INDIA CLEAN AIR CHALLENGE

PROGRAM CLOSURE REPORT

EARLY STAGE INNOVATION TRACK

PROGRAM BRIEF

With the aim to create pathways for wider adoption of clean air technologies, demonstrate their value proposition for government and industry, and mobilise a supportive global ecosystem to scale clean air innovations in India, ACT Grants and Social Alpha in partnership with the Smart Cities Mission, Ministry of Housing and Urban Affairs, City Innovation Exchange, Green Artha, Air Pollution Action Group and the Environmental Defense Fund, launched the India Clean Air Challenge on 17th December 2021 to enable a coming together of public policy, risk capital, industry and innovation.

The Challenge was designed in alignment with the National Clean Air Programme (NCAP), where the innovations being supported contribute to its objectives of implementation of mitigation measures for prevention, control and abatement of air pollution, establishing a comprehensive and reliable database on air quality, and raising awareness and building capacity to address air pollution.

PROGRAM PREMISE

Air quality in India has been a persistent concern due to various factors such as industrial emissions, vehicle pollution, unsustainable agricultural practices, and unprecedented degrees of urbanisation. Hundreds of millions of people in India are continually exposed to toxic air: they inhale, for example, a 24-hour average of up to 25 micrograms/cubic metre of air of the deadly, microscopic pollutant, PM 2.5—far above the World Health Organization's (WHO) limit of 10 micrograms/cubic metre. Vulnerable groups such as children, the elderly, and individuals with pre-existing respiratory conditions are especially at risk.

Based on the concentrations of PM2.5 emissions, India was ranked the fifth most polluted country by WHO (2019), in which 21 among the top 30 polluted cities were in India. The Indian cities, on average, exceeded the WHO threshold by an alarming 500%. Transport, construction, and coal burning are the greatest contributors to air pollution in urban India. Of the premature deaths due to air pollution, around 2/3rd happen in rural areas. Most heavy industries and brick kilns now operate beyond city limits and usage of solid fuel continues to plague rural households, which disproportionately affects women and children.

Further, India has 804 manual monitoring stations under the National Ambient Monitoring Programme (NAMP) and 300 real-time monitoring stations (CAAQMS). Most stations are disproportionately located in tier-1 cities; a few are in tier-2 cities, highlighting a critical gap in access to accurate data on air quality in different parts of the country. However, the lack of guidelines for low-cost sensor based monitoring prevents state pollution control boards and urban local bodies are from using these technologies and augmenting current monitoring systems. Similarly, India lacks standards for indoor air monitoring devices, due to which the testing and certification pathways for innovation is unclear.

In order to address these challenges, deep science and technology based innovations are key, particularly in low cost sensing technologies to capture pollutant levels, retrofit emission control devices for transport and industry, and waste to value processes to prevent stubble burning. Most solutions are at early stages and in order to avoid their valleys of death, it is critical to successfully demonstrate their viability in a real world environment.

PROGRAM STRUCTURE

The India Clean Air Challenge was designed to seek and support innovators and start-ups at different stages of their growth through the following tracks, where the Early-Stage Innovation track was anchored by Social Alpha in partnership with the Smart Cities Mission:

This report encapsulates the traction and learnings of the Early Stage Innovation Track of the India Clean Air Challenge program.

Figure 1: Program Structure of the India Clean Air Challenge

With a view to foster innovation in air pollution management in India, the Challenge aimed to source solutions addressing problem statements in the following focus areas:

DOMAIN	PROBLEM STATEMENT	IMPLICATIONS
Air Quality Monitoring & Remediation	Lack of real time air quality data to initiate preventive and remediation measures, lack of low-cost sensing technologies with reasonable degrees of accuracy, and limited validation on cost effective, accurate, indoor and outdoor purification technologies	**India's air quality monitor density** – about 0.14 monitors per million people – is below China (1.2), the United States of America (3.4), Japan (0.5) and Brazil (1.8)
Agriculture & Livestock	Lack of cost effective waste to value technologies to manage agricultural waste, leading to stubble burning	In Punjab, rice farms **collectively burn 7 to 8 million tonnes of plant debris** every year
Construction & Demolition Waste	Limited solutions in collection, segregation, recycling, disposal and conversion of waste to value for different streams of waste	As per the Delhi Pollution Control Committee, in Delhi **30% of air pollution** is caused due to dust which emanates from construction sites. In Mumbai, at least **27% of PM 2.5** emissions generated came from waste and biomass burning
Mobility and Transport	Limited solutions to accelerate the transition to Electric Vehicles and sustainable retrofit devices in alignment with BS VI standards	The transport sector contributes to a **third of India's PM pollution and 20-35% of PM 2.5** pollution in urban Indian cities
Industrial Decarbonisation	High dependency on fossil fuels for industrial production processes leading to significant degrees of industrial pollution	In 2019, the industry sector, including production processes, emitted **2.8 Mt SO2, 1.5 Mt PM 2.5 and 1.8 Mt NOX**, which accounts for one-third of total energy related SO2 and PM2.5 pollution and about one-fifth of NOX emissions

