airvolt

Better Air in Cities with AQ DOOH Networks

How air quality data, air remediation technologies and outdoor media help tackle urban air pollution

WHITEPAPER | 2023

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Breathe Better Ads

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Foreward

According to the World Health Organization (WHO) *"air pollution from both outdoor and indoor sources represents the single largest environmental risk to health globally"* and causes 7 million deaths a year, worldwide.

Since 1990 the concentration of air pollutants have dropped significantly, but worldwide the air quality concentrations remain below the current established standards, while governments worldwide find air quality management cost-prohibitive and lack the drive to implement necessary technology.

In this delicate global context, Airvolt joins the battle against air pollution by bringing to the forefront an innovative, cost-efficient solution to cleanse and raise the air quality while fostering social involvement.

Capitalizing on two markets - Air Purification and Digital Out-of-Home (DOOH) - Airvolt proactively safeguards the communities from viruses and pollution and harnesses the potential of advertising to go beyond communication and actively help monitor and purify the air we breathe. By integrating ads with air quality initiatives, we strive to create a healthier and more sustainable future for all.

Introduction

With indoor and outdoor habitats suffering from industrial contaminants, municipalities are missing the drive to implement technologies that monitor and mitigate air pollution. According to WHO, almost all of our global population breathes air that exceeds guideline limits, containing high levels of PM, NO2, O3, SO2, CO, and NO pollutants.

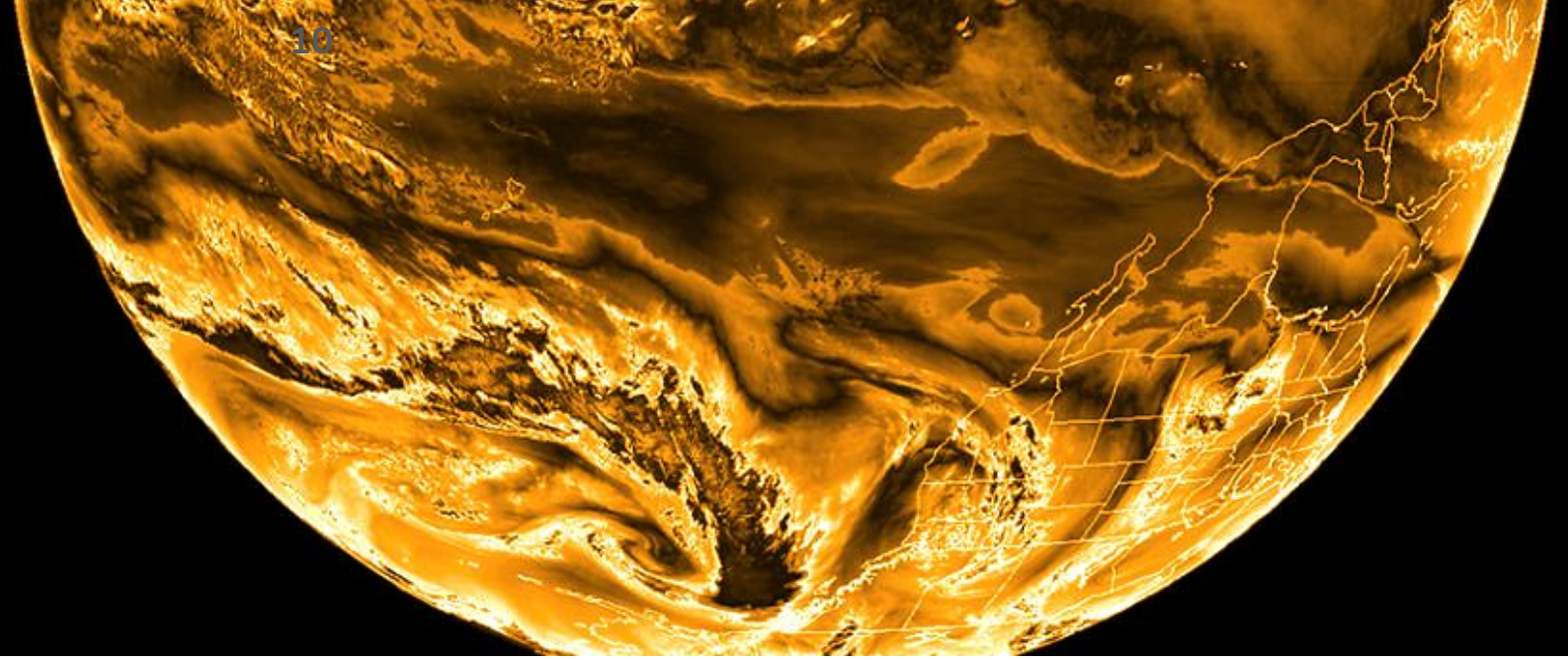
Exposure to poor air quality leads to serious illnesses such as stroke, lung cancer, pneumonia, ischaemic heart disease, chronic obstructive pulmonary disease, and more. Life expectancy drops by 4+ years in polluted cities. A 7M premature annual death-toll accounts for 13.5B years - collectively lost by all humans in existence today.

