Imperial College London Projects

Environmental Research Group

Breathe London – quarterly report January – March 2021

Gary Fuller, Timothy Baker, Robert Hepburn, David Green, Andrew Grieve, Andrew Brook.

Environmental Research Group, Imperial College London

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1. Summary and key performance indicators

This report details work undertaken by Imperial College London Projects on the Breathe London network. This contract was awarded to the College in December 2020.

The main work tasks during the first quarter of 2021 have focused on deploying the first nodes, the creation of the network data systems, an initial QA/QC programme and website. By the end of March 2021, 27 nodes were deployed and operational. A new website was launched on 15th March displaying near real-time measurements.

Indicator	Target	Status
Install 100+ sensors	28 by end of March 2020	27
EU indicative uncertainty requirements	NO_2 - 25% PM2.5 - 50%	Co-location of 60 nodes – uncertainty: NO2 - 17% PM2.5 - 29%
90% of nodes in operation at any time	100% of hours	97.4%
Increase sensors by 5% per year		Not applicable
Website displaying real time information	End of March 2021	Launched 15th March 2021
Data via API	Due summer 2021.	

Table 1 Summary of key performance indicators.

2. Introduction

Breathe London is a new partnership between the Mayor of London, Imperial College London and Bloomberg Philanthropies. The Mayor is providing funding for more than 100 air quality sensor nodes to be installed at hospitals, schools and other priority locations which will be displayed on the new website.

Community groups, charities, businesses, individuals, academics and boroughs will also be able to “buy in” at a substantially reduced cost to the Breathe London network to source air pollution data for local projects or schemes.

This report summarises progress on building the network during January to March 2021.

3. Nodes deployed and data capture

Nodes were deployed to meet contract milestones in January (hospitals) and February (co-location reference sites). Nodes deployed and dates are shown in Table 2. The installation of the Guy's Hospital node was delayed while the hospital undertook electrical works to move the measurement location.

Month	New deployments	Cumulative deployments
January 2021	9	9
February 2021	18	27
March 2021	0	27

Table 2 Nodes deployed.

Data capture across the quarter is shown in Table 3 and Table 4. A network outage was experienced across the Clarity data collection system in February.

Month	Data capture	% hours with 90% of nodes
January 2021	99.8	100
February 2021	87.8	93.2
March 2021	98.3	99.1

Table 3 Data capture per month for NO_2.

Month	Data capture	% hours with 90% of nodes
January 2021	99.8	100
February 2021	87.5	93.2
March 2021	97.2	99.1

Table 4 Data capture per month for PM2.5

The nodes were deployed in 15 of London boroughs by the end of the quarter. These are listed in Table 5.

Borough	Number of nodes
Bexley	1
Brent	1
Camden	2
Enfield	1
Greenwich	5
Hammersmith & Fulham	1
Havering	1
Kensington & Chelsea	2
Lambeth	1
Lewisham	3
Newham	1
Redbridge	1
Southwark	1
Sutton	1
Tower Hamlets	2
Waltham Forest	1
Westminster	3

Table 5 Nodes per borough

The nodes installed at St Thomas' and Newham University Hospitals during January are shown in Figure 1.

Figure 1 Nodes installed at St Thomas' (upper) and Newham University Hospital (lower).

A data collection system was created at Imperial to interface between the Clarity data collection system and our database, and the Breathe London website. The database system allows for the application of quality control / quality assurance corrections. A schematic of the system is shown in Figure 2.