SELECTION & COMPOSITION OF WINNING COHORT

70 applications were received as a part of the innovation scouting challenge, post which 5 winners (originally 6 – 1 withdrawal on account of team dynamics) were chosen across the incubation and acceleration tracks after a rigorous evaluation spanning across 3 rounds with functional and technical experts. The final cohort composition is as follows:

STARTUP	DESCRIPTION	TRACK
Airveda Technologies	Enables air quality monitoring through in-house software and hardware development that cater to conditions in India, where data can be integrated to government agencies' dashboards for wider dissemination	Acceleratio
Panjurli Labs	Addresses a large volume of pollutants in semi-indoor spaces using self-cleaning, sensor-equipped filters	Acceleratio
Takachar (Himalayan Sustainable Energy Solutions Pvt. Ltd.)	Enables the production of value-added products from agricultural waste to prevent stubble burning by developing portable equipmentthat uses a thermo-chemical process	Acceleratio
Ubreathe (Urban Air Labs Pvt. Ltd.)	Addresses indoor air pollution through plant-based filters using the principle of phytoremediation	Acceleratio
Prayogik Technologies	Indigenously developed gas-based generator which uses renewable biomass to produce electrical power	Incubation

PROGRAM IMPLEMENTATION

• **Customised Offerings:** Based on a detailed needs assessment exercise, the cohort availed support across marketing and branding, technical consultations on their product, IP filing, product development and design for manufacturing.

• **Marketing and Branding:** All the start-ups in the cohort had individual scopes of work based on their requirements which allowed for the creation of digital and social media marketing strategies, website redesign and development, and collaterals for online and offline dissemination. As early-stage startups looking at developing their brand, this was an especially useful offering which allowed for creation of specific need-based collaterals and build credibility.

• **Technical Consultation:** Start-ups received feedback on their products and core technologies from Dr T Swaminathan, retired Professor from the National Environmental Engineering Research Institute (NEERI). This particularly included discussions on how startups could measure the efficacy of their products and effectively articulate the products' potential impact in addressing air pollution.

• **Product Development:** Through the International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), the program facilitated a part of one start-up's product development needs.

• **Design for Manufacturing (DFM):** Support was offered to start-ups for the development new product suites or improvements in the design and operations of their existing product suite.

• **Intellectual Property:** Support was offered to start-ups to file applications for trademarks on their new logo, and copyright/patents on software which has been developed in house.

• **Knowledge Sessions:** Start-ups attended sessions on best practices on human resources management(facilitated by Raghava Kumar Molluru, Chief Operations Officer, Social Alpha), the tenets of the National Clean Air Programme and mandate alignment (facilitated by Dr SN Tripathi, Professor, IIT – Kanpur), and Intellectual Property approaches(facilitated by Banana IP).

KEY HIGHLIGHTS ON PILOTS ENABLED THROUGH THE PROGRAM

Pilots were enabled through seed grants for the acceleration track enterprises. This was critical for startups to create critical proofs of concepts, and the pilot allowed the startups to finetune their offerings as they move towards scale.

STARTUP	SCOPE OF PILOT	TRACTION & SCALE UP PATHWAYS
Airveda Technologies	Deployment of 8 air quality monitors in collaboration with the Gurugram Metropolitan Development Authority (GMDA), to identify pollution hotspots over a 3-year period and enable preventive action through integration of data on GMDA's platforms.	The pilot enabled the renewal of the company's MoU with GMDA for deployments of air quality monitors. The success of the pilot invited demonstrated commitment from GMDA to scale up the solution to 114 wards in Gurgaon through deployment of all-weather monitoring stations in Gurugram. GMDA also facilitated collaboration with the Carrier CSR division to enable display of AQIs at critical traffic junctions in the city.
		

STARTUP	SCOPE OF PILOT	TRACTION & SCALE UP PATHWAYS
Panjurli Labs	Deployment of 5 outdoor air purifiers at the Banashankari Traffic Transit Management Centre (TTMC) in collaboration with Bengaluru Municipal Transport Corporation (BMTC), to use the results from the pilot to enable deployments in other semi-outdoor spaces and locations with a large volume of pollutants.	Given the enhancement in the pre and post AQI at the TTMCs, BMTC has committed to installation of additional purifiers in 5 other TTMCs in the short-term. The funding is being mobilised with the support of Bangalore Clean Air Action Plan and Karnataka State Pollution Control Board (KSPCB). The startup is also looking to target other semi outdoor spaces such as offices, malls, educational institutions, airports, and railway stations.
	 	
