jobs By 2030, 2024

Potential Opportunities and Challenges

The potential to scale clean mobility in India's transport sector is underscored by multiple emerging opportunities, driven by a large domestic market, policy ambition, and evolving technologies.

Opportunities and Challenges for E-buses

Unlocking Economic and Environmental Gains

- **Tapping into the multi-billion dollar e-bus market**: India is expected to replace 8 lakh diesel buses with e-buses over the next 6-7 years, creating a multi-billion-dollar market for e-buses and generating significant employment opportunities across the value chain.
- **Potential to reduce CO2 emissions from urban transport**: Electrifying bus fleets can substantially lower CO2 emissions, with 14 tonnes of CO2 abated per year by transitioning 1 diesel bus to e-bus.[61]

Key Barriers to Private Sector Participation

- **Limited policy benefits:** Despite policy momentum for e-buses through PM E-DRIVE and PM E-Bus Sewa, electrification of buses remains limited in scale as the private sector is largely excluded from these policies.
- **High upfront costs coupled with perceived risk:** Commercial lenders typically finance only up to 80% of e-bus costs, due to high perceived risk, leaving operators to cover high upfront margins, up to Rs 30 lakh per bus, while also demanding significant collateral.
- **Limited charging infrastructure and depot electrification:** The current shortage of charging stations and inadequate depot electrification infrastructure pose barriers to supporting the growing fleet of e-buses, especially with concerns about range anxiety (>300 km).
- **Lack of skilled workforce for e-bus maintenance and operations**: There is a shortage of trained technicians and operational staff capable of maintaining and operating e-buses.
- **Scalability barriers in the e-bus leasing model for private operators:** While the bus leasing model has shown promise in the public sector, its scalability in the private sector is constrained by fragmented demand and the lack of support from industry bodies.

Solution Pathways to Scale E-Bus Adoption

- **Large-scale electrification of buses by extending government schemes to the private sector**: Government-led programs such as PM e-Bus Sewa aim to deploy 10,000 e-buses across 169 cities,[62] creating a foundation for mass urban electrification and city-level emissions reduction, with large-scale transition potential if extended to the private sector.
- **Replicating public sector leasing models for private operators:** The Gross Cost Contracting model, used successfully by State Transport Undertakings through demand aggregation, can be adapted for private fleets with appropriate policy and market coordination support.
- **Exploring innovative and blended finance solutions to unlock private capital:** Models that blend concessional and commercial finance, like ADB's $40M blended finance package to GreenCell, can de-risk investments and unlock private capital for bus electrification.

Opportunities and Challenges for E-trucks

Unlocking Economic and Environmental Gains

- **Leveraging the freight market opportunity**: India's trucking demand is expected to grow

61.Dalberg analysis
62.Ministry of Housing & Urban Affairs, Cabinet approves "PM-eBus Sewa" for augmenting city bus operations; priority to cities having no organized bus service, 2023

over fourfold by 2050, requiring ~17 million trucks, creating a huge market opportunity for freight electrification alongside job creation in manufacturing, logistics, and maintenance sectors.

- **Potential to reduce CO2 emissions from road transport by half:** Heavy-duty vehicles are the highest contributors of transport emissions at ~45%, with electrification offering a significant opportunity to cut emissions.

Key Barriers to Adoption

- **High upfront costs of e-trucks and BS-6 trucks:** E-trucks can cost 2–4x more than diesel trucks. Similarly, BS-6 trucks are expensive, with the landed cost of a new BS-6 truck exceeding Rs 20 lakhs, including GST of Rs 5 lakhs, offering little incentives for transition.[63]
- **Challenges in access to finance:** Commercial banks perceive e-trucks to be risky, with no commercial e-truck loans available in the market.
- **Inadequate charging infrastructure:** India currently has around 12,000+ public EV charging stations, far below the demand needed for large-scale e-truck adoption on long-haul routes.
- **Limited model availability and performance challenges in e-trucks:** Reduction of battery efficiency with heavy loads, limited availability of models in medium- and heavy-duty segments, and battery degradation and safety concerns constrain the transition to e-trucks.
- **Low compliance with vehicle scrappage norms**: Old trucks continue to stay on roads either illegally or by being re-registered in other jurisdictions, with a strong informal resale market further disincentivizing scrappage.

Solution Pathways to Scale E-truck Adoption

- **Transitioning to BS-VI for short-term emission reduction:** In the near term, transitioning old diesel trucks to BS-VI standards, especially through state-supported scrappage incentives such as tax waivers, penalty amnesties, interest subvention, and incentives from OEMs, offers a feasible pathway to reduce pollution while EV freight technologies mature.
- **Testing and scaling of e-truck fleets in logistics and urban freight:** Pilots like Amazon India's partnership with Eicher Motors to deploy up to 1,000 e-trucks show potential for early commercial viability in middle- and last-mile delivery.

Moderators and Key Speakers

The **International Council for Clean Transportation (ICCT)** was the knowledge partner for this technical roundtable session. It was moderated by **Amit Bhatt, Managing Director, ICCT**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
Anish Kumar	Co-founder, Switch Labs
Jit Banerjee	Senior Manager - Public Affairs and Corporate Communications, Flixbus
Sumit Barat	Vice President - Business Development and Corporate Affairs, GreenCell Mobility

The roundtable saw 15-20 participants across organizations such as CEEW, Bloomberg Philanthropies, the Air Pollution Action Group (A-PAG), iX Energy, EPIC, and IIT Bombay.

Key Insights from the Roundtable

Gaps in emissions testing and reporting for commercial fleets

- **Current testing systems underreport real-world emissions**. The roundtable highlighted that stationary emissions assessments fail to

63.Dalberg analysis

reflect actual road use, especially for diesel and CNG trucks, which produce significantly higher PM2.5 emissions than personal vehicles.

- **Real-world performance monitoring is essential for accountability**. The discussion underscored the need to reform testing protocols to better capture on-road emissions from commercial fleets and guide more effective regulation.

High upfront costs and financing barriers to EV adoption

- **Electric trucks and buses remain cost-prohibitive for many operators.** Battery costs are up to three times higher than diesel alternatives, contributing to high capital costs.
- **Financing remains expensive and underdeveloped for EVs.** The group noted that EV financing rates are 2.5 to 3 times higher than those for diesel vehicles

Infrastructure and operational bottlenecks slowing fleet electrification

- **Charging infrastructure is insufficient along key corridors.** Stakeholders pointed out that major highways like Delhi–Jaipur lack high-capacity chargers, while public charger utilization remains low at just 2–3%.
- **Small fleet operators face operational scale and access constraints.** The group noted that most private operators run fewer than 10 vehicles, often lack depot access, and face high maintenance costs, creating structural barriers to electrification.

Innovative models and financial tools to unlock clean mobility at scale

- **Battery swapping and leasing models can reduce ownership burdens**. The roundtable suggested that combining leasing with driver training, telemetry, and performance-based subsidies could lower costs and improve operational efficiency.
- **Standardization and demand aggregation are needed to scale solutions**. The group recommended measures such as 3+1+1 GGC contract models, demand pooling, and targeted public procurement to enable more coordinated deployment.
- **Carbon finance and integrated supply chain approaches can bridge viability gaps**. The discussion proposed leveraging carbon markets and engaging OEMs and financiers to create scalable investment ecosystems.