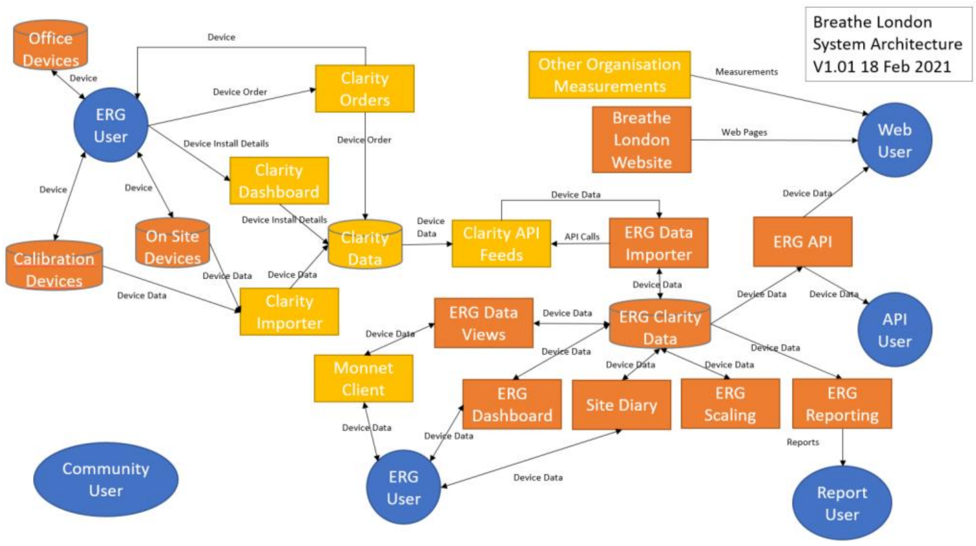

Figure 2 Data collection and data flow schematic

The order of events is as follows:

1. ERG make a Clarity node device order.
2. Clarity send ERG the device and assign node ID to our account.
3. ERG enter device install details into the Clarity dashboard for the move to the calibration site (Honor Oak Park).
4. ERG install the device at the calibration site.
5. The clarity system fetches data from the device.
6. Our automated collection system queries the Clarity API and then fetches data from any active devices.
7. ERG Internal tools allow users to see an overview of all devices, edit meta data, view data on a graph, and flag selected data as invalid.
8. Once we have sufficient valid data we run a calibration on the device, which will then allow us to scale the future data.
9. When the device is to be deployed to a site for use ERG enter device install details into the Clarity dashboard.
10. ERG install the device at the deployment site.
11. As before the Clarity system will fetch data from the device.
12. Our automated collection system queries the Clarity system and detects the new meta data and creates a new deployment site.
13. Data is then fetched from the Clarity API as before.
14. The data is scaled with the calibration factors created at the calibration site for this node.
15. The data is also evaluated ever hour to create the Daily Air Quality Index (DAQI).
16. ERG enable the site so it can appear on the website.
17. The Breathe London website queries the ERG API to get site details (Deployed sites that are enabled) and data as needed.

Our plan for the next phase of development during quarter two and three is:

1. To add an additional stage 2 real-time network calibration to the system. The method for this is under development.
2. To allow community users to acquire devices using the Breathe London website.

4. Quality assurance and quality control

The quality assurance and quality control of the Clarity nodes on the Breathe London Network will be achieved using a two stage approach. The impact of the corrections applied to the nodes will be assessed using the methodology recommended in EU guidance to ensure the network achieves the indicative criteria specified by the GLA. The uncertainty is calculated at the hourly limit value (200 μgm^{-3}) for NO_2 and the indicative threshold is 25%, the uncertainty for PM2.5 is calculated at the suggested daily limit value of 35 μgm^{-3} and the indicative threshold is 50%.

Figure 3 Co-location testing at Honor Oak Park.

Stage 1 - Node specific correction algorithm

This step is designed to correct for deviations between the node (NO_2 or $PM_{2.5}$) and the reference measurement as well as any identified impact of meteorological variables such as relative humidity and temperature. Prior to deployment each node is collocated at the Honor Oak Park London Supersite, shown in Figure 3, and a correction algorithm generated from the node and the reference instrument is derived and applied when deployed at their destination location. The impact of this stage 1 correction can be seen in Figure 4 which compares the "out of box" uncertainty of NO_2 and $PM_{2.5}$ nodes with the uncertainty after correction. Here the "out of the box" measurement refers to data after a stabilisation period of two days following deployment.

- Before correction, the mean NO_2 uncertainty was 48% (range 12% to 101%). After correction, mean NO_2 uncertainty was 17% (range 9% to 24%).
- Before correction, mean $PM_{2.5}$ uncertainty was 364% (range between 122% to 492%). After correction, the mean $PM_{2.5}$ uncertainty was 29% (range 20% to 37%).

Therefore, after correction the uncertainty of all NO_2 and $PM_{2.5}$ nodes was below the indicative uncertainty threshold. So far one node has failed with a faulty NO_2 node and was removed from service.