Takachar	Deployment of beta prototype at Indomitra Farms in Coimbatore, Tamil Nadu to process 21 tonnes of coconut shells into carbon and enable their sale to companies using carbon as a raw material in their supply chain.	The pilot provided necessary insights to the start-up to standardise the quality of charcoal produced from coconut shells to suit various use cases. This has helped fast track the product development journey for the start-up.
	  	
Ubreathe	Deployment of 28 air purifiers in two schools in Chennai, Tamil Nadu in collaboration with Bhumi, an NGO.	The pilot enabled the start-up to understand the efficacy of plant-based filters and demonstrate the use of nature-based solutions in the purification of indoor air to build a healthy environment for school-going children.
	 	

EVENTS & DISSEMINATION FORUMS ENABLED AS PART OF ICAC

The Fireside Chat, January 2022 – Prior the launch of the Program, ACT Grants, Social Alpha, and the Smart Cities Mission organised a Fireside Chat on ***Innovating for Clean Air in Urban India***. Mr Kunal Kumar, then Joint Secretary and Mission Director, Smart Cities Mission, Mr Prashant Prakash, Partner, Accel and ACT Leadership, and Mr Manoj Kumar, Founder, Social Alpha highlighted **the need for collaboration between multiple stakeholders, and innovation-led entrepreneurial solutions to address air pollution**.

Winners' Ceremony, April 2022 – At the India Habitat Centre, New Delhi, the winners of the India Clean Air Challenge were announced, across both tracks in partnership with the Smart Cities Mission, ACT Grants and Green Artha.

Smart Cities, Smart Urbanization Conference, Surat, April 2022 – The Smart Cities Mission facilitated the participation of the winning cohort at this conference where each member of the cohort had a dedicated stall. This gave them the platform to showcase their innovations and interact with representatives from the Smart Cities' Mission across various cities, government officials, stakeholders from the industry, and the larger ecosystem. Further, each start-up also pitched their solutions to a wider audience. Members of the cohort received interest from the representatives of the following cities: Ahmedabad, Chandigarh, Chennai, Davanagere, Faridabad, Guwahati, Jalandhar, Kalyan Dombivli, Mumbai, Sagar, Saharanpur, Surat, and Varanasi.

Conference on Data and Technology, Smart Cities Mission, Chandigarh, April 2023 – Social Alpha represented the winning cohort at this Conference and had the opportunity to highlight how various city administrations can collaborate with innovators and start-ups to ensure the adoption of solutions tackling air pollution at scale. The India Clean Air Challenge was presented as a proof of concept for bringing together alternate forms of finance to galvanise innovation. At the Conference, the start-up experiences in the pilots were shared, particularly the scope for greater collaboration between the private and public sectors in creating an enabling ecosystem to support newer technologies.

CRITICAL LEARNINGS FROM THE PROGRAM

a. Lack of Standards on Indoor Air Quality:
While India has standards on outdoor air quality (NAAQS), and energy efficiency standards for buildings, which indirectly affects air quality (Energy Conservation Building Code), there are no national standards on indoor air quality. Despite multiple nudges from the National Green Tribunal (NGT), the lack of standards places the testing and certification burden on startups developing air purifiers for improving indoor air quality.

b. Limiting Regulations on Low Cost Sensors:
Given India has a dearth in air quality monitoring stations (700 against 3000 as per the norm) it is imperative to support low-cost sensor based monitoring solutions. However, the current regulations do not support standards to regulate the use of such technologies, thereby hindering the adoption of such solutions in government ecosystems, especially in urban local bodies. While there is demonstrated interest from highly polluting ULBs (such as Mumbai, Gurgaon and Delhi NCR) to use such technologies, they are unable to pay for it from approved government budgets due to lack of requisite standards.

c. Evolving Policies & Need for Advocacy Efforts:
In August 2021, the Central Pollution Control Board (CPCB) announced the process to revise the National Ambient Air Quality Standards, and once published, there will be **scope for entrepreneurial innovations to meet these newer standards in India**. The revision is expected to include a revisiting of the existing standards for criteria pollutants, potentially expand the base of pollutants being measured, setting up of monitoring networks, reviewing the air quality index, and determining the effects of air pollution on human health and vegetation. This, in addition to the increasing national focus on clean air through national, state and city level clean air action plans which are focussing on a holistic approach of source reduction, monitoring and mitigation is a welcome step. There is a felt need for advocacy efforts to build standards and regulations in the space of air quality monitoring and mitigation for indoor and outdoor spaces.

d. Trends in Air Quality Innovations in India:

- The program pipeline revealed a **majority of innovations in air quality monitoring (AQM)** with a combination of low-cost sensors for varied pollutant mixes and SaaS based offerings in indoor and outdoor settings. There is a need to support affordable AQM sensors (electrochemical, metal oxide semiconductor, optical) tested for varied environmental conditions, with high data accuracy, and minimal need for re-calibration and maintenance at regular intervals.