Rags to Riches: Turning Trash into Clean Air Opportunity

Context for the Roundtable

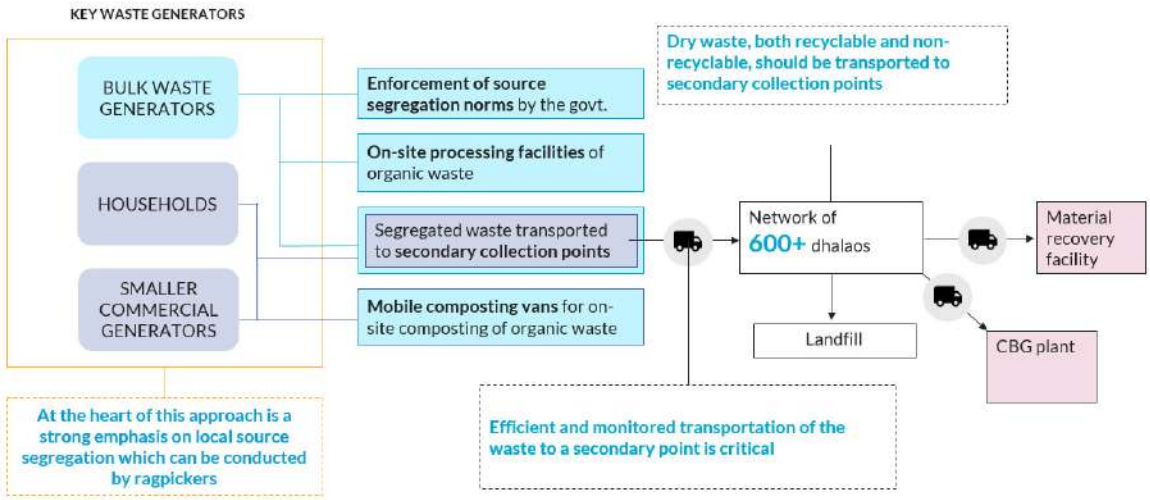
Solid waste burning is a major but often overlooked source of air pollution in Indian cities. India generates over 1,70,000 tonnes of municipal solid waste daily, with up to 24% of it burnt across cities.[64] In Delhi, solid waste burning contributes to 10% of total air pollution.[65] This burning occurs at three points along the waste value chain, including illegal open burning in small fills, incineration at waste-to-energy plants, and burning to clear landfills, each releasing harmful pollutants and emitting black carbon and airborne microplastics.

India has a robust policy framework for solid wastemanagement,anchoredindecentralized action by municipal bodies and private sector players. The Solid Waste Management Rules (2016), Swachh Bharat Mission 2.0, and the Extended Producer Responsibility (EPR) guidelines have driven improvements in source segregation, processing capacity, and recycling. Local bodies such as the Municipal Corporation of Delhi and Brihanmumbai Municipal Corporation are investing in MRFs and landfill remediation. Private players like Hindustan Unilever and Tata Consumer Products have complied with EPR mandates, while organizations like Chintan and Sahaas Zero Waste support decentralized collection systems and wastepicker enterprises. For example, Chintan enables zero-waste campuses and operates micro-MRFs across Delhi.

64.WRI, Combating Open Waste Burning to Reduce Air Pollution, 2024
65.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021

Material Recovery Facilities (MRFs) and Compressed Biogas (CBG) plants offer scalable solutions to reduce air pollution and landfill pressure. After decentralized waste collection and segregation, dry waste, both recyclable and non-recyclable, can then be transported to secondary collection points (e.g., dhalaos in Delhi). From there, inorganic waste is directed to centralized MRFs, where it is sorted and baled, with recyclables sold to end-buyers. Organic waste is treated through a mix of technologies such as composting, which requires strong linkages to ensure access to market, and routing to CBG plants where it is converted to biogas that can be used for transportation or pipeline networks. Only inert or contaminated waste that cannot be recovered is ultimately sent to landfills.

Figure 12: Centralized and decentralized solid waste management



However, challenges in source segregation, financing, and institutional coordination limit scale of MRFs and CBG plants. In cities like Delhi, only 55% of waste is segregated at source,[66] reducing input quality and operational efficiency of MRFs and CBG plants. Both require high upfront capital, face difficulty securing funding due to long payback periods and sectoral risk, and struggle with land access, permissions, and consistent waste supply. The lack of formal integration for informal workers further constrains sustainability, despite their critical role in collection and sorting.

Successful models and innovative financing pathways are beginning to emerge, unlocking major economic potential. Partnerships such as NEPRA's PPP model in Ahmedabad and EverEnviro's CBG plant in Indore demonstrate how public land and private execution can work together. Blended finance, concessional lending, and monetization of carbon and plastic credits are easing capital constraints. Nationwide, scaling up to 5,000 CBG plants and 300+ MRFs could attract $20 billion in investment, divert 50,000 tonnes of waste daily, and create over 4 lakh jobs.[67],[68] With India's carbon credit market set to launch in 2026, these solutions present an opportunity to turn waste into a driver of cleaner air and inclusive economic growth.

66.Hindustan Times, 55% of waste segregated at source, MCD tells SC, 2024
67Indian Biogas Association, Rural employment generation through biogas production in villages of India, 2022
68. Dalberg analysis

Potential Opportunities and Challenges

The potential to scale solid waste management in India, especially through MRFs and CBG plants, is underscored by multiple emerging opportunities, driven by a large domestic market, supportive policies, and advancing technologies.

- **Reducing PM 2.5 and GHG emissions through the diversion of solid waste from burning:** Redirecting solid waste burned to MRF and CBG plants can significantly curb PM 2.5, by upto 10% in cities like Delhi.[69] Each MRF, recycling 150 TPD, can abate ~3,700 tonnes of CO_2 annually by avoiding waste burning while a CBG plant handling 500 TPD can abate ~35,000 tonnes of CO_2[70] by avoiding waste burning and displacing the combustion of CNG. Additionally, redirecting the waste reduces the overall volume of waste sent to landfills, which further reduces emissions by reducing the risk of methane-induced landfill fires.
- **Creating large-scale employment across the waste value chain:** Nationwide deployment of 5,000 CBG plants and 300+ MRFs could create over 4 lakh jobs across the value chain, including skilled engineers, semi-skilled construction workers, and workers for daily operations.
- **Unlocking a multi-billion dollar circular economy opportunity:** India's targets to establish 5,000 CBG plants could generate $20 billion (~Rs 1.7 lakh crore) in investments, with corporates like Reliance setting up 100+ CBG plants across the country by investing $600 million - $1.2 billion (~Rs 5,000 – 10,000 crore).[71] Additionally, diverting 50,000 TPD of waste to MRFs represents a $3 million capital opportunity, with companies like NEPRA which operate waste management solutions like MRF raising $18 million (~Rs 150 crore) from investors.[72]
- **Monetizing carbon and plastic credits to enhance financial viability:** MRFs and CBG plants have the potential to generate tradable plastic (for MRF) and carbon credits (for MRF and CBG). Instruments like the World Bank's $100 million Plastic Waste Reduction-Linked Bond in Ghana and Indonesia tied investor returns to Plastic Credits and Verified Carbon Units. With India's Carbon Credit Trading Scheme in place and its first carbon market set to launch by mid-2026, these credits could offer critical supplementary revenue. There is further potential to integrate carbon and plastic credit benefits across the value chain, including waste workers.
- **Leveraging progressive policy momentum to accelerate adoption:** Policies like Solid Waste Management Rules (2016), Swachh Bharat Mission 2.0, and SATAT scheme provide a robust policy base. These can be further strengthened through national-level incentives like viability gap funding, standardized PPP frameworks with municipal corporations, stronger enforcement for source segregation, and recognition of carbon and plastic benefits in financing schemes.

At the same time, several financial and operational challenges limit the scalability of MRF and CBG solutions:

- **Large upfront capital investments**: MRFs and CBG plants require substantial upfront capital, ~Rs 80 cr for an MRF and Rs 25–35 crore for a 100 TPD CBG plant.
- **High perceived risk due to uncertain MRF revenue streams and low CBG capacity utilization**: MRFs take time to establish operations, secure contracts for recyclable material collection, and build a steady stream of revenue, with most having an unproven operational track record. Additionally, most CBG plants operate well below capacity due to poor waste segregation. This deters commercial lenders, who offer unfavorable lending terms.
- **Fragmented coordination with urban local**

69.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
70.Dalberg analysis
71.iamrenew, Reliance to spend Rs 5,000 Cr on 50 CBG plants in 2 years, 2024
72.Economic Times, Aavishkaar, Circulate invest $18 million in NEPRA Resource Management, 2020

bodies: MRF and CBG projects often face delays in securing land leases, licenses, and consistent waste supply from urban local bodies, along with the expectation of royalties despite narrow margins, if not negligible.

- **Nascent plastic and carbon credit markets**: Although plastic and carbon credit monetization could offer supplementary revenue streams, India's plastic and carbon credit market is nascent. There is some momentum towards India's carbon market with the launch of the Carbon Credit Trading Scheme, however, the plastic credit market is at a much earlier stage, lacking clear frameworks for certification, trading, or integration with EPR mandates.

Moderators and Key Speakers

Chintan was the knowledge partner for this technical roundtable session. It was moderated by **Bharati Chaturvedi, Founder and Director, Chintan**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
Adeel Khan	Programme Associate, CEEW
Neeraj Jain	Country Director - India, PATH
Pradeep Dadlani	Director-Owner, Sycom Projects Consultants

The roundtable saw 20-25 participants across organizations such as India Climate Collaborative, GDI Partners, Waste Warriors, Centre for Chronic Disease Control, the Air Pollution Action Group (A-PAG), CDC, and Safai Sena.

