IBAQ
Integrated Programme for Better Air Quality in Asia

CLEAN AIR ASIA

ADVANCING BETTER AIR QUALITY IN INDIAN CITIES

ENABLING ENVIRONMENTS FOR TECHNOLOGY TRANSFER

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Reviewer and Editor: Prarthana Borah
Research, compilation and writing: Riya Rahiman and Ruchi Tomar

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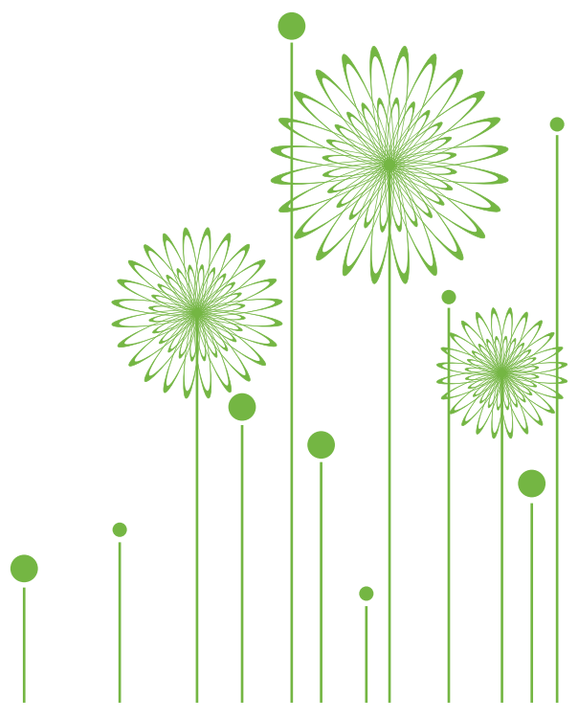
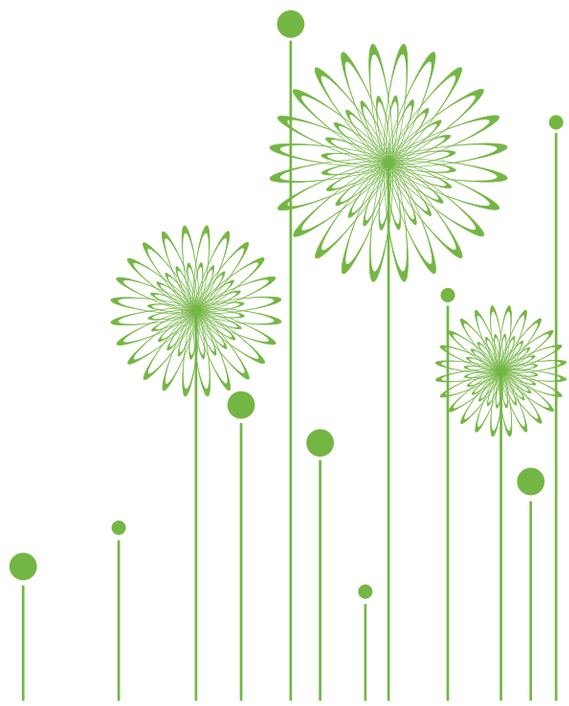


Abbreviations

AIM	Atal Innovation Mission
AQ	Air Quality
AQM	Air Quality Management
BAT	Best Available Technology
BS	Bharat Standard
CAAQMS	Continuous Ambient Air Quality Monitoring System
CAKN	Clean Air Knowledge Network
CEMS	Continuous Emission Monitoring System
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CSIR-NPL	Council of Scientific and Industrial Research- National Physical Laboratory
EPA	Environmental Protection Agency
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
GDP	Gross Domestic Product
GRAP	Graded Response Action Plan
H-CNG	Hydrogen-Compressed Natural Gas
IBAQ	Integrated Better Air Quality
IGCC	Integrated Gasification Combined Cycle
LPG	Liquified Petroleum Gas
MCERTS	Monitoring Certification Scheme
MNRE	Ministry of New and Renewable Energy
MoC	Ministry of Coal
MoEJ	Ministry of Environment, Japan
MoEF&CC	Ministry of Environment, Forest & Climate Change
MORTH	Ministry of Road Transport and Highways
NAAQS	National Ambient Air Quality Standards
NAMP	National Air Monitoring Programme
NAPCC	National Action Plan on Climate Change
NCAP	National Clean Air Programme
NDCs	Nationally Determined Contributions
NEMMP	National Electric Mobility Mission Plan
NOx	Nitrogen Oxide
OBD	On-Board Diagnostic
PFBC	Pressurised Fluidised Bed Combustion
PPP	Public Private Partnership
PUC	Pollution Under Control
SCM	Smart Cities Mission
SDG	Sustainable Development Goals
WHO	World Health Organisation
Y-CAN	Youth Clean Air Network



Foreword

The National Clean Air Programme of the Government of India proposes a tentative national level target of 20%–30% reduction of PM2.5 and PM10 concentration by 2024 taking 2017 as the base year for the comparison of concentration. With the objectives of augmenting an effective ambient air quality monitoring network across the country, efficient data dissemination and public outreach mechanism and devising a feasible management plan for prevention, control and abatement of air pollution NCAP hopes to achieve prescribed air quality standards.

One of the areas mentioned as a strategy for air pollution mitigation is adopting technology solutions towards which a Technology Assessment Cell is being set up to evaluate the technologies having significance in reference to prevention, control and abatement of pollution that will contribute towards evaluating the technology and devising the mechanism of technology transfer under various bilateral and multilateral agreements.

Clean Air Asia in the past one year has been working with cities to support the preparation and implementation of city air action plans. We understand that effective reductions of PM2.5 levels need to balance emission control across all source sectors including transport, power, construction, and so on. Focusing on a single source of emissions will not deliver long-term improvements and will waste already limited economic resources. Towards this one of the strategies that we have been facilitating is the technology for better air discourse.

