Clean Air Tonbridge

Clean Air Tonbridge is a community project for measuring air quality throughout Tonbridge, Kent. We use citizen science to collect and publish realtime open data on levels of air pollution in the town. For more background please see the initial proposal (github.com/tonbridge-digital/clean-air).

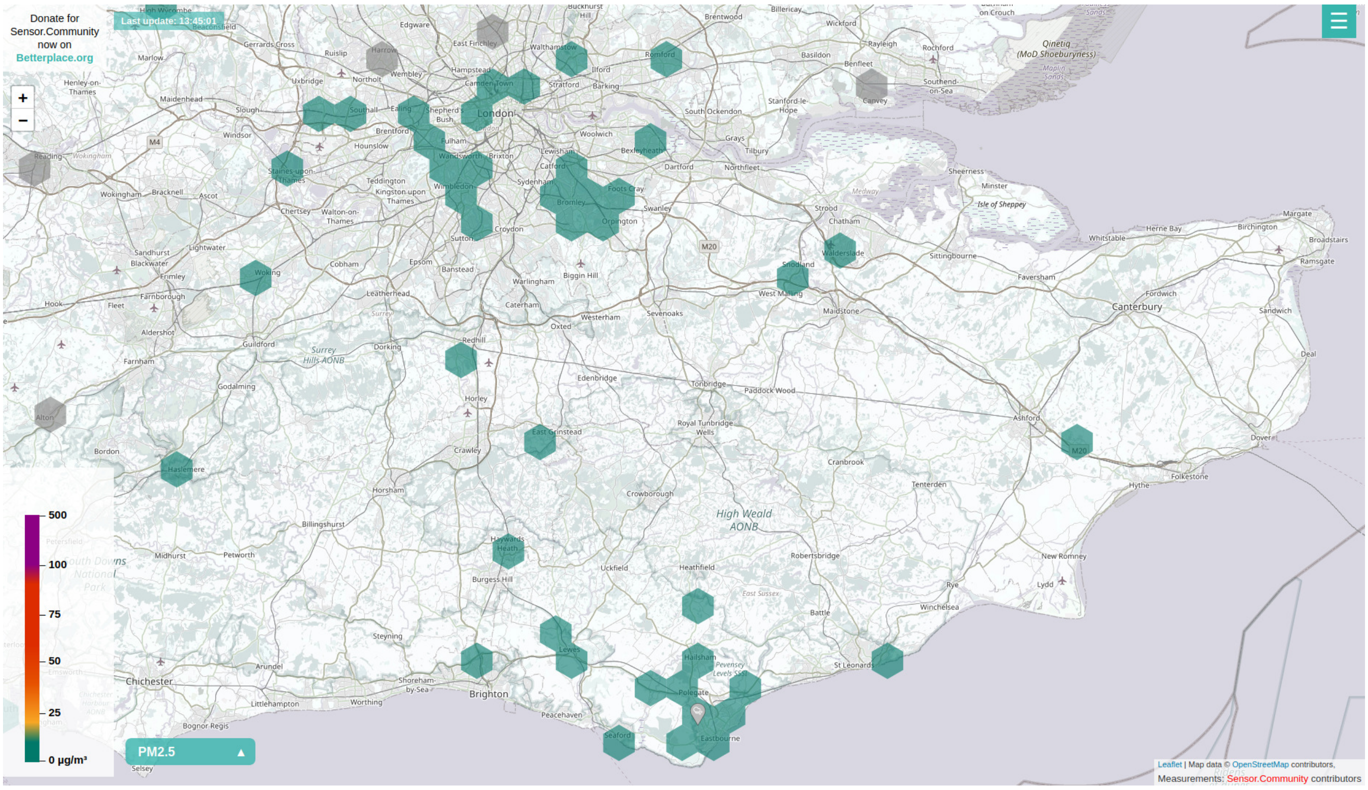
Clean Air Tonbridge is led by the Tonbridge Digital technology group (digital.tonbridge.net). Follow us on Twitter (@tonbridigital) or ask to join our online chat if you want to get involved.