Key Insights from the Roundtable

Segregation and waste burning as major pollution drivers with severe consequences

- **Poor waste segregation remains a persistent implementation gap**. Despite clear policies, widespread non-segregation continues due to limited public awareness and motivation, resulting in mixed waste being landfilled or incinerated, both of which contribute significantly to air pollution.
- **Waste burning has severe health and economic consequences**. The roundtable noted that around 20% of waste is burned in cities, with even higher rates in rural areas, leading to respiratory and cardiovascular illness and causing economic losses of up to 1.4% of India's GDP.

Integration of informal waste workers into formal systems

- **Informal workers are central to waste management but remain excluded**. Waste pickers play a vital role in collection and segregation, yet are often left out of structured systems, limiting efficiency and worker protections.
- **Formal integration can improve outcomes and worker livelihoods.** The group emphasized that recognizing and integrating informal workers would not only enhance operational efficiency but also improve safety and ensure dignified employment.

Decentralized and circular models as scalable solutions

- **Community-led and financially viable solutions are emerging**. The discussion highlighted models such as converting organic waste to bio-CNG, local recycling units, and decentralized processing as scalable options.
- **Examples like the Maligaon plastic cluster show circularity in action**. This Maharashtra-based initiative was cited as a successful, community-driven model that has benefitted from targeted subsidies and local engagement.

Policy enforcement and systemic enablers for sustainable reform

- **Stronger regulation and data systems are essential to shift from intent to impact**. The roundtable called for the urgent implementation of Extended Producer Responsibility, robust data tracking, and greater alignment between air quality and public health goals.

Fires We Can't See: Cleaning the Air in Indian Households

Context for the Roundtable

Residential combustion is the single largest source of air pollution exposure in India. Nearly half of India's PM2.5 emissions come from burning biomass, firewood, and kerosene for cooking and heating. Household air pollution contributes to up to 52% of ambient air pollution and causes nearly 800,000 premature deaths annually, with another 300,000 linked to outdoor pollution caused by household emissions.[73]

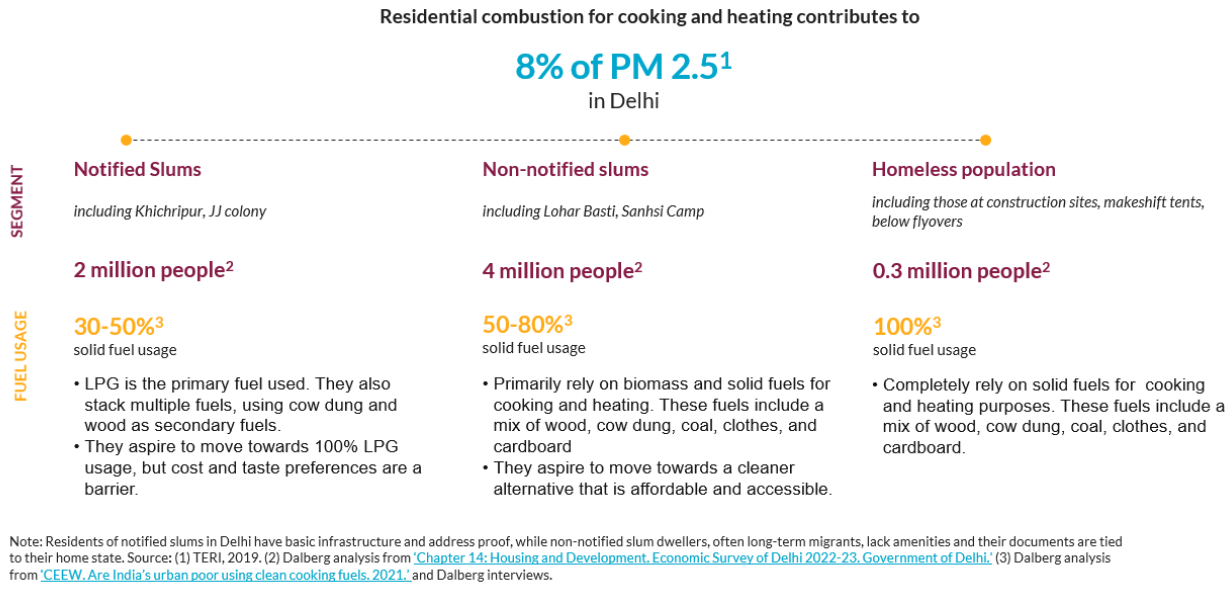
India has made significant progress in expanding access to clean cooking fuels, but gaps remain. The Pradhan Mantri Ujjwala Yojana (PMUY) has helped extend LPG coverage to over 90% of households nationwide, supported by increased subsidies and last-mile delivery.[74] Initiatives like the National Efficient Cooking Programme (NECP) promote electric cooking alternatives. Delhi offers a strong policy example, with LPG distributors within 1–3 km of households, direct benefit transfers, and ~USD 3.5 (₹300) per cylinder subsidy.[75]

However, non-notified slums remain excluded from these gains. Around 40 to 50% of households in such settlements still rely on polluting fuels like firewood, charcoal, and kerosene.[76] Documentation barriers prevent access to PMUY and other government schemes. Combined with volatile incomes and lack of formal delivery channels, residents remain locked into traditional fuels.

Even where access exists, affordability and behavioral factors limit sustained use. A single

73.Collaborative Clean Air Policy Centre, The contribution of household fuels to ambient air pollution in India, 2019
74. Ministry of Petroleum & Natural Gas, 2023.
75.Ministry of Petroleum & Natural Gas, Cabinet hikes LPG subsidy to Rs 300, cylinder to cost Rs 603 in Delhi, 2023
76.Council on Energy, Environment and Water, Are India's urban poor using clean cooking fuels?, 2021

Figure 13: Distribution of solid fuel usage in Delhi

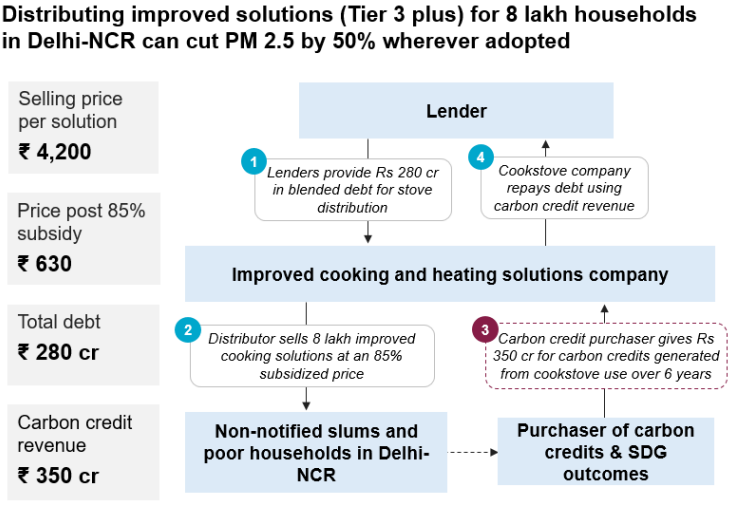


Note: Residents of notified slums in Delhi have basic infrastructure and address proof, while non-notified slum dwellers, often long-term migrants, lack amenities and their documents are tied to their home state. Source: (1) TERI, 2019. (2) Dalberg analysis from 'Chapter 14: Housing and Development, Economic Survey of Delhi 2022-23, Government of Delhi.' (3) Dalberg analysis from 'CEEW, Are India's urban poor using clean cooking fuels, 2021.' and Dalberg interviews.

LPG refill costs nearly USD 12 (₹1,000), a burden for daily-wage households.[77] Improved cookstoves and electric options are often unaffordable due to high upfront costs. Cultural preferences and perceptions around safety, taste, and nutrition drive fuel stacking, especially among low-income families who prefer using chulhas due to familiarity and cooking outcomes.

