BREATHE LONDON PILOT VERIFIES 'SMALL SENSORS'

The Breathe London pilot project ran over two years from October 2018; monitoring and characterising air quality across one of the world's major cities. With over 100 AQMesh 'pods' located across the city, the Breathe London partners were, for the first time, able to provide hyperlocal detail on London's air quality. At the end of the two year period, the entire network continued to operate for a further 5 months in a separate project funded by NERC/UKRI and managed by Prof. Rod Jones (University of Cambridge) and colleagues.

Each AQMesh pod contained small low-cost sensors, developed and manufactured in the UK by Alphasense. The company's Arthur Burnley says: "One of the main objectives of the project was to evaluate the utility of small sensors, so we were delighted that they performed so well, and hope that this will provide other cities with the confidence to invest in their own networks."

In addition to the pods, Breathe London also equipped Google Street View cars with reference-grade monitors, which together with the pods, complemented and expanded London's existing regulatory monitoring network.

The air quality monitoring dilemma

Historically, air quality monitoring has relied upon expensive, highly accurate and reliable reference-grade air quality monitors that are often located in large air-conditioned, mains powered cabinets. As a result of their size and the requirement to be installed in urban areas, these systems sometimes require planning permission and can be difficult to locate in ideal locations.

In addition to their large capital cost, reference stations also incur large operational costs for maintenance and calibration work. Nevertheless, reference stations perform an essential role in providing accurate reliable data for comparison with air quality standards – especially for particulates and nitrogen dioxide (NO_2). They also provide a reliable method for temporal and spatial air quality comparisons.

The air quality dilemma is therefore that reference stations are so costly that they have to be located sparsely. Consequently, they are unable to deliver granular local data, so operators have to rely on modelling. The Breathe London project was therefore established to help resolve this dilemma.

Data from the project have now been fully evaluated and one of the partners, Environmental Defense Fund (EDF), has published a summary entitled: The Breathe London Blueprint:

How cities can use hyperlocal air pollution monitoring to support their clean air goals.

Breathe London Objectives

1. Advance the use and development of innovative, lower-cost monitoring techniques to support cities around the world;
2. Enhance London's existing regulatory network to better understand pollution and assess targeted solutions for cleaner air, like the Ultra-Low Emission Zone (ULEZ); and
3. Make air pollution data publicly available and visualise it in new and innovative ways.

The Breathe London pilot met and surpassed these objectives. London Mayor Sadiq Khan said: "These findings, from our world-leading Breathe London sensor network, are a stark reminder that pollution hotspots exist across London and will refocus our efforts on improving air quality for all. As we face up to the current climate emergency, I hope the success of this scheme will act as a blueprint for cities around the world to battle their own toxic air emergencies."

1. Innovative, lower-cost monitors

Any city considering the use of lower-cost sensors will be keen to learn whether they can provide reliable data and insights. The Breathe London Blueprint concludes: "Yes - you can use emerging monitoring technologies and techniques to identify and characterise air pollution."

Breathe London data produced insights that were broadly comparable to findings from London's extensive regulatory network, demonstrating that lower-cost sensor systems and mobile monitoring are valid options for generating useful data.

2. Solutions for cleaner air

Even towns or cities with limited access to reference-grade air quality monitors can assess pollution levels and find ways to

improve air quality. For example, lower-cost sensor systems can help find air pollution 'hotspots,' or the places and times of day that need the most attention. These sensors can also provide flexible tools for assessing the effects of air quality intervention measures.

3. Making the invisible visible

Traditionally, air quality data is made available in a simplified format via Apps and websites; letting citizens know when their region is being affected by poor air quality. However, localised data is necessary if citizens are to be empowered to make decisions based on air quality data. For example, if people know which streets are the most polluted they can choose which method and route to travel, or where to exercise; they may even take this into account when choosing a school, or deciding where to live.

The Breathe London pilot project published a website providing a real-time map of air quality data from the streets in which the AQMesh pods were located. This localised data helped to engage with the public on air quality, so they would be more likely to support and understand the need for interventions such as the ULEZ.