- In the air quality remediation space, the **technical feasibility and efficacy of outdoor air purifiers has often been questioned**. This has largely been on account of the dynamic nature, scale and coverage of outdoor air pollution, limited visibility on source control or prevention and substantial energy consumption. We came across some promising innovations in this domain working on patented filter technologies to combat critical pollutants in outdoor spaces, where urban congestion is an established phenomenon. There is a need for active R&D efforts and early stage, proofs of concepts to demonstrate viability of solutions.

- The proliferation of **organic and bio(tech) based innovations in filter materials** (such as algae based, phytoremediation, polymer based) which are used in place of or in conjunction with traditional HEPA and activated carbon filters in concentrated indoor spaces, is significant. This has a visible impact on removal of SOx, NOx, and COx pollutants, with **potential for carbon capture and utilisation**. However, such filters are more effective in capturing larger coarse particles than the smaller, fine and ultrafine Particulate Matter (PM). Testing, validation and certifications on efficiency, longevity and maintenance including an accurate sense of the Life Cycle Analysis (LCA) will help determine uptake.

- While we came across critical innovations **which focus on reducing pollution at source**, in the case of stubble-based burning (Takachar), and that of Construction & Demolition (C&D) Waste, the gap clearly lies in establishing the value chain and the product-market fit. There lies a market creation opportunity with real estate players, farmer producer organisations and associated collectives, to create awareness about the adverse health and environmental impacts of not acting in the longer run on people and the planet.

- Given vehicular emissions (personal transportation, logistics & freight) contribute to a significant chunk of air pollution, **tail pipe emissions reduction** is an important area of focus for abatement of air pollution. We did not see enough applications in this regard, which points to the lack of innovations in the domain. Our research points to the acute need for BS-VI aligned solutions and retrofit innovations which can help reduce tail pipe emissions at source.

- Given the sectoral emphasis on green buildings towards emissions reduction, there is an **increasing demand for monitoring and mitigation solutions** (typically by facility management companies) for **both greenfield and brownfield construction sites**. Several start-ups in the ICAC cohort are veering towards building end to end pollution management solutions. Further, the scope for innovation lies in the development of preventive measures and technologies that address pollution at source, in industries, agriculture and waste management.

e. Emerging Needs of Air Pollution Start-ups

- Through the course of the program, technical mentorship towards product development, validation of sectoral use cases, and access to testing and certification agencies seemed to be the major focus areas of the start-ups.

- Given the evolving regulations, **certification seems to be the primary driver for adoption**, seen favourably when done in partnership with an academic entity.

- The non-dilutive grants which were enabled through the program, were especially helpful for the start-ups to pilot their solutions for the first time in newer geographies (schools/NGOs) or with the government (GMDA/BMTC).

f. Need for Multi-Stakeholder Collaborations

Given the nascent stages of air pollution research and stage of innovations in India, there is an urgent need to promote multi stakeholder collaborations which brings together government bodies, corporates, philanthropies, and investors to come together to galvanise dilutive and non-dilutive forms of support to entrepreneurs.

- The support unlocks demonstration opportunities for path breaking solutions, create proofs of concepts in different geographic contexts, and allows start-ups to establish product – market fits and adopt pathways to scale.

- This also provides Urban Local Bodies and associated departments (such as Environment & Transport) to understand the success factors of innovative solutions piloted in their jurisdictions which improve quality of lives of citizens. The buy in becomes crucial when unlocking higher work orders from the government ecosystem.

ANNEXURE

Photographs (taken during the course of the program)

MILESTONES	PHOTOGRAPHS
Fireside Chat (Jan 2022): ***Innovating for Clean Air in Urban India.*** Precursor to the launch of ICAC	
ICAC Winners' Ceremony, Delhi (Apr 2022): Winners and Partners at India Habitat Centre	
Smart Cities Urbanization Conference for Smart City CEOs, Surat (Apr 2022): Takachar & Airveda showcasing respective solutions	 

MILESTONES	PHOTOGRAPHS
Surat Conference (Apr 2022): Panjurli & Ubreathe showcasing respective solutions	 
Conference on Data and Technology, Smart Cities Mission, Chandigarh (April 2023): Discussion on procurement of innovations by Smart Cities	

A Report By

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