Innovative financing and behavior change solutions can address these barriers while unlocking a growing market. Carbon-linked subsidies and micro-loans can reduce upfront costs by 40 to 80% and ease adoption friction.[78] Women-led SHGs and community intermediaries, as seen in models like SEWA and ENERGIA, play a critical role in shifting norms and sustaining use. These models also open up livelihood opportunities and improve health outcomes for women. The clean cookstove market in India is projected to reach about USD 1.2-1.4 billion (₹10,000 to ₹12,000 crore), with the potential to generate thousands of jobs across the value chain.[79],[80]

Figure 14: Financing model for distributing subsidized cookstoves in Delhi-NCR through carbon credits



Potential Opportunities and Challenges

The potential to accelerate India's clean cooking transition is underscored by growing market

77.ASAR and CEEW, Barriers to access, adoption and sustained use of cleaner fuels among low income households: An exploratory study from Delhi and Jharkhand, India, 2023
78.Calyx Global, Cooking up quality: Carbon credits from efficient cookstove projects face integrity issues worth fixing, 2023
79.Council on Energy, Environment and Water, A roadmap for access to clean cooking energy in India, 2019
80.Dalberg analysis

demand, supportive policy frameworks, and emerging solutions in financing, distribution, and behavior change

- **India's clean cooking transition represents a market opportunity of over USD 1 billion by 2030, spanning stove manufacturing, distribution, servicing, and carbon financing:** Leveraging blended finance structures, carbon-linked subsidies, and gendered supply chains can unlock scale, particularly in low-income and peri-urban areas, while delivering strong co-benefits.
- **Market-based distribution can drive last-mile access:** Leveraging LPG distributors, SHGs, and micro-entrepreneurs for clean cookstove and e-cooking devices sales can ensure affordability and service continuity, especially when paired with microfinance or pay-as-you-use models.
- **Gendered supply chains can accelerate adoption:** Women-led SHGs and female entrepreneurs can overcome cultural barriers and promote sustained use, while also generating livelihood opportunities, building on successful models like SEWA and ENERGIA.
- **Carbon-linked financing can reduce upfront costs:** Monetizing emission reductions from clean cookstoves through carbon markets (e.g., Gold Standard, Verra) can subsidize costs by 40–80%.
- **Integrating clean cooking into urban air quality plans can unlock scale:** Embedding clean cooking targets into NCAP and city air action plans allows cities to tap into additional funding sources, aggregate demand, and align interventions with PM2.5 reduction goals.

At the same time, certain key challenges must be addressed to realize these opportunities:

- **Fragmented program delivery and limited urban focus hinder clean cooking adoption at scale:** While national programs like PMUY focus on rural LPG access, urban slums, especially non-notified settlements, often fall outside the purview of formal schemes, leading to coverage and service delivery gaps.
- **High recurring costs and fuel stacking dilute the transition to clean fuels:** Even when LPG connections are available, the high cost of refills (~USD 12 per cylinder) drives households back to solid fuels, resulting in fuel stacking. This undermines exclusive adoption of clean cooking and limits pollution reduction.
- **Behavioral resistance and low consumer awareness limit sustained adoption:** Cultural preferences, taste perceptions, and unfamiliarity with improved technologies (like electric cookers or induction stoves) slow behavioral shifts, even when affordable solutions exist.
- **Carbon market dependency creates revenue uncertainty for stove distributors:** Financing models tied to carbon credits face risks from fluctuating carbon prices and complex verification processes, making it harder to rely on these as stable revenue streams.

Moderators and Key Speakers

Intellecap was the knowledge partner for this technical roundtable session. It was moderated by **Santosh Singh, Partner and Managing Director, Intellecap**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
Ankit Mathur	Co-founder and CEO, Greenway Grameen Infra
Gaurav Mehta	Founder and CEO, harmalife
Jyoti Parikh	Executive Director, Integrated Research and Action for Development
Sharlene Jehanbux Chichgar	Senior Environment Specialist, World Bank Group
Sreyamsa Bairiganjan	Chief of Programmes, Shakti Sustainable Energy Foundation

The roundtable saw 15-20 participants across organizations such as SIDBI, CSTEP, ASAR, iForest, CPI, Bridge Carbon, Sustainable Futures Collective, Ethereal Climate, and the Air Pollution Action Group (A-PAG).

Key Insights from the Roundtable

Persistent reliance on solid fuels due to uneven access and lack of affordability

- **Over 25 million households continue to rely on solid fuels.** Despite the reach of Ujjwala, the roundtable noted that clean cooking access remains inconsistent, especially in rural areas where women face the highest exposure to harmful household air pollution.
- **Affordability and accessibility remain primary barriers**. The roundtable emphasized that even with subsidies, clean cookstoves are unaffordable for many Tier 4 and 5 households, and that electric and LPG options require additional support through subsidies, electricity access, and improved portability.

Systemic challenges in supply chains and sustained usage

- **Weak supply chains and stove stacking hinder long-term transitions**. Inconsistent fuel availability and lack of reliable support often lead users to revert to biomass.
- **Localized demand and coordinated supply planning are needed**. The roundtable proposed aggregation models and state-level supply chain strategies to ensure continuity and reduce drop-off in clean stove use.

Behavioral and gender-responsive approaches for durable adoption

- **Sustained adoption depends on behavior change and gender-sensitive design**. The discussion highlighted that clean energy transitions require community engagement and culturally relevant interventions.
- **India must integrate gender and aspiration into clean cooking programs**. Drawing on lessons from Bangladesh, the group noted that women-led decision-making and design tailored to convenience can significantly improve uptake and usage.

Financing innovations and data systems to enable scale

- **Carbon finance and results-based mechanisms can reduce cost barriers**. The roundtable explored how outcome-linked incentives tied to verified usage data and carbon offsets could attract investment and de-risk financing for MFIs, NBFCs, and rural enterprises.
- **Monitoring and data systems are essential to guide policy and finance**. The roundtable stressed the need for sensor-based air quality tracking, smart usage meters, and improved survey data to inform clean cooking strategies across diverse household segments.

Fields of Smoke: Rethinking Agriculture for Cleaner Air

Context for the Roundtable

Crop residue burning is a major contributor to air pollution, particularly in north India. Crop residue burning is the second largest source of air pollution in Delhi-NCR.[81] In states like Punjab and UP, 30-50% of crop residue generated is burned either partially or entirely annually, worsening air quality.[82],[83]

Figure 15: Crop residue management of the 20 million tonnes produced in Punjab annually

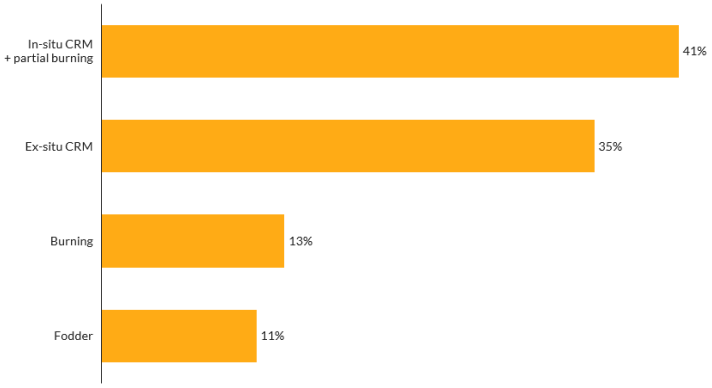
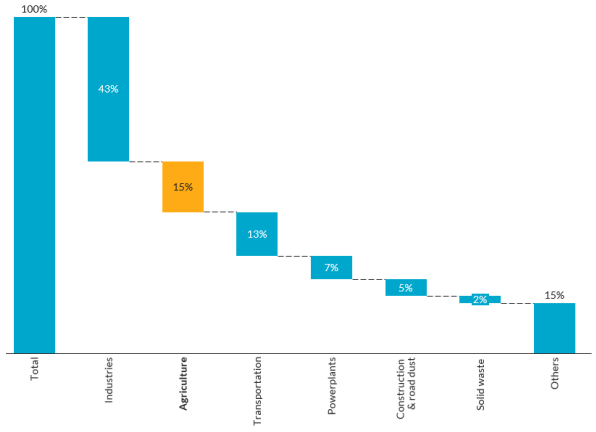


Figure 16: Contribution of crop residue burning to air pollution in Delhi-NCR



Farmers are increasingly shifting toward ex-situ residue management, with compressed biogas (CBG) emerging as the preferred solution. While in-situ methods like happy or super seeders help incorporate residue into the soil, they remain costly and difficult to access. Farmers face challenges such as high operational costs, pest risks, and limited last-mile availability of equipment. As a result, ex-situ methods are gaining traction. One-third of Punjab's farmers use ex-situ practices, with 60% of them supplying residue to CBG plants.[84]

81.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
82.CEEW, How can Punjab increase the adoption of crop residue management methods?, 2024
83.Social and Political Research Foundation, Stubble Burning in North India: Defogging the facts, 2021
84.CEEW, How can Punjab increase the adoption of crop residue management methods?, 2024

Supportive policy momentum is helping scale CBG infrastructure across India, unlocking win-win opportunities for all by connecting farmers with offtakers. National schemes like SATAT and the MNRE's bioenergy initiatives provide financial assistance and regulatory recognition for bio-based products. States such as Punjab are setting up dedicated CBG targets, with a state biofuels policy underway. These policies have catalyzed interest in commercial CBG ventures, including large-scale models like Verbio, which processes 100,000 tonnes of residue annually and supplies both bioCNG and manure to farmers.[85]

However, low capacity utilization and financing constraints remain key barriers. Most CBG plants operate at under 30% capacity due to limited demand for byproducts like bioslurry.[86] High capital costs of ~Rs 200 crore per plant and high perceived risk among lenders restrict financing, despite efforts by institutions like IREDA.[87] Without secure offtake and feedstock supply, many plants struggle to scale.