Real Estate Developers make efforts to purchase and maintain inefficient and highly expensive HVAC Installations for indoor environments. To make matters worse, most governments and local administrations find air quality management to be cost-prohibitive and lack the drive to implement technology that can monitor and capture air pollutants. Therefore, there is a need for an effective and low-cost technology that drives a higher standard of air quality in public urban environments.

This whitepaper seeks to showcase the challenge of air pollution and how to address it in cities, suggesting a rethink on how to engage different stakeholders - (local) governments, communities, academia, businesses and individuals - concretely and realistically to address air quality.

It starts by looking at how climate change and air pollution are linked, and the current stressors that are affecting nature and human lives. Then it outlines the different types of air pollutants and their direct impact on health, before looking at the context of air remediation technologies as well as the importance and cost-barriers of implementing these in cities.

It then looks at an innovative solution to bridge the gap, by combining data, air remediation technologies and digital outdoor advertising to drive a public-private approach to address the problem of air quality. Air pollution is a global issue that invites global action. The delicate context shows us that no golden solution has been implemented and that there is space of innovation, involvement, and expansion.



Key indicators on today's climate crisis

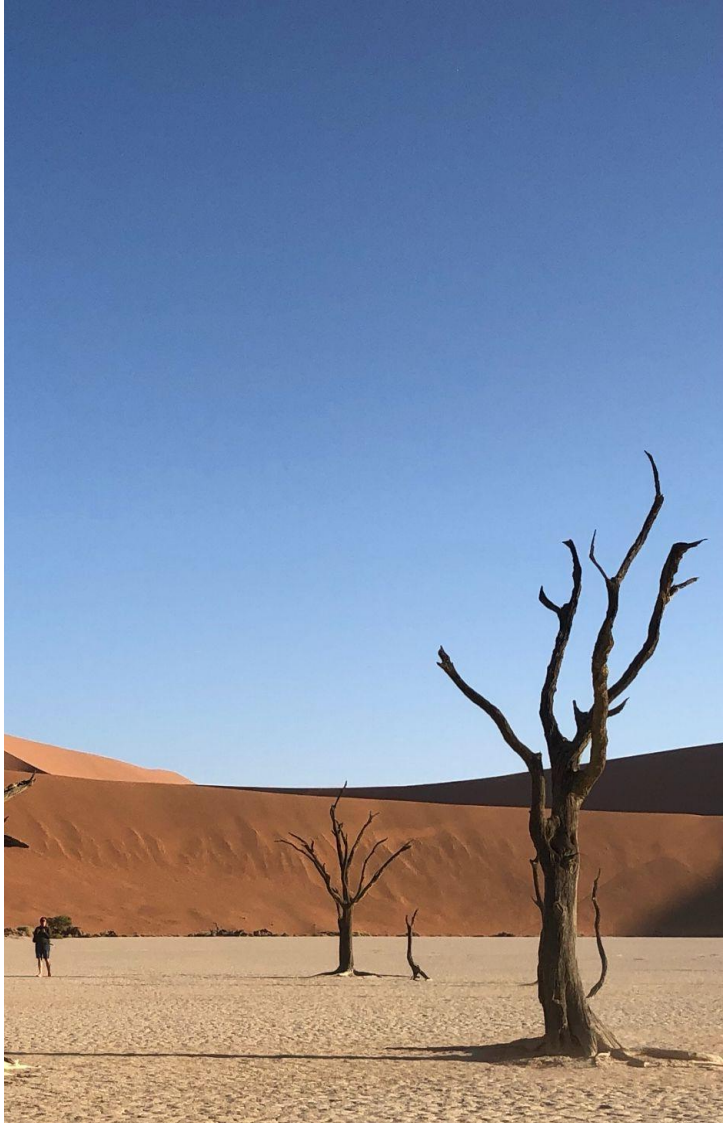
Climate warming tops the current list of interconnected polycrises today, elevating the rate of risks by simultaneous occurrences of catastrophic events throughout the globe and are linked to air pollution. The Global Indicators are a set of relevant domains of climate change: global surface temperature and energy, atmospheric composition, ocean, and water, as well as the cryosphere. All have multiple impacts on our lives and the environment.