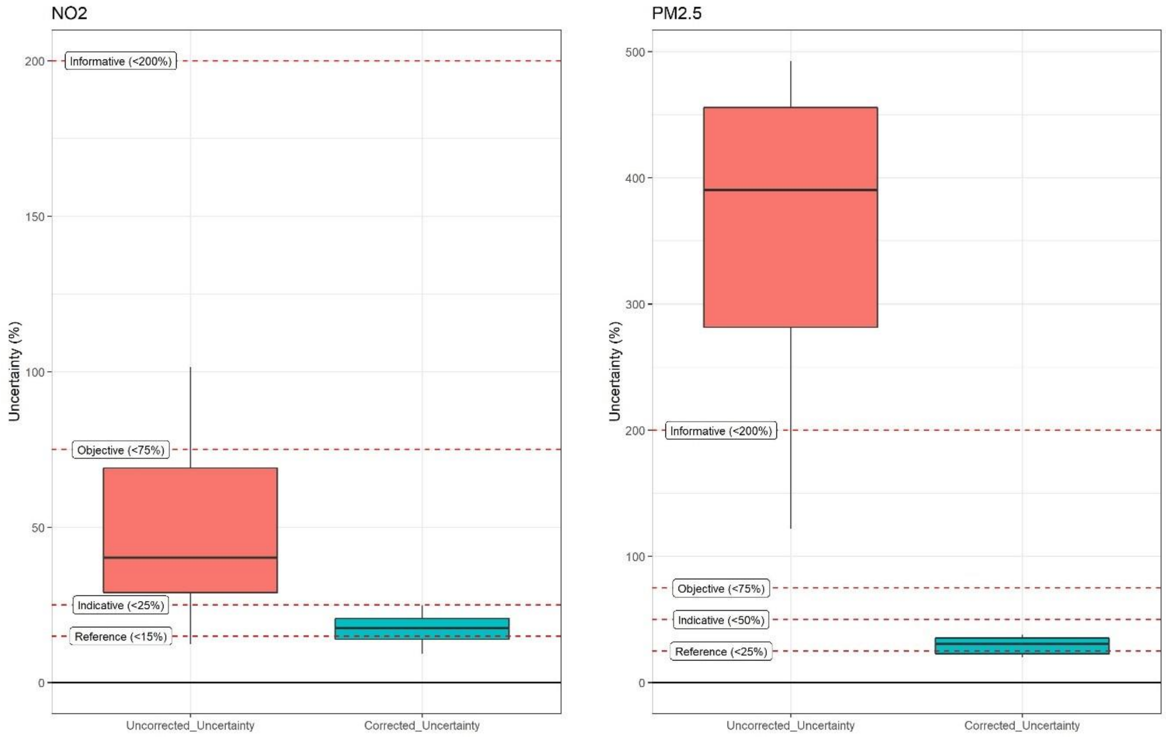

Figure 4 Comparison of node uncertainty before and after application of node specific correction algorithm.

Month	Nodes completing co-location testing
January 2021	15
February 2021	16
March 2021	29

Table 6 Nodes completing colocation testing by month.

Stage 2 Dynamic Network Correction Algorithm

Node response will be influenced by concentrations of the pollutant and environmental factors. It is not always possible to represent these in the initial correction algorithm so they will be corrected for dynamically using information from the nodes at reference monitoring stations.

For the cohort of reference nodes, the dynamic correction algorithm will be calculated using preceding hourly measurements to ensure that the most up to date correction is applied that is representative of current environmental conditions (temperature, relative humidity, ozone, aerosol chemical and physical composition) and node response.

The impact of applying this dynamic correction on uncertainty will be assessed on a node-by-node basis when compared to the co-located reference method.

It is planned to assess the impact of applying this dynamic correction on uncertainty by grouping the correction by site type or NO_X concentration. This will be equivalent to applying the correction to the wider network and will therefore be a good estimate of network uncertainty.