Over the last two decades, improved vehicles and technologies have helped mitigate some major health impacts of vehicle travel, namely air pollution and injury. For instance, Bus fleet improvements, such as the inclusion of particle filters, low-sulphur diesel and the transition from diesel vehicles to compressed natural gas (CNG) , electricity, or other alternative fuels significantly decrease harmful particle emissions.

Industrial processes that emit large amounts of black carbon include brick production and the use of coke ovens. As with brick kilns, inefficient low-technology coke ovens are widespread in many developing countries and are characterized by high emissions when compared to more modern production processes.Technologies reducing black carbon emissions from traditional brick kilns and coke ovens can reduce high levels of human exposure to particulate matter from these sources for workers and communities near these industries, providing an important health-enabling opportunity for mitigation.The fossil fuel industry is a key source of methane emissions, which contribute to tropospheric ozone. Recovery and use of gas released during fossil fuel production and distribution can reduce methane emissions and the production of ozone. Specific actions include the recovery and use of coal mine methane and methane released from oil and natural gas production processes, as well as reducing leakages, such as during pipeline distribution. Strategies for waste reduction, separation, processing, management and recycling and reuse are feasible, low-cost alternatives to the open incineration of solid waste, which is common now in developing cities. Where incineration is unavoidable, then combustion technologies with strict emissions control are critical.

These and many more can substantially contribute to reducing air pollution but however the danger is in the one size fits all approach. It is with this in mind that we at Clean Air Asia took up the scoping exercise under the Integrated Better Air Quality Programme to assess technology needs of cities. To get a perspective beyond Delhi we had dialogues between city officials and technology providers in three other non-attainment cities.

This policy brief “Advancing Better Air Quality in Indian Cities: Enabling Environments for Technology Transfer” has been prepared with inputs from city officials, technology providers and experts working in the technology space. We hope that it will add value to work being done towards Air Pollution mitigation and will be useful for all who are working in the important area of cleaning the air in our cities.

Prarthana Borah
India Director, Clean Air Asia

Abstract

With the Air Pollution discussion gaining momentum in the country it is fair to say that there is now a higher inclination to emphasize the need to clean up air pollution in India especially in Delhi and the Indo – Gangetic Plains where the dialogue is now driving policy and action. The launch of the National Clean Air Programme in 2019 is a step in enhancing air pollution policy and at the same time initiates the process of clean air action in 122 non- attainment cities. Clean Air Action Plans in cities have three types of proposed action categorised as policy, regulatory and implementation. In the context of implementation, the role of technology as a "solution" for clean air action is highlighted. This has also generated debate of discussion on how far technology can help clean up the air. Key technologies being discussed include lower emission vehicles (including electric, hybrid and LPG), car sharing, and lower emission sources of heat and power, adaptation technology like smog towers, purifiers and so on. Additionally, there are also numerous other emerging technologies which could also play a role in the future. Clean Air Asia, an international not for profit headquartered in Philippines and offices in China and India has been working towards assessing technology needs for better air quality in the context of cities. This policy brief includes the challenges, policies, technological landscape and recommendations for creating conducive environments for technology solutions for clean air, based on discussions with relevant stakeholders by Clean Air Asia India in 2019.

Overview

The World Health Organization (WHO) has identified air pollution as the single largest environmental health risk. Poor air quality is a serious issue that effects the health of millions of people, particularly vulnerable groups such as children, the elderly and people with respiratory conditions. Globally, with cities contributing to 82 per cent of GDP, they also contribute to 75 per cent of the total CO2 emissions (UNEP). Rapid urbanization has led to an increase in energy demand and concomitant emissions and air pollution from both stationary and mobile sources.

Against this background, the Government of India launched, the National Clean Air Programme (NCAP), a time bound national level strategy to tackle the growing challenge of air pollution. The NCAP prescribes a collaborative and participatory approach across all relevant Central Ministries,

State Governments, Urban Local Bodies and other stakeholders to, develop comprehensive mitigation actions for prevention, control and abatement of air pollution, strengthen air quality monitoring network and enhance awareness and capacity building activities. Further the need to mainstream and integrate NCAP with existing relevant government policies and programmes such as the National Action Plan on Climate Change (NAPCC), Smart Cities Mission (SCM), National Mission for Electric Mobility (NEMMP) has also been emphasised.

Indian cities deal with a range of challenges such as use of outdated technology in industries, poor fuel quality, lack of adequate monitoring systems etc. which impact the quality of air. The need of the hour is to take immediate action by developing technical and research knowledge, building awareness to bring about behavioural changes and promoting technological advancements and innovations to address air pollution. The role of technology in reducing air pollution cannot be denied, however effective technology transfer cannot be achieved without technology needs assessment; technology information and capacity building; and an enabling environment that promotes research and innovation and facilitates institutional and financial mechanisms for technology development and transfer.

The challenge also lies in the lack of support for emerging technological innovations from research to industry and the technology eventually being absorbed on ground for combating air pollution.

Clean Air Asia India, under the Integrated Programme for Better Air Quality in Asia (IBAQ Programme) supported by the Ministry of Environment, Japan (MoEJ) has been involved in facilitating dialogues to assess the technology needs of cities especially in the context of generation of air pollution data and mitigation action for air pollution.

In March 2018 Clean Air Asia organised a dialogue in Delhi with 14 cities and 10 technology providers to assess the role of innovation and cutting edge technologies for better air quality management with specific focus on air quality monitoring and sustainable mobility. Technologies like mobile monitoring platforms, dust suppressants and clean vehicular technology was discussed. An interesting outcome of this discussion was that cities expressed interest in technology that had co- benefits especially in the context of climate change or expressed the need for highlighting this more specifically.