Limiting temperature increase

Climate change and air pollution are linked

Climate crises and risk mitigation

Systems are tipping toward a new state from which they may never recover



Staying within 1.5 degrees

The domains of climate change are interrelated with the Paris Agreement, whose central aim in 2015 to all participating nations required strengthening the global response to the threat of climate change by keeping a global temperature rise this century well below 1.5 degrees Celsius and to pursue efforts to limit the temperature increase. Under the Paris Agreement, the Global Stocktake assessed the collective progress and introduced a further reduction to 1.5 degrees Celsius. Even so, 2023 is turning into the hottest year ever recorded.

Climate change and air pollution are linked

Concentrations of heat-trapping greenhouse gases are increasing in the Earth's atmosphere response, and average temperatures at the Earth's surface are increasing and expected to continue rising, causing air pollution rates to rise. Air pollutants and greenhouse gases often come from the same sources, such as coal-fired power plants and diesel-fueled vehicles. Irreversible climate change can supercharge air pollution, affect indoor air quality, and increase outside air pollutants, such as ozone and particulate matter.

Climate crises and risk mitigation

As greenhouse gas emissions blanket the Earth, they trap the sun's heat. This leads to global warming and climate change. Warmer temperatures over time are changing weather patterns and disrupting the usual balance of nature. Climate action coalitions are at work around the world to cut emissions, pursue nature-based solutions, extend sustainable energy and invest in resilient cities, among many other initiatives we mention ways of reducing emissions, tackling critical concerns such as jobs and gender equality, unlocking finance, building sustainable infrastructure, using nature-based solutions, technology innovations, advancing adaptation and climate resilience.

Three known effects of low air quality in urban environments

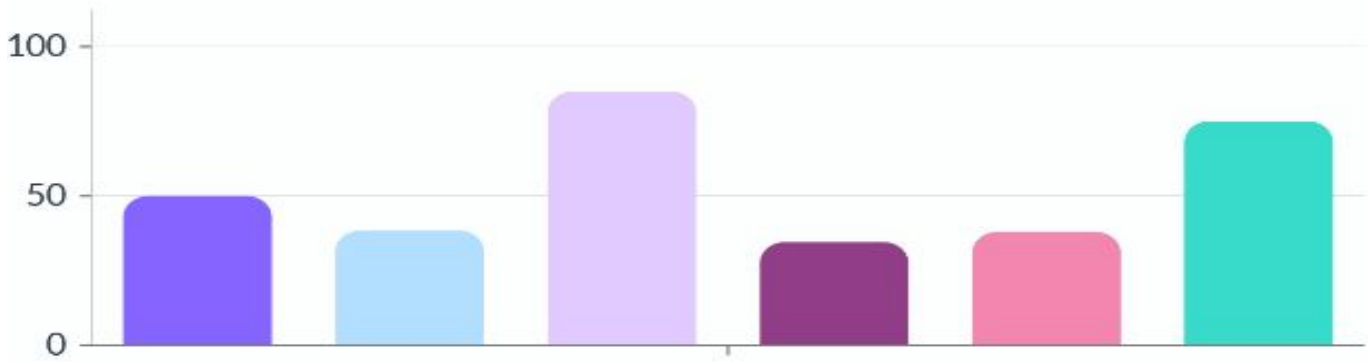
The cumulative effects of continued greenhouse gas emissions could potentially trigger what scientists refer to as climate tipping points. The tipping points may move the Earth's climate from one state to another, therefore the ecosystem can no longer cope with environmental change. As the natural systems shift into an entirely different states, they lead to potentially irreversible, catastrophic impacts for the planet—including more warming.

1. Natural systems at risk will accelerate in many parts of the world with dramatic consequences. Systems at risk include the Atlantic meridional overturning circulation collapse (AMOC), increased ice sheet loss in the Antarctic, Boreal Permafrost, elevated world's oceans surface temperature, El Niño impacts, and rising Atmospheric CO2.

2. Environmental Stressors and Air Quality causes stress to natural ecosystems, often leading to acidification and eutrophication of both terrestrial and aquatic ecosystems. Worldwide regulations are being put into place to protect animals, soil, crops, vegetation, water and buildings from the impacts of air pollution.

