WHITE PAPER

Evolution of the UK air pollution monitoring network

Ensuring air quality across a local authority district is a high priority for those serving communities in local government. Whichever crucial government department you are in, be it neighbourhoods, regeneration and sustainability, environment or transport, ensuring high quality air monitoring will be at the top of your to do list.

Staying abreast of the air pollutants within your environment will also be on the agenda if you are a decision maker in the construction, waste, and transport industry, all of which are large contributors to air pollution. Understanding the legislation you need to comply with, the solution that can help you achieve this conformity, and the scientific complexities surrounding air pollutants and their impact, should be a focus.

In the UK, the Automatic Urban and Rural Network (AURN) is the biggest automatic monitoring network, and is the main hub in the country for compliance reporting against the Ambient Air Quality Directives. These directives set legally binding limits for concentrations in outdoor air of major air pollutants that impact public health. Compliance with this legislation, as well as the obvious preventative measures to safeguard human and environmental health, are the main reasons why the implementation of a reliable and robust air quality monitoring solution is so important.

Unfortunately there are widespread assumptions that lower cost means lower quality when it comes to air monitors. With emerging case studies proving this assumption to be untrue, alongside tightening budgets and an increased global focus on reducing the impact of air pollutants and legislation compliance, now is the time to weigh up the pros and cons of different solutions to find what works best for you.

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What is the AURN?

In 1998, the previously separate UK urban and rural automatic networks were combined to form the current Automatic Urban and Rural Network (AURN). The network was established primarily to provide data in compliance with EU Directives on Air Quality for a range of pollutants. The secondary reason for its formation was to utilise the data gathered for research purposes and to inform policy.

With 127 sites across the country, the network comprises a number of organisations that carry out the daily running of the enterprise. Different areas of operations are assigned to various contractors with the Central Management and Co-ordination Unit (CMCU) of AURN being contracted to Bureau Veritas, and Quality Assurance and Quality Control (QA/QC) activities in the hands of the National Physical Laboratory for London (the ALN). Currently Ricardo Energy & Environment are responsible for the rest of the network's monitoring activities.

The individual monitoring of sites is assigned locally to organisations, such as local authority Environmental Health Officers with relevant experience in the field. Calibration gases for the network are supplied by BOC Limited and are provided with a UKAS certificate of calibration by Ricardo Energy & Environment.

The AURN includes automatic air quality monitoring stations measuring oxides of nitrogen (NO_x), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particles (PM10, PM2.5). Network sites provide high resolution hourly information which is communicated to the public, across a wide range of electronic, media and web platforms.

Required monitoring methods

The techniques used for air monitoring and measurement within the Automatic Urban and Rural Network (AURN) are shown in the table below