It was also observed that discussions in this as well as other consultations that followed in Nagpur and Agra, sustainable mobility situations such as eco-driving and eco-routing, emission reduction technology, micro-climate stations, mobile air quality sensors and air quality mapping dominated the discussions.

The June 2019, Nagpur consultation focussed mainly on assessing air quality monitoring solutions in smart cities and exploring mitigation technology solutions in alignment with smart city plans. The major solutions discussed during the consultation included introduction of electric vehicles and supporting financial schemes to facilitate the switch to cleaner options. With respect to industries the need to switch to Best Available Technology (BAT) and adopt latest air pollution control systems by concerned authorities, installation of remote sensor based Pollution Under Control (PUC) systems etc. was discussed.

Continuing the dialogue, Clean Air Asia, India in collaboration with Imagine Panaji Smart City Development Limited looked at possible city level technology interventions that can contribute better air quality to support the concept of a smart liveable city. The dialogues focused on assessment of the needs and capacities of smart cities and match technology solutions meeting local conditions; improve access to technology by providing a platform for cities and industries to engage and enhance institutional capacity of cities by improving technological know-how of cities.

The need for maintaining international standards while introducing international technology was discussed in detail especially in the context of waste to energy plants. The need for demonstration experiences from other cities which could be matched with Indian cities was expressed.

The Policy Landscape

The Ministry of Environment, Forest & Climate Change (MoEF&CC) along with Central Pollution Control Board (CPCB) has formulated various programmes and policies to support the development and implementation of various measures to promote air pollution mitigation and adaptation. Since air pollution comprises emissions from different sectors, the supportive programmes and policies also cut across different sectors of development. This section will give an overview of the current policy and institutional frameworks governing technology innovation and development for air pollution to advance better air quality management:

Ministries Directly Engaged in the Air Quality Management Technology Framework	Ministries Indirectly Engaged in the Air Quality Management Technology Framework
Ministry of Environment, Forest and Climate Change implements policies and programmes relating to conservation of the country's natural resources including prevention and abatement of pollution.	Ministry of New and Renewable Energy is actively working towards addressing problems related to Indoor Air pollution and Black Carbon.
Ministry of Earth Sciences promotes scientific research in the country in the field of air quality monitoring, source, air quality modelling studies and emission characterisation studies related to various pollutants.	Ministry of Coal indicated that industries now run the risk of even having to their coal linkage cancelled if the transporters engaged by them are found flouting norms that lead to pollution due to spillage of coal particles that rise in the air.
Ministry of Science and Technology promotes research which facilitates greater understanding about ambient air quality and its implications on the environment, human beings, crops, animals, etc.	Ministry of Corporate Affairs had mandated Corporate Social Responsibility activities for PSUs (Public Sector Undertaking) and given voluntary guidelines to corporate entities. These activities can eventually lead to air pollution control.
Ministry of Petroleum and Natural Gas is an active participant in efforts to reduce vehicular emissions from incomplete combustion and inappropriate usage of fuel. The ministry is also a participant in various inter-ministerial committees, which form policy framework for the air quality management in the country, specifically related to automobile fuel policy.	Ministry of Housing and Urban Affairs has come up with various policies which are intended to reduce pollution, prioritizing the use of public transport and using clean technologies.
Ministry of Health and Family Welfare undertakes various research activities on studying the impact of both 'Indoor Air Pollution' and 'Outdoor Air Pollution' on human health.	Ministry of Heavy Industries and Public Enterprises has various projects aiming at industrial pollution control technologies with respect to air, water and solid waste to avoid unintended side effects of economic growth.
Ministry of Power emphasize the supply of clean power in the country by mandating conventional power generation to comply with the pollution control norms.	Ministry of Commerce and Industry recognizes the importance of environmental clearances in its 'Industrial Policy.
Ministry of Road, Transport and Highways is involved in the formulation of regulations relating to Emissions. Fuels and Alternative Fuel vehicles.	

Air (Prevention and Control of Pollution) Act 1981

The Air (Prevention and Control of Pollution) Act 1981 was constituted to prevent, control and reduce the air pollution for the establishments. This extends to whole of India to prevent the air pollution and preserve the quality of air.
The act enables provisions for Central and State Boards with certain powers to declare pollution control areas, restrict certain industrial units, taking samples and analysis, penalties and offences for the polluters. The Act provisioned state and central board with powers to take preventive measures to monitor and control the air pollution.
The corrective measures include suggesting change in type of fuel technology, adopting best available technologies to combat air pollution, monitoring the emission standards etc. Hence, this act is supporting adoption of technological solutions as a way of prevention and control of air pollution.

The Environment (Protection) Act 1986

The Environment (Protection) Act 1986 was constituted for protection and improvement of environment and matters related with environment such as air, water, land, human beings etc. This act was constituted as an umbrella term that shall have all the necessary measures to protect and improve the environment by controlling, preventing and reducing all kind of environment pollution. The specific measures include laying down national wide programmes for abatement of environment pollution, standard of emission levels for different sources, establishment of laboratories and institutes to carry out provisions enlisted in this act, etc. As per this act, below mentioned five rules with respect to waste management and air quality standards were provisioned with aim to manage and control the sources of emission and air pollution levels:

National Ambient Air Quality Standards (NAAQS)

Under The Environment (Protection) Act 1986, the National Ambient Air Quality Standards were formulated for criteria pollutants. The Ambient Air Quality Standards are formulated or adopted to design different adaptation or mitigation measures which might include technological solutions and aim to meet the designated standards for all the criteria pollutants. The National Ambient Air Quality Standards provides benchmark values for different measures taken to reduce air pollution.