3. Mitigation and decisive action is the only way to move forward. The EU is setting ambitious goals, including a net 55% or greater reduction below 1990 levels by 2030 and a climate-neutrality objective by 2050.

The particles and gases we breathe daily in cities



CO

Carbon monoxide is a poisonous gas that you can't see, taste or smell. The sources of CO are natural or domestic material burns.

NO2

Nitrogen dioxide is a highly reactive gas formed by emissions from motor vehicles, industry, unflued gas-heaters and gas stove tops.

H2S

Hydrogen sulfide (H_2S) is a colorless gas with a strong odor of rotten eggs. The most common sources for H2S are oil and gas extraction, swage, and landfills.

SO2

Sulphur dioxide is highly reactive gas with a pungent irritating smell. It is formed by fossil fuel combustion at power plants and other industrial facilities.

O3

Ozone is the main component of smog and is the product of the interaction between sunlight and emissions from sources such as motor vehicles and industry.

PM

Known as particle pollution or particulate matter, is a term that describes extremely small solid particles and liquid droplets suspended in air. Particle pollution mainly comes from motor vehicles, wood burning heaters and industry.

Pollution is widespread in our environment

Air pollution has a direct impact of health

According to WHO data from 2019 outdoor (ambient) air pollution in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide - 37% of outdoor air pollution-related premature deaths were due to ischaemic heart disease and stroke, 18% and 23% of deaths were due to chronic obstructive pulmonary disease and acute lower respiratory infections respectively, and 11% of deaths were due to cancer within the respiratory tract.

Governmental policies try to fight back pollution

Following the establishment of air quality standards and emission control policies the number of air quality monitoring stations increased rapidly worldwide. The Tropospheric Ozone Assessment Report (TOAR), initiated by the International Global Atmospheric Chemistry Project, gathers surface O3 measurements from monitoring stations worldwide. However, the spatial distribution of monitoring stations tends to be heterogeneous, and gaps within time series can be noted for suitable human health and ecological risk assessments.

Reclassification of air pollutants brings light on their effect on human health

Many harmful byproducts of combustion, material refining, and mass manufacturing are released into our air, waters, and soils. For some pollutants, their hazardous effects on human health have long been known, even if their mechanisms of action have not been fully understood. Modern epigenetic research allows for both the elucidation of the harmful effects of both historical toxic pollutants which may still remain in the environment, as well as the reclassification of pollutants previously considered benign.

Particulate matter The most harmful component

There are several natural and human-made air pollutants that are usually considered responsible for health issues - Traffic-Related Air Pollution (TRAP), ozone, noxious gases (carbon dioxide, carbon monoxide, nitrogen oxides, and sulfur oxides), Particulate matter (PM), Volatile organic compounds (VOC), Polycyclic aromatic hydrocarbons (PAH).

Of the air pollution cocktail, particulate matter (PM), the particulate fraction, is the most harmful component. In 1993 National Ambient Air Quality Standards (NIEHS), the global leader in air pollution research, established an association between fine particulate matter and mortality.

The exposure effectiveness of PM is greatly influenced by local conditions such as weather, seasons, topography, sources of particles, concentrations being emitted, and microenvironments.. Although the effect of PM exposure depends on physical characteristics (e.g., breathing mode, rate, and volume of a person), the size of particles has been directly linked to being the main cause of health problems.

In 2019, the exposure exceeded the annual WHO's 2005 limit value for PM2.5 (10 μg m to 3) led to 1.8 million attributable deaths in 13,160 urban areas with >50,000 inhabitants.

Exposure to PM has observable physical damage to human health, but its economic impact is also significant. PM related illness can ultimately lead to financial and non-financial welfare losses of not only patients and their families but also a significant portion of gross domestic product (GDP).

Particle size truly matters

Particulate matter subdivided into different categories based on particle size. The size, surface, number and composition of particles play an important role in eliciting health effects, however it can be inferred that finer particles are more hazardous to human health than the coarser ones.

Fine particles (PM2.5)

These particles have aerodynamic diameter of 2.5 µm or less. They come from natural or human-made sources, like: vehicle exhaust, wildfires, power plant emissions etc. They can penetrate within the respiratory tract beginning with the nasal passages to the alveoli, deep within the lungs due to their excessive penetrability, further escaping into the bloodstream.

Coarse particles (PM10)

These are all particles with an aerodynamic diameter of 10 µm or smaller. These particles are coarse and because of this characteristic they are initially collected in the nose and throat, they lodge afterwards in the trachea or in the bronchi. PM10 are usually created directly, with sources like construction work, road dust, natural dust storms.