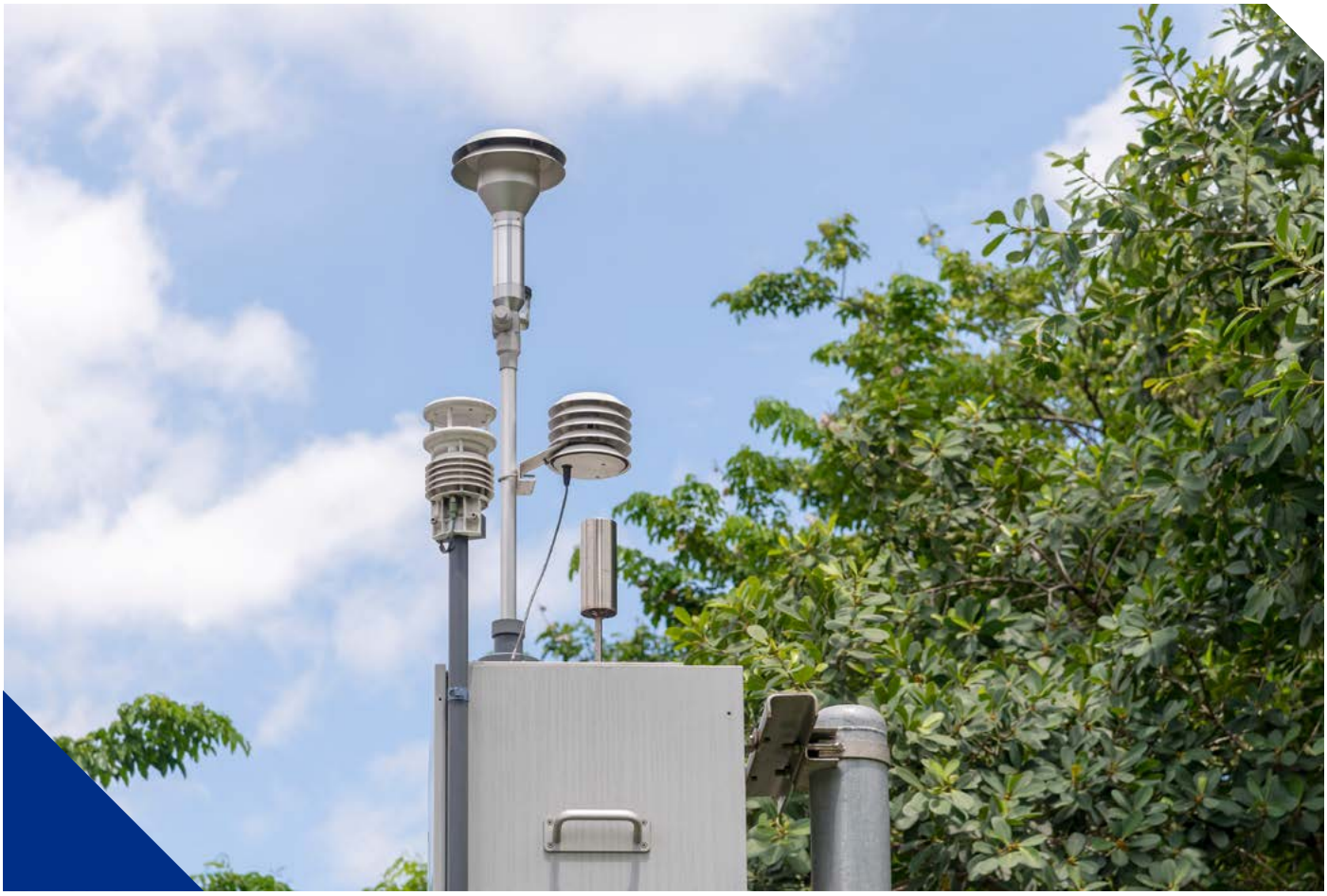
O_3	UV absorption
NO/NO_2	Chemiluminescence
SO_2	UV fluorescence
CO	IR Absorption
PM10 and PM2.5	• Tapered Element Oscillating Microbalance • Beta Attenuation monitor • Gravimetric monitor • Filter Dynamics Measurement System (FDMS) • Optical light scattering • Fine Dust Analysis System (FIDAS)

Apart from automatic Particulate Matter10 analysers, the reference methods of measurement are outlined in the specific EU Directives.

Original Standard Methods for monitoring air pollutants were defined by The European Commission, acting through the European Committee for Standardisation (CEN). These directives provide information about the minimum performance requirements for analysers, in order to meet the compliance required with the Data Quality Objectives (DQO) set down in the Ambient Air Quality Directive (2008/50/EC) and in the amending Directive (EU) 2015/1480.

After much consideration, in 2005, a new series of Standard Methods were published. The current versions of these standards are as listed below:

- EN14211:2012 Nitrogen Oxides
- EN14212:2012 Sulphur Dioxide
- EN14625:2012 Ozone
- EN14626:2012 Carbon Monoxide
- EN12341:2014 PM10 and PM2.5
- (EN16450:2017 Automatic PM analysers)
- EN14662-1:2005 and 14662-3:2015 Benzene



"For many years, air quality has been measured and communicated through reference network monitoring data,"

How low-cost sensors can supplement the reference networks

Recent statistics have illustrated that the annual percentage of data captured by AURN has been falling since 2000. The requirements for data capture, as set by DEFRA, have now been lowered to 85%, down 5% from the originally required 90%.