Five Waste Management Rules

With waste burning being a source of air pollution, Ministry of Environment, Forest & Climate Change enacted five different waste management rules to ensure safe management and handling of waste under below mentioned categories:

- Municipal Solid Wastes (Management & Handling) Rules, 2016
- Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016
- E- Waste (Management) Amendment Rules, 2018
- Bio-medical Waste (Management & Handling) Rules, 1998
- Plastic Waste Management Rules, 2016

Under these rules, concerned authorities are found to be responsible for collection, segregation, storage, transportation, processing and disposal of above mentioned wastes. The rules are drafted to manage the waste decomposition and burning issues resulting in air pollution. These rules provide roadmap to manage the waste and adopt technological solutions to reduce waste in sustainable manner without contributing as source of air pollution or any other kind of pollution.

Construction and Demolition Waste Management Rules, 2016

Ministry of Environment, Forest & Climate Change notified Construction and Demolition Waste Management Rules, 2016 as one of the aim to address the issue of dust pollution being a major source of air pollution from construction and demolition activities and ill management of waste from these activities. These rules focus on duties of all the stakeholders involved i.e. waste generators, service providers and contractors, central pollution control board and other concerned authorities to take various initiatives including development of waste management plan, adoption of equipment and methodology for cleaning process, safe disposal of construction and demolition waste contaminated with industrial hazardous or toxic material or nuclear waste etc. Hence these rules provide scope to explore technological solutions to deal with the dust pollution as one of the major source of air pollution.

National Air Monitoring Programme (NAMP)

National Air Monitoring Programme is a nation-wide programme for ambient air quality monitoring executed by Central Pollution Control Board. Understanding the need of air quality monitoring, the network consists of 779 operating stations across 29 states and 6 union territories of the country. The NAMP supports technological solutions as part of its objectives. The expansion of monitoring network shall provide trends and status of ambient air quality and whether prescribed standards are violated for four criteria pollutants i.e. Sulphur Dioxide (SO2), Nitrogen Dioxides (NO2) and Respirable Suspended Particulate Matter (RSPM/PM10).The violation of standards emerged as a criterion to identify non-attainment cities, obtain understanding to develop preventive and corrective measures towards reducing air pollution. The NAMP provides need assessment scenarios for innovation of technological solutions.

National Clean Air Programme (NCAP)

With the realisation of gaps between the current air pollution status and ongoing government initiatives, the National Clean Air Programme was launched in mission mode as an improved effort towards mitigating the air pollution. The NCAP focused on need of expansion of air quality monitoring network and supports continuous ambient air quality monitoring network across the country. The NCAP directly supports the identification of alternative technology for real time monitoring. Under NCAP, technologies with potential to support air pollution mitigation will be supported and to evaluate this technology assessment cell is foreseen with reference to prevention, control and reduction of pollution.

Bharat Stage VI Emission Standards

The Ministry of Road Transport and Highways (MORTH) has issued notification of enforcing Bharat Stage (BS) VI emission standards for all major on road vehicle categories including light and heavy duty vehicles, as well as two and three wheeled vehicles. It is decided that Bharat Stage VI emission standards will go into effect from April 1, 2020 and on or after this date no car shall be manufactured with Emission Standards other that Bharat Stage VI. The BS VI emission standards specifies mass emission standards, approval requirements, on-board diagnostic system (OBD) system and durability levels for each vehicle category and therein sub-categories. Reference and Commercial fuel specifications are also included in the BS VI proposal. With adoption of BS VI standards, Indian motor vehicle regulations will align with European Union regulations for all vehicle categories including light-duty passenger cars and commercial vehicles, heavy-duty trucks and buses, and two-wheeled vehicles. The Bharat Stage VI Emission Standards shall not yet reach to European levels but this will bring more stringent emission standards for three-wheeled vehicles.

Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India)

Under the National Electric Mobility Mission Plan (NEMMP) 2020, a scheme viz. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) was formulated by Department of Heavy Industry in the years 2015. The objective envisioned within this scheme was to promote manufacturing and sustainable growth of electric and hybrid vehicle technology. The scheme has been launched in two phases. The first phase was of two years and started from 1st April 2015 with subsequent time to time extension and finally ended on 31st March 2019. The first phase of the scheme focused on four areas viz. demand creation, creation of technology platform, implementation of pilot projects and availability of charging infrastructure. Based on experiences gained from first phase of the scheme, the Department of Heavy Industry launched its second phase for 3 years from 1st April 2019. The revised scheme is focused on EVs commercial use with inclusion of shared mobility, buses, three wheelers and two wheelers for private use. The second phase is also addressing issues of national energy security, mitigation of

adverse impact by vehicles on environment and growth of domestic technologies and their manufacturing capabilities.

Graded Response Action Plan (GRAP)

With the aim to address the episodes of region air pollution of Delhi and NCR Region, Ministry of Environment, Forest & Climate Change has notified the Graded Response Action Plan as an emergency tool to reduce the air pollution levels in Delhi-NCR. GRAP includes the serious matters of concern and mention urgent measures to address episodes of higher air pollution levels. Based on air quality the grades have been qualified as Emergency, Severe, Very Poor and Moderate poor. Each grade includes the measures to combat the air pollution levels. The measures indicated within this plan supports the technological solutions to combat air pollution such as mechanised cleansing and water sprinkling on road, intensifying public transport services, ban on diesel generators etc. The measures indicated within this plan provides push and space to identify technologies for various sources.