Ultrafine particles (PM0.1)

These are even smaller than fine dust, with an aerodynamic of 0.1 µm or smaller, and originate from similar sources as PM2.5. Particles smaller than 1 µm in general behave similar to gas molecules and will therefore penetrate down to the alveoli, and can translocate further into the cell tissue and/or circulation system.

Air filtration and purification for indoor and outdoor applications

There is a strong correlation between air pollution and health according to WHO. The air pollution determined by both outdoor and indoor sources has significant economic impacts on societies. The majority of inhalation exposures to particulate matter occur while being indoors. This highlights the importance of the proper design and management of building defense mechanisms against outdoor pollution by providing adequate air filtration systems.

The need for a change

Air filtration
A way of improving health

Air filtration as an efficient solution

Air filtration, an efficient method for environmental control measures

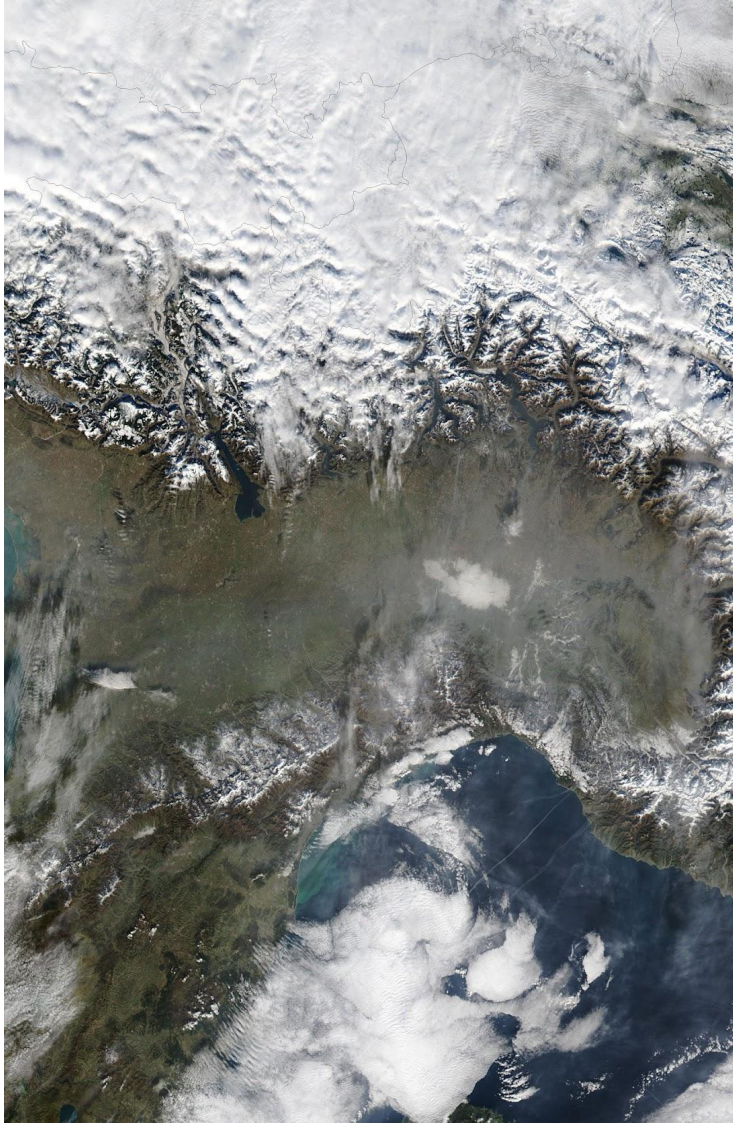
Air filtration - a way of improving health

The biological and non-biological contaminants of air can be reduced through air filtration solutions. The key attribute of any air filter, is a balance of the air flow to assure adequate ventilation, efficiency to filter out a range of small particle sizes, and the cost-effective maintenance.

The main types of air filters are activated carbon air, air compressor, baghouse, cabin air, car exhaust, diesel particulate, engine air, exhaust hood, HEPA, HVAC, ionizer air, ULPA, UV, washable electrostatic. From this listing, the most efficient filters according to Minimum Efficiency Reporting Value (MERV), a scale that evaluates the efficacy of air filters in capturing particles with diameters between 0.3 and 10 microns are HEPA and ULPA filters.

HEPA efficiency

According to European standards, there are 17 classes of filters - the higher the class, the greater the efficiency. Classes E10 to E12 are Efficient Particulate Air (EPA) filters, H13 and H14 are HEPA filters, and U15 to U17 are Ultra Low Penetration Air (ULPA) filters.