Alongside this, large AURN reference monitoring equipment is expensive and there has been a rise of viable, low cost alternative options for local authorities and private industry to invest in.

For many years, air quality has been measured and communicated through reference network monitoring data, entirely operated by government agencies, both in the UK, US and throughout the world.

The data generated from the AURN is used for a number of reasons including compliance reporting under the Air Quality Standards Regulations 2010, comparison with objectives in the Air Quality Strategy, and public service announcements through the Environment Agency. The figures gathered are also used to forecast future air quality levels and utilised within the development of policy for the protection of human health and ecosystems.

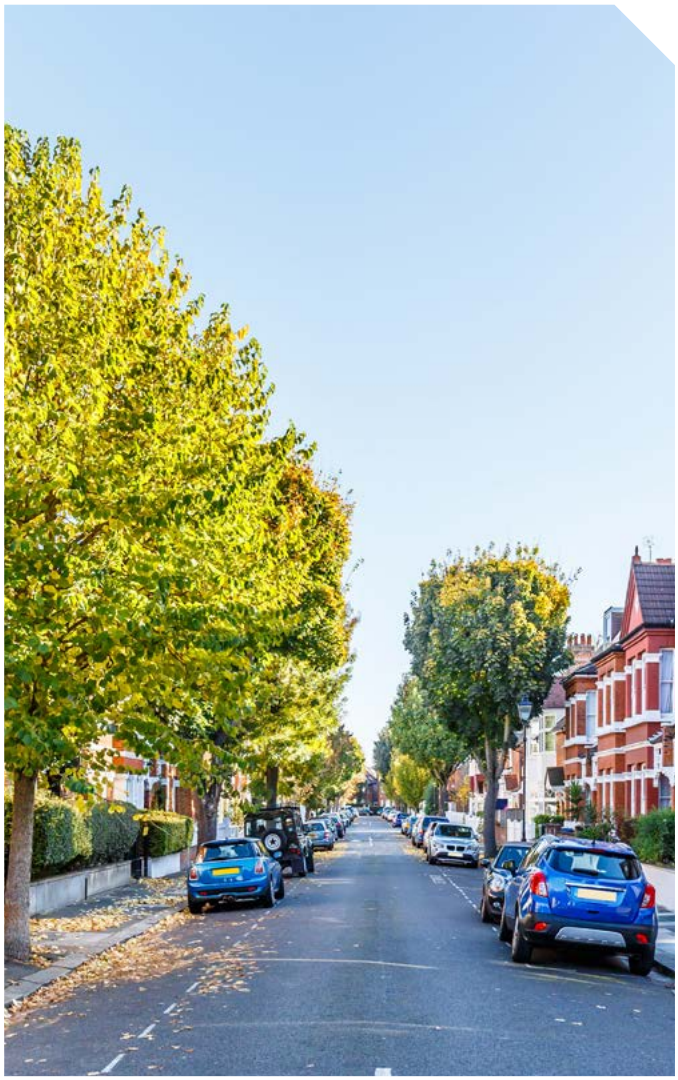
Data is also utilised within The European Monitoring & Evaluation Programme (EMEP), which is a co-operative programme for monitoring and evaluating how air pollutants in Europe are transmitted. AURN figures also support the UK Local Air Quality Management regime under Part IV of the Environment Act 1995, and provide National Indicators on environmental quality.

However, with the required percentages of data captured by AURN on the decline, lower cost, smaller air monitoring sensors have the capacity to fill in the blank data spaces of air quality within neighbourhoods, rural communities and areas the network doesn't reach. Arguably lower cost, air pollutant sensors offer an opportunity to supplement the reference networks data

This reduction in the required levels of data capture as defined by DEFRA are concerning as they could result in a reduction in the measurement of air pollutants nationally, and ultimately affect the air quality itself if smaller businesses and organisations do not make up the shortfall.