CBG plants present an untapped economic opportunity with environmental and employment benefits. India's biogas market is projected to reach $3.5 billion by 2032.[88] The government's target of 5,000 CBG plants could generate over 4 lakh jobs.[89] Corporates like Reliance have committed Rs 65,000 crore to CBG infrastructure, indicating strong private sector interest.[90] With the right financial mechanisms, offtake support, and enabling regulation, CBG can become a scalable solution.

Potential Opportunities and Challenges

The potential to scale crop residue management in India, especially through CBG, is underscored by multiple emerging opportunities.

- **Reducing PM 2.5 and GHG emissions through the diversion of crop residue from burning:** Redirecting the ~92 million tonnes of residue burned annually in India to CBG plants can significantly curb PM 2.5 (up to 15% in Delhi),[91] with each plant abating ~30,000 tonnes of CO_2[92] by avoiding residue burning and displacing traditional fuels.
- **Creating large-scale employment across the value chain:** The SATAT initiative's target of 5,000 CBG plants could create over 4 lakh jobs across the value chain, including 55,000 skilled engineers, 2 lakh semi-skilled construction workers, and 1.5 lakh unskilled daily workers.[93]
- **Scaling biogas infrastructure as an emerging economic opportunity:** Corporates like Reliance are setting up 500+ CBG plants in states like Andhra Pradesh by investing Rs 65,000 crore.[94]
- **Increasing capacity utilization of CBG through policy and innovative technologies like biopellets:** Policies that incentivize CBG byproduct use over urea and increase prices for organic manure and CBG can boost plant utilization and producer viability. Additionally, bio-pellet production offers a promising revenue stream amid rising demand for biomass cofiring.
- **Monetizing carbon credits by leveraging India's upcoming carbon market:** With India's carbon market set to launch by mid-2026, by reducing carbon emissions from residue and traditional fuel burning, CBG

85.RenewableWatch, Verbio India: New player in India's bio-CNG sector, 2023
86.RenewableWatch, Harnessing CBG: Punjab's efforts to mitigate waste and generate renewable energy, 2024
87.Ministry of Petroleum & Natural Gas, Compressed Bio Gas (CBG) is the need of the hour, and Government is taking all steps to promote ecosystem around it, 2022
88.Fortune Business Insights, India Biogas Market, 2025
89.Indian Biogas Association, Rural employment generation through biogas production in villages of India, 2022
90.CNBC, Reliance Industries breaks ground on first of 500 CBG plants in Andhra Pradesh, 2025
91.Ministry of Agriculture, National Policy for Management of Crop Residues, 2014
92.Dalberg analysis
93.Indian Biogas Association, Rural employment generation through biogas production in villages of India, 2022
94.CNBC, Reliance Industries breaks ground on first of 500 CBG plants in Andhra Pradesh, 2025

plants can generate tradable carbon credits under India's Carbon Credit Trading Scheme to unlock additional sources of revenue.

- **Piloting and tapping into new carbon-sequestering products and methods like biochar:** Beyond CBG, innovations such as biochar production from agri-residues offer avenues for carbon sequestration, improved soil health, and additional monetization through carbon credits. Crop residues derived biochar has an estimated market value of ~$500 billion in India.[95]

At the same time, several financial and operational challenges limit the scalability of CBG solutions:

- **Huge upfront investment**: Setting up a CBG plant processing 100,000 tonnes of crop residue requires ~Rs 200 crore in investment.[96] With loan-to-value ratios between 25-70%, this translates into high upfront investments.These costs are significantly higher under the retail outlet model compared to pipeline injection models.[97]
- **High risk perception by commercial lenders:** Low capacity utilization driven by low demand raises risk perception of the CBG sector, with commercial lenders offering loans at high interest rates, short tenures, and low loan-to-value ratio, driving costs of debt.
- **Low Internal Rate of Return (IRR) at Smaller Scales**: Projects under 50 TPD show poor returns (5–7% IRR). Returns improve only at scale, making small and medium plants less attractive.[98]
- **Low capacity utilization due to weak market demand for byproducts and uncertain feedstock supply**: Most CBG plants operate at only 30–40% capacity due to limited offtake of byproducts. Further, lack of long-term, assured feedstock arrangements poses a major risk, with seasonal variability and logistical challenges in biomass collection affecting reliability.[99]
- **Nascent stage of bio-carbon credit market**: Tapping into additional revenue streams like carbon credits is critical to scale CBG plants, however, India's carbon market is at a nascent stage, with the Indian government launching the first carbon market by mid-2026.

Moderators and Key Speakers

Iora Ecological Solutions was the knowledge partner for this technical roundtable session. It was moderated by **Swapan Mehra, Founder, Iora Ecological Solutions**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
Ambuj Verma	Founder, Unmukt
Chhaya Bhanti	Founder and CEO, Vertiver
Dilip Khare	Former Advisor, Ministry of New and Renewable Energy (MNRE)
Sukhmeet Singh	Founder and CEO, A2P Energy

The roundtable saw 10-15 participants across organizations such as Roots Foundation, Envirocatalysts, Indian Sugar and Bio-energy Manufacturers Association, S M Sehgal

95.Renewable and Sustainable Energy Reviews, Biochar and its twin benefits: Crop residue management and climate change mitigation in India, 2022
96.Ministry of Petroleum & Natural Gas, Compressed Bio Gas (CBG) is the need of the hour, and Government is taking all steps to promote ecosystem around it, 2022
97.PowerLine, Feedstock to Fuel: Challenges and opportunities in the CBG segment, 2024
98.International Journal of Science and Research, Technological Challenges in CBG Manufacturing in India - A Critical Review, 2025
99.PowerLine, Feedstock to Fuel: Challenges and opportunities in the CBG segment, 2024

Foundation, and the Air Pollution Action Group (A-PAG).

Key Insights from the Roundtable

Low demand and technological mismatch in biomass utilization

- **Weak demand for biomass-based products is limiting scale**. Despite policy support and ample crop residue, uptake of pellets, biochar, and compressed biogas (CBG) remains low, particularly for paddy straw, which is poorly suited to foreign-developed technologies.
- **The supply-demand mismatch is a key barrier to sustainable residue use**. The group stressed that viable utilization of available biomass requires tailored technologies and stronger market pull.

Behavior change and complementary in-situ solutions as essential solutions

- **Burning remains a habitual practice in the absence of alternatives**. The roundtable emphasized that behavior change is critical, and that farmers need better awareness, clear alternatives, and stronger incentives to shift away from open burning.
- **Ex-situ methods alone cannot solve the problem**. The discussion reinforced that residue management must integrate in-situ approaches, such as mulching or localized biochar application, alongside market-based ex-situ solutions.

The need for redesigning technologies and incentives

- **Current technologies are not suited to India's smallholder context.** The roundtable called for indigenized innovations that reflect ground realities, especially for biochar and CBG, which can be produced more effectively at local scales.
- **Public subsidies must shift toward demand creation and income support.** The group argued that machinery distribution schemes often fail to ensure actual usage, and proposed mechanisms like Green MSP and carbon credit monetization to directly reward farmers for sustainable practices.

Inclusion, data systems, and decentralized infrastructure as system enablers

- **Women remain excluded from benefit-sharing in residue management**. The discussion noted that carbon methodologies often overlook women's roles, and that inclusion must be integrated into benefit design and distribution.
- **Stronger data systems are critical to drive accountability and investment**. The group highlighted the need for improved crop burning data, granular monitoring, and decentralized infrastructure to support an equitable, circular biomass economy.