Swaach Bharat Abhiyaan

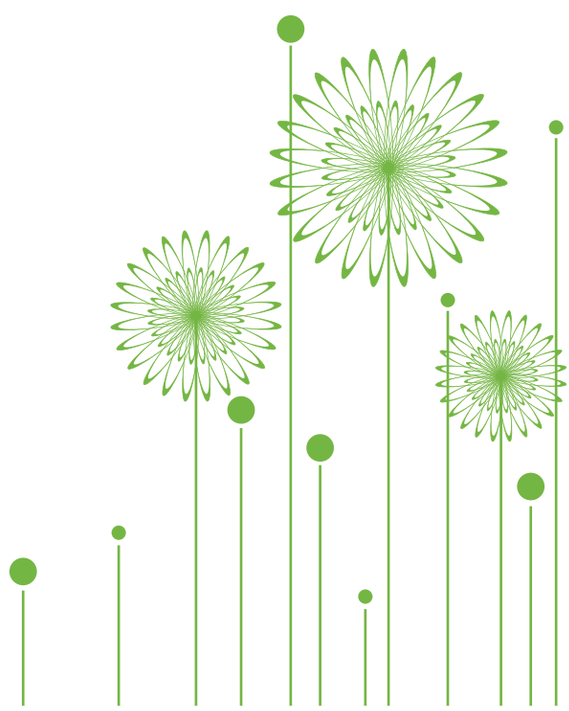
Innovations and technology involvement is there in various facets of the Swaach Bharat Abhiyaan mission of the government of India. While it may not have a direct reference to air the role of technology is being explored in areas from sanitation to cleaning of roads, management of waste, accessing the progress of different states/cities or local bodies under swachh bharat abhiyan, encouraging people about cleanliness and more. Another Mission the Digital India missions meets the Swaach Bharat Abhiyan through information technology platforms like the Swaachhta App. To make it easy for the citizens to report a cleanliness related issues, Ministry of Urban Development launched an app – Swachhta App to connect citizens with their respective urban local bodies. Apart from this national app, many cities and civic authorities have their own apps to support regulation by facilitating enforcement via public engagement.

National Solar Mission

The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. The first phase (up to 2012- 2013) focussed on low-hanging options in solar thermal; on promoting off-grid systems to serve populations those without commercial energy through small capacity addition in grid-based systems. In the second phase, capacity has been aggressively ramped up to create conditions for up scaling and competitive solar energy as an energy option. The mission aims at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022.

Start Up India

Startup India is an initiative of the Government of India, intended to build a strong eco-system for nurturing innovation and Startups in the country that will drive sustainable economic growth and generate large scale employment opportunities. Through this initiative, the government aims to empower Startups to grow through innovation and design. Start Up India Action Plan looks at various sectors like digital/ technology sector to a wide array of sectors including agriculture, manufacturing, social sector, healthcare, education, in existing tier 1 cities to tier 2 and tier 3 cities including semi-urban and rural areas. The Action Plan is divided simplification and handholding, funding support and incentives and industry-academia partnership and incubation.



The Technology Landscape

To understand the technological options cutting across each sources or sectors, there is need to understand the need of technological advances in the sector of air quality monitoring. This is required with an aim to adopt suitable technology and assess the impact of adoption of any technology. As mentioned earlier, the Air Quality Monitoring is the foremost and integral part of the effective air quality management system. The air quality monitoring system provides an understanding of the areas where pollutant levels are violating the ambient air quality standards.

In India the instruments used for Continuous Emission Monitoring Systems (CEMS) and Continuous Ambient Air Quality Monitoring Stations (CAAQMS) are imported and their respective certificates are issued by agencies such as EPA, Monitoring Certification Scheme (MCERTS) etc. The instruments are generally based on the environmental conditions of the country issuing the certificate and do not match with climatic and environmental conditions predominant in India. This situation used to arise deviance in the design and performance of the instruments therefore leading to inflow of low quality instruments in market and no uniform standard to choose the right instrument.

With understanding of this situation, Ministry of Environment, Forest & Climate Change appointed Council of Scientific and Industrial Research- National Physical Laboratory (CSIR-NPL) as a national agency to carry out certification of instruments and equipment for monitoring of ambient air and emission standards. The enhanced scrutiny of design and performance will bring uniformity in the monitoring equipment's being used for regulatory grade monitoring. With this background the below given table provides the available technologies cutting across different sectors and sources of air pollution with also including the different kinds of instruments and devices used for air quality monitoring and directly mitigating the air pollution.

The challenge with air pollution mitigation/ adaptation technology is that it is new to the country. For policy makers to support new technologies from research through to commercialisation is a decision that requires much thinking through. Since clean air results are long term, picking the right technology and ensuring that technologies do deliver claimed improvements in air quality is a risk. Also air pollution is location specific and complex. A successful technology in one area may not be successful in another because of meteorological, geographical or other undirect impact. Finance and economics too play a stronger role in technology solutions compared to others. For instance a technology may offer fuel savings, which may help to drive their adoption by vehicle manufacturers and owners.

Another issue is where to focus its limited research budget. Much research in the air pollution space is limited to reducing vehicular emissions and to some extent industry emissions. Given the overwhelming contribution of existing diesel vehicles to urban air pollution, research into retrofit technologies is justified. But dust which is a major source of air pollution in India and the information technology solutions that promote for instance waste recycling, marketing of agricultural bio-mass etc., and low cost sensor technology as a source of data generation for the country have not received adequate research investment or opportunity.

The NCAP does however try to initiate a dialogue towards the issue of technology solutions with the mention of setting up the Technology Assessment Cell. The cell as mentioned in the policy document is being envisaged to evaluate technologies that can contribute to prevention, control and abatement of air pollution. The cell is expected to look into both indigenous and international monitoring and abatement technologies. Another function of the cell as mentioned is that it is expected to contribute towards evaluating the technology that can be applicable locally while devising the mechanism of technology transfer under various bilateral and multilateral that agreements.