According to a study by Environment International, commercial low-cost sensor platforms can 'provide relative and aggregated information about the observed air quality' in specific areas. Their extensive research into this field measured solutions against CEN (European Standardisation Organisation) reference analysers and reported the importance of ensuring to examine the data quality of each node before use.

Smaller air quality monitoring solutions are able to build a more complete picture of the causes of poor air quality. This is in contrast to the static data provided by reference stations which are unable to do this.



"Sensors offer up a valuable opportunity to tackle the cost of poor public health and strain on services as a result of poor air quality."

Tackling the key issues through quality low cost sensors

Both high and low cost air monitoring options offer a variety of features and should be thoroughly explored in order to implement the resolution that works best for you and the environment within which it sits.

Sensors offer up a valuable opportunity to tackle the cost of poor public health and strain on services as a result of poor air quality. Implementing a quality air monitoring solution is also a means by which to improve the occupational health and safety of workers within a range of industries.

When it comes to choosing an expensive air monitoring technology there are obvious cost ramifications which can affect a company's bottom line, or an authority's remaining budget. This has knock on effects on the remaining yearly expenses.

A study by Bingqi Liu and Naomi Zimmerman at Dept. of Mechanical Engineering, The University of British Columbia, as published in Elsevier Science Direct journal, exploring fleet-based vehicle emission factors using low-cost sensors found that 'low-cost sensors are a promising technology for real-world vehicle emissions measurement'.

The study deployed six Sensit Real-time, Affordable, Multi-Pollutant (RAMP) monitors measuring PM2.5, NO, NO_2, CO_2, O_3 and CO in three parking garages in Vancouver across a four month period in 2019.

After sensor calibration, integrated pollutants and CO_2 signals were converted to fuel-based emission factors (EFs). The study's calculated EFs fell within the range of previous studies. Evening EFs when vehicles were cold were 10–50% higher than in the morning. The study also observed a disproportional contribution of high emitters; the top 25% of plumes contributed 45–65% of total emissions.

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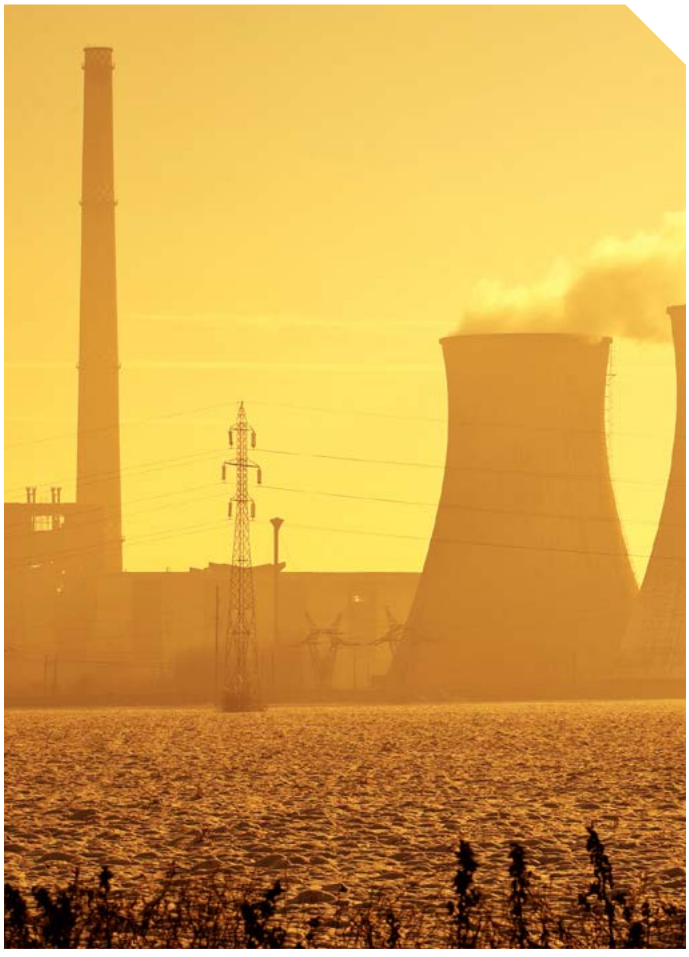
The study found that low-cost sensors are a promising technology for real-world vehicle emissions measurement, specifically in the transportation sector which is a large contributor to air pollutants.