Factories of the Future: Clean Production and Competitive Industries for a Cleaner India

Context for the Roundtable

Industrial pollution is a major contributor to India's air quality crisis. Heavy industries such as cement and steel emit large volumes of particulate matter, SO_2, and NO_2 through energy-intensive processes. In Delhi-NCR, industries contribute nearly 48% of PM2.5 emissions.[100] Small and medium enterprises (SMEs), such as brick kilns, foundries, stone crushers, also contribute significantly due to resource constraints and informal operations.

A suite of pollution control technologies and market mechanisms is already shaping India's industrial emissions landscape. Measures such as flue gas desulfurization, electrostatic precipitators, waste heat recovery, and fuel switching to natural gas are being deployed. Green hydrogen is emerging in hard-to-abate sectors, while zigzag kiln technology has cut particulate emissions by 30-40%.[101]

However, weak enforcement, financing gaps, and lack of technical capacity limit progress. Fragmented regulation, limited coordination, and poor monitoring slow the uptake of clean technologies. High upfront costs, long investment cycles, and uncertain cost recovery discourage industrial adoption. SMEs, which are largely self-financed, lack both affordable capital and technical support. Most operate with outdated, inefficient equipment.

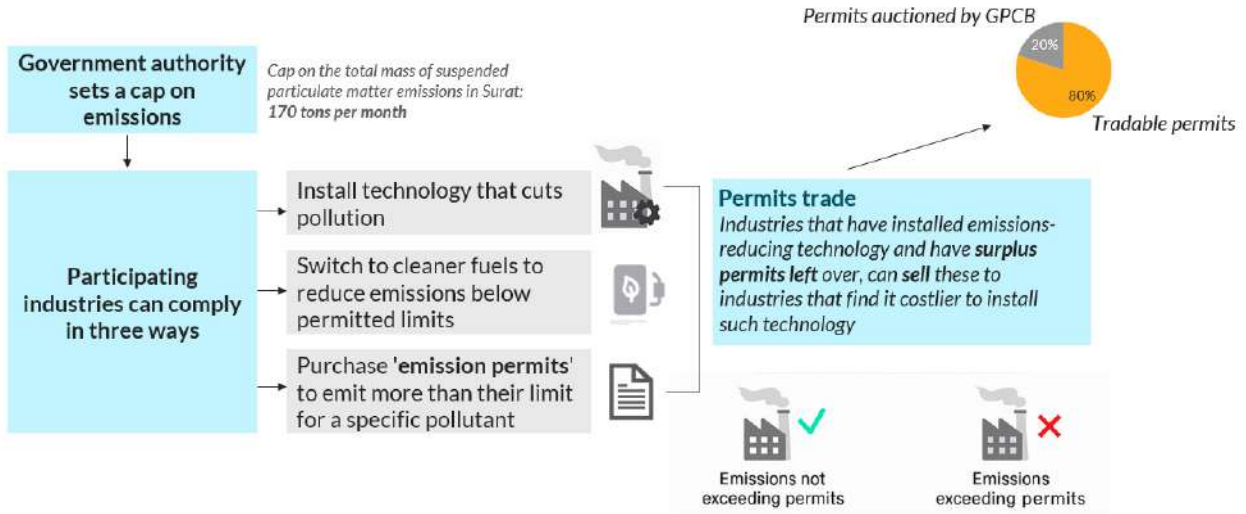
Solving these barriers requires a convergence of regulation, innovation, and investment. Strengthening enforcement through sector-specific emissions benchmarks, green procurement mandates, and conditional industrial approvals can create stronger compliance signals. For large industries, policy instruments like Production-Linked Incentive (PLI) schemes, performance-based subsidies, and preferential treatment in public procurement

100.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
101.CSE, Emission Monitoring of Brick Kilns, 2019

can incentivize clean technology adoption. China's Ultra-Low Emission policy, which mandated retrofits in over 70% of coal plants within five years, reduced SO_2 and PM emissions by over 65% and 70% respectively, showing the impact of integrated mandates.[102] For SMEs, financing must be coupled with technical support, including training, design guidance, and access to retrofit service providers.

India can build a modern emissions control ecosystem through digital tools, financing innovation, and public–private collaboration. Digital platforms for real-time emissions tracking, including satellite monitoring, IoT sensors, and AI-enabled analytics, can improve compliance, hotspot detection, and source attribution. These systems, modeled on China's Blue Sky program and Europe's E-PRTR, can be embedded into India's digital public infrastructure like PM Gati Shakti and ULIP to institutionalize compliance in industrial planning. Financing innovation through green bonds, concessional credit lines, and results-based financing can help industries overcome high upfront costs. Sovereign green bond models from countries like Indonesia show how public capital can support pollution control. Emissions trading schemes piloted in Gujarat, if scaled to regional markets, can provide cost-effective incentives for industrial decarbonization. Proven technologies such as zigzag kilns and low-NOx burners can be deployed at scale through coordinated policy and private sector participation

Figure 17: The working of Gujarat's Emissions Trading Scheme (ETS)



Potential Opportunities and Challenges

India has an opportunity to build a next-generation industrial emissions control ecosystem that is real-time, verifiable, and scalable.

- **Unlocking a ~$15 billion industrial retrofit market through green finance and innovation:** India's drive for cleaner industry can catalyze a $15 billion market by 2030 for retrofits.

102.Nature Energy, Substantial emission reductions from Chinese power plants after the introduction of ultra-low emissions standards, 2019

- **Mainstreaming emissions compliance into India's digital public infrastructure:** Embedding real-time emissions dashboards into platforms like PM Gati Shakti and ULIP can institutionalize compliance within industrial zone planning and freight corridors.
- **Expanding regional emissions trading schemes (ETS) across industrial clusters:** Scaling ETS pilots to multi-state markets can drive cost-effective emission reductions while enhancing regional competitiveness.
- **Deploying AI-driven emissions intelligence for compliance and hotspot detection:** Using CEMS, satellites, drones, and IoT, AI tools can deliver real-time alerts and pinpoint pollution sources, targeting 80% of industrial emissions by 2030.
- **Unlocking climate-air quality co-benefits through sectoral transition pathways:** Coordinated action across high-emitting sectors can cut PM2.5 by 30-40%, with broader gains unlocked when paired with energy efficiency, cleaner fuels, and green hydrogen.

At the same time, several financial, technological and operational challenges limit the scalability and effectiveness of industrial pollution control solutions in India:

- **High capital costs of air pollution control devices, coupled with limited cost pass-through, discourage industrial investment in cleaner solutions.** Installing devices such as electrostatic precipitators (~USD 3 thousand or ₹25 lakh) or cyclone separators (~USD 6 thousand or ₹5 lakh) represent a significant upfront expense, which industries are unable to recover due to regulatory or market constraints.
- **Absence of sector-specific emissions intensity benchmarks hinders differentiated policy action.** Uniform standards risk overburdening SMEs and under-regulating large polluters, with India lacks tailored benchmarks by sector, size, or technology as seen in China's ULE policy.
- **SMEs face a structural financing gap that impedes pollution control upgrades**. Limited access to credit, high collateral demands, and poor awareness of schemes prevent SMEs from adopting critical technologies like scrubbers or efficient boilers.
- **Operations & maintenance non-compliance leads to 20-30% downtime in pollution control equipment across industrial clusters.** Audits by SPCBs indicate that many SMEs run devices intermittently to cut costs, weakening the effectiveness of installed systems.
- **Technological fragmentation across vendors leads to incompatible CEMS platforms.** A lack of standardized formats hinders data integration and centralized oversight, unlike Europe's unified E-PRTR system.

Moderators and Key Speakers

The Confederation of Indian Industry (CII) was the knowledge partner for this technical roundtable session. It was moderated by **Mohit Sharma, Senior Counsellor, Confederation of Indian Industry (CII)**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
Anjan Ray	Technical Advisor, Bitchem
Nivit Yadav	Programme Director - Industrial Pollution & Renewable Energy, CSE
Sayantan Sarkar	Environment Specialist, the World Bank

The roundtable saw 10-15 participants across organizations such as EPIC, Aurassure, India Climate Collaborative, Climate Parliament, Oizom, Bridge Carbon, Bloomberg Philanthropies, and Airth.