Why AQMesh?

The first AQMesh pods were developed around 10 years ago to resolve the air quality dilemma outlined above. The UK based company Environmental Instruments manufactures the pods and has invested heavily in trials and product development over that period. Critically, this has included operational evaluations in a wide variety of (international) environments. "Our partnership with Alphasense was important because, whilst we needed lower cost technologies, we also needed sensors that are reliable and provide repeatable output," explains Environmental Instruments MD Amanda Billingsley. "With the benefit of this extensive development work, we are now able to offer monitors with levels of uncertainty approaching those of reference stations, which means that AQMesh pods are ideal for filling the gaps in sparsely located reference networks."

AQMesh pods utilise cellular communications to transmit data to a server which delivers the data via a secure website. The pods can be mains or battery powered with a solar charger, and users are able to select from a range of air quality parameters.

The Breathe London pods contained sensors for measuring NO_2, NO, CO_2 and particulates, and ten of them also contained ozone (O_3) sensors. By monitoring a broad range of parameters simultaneously, the Breathe London partners were able to conduct more effective source attribution. There are now thousands of AQMesh pods around the world, with customers either being provided with weekly data reports, or they are able to pay for on-demand access to live data for £150/year.

Pilot project extension

At the end of the 2-year pilot, as part of the 5-month extension project managed by Prof. Jones, the sensors inside the Breathe London pods were replaced, and monitoring continued through the UK's COVID-19 lockdown and into the period when lockdown restrictions were withdrawn. "The extension project delivered an extremely useful set of data, that we are currently running through CERC'S models," explains Prof. Jones. "Lockdown presented a unique set of circumstances and this monitoring will greatly inform our understanding of London's air quality. This modelling will also provide source attribution which we hope will be used to inform future mitigation measures."

One of the interesting aspects of the Breathe London Pilot was its ability to take measurements at one minute intervals; as opposed to 15 minute readings, which is the norm for reference monitors. Prof. Jones says: "By capturing data faster, we were able to implement advanced features such as remote calibration and source attribution. So we are excited to take the learnings from a low-cost network and apply them to a reference station network in a new project that is currently underway in Glasgow."

The new project is also funded by NERC and titled: Quantification of Utility of Atmospheric Network Technologies (QUANT). Fifteen AQMesh monitors have been co-located with reference monitors in Glasgow; all of which (reference and AQMesh) will run at one minute measurement intervals. The high time-resolution and the opportunity to create dense networks of low-cost monitors offers a paradigm shift in the way that key pollutants are measured, how health impacts are evaluated and how potential solutions are assessed.

Summary

The Breathe London pilot demonstrated that the value of a network is greater than the sum of its components. This is because networks enable the tracking of pollution, and differentiation between local and external sources. In addition, Breathe London enabled the project partners to develop new methods for improved data quality with faster, easier, lower cost calibration.

The success of the project underlined the importance of low-cost sensors in providing the localised granularity of data that is necessary to help citizens better understand the impacts of air quality and to facilitate the implementation and evaluation of effective air quality mitigation measures.

Reference:

Breathe London Blueprint: www.globalcleanair.org/files/2021/02/EDF-Europe-BreatheLondon_Blueprint-guide.pdf

Based in the UK, Alphasense is a totally independent gas sensor development and manufacturing company founded in response to a demand from gas detection equipment manufacturers for better quality gas sensors and a higher level of after-sales support.

The company's technologies include Electrochemical, Catalytic, Laser optical particle counting, Metal Oxide semiconductor and Optical (including NDIR & PID). Driven by customer demand, new technologies are continually explored and developed.

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Through the delivery of its products and services the company contributes to a world that is safer, cleaner and more energy efficient.

Author Contact Details

Arthur Burnley - Sales and Marketing Director, Alphasense Ltd • Sensor Technology House, 300 Avenue West, Skyline 120, Great Notley, Essex CM77 7AA, United Kingdom • Tel +44 (0) 1376 556 700 • Email: sensors@alphasense.com • **Web: www.alphasense.com**