The dense arrangement of fibers in the HEPA filter help to catch a range of particle sizes. As air particles pass through the air filter, they are caught by three mechanisms: diffusion, interception, and impaction. HEPA filters can remove 99.97% - 99.99% of airborne particles that are equal to, smaller or larger than 0.3 microns in size (EPA), like those the size of viruses (which on average are 0.1 microns), due to how these smaller size particles behave (see NASA research).

HEPA application

For extra performance and efficiency HEPA filter-based devices can include germicidal ultraviolet (UVC) light alongside HEPA filters are likely to be effective.

How air quality data improves smart cities infrastructures

Air quality data also serves as valuable input to other smart city systems to support decision-making around optimised traffic flow, reduced energy consumption, and enhanced emergency response capabilities. Harnessing historical and big data for predictive modelling helps cities better prepare, adapt and respond to future urban air pollution emergencies.

Targeting interventions

Building resilient systems

Engaging citizens

How Data-Driven decision making can build the cities of tomorrow

Targeting interventions

Access to hyperlocal and timely air quality data is critical for cities to use limited budgets wisely. The deployment of sensors in Quezon City, Philippines has enabled the local government to assess changes in air pollution levels, identify areas with elevated values requiring immediate attention and integrate actions into its Air Quality Management Plan, C40 Cities found.

Building resilient systems

High-quality air quality data supports analytics and machine learning applications for building resilient cities. Wildfires, drought-induced sandstorms and extreme temperatures are only expected to increase given the current pace of climate change, with dire knock-on effects on the air urban residents breathe.

Engaging citizens

Truly smart cities make access to air quality data easy for local stakeholders. London public transport provider TfL sharing its air quality and other data openly to citizens and businesses alike in the local authority-run London Datastore is estimated to bring GBP 130 million in annual savings and benefits to the city's economy. Open air quality data helps urban decision-makers build awareness and engagement ahead of important actions, fostering collaboration and active participation to tackle air pollution.

Air remediation technologies for urban environments are expensive

Air remediation technologies present an important opportunity for cities to address high levels of air pollution, in particular when preventative interventions or policies aimed at mitigating the impact are slow to take root. However, making a bet on new technologies is a challenge given limited city funding, particularly after the Covid-19 pandemic. As cities in Europe and the USA face constrained budgets, even more so do local administrations in emerging and developing countries where the speed of urbanisation and the pressure to deliver basic services are even greater.

1. Capital investments and operating costs of new air remediation technologies can be prohibitive for cities without innovation also in business models
2. Lack of technical skills and fit-for-purpose procurement approaches can hamper cleantech adoption, but learning from other cities and their use cases helps
3. The costs of not addressing urban air pollution are extremely high for humans, the environment and the economy, meaning business as usual is not an option

High cost *barriers to entry* for municipalities

Financial limits

Municipalities grapple with constrained budgets to manage often high upfront and subsequent maintenance costs to implement air quality remediation technologies. In Europe, nearly 70% of cities found the lack of funding and financing schemes the biggest obstacle to pursuing climate goals, based on European Commission findings. Innovations in technology need to be accompanied by innovations in business models and private sector partnerships that ease the fiscal burden of local authorities.

Knowledge gaps

Beyond financial barriers, urban governments may lack the skills needed to identify, evaluate, and implement new technologies to improve air quality. The gaps in technical expertise and procurement know-how needed, combined with often risk-averse public spending habits, can hamper cleantech adoption in cities. Peer-to-peer knowledge sharing and skills exchanges among cities can help bridge this gap and de-risk the use of air remediation technologies to bring about broader benefits for urban citizens.

Greatest cost? Inaction

Urban administrations face a far greater cost of doing nothing than that of addressing poor air quality. Four of Africa's largest cities - Lagos, Cairo, Accra and Johannesburg - risk nearly USD 116 billion in human, environmental and financial costs between 2023 and 2040 if the current trajectory of air pollution continues, a 2022 report from the Clean Air Fund said. Finding innovative and cost-effective ways to prevent, mitigate and remediate the impact of air pollution is critical for creating thriving cities of tomorrow.

Digital OOH Media: a direct driver for clean air in urban spaces

DOOH has been proven to lead to direct benefits including better air quality, fewer vehicle miles, saving of trees, and reduced need for disposal of waste materials. Due to this DOOH is an already established sustainable solution. 57% of adult consumers consider that companies that choose to use DOOH are making a public commitment to sustainability.