Key Insights from the Roundtable

Persistent challenges in pollution control among SMEs and high-emission sectors

- **SMEs remain a major blind spot in industrial pollution management**. While large industries have improved over time, SMEs struggle with low technical capacity, poor awareness, and limited access to clean fuels, making compliance difficult.
- **High-emission sectors lack tailored support to reduce pollution**. Sectors like brick kilns and industrial clusters require targeted interventions to overcome legacy practices and transition toward cleaner operations.

Institutional reform and SPCBs' capacity building as essential levers for enforcement

- **State Pollution Control Boards (SPCBs) face operational constraints in enforcing standards.** The discussion highlighted challenges such as staffing gaps, capacity limitations, and financial dependencies, which can hinder effective monitoring and regulation.
- **Stronger mandates and coordination could strengthen regulatory outcomes**. Clearer institutional roles and better inter-agency alignment could enable consistent application of emission across high-risk sectors.

Misalignment of fuel pricing and market structures with clean energy goals

- **Clean fuels remain financially inaccessible for most SMEs**. The group noted that the price gap between clean and polluting fuels, such as petcoke, makes it economically unviable for SMEs to switch without subsidies or reforms.
- **Emissions Trading Schemes (ETS) have strong potential but require further strengthening.** The group noted that enhancing transparency, clarifying enforcement mechanisms, and ensuring a robust legal foundation under the Air Act would help build trust and support broader adoption.

A 5I framework as a pathway to accelerate industrial transition

- **A comprehensive 5I approach was proposed to close implementation gaps**. The framework includes Incentives (e.g., subsidies, tax rebates), Investments (financing for SMEs), Infrastructure (energy and monitoring systems), Information (training and awareness), and Institutions (regulatory coordination) as essential levers to drive systemic change.

Smoke and Power: Retrofitting India's Energy Backbone

Context for the Roundtable

Thermal power plants are a major contributor to India's air pollution challenge. Power generation accounts for 12% of national air pollution,[103] with thermal power plants alone responsible for 8% of Delhi-NCR's pollution load.[104]

SO_2 emissions from coal-fired power plants drive high PM2.5 levels. India emitted 11.2 million tonnes of SO_2 in 2022, the highest globally, contributing over 20% of global anthropogenic SO_2 emissions. SO_2 acts as a critical precursor to PM2.5, converting into fine particulate matter under certain meteorological conditions. Five of the world's top ten SO_2 hotspots from coal use are in India.[105]

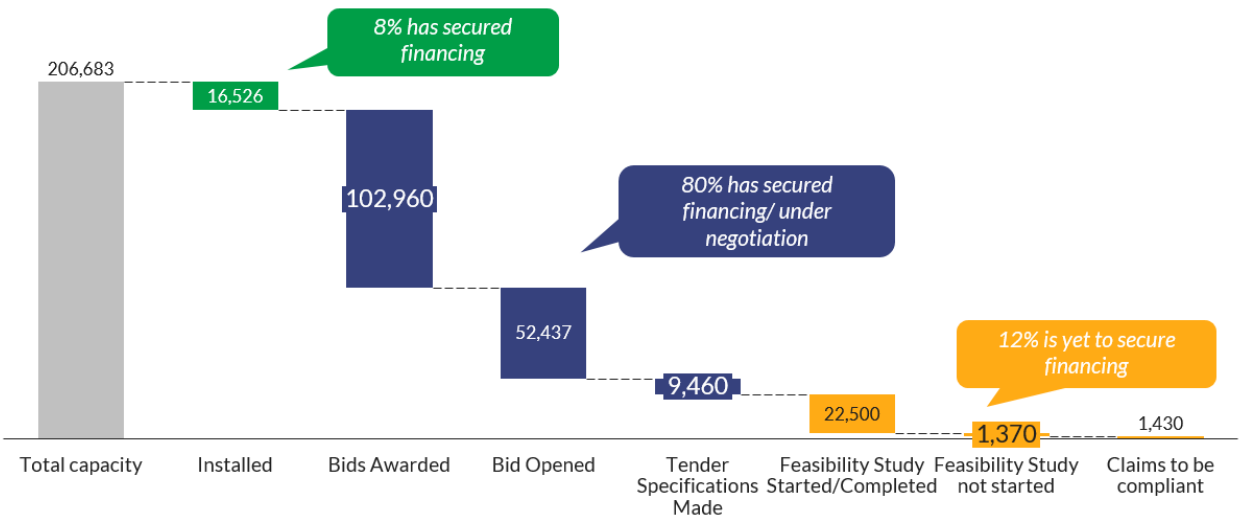
Globally, Flue Gas Desulphurization (FGD) has emerged as a commercially viable and scalable technology to curb SO_2 emissions from thermal power plants. Global experience shows FGD can reduce SO_2 emissions by over 90%. China achieved 95% SO_2 reduction with over 90% FGD coverage, despite five times more coal use than India.[106] The US, Poland, and Indonesia have also achieved high reduction rates using FGD.

India has mandated FGD installation, but implementation is lagging. Despite emission norms introduced in 2015 and staggered deadlines up to 2029, only 12% of thermal capacity has installed FGD. Almost half of the capacity (~85 GW) is in the nascent, pre-bid awarded stages i.e., bid opened, tender specification made, feasibility study started/ completed/not started stages.[107]

103.Environmental Science & Technology, Source Contributions to Fine Particulate Matter and Attributable Mortality in India and the Surrounding Region, 2023
104.TERI, Cost effectiveness of interventions for control of air pollution in Delhi, 2021
105.CREA, Increased SO_2 emissions from coal-fired power plants: FGD installation should not be delayed further, 2024
106.Dalberg analysis
107.CREA, Emission Watch: Tracking the implementation of emission standard notification for coal-based power plants in India, 2023

Supply-side bottlenecks, not financing, are the primary barrier to FGD implementation. While FGD installation is capital-intensive, financing is not the main constraint as over 8% of capacity has already secured funding, and 80% is in advanced bidding stages.[108] Projects like CLP Jhajjar and NTPC have demonstrated viability using consortium and syndicated loans. The core challenge lies in limited domestic manufacturing capacity, as SO_2 norms were introduced only in 2015, giving local industries little lead time. With around 30% of components still imported and few domestic vendors, the ecosystem remains underdeveloped. Simultaneous demand from over 500 thermal units has overwhelmed vendor capacity, further accelerated by long installation timelines and compressed compliance deadlines.[109,110]

Figure 18: Status of financing for FGD across thermal power plants in India by capacity (MW)



A dual approach of stricter enforcement and targeted incentives can unlock faster adoption. Global examples show the value of pairing mandates with capital subsidies, monitoring, and domestic production incentives. Accelerating FGD adoption could unlock over Rs 35,000 crore in capital investment, create jobs across the value chain, and support India's clean air and Atmanirbhar goals.

Potential Opportunities and Challenges

The potential to accelerate FGD installation is underscored by multiple emerging opportunities, across economic opportunity, supportive policy momentum, and access to sustainable financing.

- **Reducing SO_2 and PM 2.5 emissions to drive clean air gains:** Global benchmarks show ~90–95% reduction in SO_2 post-FGD installation. In India, this could reduce SO_2 significantly and cut PM 2.5 by up to 8% in hotspots like Delhi-NCR.
- **Scaling up domestic manufacturing to reduce import dependence and support Atmanirbhar Bharat:** With 30% of FGD components imported, DCR-linked subsidies can help scale domestic capacity and reduce reliance on imports.

108.Ibid.
109.Central Electricity Authority, A review report on new SO2 norms, 2021
110.Ministry of Power, Status of FGD installation in thermal power plants, 2024

- **Strengthening monitoring and enforcement by learning from global models:** Countries like China, the US, and Indonesia combined mandates with penalties and CEMS-based monitoring, achieving over 90% FGD coverage, offering strong lessons for India.
- **Leveraging sustainable financing mechanisms to ease capital burden:** FGD installation is capital-intensive (Rs 1 crore/MW), but financing models such as CLP's Jhajjar TPP and NTPC's pan-India rollout show the viability of syndicated/consortium loans and international financing.
- **Unlocking large-scale capital investment and job creation:** With over 35 GW of capacity still in pre-tendering stages, India stands to unlock over Rs 35,000 crore in capital investments through FGD implementation and a significant number of jobs across the value chain.