Table: Technologies cutting across sources of air pollution

Sr.No.	Sectors/Sources	Available Technologies
1.	Air Quality Monitoring	• Real time Local Air Monitoring Sensors • Mobile Monitoring sensors • Low Cost Monitoring sensors • Micro climate Monitoring Stations
2.	Vehicular Emission	• Electric Vehicles • Hybrid Vehicles • Diesel to CNG • H- CNG (Blending 18% Hydrogen with CNG) • Bharat Stage VI Fuel Technology
3.	Waste Burning	• Waste to Energy Plants • Bio-Remediation
4.	Construction & Demolition Waste	• Water Sprinkler System • Dust Suppressors
5.	Road Dust	• Mechanical Sweeping • Dust Suppressors
6.	Industry (including Power Plants)	• Electrostatic precipitators and fabric filters • Flue gas desulfurization • Low-NOx burners • Integrated Gasification Combined Cycle (IGCC) and Pressurised Fluidised Bed Combustion (PFBC) • Carbon Capture & Sequestration
7.	Brick Klins	• Zigzag technology
8.	Crop and Agri Residue Burning	• Bio-Gas and Bio-Fuel Production • Bio Pile farming • Bio-methanation • Direct Sowing Machines
9.	Indoor Air Pollution	• Cleaner stoves and fuels for cooking and heating
10.	Air Pollution Mitigation	• Smog Tower • WAYU Purifiers

Enabling the Environment for Technology Interventions

Recommendation and Suggestions for Implementation

At various platforms it has been discussed recurrently that abundance of technology need to be aligned with proper planning and management. Talking about the challenges with respect to implementation of technology there is a wide gap that exists between the needs of the cities and proposed technologies. Apart from this, the economic and financial support is another big challenge with technological solutions implementation in air pollution sector. Other issues with technological implementation includes long procurement process, lack of operation and maintenance post installation, lack of co-benefits identification, issues of clean technologies and not meeting Indian standards etc. With realisation of these challenges, below mentioned recommendations can be used as a solution for enabling environment and conditions conducive for effective implementation of technologies.

Recommendation 1: City Needs Assessment.

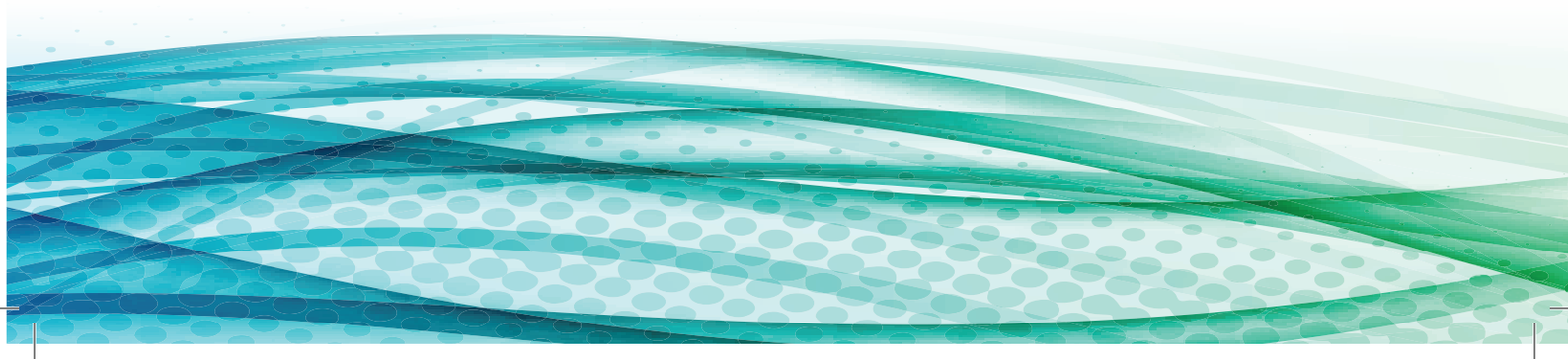
Air Pollution is complex and requires very detailed analysis and assessment about key pollutants, sources of air pollution and the mix of pollutants in the air to be effectively addressed. Any technology intervention therefore requires adequate information on the local sources of pollution if it has to be successful which is why local level city assessment is important before introducing it. Effectiveness of technology also depends on local conditions and once the baseline of the city is completed, one cannot be sure that a technology intervention will succeed which is where pilots can play a relevant role. Pilots are also good examples where scaling is successful. This can especially be impactful in case of smaller two-tier cities where the eco-system is easier to intervene in. It is recommended that technology introductions need to follow local level city assessment preferable with the introduction of pilots so as to assess the scale for adequate impact on the air quality of the city.

Recommendation 2: Providing maximum options in Technology.

Often in the absence of options there is a rush to introduce technology that is easily accessible. World over there are examples of air pollution mitigation in cities by introducing technology for reducing vehicular emissions, industry emissions and others. However the challenge to cities is that this information on best practices is not available. Similarly there are smaller local technology solutions that can be introduced at affordable budgets in cities which are already grappling with small budgets to address multiple problems. It is recommended that a mechanism be devised for showcasing technology solutions. This will require efforts to harness synergies between various stakeholders, bringing together business houses, showcasing innovation. A single platform that is a repository for technology solutions for air pollution can serve as good resource base for cities looking for opportunity to address air pollution.

Recommendation 3: Matchmaking between proposed Technological Solutions and needs of the cities

To propose a technology there is need to conduct a need assessment study by the concerned authorities or technological vendors. The need assessment study should look at the air pollution level and trends over a long period of time, identifying hotspots and sources of air pollution, study the features and behaviour of the city or areas affected by air pollution. The matchmaking exercise should be in alignment with the requirement of the area for the effective implementation and outcomes of the technological solutions. The matchmaking exercise shall provide a menu card of solutions based on the need assessment study and bring improved effectiveness and sustainability of the technology proposed or implemented in the areas or cities with air pollution issues.
The matchmaking also provides scope for betterment or innovation of technological inputs in the areas where available technologies are found to be mismatched or underperforming with respect to the concerned challenges.