Monitoring the environmental impact of emissions is incredibly important for those in this industry, with 2020 figures from the US Department of Energy stating that almost a third of all fossil fuel consumption in the US were from the transportation sector. These high figures illustrate the need for those in the transport, and other relevant sectors, to remain vigilant and proactive about their emissions and ensure that the solutions in place are enabling them to do their bit to abate climate change.

Historically the usage of higher-costing regulatory-grade instruments have been the first choice for the assessment of emission factors. More recently, low-cost sensors (LCSs) have been increasingly used due to their capacity for different calibration approaches and accuracy in this area.

The study states that low cost air quality sensors are specifically beneficial due to their capacity to utilise a remote sensing tool for the measurement of fleet-based EFs. This remote monitoring functionality can be used at a multitude of locations and gather broader data in varying conditions and environments. This in turn provides heightened opportunity for deeper analysis and understanding of the pollutants in our atmosphere.



Sensit by Crowcon RAMP

A valuable example of a low cost air quality monitoring platform is Sensit by Crowcon's RAMP. The platform enables the remote measurement of up to five gaseous chemical pollutants, and can also monitor temperature, humidity, particulate matter and meteorological conditions. It can be utilised across a range of industries, such as the construction, transport, heavy and waste and local authority sectors.

The unit offers reliable pollutant measurement and provides the relevant personnel with robust data to make actionable changes to their environment to keep their team safe and secure.

The platform is fitted with a range of electrochemical sensors that offer PPB (parts per billion) resolution for CO,NO, NO_2, O_3 and SO_2 gases, along with an integrated PM2.5 particulate matter sensor to measure pollutants in the atmosphere.

The web-based platform facilitates remote access to real-time and archived data, data visualisation tools, sensor health and settings, device location and tracking information. It also comes with a range of notification options and parameters for ongoing flexibility, and can assist with leak location identification and quantification estimates.

This wide ranging functionality and measurement provides peace of mind and increases confidence for operators as it ensures reliable data in the long term. Durability is also not a problem as the unit does not require mains power, either solar or battery powered, and so is long lasting for reliable air quality monitoring in the long term.

The web-based platform also hosts internal SD storage, and optional solar charging and global cellular integration for operation when away from the site. Additional instrumentation can also be incorporated into the unit via four I/O parts on its side.

As the unit will be encountering and monitoring pollutants, the need for it to be impervious to a range of weather conditions is important. The unit has been designed with this in mind, and comes with weather resistant casing to ensure its protection from the elements.

The module is flexible in terms of its hardware choices and comes with an optional solar panel, tripod, mechanical anemometer, ultrasonic anemometer and outdoor power supply, depending on your requirements.

RAMP allows users to easily monitor air quality, remain fully aware of the pollutants prevalent in the environment, and to take the required action where necessary to protect those within it.

Evolve with the times

With the ongoing evolution of the UK air pollution monitoring network, it is time for those concerned with ensuring high quality air monitoring to evolve with changing requirements. Low cost sensors offer the chance to do this.

Not only do they improve the quality and reliability of individual air monitoring processes within local authorities and businesses, they can also supplement reference data with indicative and more granular data.

Lowering costs is an obvious benefit to implementing sensors such as Sensit by Crowcon's RAMP, and as shown by recent studies lower cost does not mean reduced functionality or accuracy. RAMP provides a valuable capacity to meet compliance requirements when reporting against the Ambient Air Quality Directives, as well as to ensure a reduction in the major air pollutants that impact public health.

For more information about RAMP and air quality monitoring click here

References

https://trid.trb.org/view/1755783