At the same time, several implementation challenges limit the acceleration of FGD installation:

- **Limited vendor capacity driving supply constraints:** FGD is a relatively new technology, with the vendor ecosystem still developing and a clear pathway to meet the demand missing.
- **Simultaneous demand from hundreds of units overwhelming implementation timelines:** Nearly 500 plants are tendering in parallel, straining vendor and EPC capacity, with compressed deadlines causing bottlenecks.
- **Long installation timelines delaying environment benefits:** Since FGD systems can take 36-44 months for installation, even if supply constraints and vendor bottlenecks are resolved, the tangible SO_2 and PM 2.5 reductions are likely to materialize only after a few years.
- **Repeated deadline extensions delaying implementation:** Despite existing mandates for emission norm compliance, deadlines have been extended four times in almost a decade,[111] with the repeated extensions diluting the urgency and accountability to install FGDs.

Moderators and Key Speakers

Envirocatalysts was the knowledge partner for this technical roundtable session. It was moderated by **Sunil Dahiya, Founder, Envirocatalysts**.

The key speakers for the roundtable included:

Roundtable Speaker	Title, Organisation
A K Saxena	Senior Fellow & Senior Director - Electricity and Renewables Division, TERI
Karthik Ganesan	Fellow and Director, Strategic Partnerships
Kritika Choudhary	Head - Strategy, Planning and Policy, The Air Pollution Action Group (A-PAG)
Maria Chirayil	Senior Research Associate at Prayas (Energy Group)
Pankaj Batra	Senior Advisor, Integrated Research and Action for Development & Ex-Chairperson, Central Electricity Authority

The roundtable saw 10-15 participants across organizations such as CEEW, Nabha Power, CREA, GE Power, NTPC, and the Air Pollution Action Group (A-PAG).

Key Insights from the Roundtable

FGD as an essential intervention for public health

- **FGD is necessary even with low-sulfur domestic coal**. The roundtable emphasized that India is the world's largest emitter of SO_2 due to the sheer scale of coal use, making robust desulfurization through FGD (Flue Gas Desulfurization) critical to reducing health risks.

111.DownToEarth, Thermal power plants get another extension for SO_2 compliance norms — it's time we reassess ongoing delays, 2025

Policy inconsistency and regulatory ambiguity delaying implementation

- **Uncertainty around FGD timelines has affected implementation momentum.** The group noted that frequent changes in deadlines and limited clarity on regulatory decisions have contributed to delays and reduced stakeholder confidence.
- **More than supplier capacity, clear policy signals are key to unlocking FGD progress**. The group clarified that contrary to popular belief, domestic supplier capacity is adequate and costs have not escalated significantly, but uncertainty and delays in timelines remain a challenge.

Need for robust monitoring and data transparency

- **Real-time emissions tracking is critical for accountability.** The roundtable emphasized the need for widespread adoption of Stack Emissions Monitoring Systems (SEMS) to track pollutants like SO_2 and mercury at the plant level.
- **Satellite-only monitoring approaches are inadequate for enforcement**. The group highlighted that beyond satellite-only monitoring, transparent, on-site emissions data is essential for effective regulation and operational oversight**.**

Conclusion of Aironomics 2025 and Plan Ahead

Aironomics 2025 marked a turning point for air quality action in India, laying the foundation for a coordinated, multi-level strategy to combat air pollution. The summit brought together leaders, experts, and policymakers to advance practical solutions for clean air. As part of this effort, CIEU and Dalberg developed a high-impact action plan for Delhi, outlining both immediate and near-term interventions, alongside a bold national roadmap to enable systemic action across states. These plans are designed to move from intent to implementation, focusing on clear priorities, institutional coordination, and public accountability.

Delhi's Immediate and Near-Term Action Plan

Delhi's immediate-term action plan is ready for deployment and targets five priority areas. The plan lays out high-impact interventions across vehicles, dust, construction, residential biomass, and institutional coordination:

- Scrap and replace 33% of diesel and CNG trucks registered in Delhi under the 'Naya Safar Yojna' with BS6 and electric alternatives.
- Deploy 500 GPS-tracked mechanical sweepers through a performance-based model to improve efficiency and coverage.
- Monitor 2,000+ construction sites using AI tools through a centralized command center to enable real-time compliance.
- Provide free LPG refills and distribute clean cookstoves to non-notified slums using carbon-credit financing to curb household biomass use.
- Establish a dedicated inter-agency task force and SPV to set clear implementation targets and finance high-impact actions.

The near-term action plan lays out five additional steps for initiation within six months. These focus on transport upgrades, secondary waste management, infrastructure audits, waste-burning control, and winter preparedness. These priorities are summarized in the figure below.

Figure 19: Near-term air pollution action plan for Delhi

Aironomics 2025 made a clear case for national action to scale clean air solutions beyond Delhi. It called for structured leadership, targeted funding, and stronger accountability to drive coordinated delivery across states. Three specific recommendations emerged to drive accountability, funding, and coordinated delivery at a national level:

- **Launch the National Mission for Shuddh Vayu**: Set bold, time-bound national targets for clean air. This mission will unite actors at a national level to fight air pollution with urgency and accountability.
- **Build a Chief Ministers' Coalition for Clean Air**: Form a powerful coalition of Chief Ministers, starting with NCR, expanding to the IGP, and scaling nationwide, to lead bold, coordinated state action.
- **Establish a ₹50,000 crore (~USD 6 billion) National SPV**: A ₹50,000 crore SPV will fund rapid, target-based, high-impact air pollution solutions at scale and catalyze private investment where it matters most.

Delhi's Clean Air Push is Already Underway

At Aironomics, the Hon'ble Chief Minister of Delhi, Rekha Gupta, committed to a clear set of actions focused on public transport, construction dust, private vehicle emissions, and enforcement. She announced the addition of 2,000 new DEVI electric buses by year-end, building on the 400 already on the road, with full fleet electrification targeted by 2028. To cut dust pollution, all high-rise buildings must now install sprinklers, while upgraded sweeping machines with integrated smog guns and water jets will be deployed across all 70 Assembly constituencies. For private vehicles, the government will introduce a new EV subsidy policy and launch a scrappage scheme for end-of-life vehicles.

Following the summit, the Delhi government unveiled the 25-point Air Pollution Mitigation Plan 2025, a comprehensive strategy targeting seven key pollution sources: dust, vehicle emissions, construction and demolition (C&D) waste, solid waste, industrial pollution, greening, and real-time monitoring. The plan emphasizes a blend of strict enforcement, technological innovation, and community engagement to address the city's chronic air quality issues.

Electrification and Sustainable Mobility: A significant component of the plan is the expansion of electric mobility. The government aims to introduce over 5,000 new electric buses and 2,299 e-autos by the end of the year. To support this shift, charging stations will be installed at strategic locations, including markets, malls, metro stations, airports, and parking lots. Additionally, Automatic Number Plate Recognition (ANPR) cameras will be deployed to prevent the entry of old, polluting vehicles into the city, aligning with the Commission for Air Quality Management's directive to allow only BS-VI, CNG, and electric commercial vehicles.

Dust and Construction Pollution Control: To combat dust pollution, the plan includes the deployment of over 1,000 water sprinklers and 140 anti-smog guns, operating year-round with GPS and CCTV tracking. Night cleaning will be enhanced with 200 mechanical sweepers, 70 electric litter pickers, and 38 tankers. All construction projects larger than 500 square meters are required to register with the Delhi Pollution Control Committee and adhere to a 14-point dust control checklist. Furthermore, the processing capacity for C&D waste will be increased by 1,000 tonnes per day, and government projects must utilize 100% recycled construction materials.

Green Cover Expansion and Innovative Technologies: Under the 'Ek Ped Maa Ke Naam' campaign, the government plans to plant seven million saplings across the city to enhance green cover. To improve air quality monitoring, six new ambient air quality stations will be established,

and a real-time source apportionment study will be conducted. The plan also introduces a 'Startup Innovation Challenge' to encourage low-cost, high-impact solutions for pollution control. In collaboration with IIT Kanpur, a pilot project for cloud seeding will be initiated to test the feasibility of artificial rain in reducing airborne dust.

Waste Management and Community Engagement: Timelines have been set to clear legacy waste from landfills: Okhla by March 2027, Bhalswa by December 2027, and Ghazipur by September 2028. Residents' welfare associations are encouraged to enforce household-level waste segregation and promote the use of electric heaters instead of biomass during winter. The 'Environment Doot' program will mobilize citizens, particularly students, to act as community monitors and spread awareness about pollution control measures.

Together, these actions mark a shift from fragmented efforts to a structured roadmap for clean air, both in Delhi and as a model for cities nationwide.

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