Recommendation 4: The impact of technology should be exercised through introducing pilot projects in decentralised manner

As a next step after matchmaking exercise for a city, the technology impact should be assessed by implementing it through pilot projects in decentralised manner. To introduce a technology and achieve effective implementation, there is need to implement in in pilot project mode with focus on few areas initially. Based on the impact assessment of technologies, the scope of implementing in other areas and ultimately adoption for whole city can be done. The implementation of technologies in pilot project mode advances the chances of successful implementation of the technologies and also beneficial from the economic perspective. The pilot projects in decentralised manner provides scope for effective implementation and innovation of technologies in sustainable ways.

Recommendation 5: There is requirement for ease of procurement and shorter gestation period supporting market for start-ups and technological innovation. (Single Window system)

The process of procurement and gestation period should be made easier and shorter by adoption of single window system. In India, with longer process of procurement of technology the implementation gets effected and delays the whole process. Hence, a single window system enables single sources to collect information and apply for the procurement of technologies. This shall act as a constructive support system for start-ups and technological innovations working towards air pollution mitigation and adaptation. With ease of information retrieval and procurement system in place the well-timed implementation of technology shall act as a catalyst in the process of reducing air pollution by adoption of technologies. In case of start-ups, the major challenges evidenced is the longer procurement process and hence disables the market to grow. The single window system will also support growth of start-ups and market dynamics.

Harnessing the Power of Start- Ups to address Air Pollution.

UNDP India conducted an Innovation Challenge for finding technological solutions to address Air Pollution at source. Three start-ups and their respective solutions were selected for incubation

- **A2P ENERGY:** A2P uses AI to track waste biomass and then works with farmers to collect and buy them. On one side it generates additional income for farmers and on the other side, A2P converts the collected biomass into NextGen biofuels, such as Green Coal and BioOil. The team collects baked paddy straw in baled form and process it into different energy products, such as the 'energy pellets' for boilers. The first company in India to commercialize products out of 100% paddy straw. The start-up plans to replicate the paddy straw processing plant into a franchisee model so that other village level entrepreneurs can take it forward.
- **PI GREEN:** With its unique 'Filterless' Cutter Technology, Pi Green has enabled the reduction of PM emissions from vehicles, gensets as well as ambient air, without the risk of choking and the hassle of maintenance.
- **CARBON CUTTER:** A filter-less retrofit device which captures around 90% of PM from vehicular emissions, can be retrofitted on vehicles and solve the PM pollution problem at source.
- **REPAIR:** Filter-less Ambient Air Purifiers that can be installed in public places like squares, dividers, parks etc.
- **URBAN AIR LABS:** Urban Air Labs aims to improve upon Air Problems associated with Urbanisation by combining three critical elements - Technology | Design | Nature. Their 'Breathing Roots' technology (patent pending) leverages a nature-based solution to amplify air purification through specific plants to provide a green & sustainable solution for both indoors and outdoors. With their use-case based products, such as the 'Ubreathe' home air purifiers, the purification capacity of plants is amplified by almost 50 times.

Contributed by UNDP Accelerator Labs, India (Peer Review Meeting 14022020)

Recommendation 6: Interventions required to find and adopt innovative financial mechanisms.

The major problem with any technology lies in providing sustainable financial support system. There is always need of cost benefit analysis with major focus on financial and economic feasibility of technology introduced or implemented. Some of the suggestions include financial support mechanism through government initiated missions and programmes such as Start-up India, Make In India, AIM Tinkering Lab etc. to support the technology from the designing to implementation. The government initiatives should provide financial mechanism to support the technological innovation from the R&D to on ground implementation. The other ways include convergence with other missions focusing on development such as Smart City Mission, National Solar Missions; exploring PPP model wherever feasible and International Funding Agencies working towards Air Pollution Reduction.

Recommendation 7: The aspect of circular economy should be adopted with focus on operation & maintenance and by ensuring sustainability of technology.

The technology provider needs to focus on the aspect of circular economy and focus in operation and maintenance of products ensuring sustainability of technology. It is often observed that after the end of contract period of technology, the operation and maintenance and waste from technology becomes a challenge for the concerned authorities. The technology providers should extend their services including operation and maintenance of the products till the life expectancy of a product and should also explore aspect of circular economy by utilising the waste or any by-products generated in the process of implementing and utilisation of technologies. This shall enable strong customer support system and market demand for the technology providers and product as well and also ensure the sustainability aspect for adoption of technology.

Recommendation 8: The co-benefits of the technologies should be promoted with inclusion of social benefits and achievement of SDGs and NDCs

The technology providers need to promote societal values while promoting their technologies. Before launching any technological product or services it is important for technological providers to take responsibility of creating awareness and best practices. It is important to include the social benefits of technology and create awareness from the societal perspective as technology alone can never suffice the agenda of air pollution reduction. The users i.e. society need to be made aware of its benefits and technology providers need to initiate such programmes along with providing technological solutions. The other co-benefits should also be taken into account while producing or inventing any technology. In current scenario, the technology providers need to also include objectives mentioned under Sustainable Development Goals and National Determined Contributions by the government on international platforms. This shall enable the sustainable environment for growth of technology and it is both socially and economically feasible to adopt technologies focusing on co-benefits.

New Technology for Addressing Air Pollution

Pilot Project to Demonstrate Results. Crop stubble burning following the harvesting season in the states of Punjab and Haryana is being attributed as a major causes of air pollution in the National Capital Region (NCR) during October to December every year. Stubble burning contributes 40-60% of air pollution in Delhi and NCR in the winter months.