Environment decluttering

Sustainable energy use

Waste management and recycling

How OOH media digitalization highlights the beginning of a new era

Back in 2015 Out of Home Media (OOH) was controversial and people were split into two groups. Those that considered that it should be banned from cities because they were visual eyesores, creating chaos and adding to the daily stressors and those that were still considering it the best medium to showcase brands and to bring cities to life.

Fast forward in time OOH has become Digital OOH Media. The digitalization of the classic OOH not only marks a natural transition from the static to the dynamic display, but highlights the beginning of a new era - the active involvement of companies into improving the air quality through their own ads.

Using digital screens as an alternative to the standard and traditional forms of marketing like printed billboards is critical in terms of sustainability gains.

The three main sustainable areas where DOOH is contributing are:

- DOOH can accommodate multiple campaigns at any time without requiring any extra materials or several billboards.
- DOOH devices are using green energy that improves energy efficiency, and offsets carbon emissions.
- DOOH are designed to last for several years (some last for several decades) so the environmental impact of extracting materials to produce the billboard materials is drastically reduced.

Air quality display OOH networks

Powered by the Airvolt AMPS

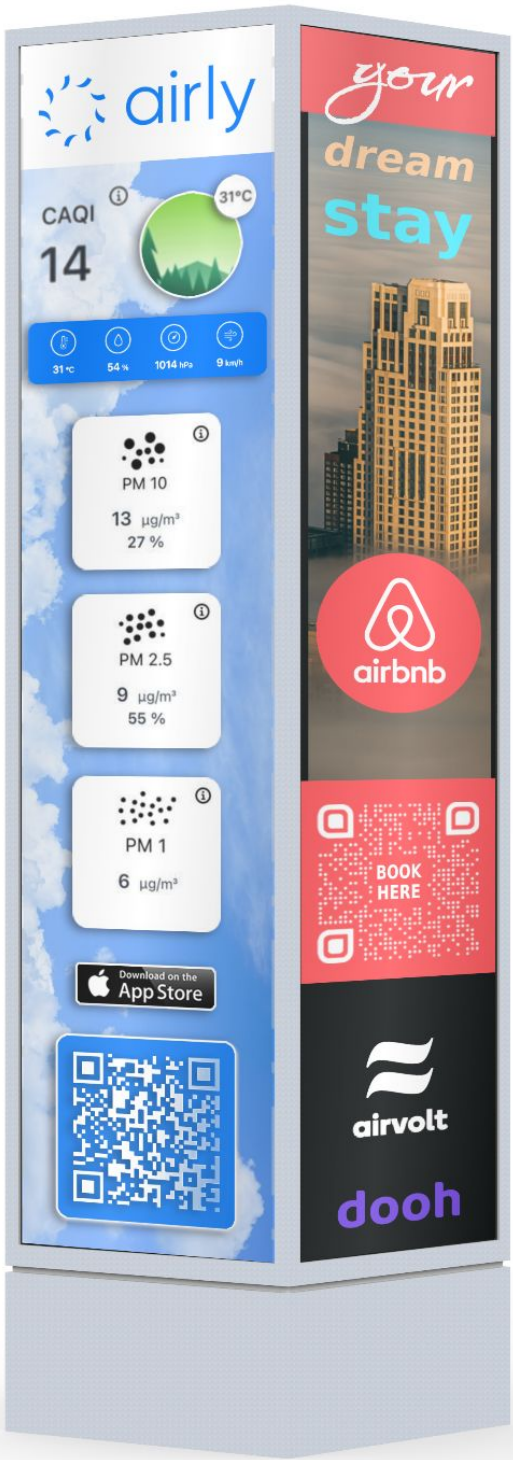
An ever-improving growth tool for life quality in public urban environments, our Display Out of Home (DOOH) air monitoring and purification networks integrate features that allow for negative value maintenance fees.

Environmental social governance brand messages allow for a special type of climate-related awareness and educational content, granting advertisers a measurable and unique air quality investor status.

Airvolt air monitoring and purification networks create circular value for each user category: hosting partners, visiting public, and advertisers.

The Airvolt DOOH Network:

Clean-tech Hardware: raise air quality and property value, at low to no cost
AQ Monitoring: gather real-time air quality data for actionable insights
Big Data: smart cities achieve better IoT integration and more data points
AI-Driven: CIM, cost-saving, energy efficiency, pollution forecast & more
Ad-tech: deliver messages to audiences at premium OOH locations



A way forward...