5. Website

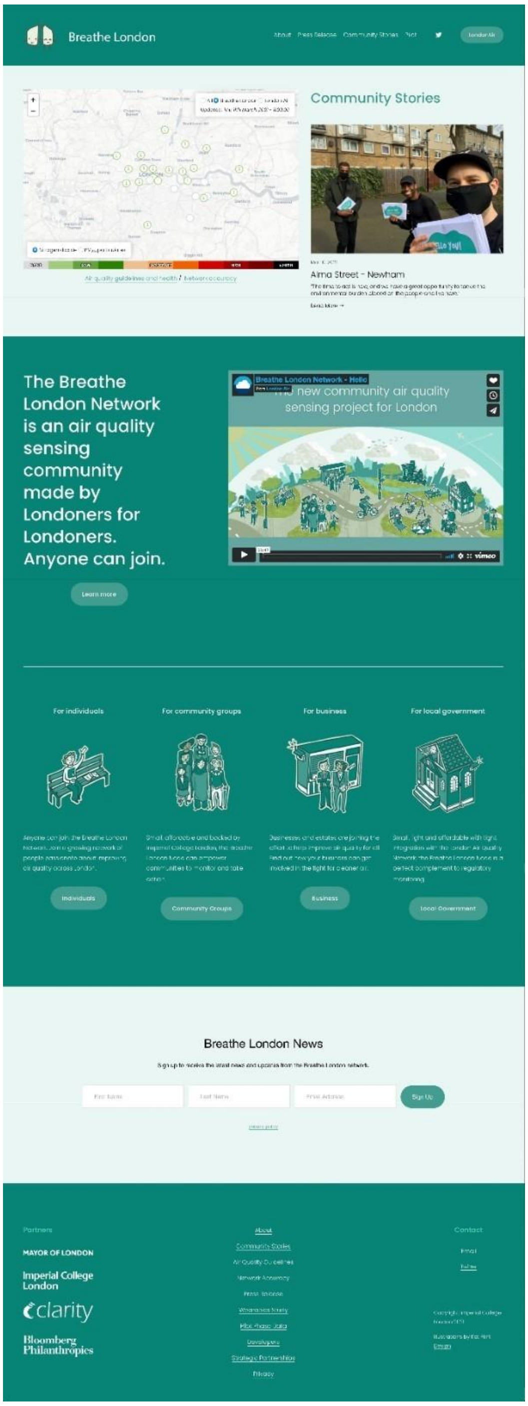

Figure 5 The Breathe London homepage - launched 15th March.

The website launched on 15th March with a live map showing the location and current daily air quality index of each deployed node alongside a selectable layer of LondonAir reference sites. Data from other reference data providers, where available, will appear in later versions. The site features bespoke hand-drawn illustrations throughout to give the site a friendly and welcoming feel.

The top of the homepage features a ‘community story’ block. This gives the site a crucial human angle. This block will rotate as we get more communities onboard.

The site consists of eight pages tailored around the themes of small nodes and community action and involvement.

Since launch, the site has hosted 4,100 unique visitors with around 50% coming direct and 50% split between email, social and search referral. Around two thirds of visitors are suing desktop devices. Visitors peaked around launch and have stabilised since.