Farmers continue to burn the crop stubble as alternatives are expensive – the operation of collection of stubble costs roughly Rs.2,500.00 per acre. It may be mentioned that the central Government allocated Rs.1151 crores to combat this activity during 2018-19 & 2019-2020. A pilot project is being implemented with technical support from Department of Agriculture, Punjab, State Pollution Control Board Punjab and Punjab Agriculture University. The Society of Indian Automobile Manufacturers (SIAM) in partnership with the

Confederation of Indian Industry (CII) is implementing this pilot showcasing in-situ technology (zero pollution technology in which stubble is mixed with soil) on adopted area of agricultural land and mitigate the crop stubble. SIAM joined hands with CII (i) taking initiative beyond what is typically expected from the industry as a testimonial of building the nation, responsibly, (ii) showcase the in-situ technology before specific target stakeholders like farmers, policy makers, judiciary, activists and media, and (iii) allow feasible replication in other areas.

Presently, the project is being implemented in Nabha of Patiala District of Punjab in three cooperative societies viz. Jasso Majra, Mallewar and Bhorey comprising of 9 villages spread in about 14700 acres of land with farmland of about 7400 acres belonging to 1500 farmers. Under the project, 46 various types of agricultural equipment (happy-seeders, mulchers, rotavators, MB plough, choppers, tractors etc) were provided through cooperative societies to the farmers. The results of in-situ technology has been encouraging:

- In 2018-19, the stubble burning was effectively stopped in more than 71% of farmland under the jurisdiction of said cooperative societies,
- In 2019-20, as per the preliminary assessment, it is expected that reduction in stubble burning would about 90%,
- In the third and last year (2020-21), the target is to achieve zero stubble burning in all 9 villages adopted under the project.

The results of the project have been promising and appreciated by all including Government, experts, academia, farmers societies, farmers etc. and it is expected that it will encourage farmers to expand the implantation of in-situ technology in other areas of Punjab and Haryana and help in reducing air pollution in the region.

Contributed by Dr Rashid Hasan, Advisor SIAM (Peer Review meeting, 14032020)

Recommendation 9: Partnerships for Successful Implementation.

Partnerships are key to success since addressing air pollution requires an integrated approach and mainstreaming in multiple sectors. Environmental sustainability can be achieved by assessing development programs and policies taking into account the ecosystem, which is not limited by political and geographical boundaries. For example, air integration requires consideration of consequences outside the region and the measurement of transboundary impacts. For example, developers of agricultural or industrial projects can achieve compliance with environmental air quality policies by selecting technologies that result in emissions of pollution in accordance with relevant standards, or support farmers by promoting proper agriculture waste methods. However this requires working across sectors and hence the need for partnerships with multiple stakeholders.

Conclusions

While introducing any technology there is a need to look at benefits accrue to all. Personal air purifiers while serving immediate needs of protection of a few are not necessarily a solution to air pollution. Advanced technology for brick kilns that considerable reduce air pollution and at the same time create a safe environment for those working in the production process can be considered a solution to air pollution. This where extended producer responsibility and shared responsibility become more than just theoretical concepts and need to be a part of technology for better quality dialogue. If the focus is on solutions more than business models there is more chance that the appropriate technology is identified, and the complex problem of air pollution is addressed.

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List of Peer Review Participants

Name	Designation	Organisation
Sanjai Gupta	Head Government Affairs	3M
Prabhjot Sodhi	Head-Circular Economy	UNDP
Rozita Singh	Head of Solutions Mapping	UNDP
Dr. Krishnan S. Raghav	Head, Exploration	UNDP
Rashid hasan	Advisor	SIAM
Sanjeev Goyal	Sr. Scientist, Head	NEERI
Namita Nair	Communication & Outreach	WBCSD
Col. Prakash Tewary	Consultant	Grameen Foundation
Dr. Shilpi Karmarkar	Project Officer	UNDP
Sanjay Maurya	Director	Urban Airlabs
Gyanendra Singh Rana	Research Scholar	JGUV
Amit Gautam	Founder	SHFT
Jyothi Menon	Senior Research Associate	PHFI

Established in 2001 by the Asian Development Bank, the World Bank, and USAID, **CLEAN AIR ASIA** is registered as an international non-governmental organization that leads the regional mission for better air quality and healthier, more livable cities in Asia. We aim to reduce air pollution and greenhouse gas emissions in 1000+ cities in Asia through policies and programs that cover air quality, transport, industrial emissions, and energy use. We work with ministries (energy, urban development, environment, health, and transport), cities in Asia, the private sector and development agencies to provide leadership and technical knowledge for Air Quality Management. Our headquarter is based in Manila and has offices in Beijing and New Delhi.

Our work in India involves engaging with Indian cities for better air quality management (AQM). This aligns with the overall CAA work program on broad air quality management (AQM) interventions. Our expertise lies in providing scientific inputs to city governments for better air quality management, sustainable transport, low emissions urban development and education/ communication for clean air in India. The focus of our work in India is in cities with high impact potential, as well as potential for leveraging wider change.

We are supporting Indian cities in improving air quality management through capacity building and direct support to preparing air action plans. We have also launched the Clean Air Knowledge Network (CAKN), (www.allaboutair.in), a forum that connects AQ experts and practitioners from across India and city officials with an objective to promote knowledge-sharing across cities on AQ issues and share best practices. A major component of our India Program is education for better air quality. Our Youth Clean Air Network (YCAN) is volunteer program in which youth can passionately work together for better air quality.

In the past, the India team has worked on green freight and sustainable mobility projects, conducting walkability studies in Indian Cities, developing the Walkability app, the National Bus Fuel Efficiency Framework, the Green Trucks Toolkit for India, and an online freight brokerage platform.

CLEAN AIR ASIA

Clean Air Asia India
Basement C-3 Green Park Extension,
New Delhi 110016 INDIA
Tel +91 11 40395508 I Mobile +91-8826225452
india@cleanairasia.org
http://www.cleanairasia.org
www.youthforcleanair.com I www.allaboutair.in