Air pollution is an urgent matter, that requires immediate action and collaboration. We hope that this white paper has raised interest in solving this important part of the ongoing environmental and climate challenges. We invite citizens, local administrations, governments, academia to engage and join in Airvolt's mission to clean the air through the data, urban and advertising opportunity.

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About Airvolt

Airvolt empowers location partners to raise air quality and property value without upfront installation and maintenance costs, making them partial media owners. Advertisers engage audiences while investing in air quality, without incurring additional overheads. Our Platform as a Service merges air quality and advertising, fostering immediate impact, transparency and corporate social responsibility.

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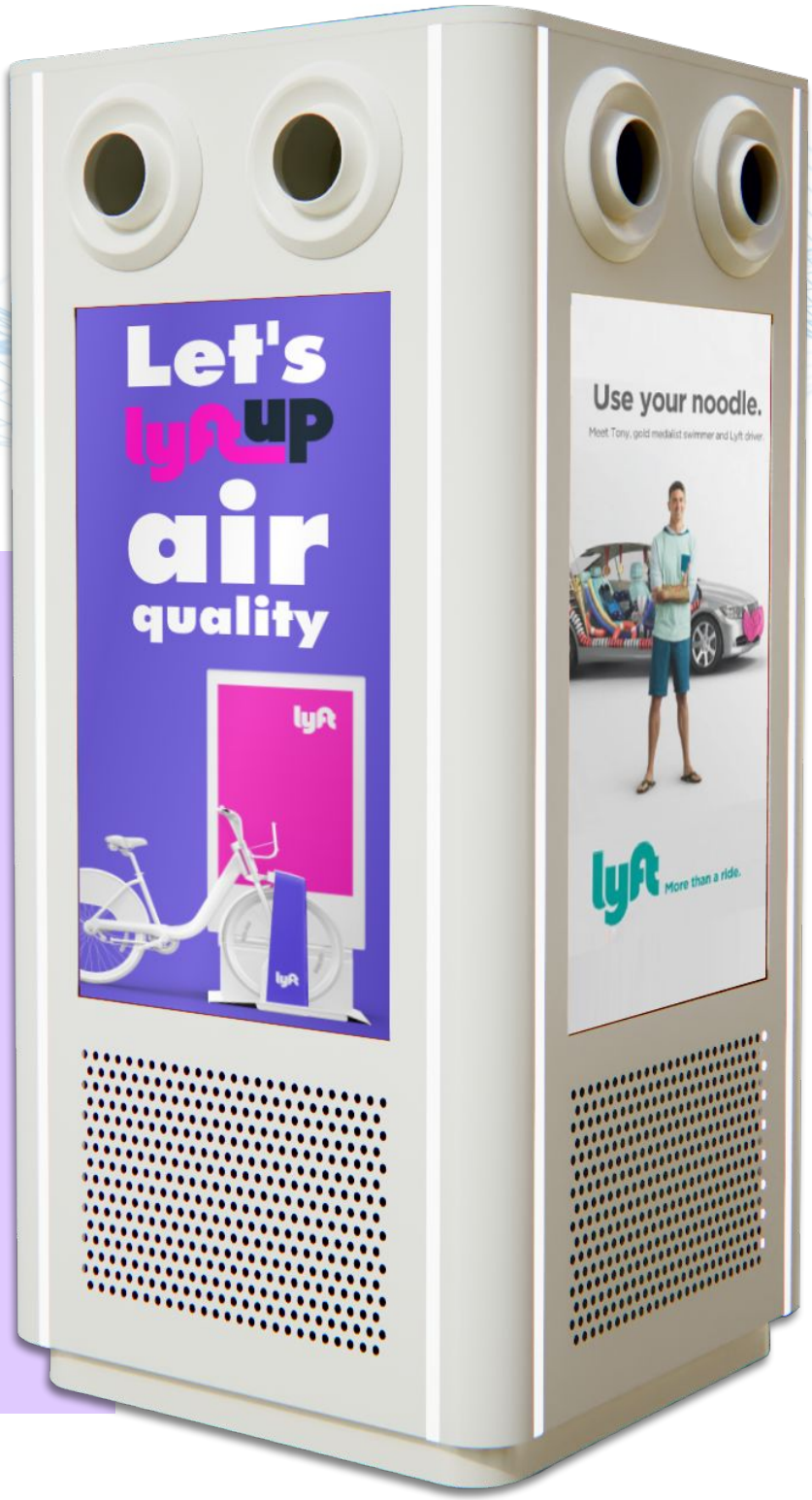
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