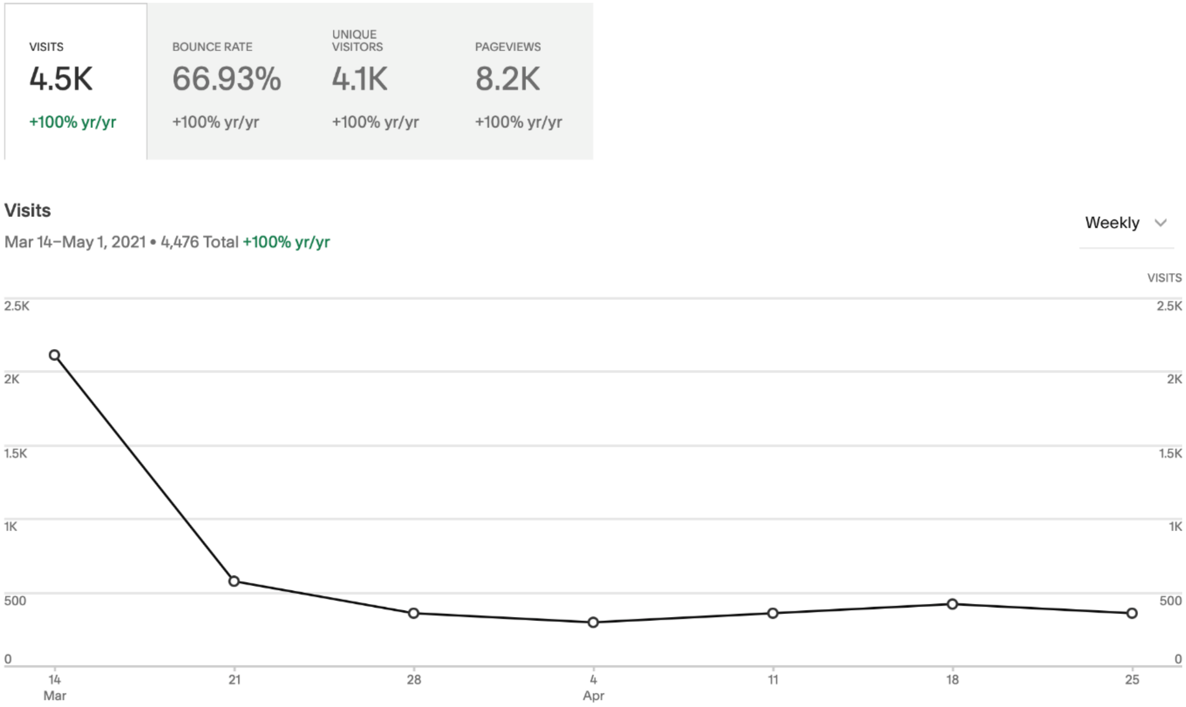

Figure 6 Breathe London website traffic from launch on 15th March onwards.

Twitter

The @Breathe_London Twitter presence has 3,700 followers. The launch tweet which featured an animated video reached 20,500 people. Overall, in March @Breathe_London tweets were seen by nearly 50,000 people.

MAR 2021 SUMMARY

Tweets 9	Tweet impressions 49.1K
Profile visits 3,620	Mentions 90
New followers 123	

Table 7 Twitter summary for March 2021.

Email registrations

The website asked users to register their emails to receive updates about the project. In each category we currently have:
General – 315
Individuals – 76
Communities –38
Local Government – 13
Business – 12
Developers -12

6. Bloomberg Philanthropies

Bloomberg Philanthropies have kindly donated funding to sponsor 50+ Nodes for community groups to apply for over the next three years.

We have started to shape the application and decision process.

Application process

To reach communities that may not have been as engaged in air pollution as others and where English may be a second language, we propose partnering with boroughs and organisations who are active in community development in a range of areas across London to help promote the opportunity and help users complete the registration form.

Decision process

We propose forming a decision panel to review and score applications. The members of this panel may have some overlap with the main stakeholder panel but it's job will be discrete. This panel should be diverse and from a range of backgrounds in the environmental/community health area. ERG will start the process of searching for candidates.

We have started to shape the criteria also. Ideally, we're looking for applications that show a path to emissions or exposure reduction, that have a community involvement element and are from a demographic group or area which is otherwise unlikely to have other routes to fund a Node.

Timeline

The aim is to distribute Nodes to successful applicants in September 2021. The timeline in

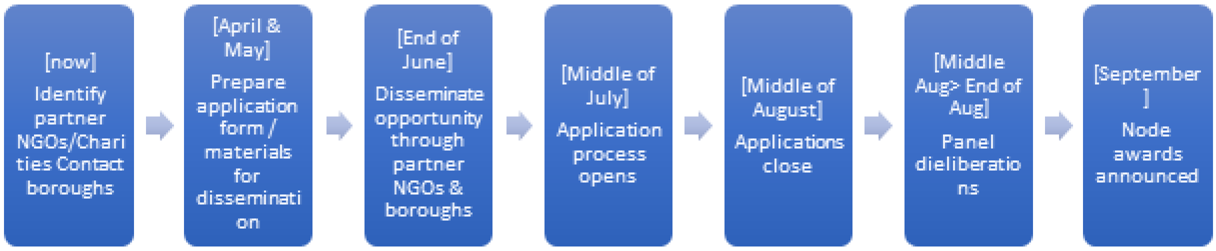

Figure 7 shows the elements which need to be in place to achieve this.

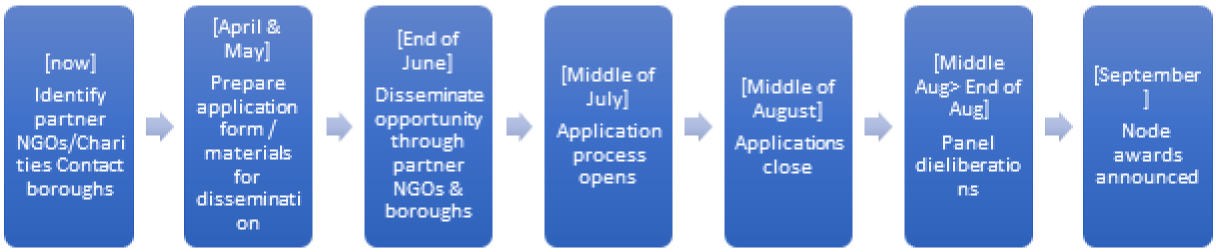

Figure 7 Indicative timeline for node applications.

Imperial College London
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Contact us:

Natasha Ahuja, Project Manager.
Email: n.ahuja@imperial.ac.uk

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