Report

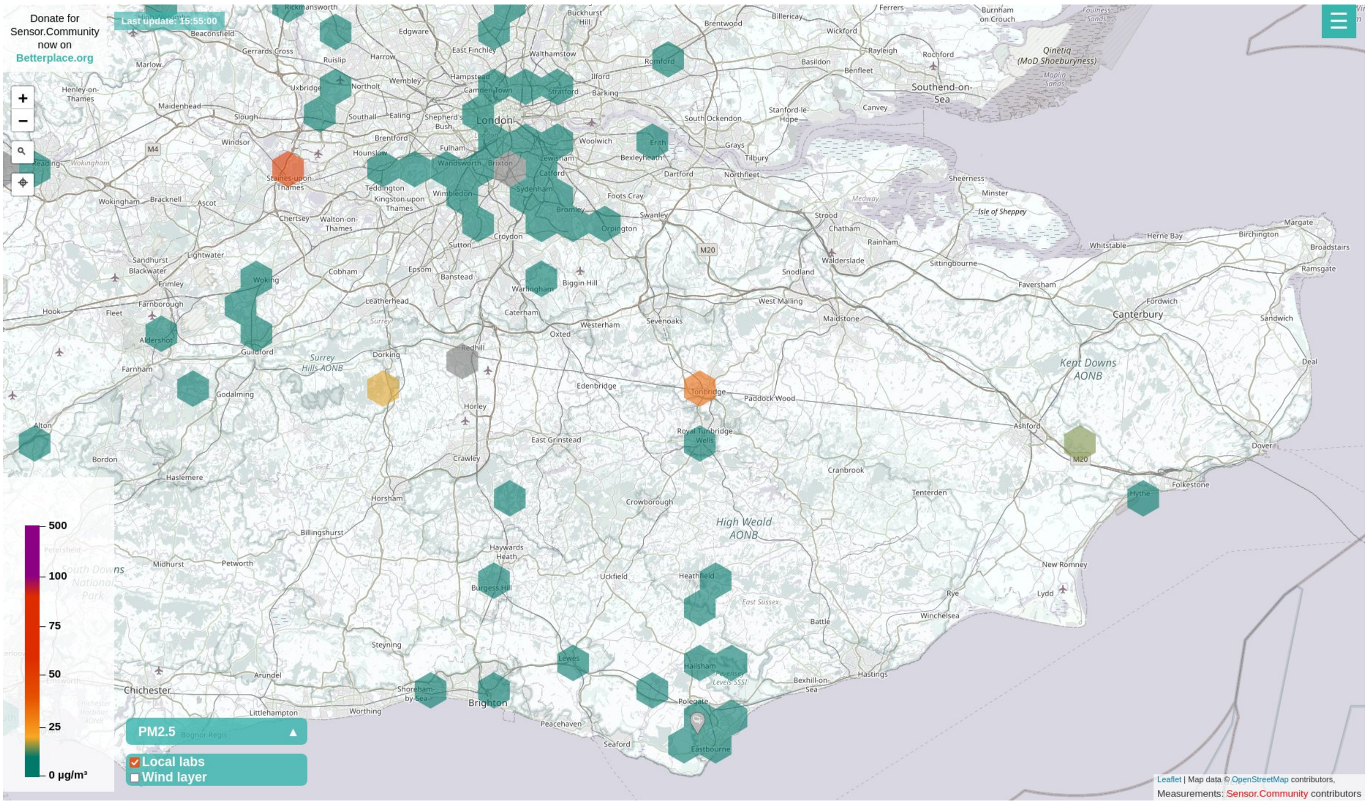
This is the first report on the findings after an extensive period of monitoring and measurement collection. The uptake of sensors has been slightly disappointing on the high street, even with shops that have a remit to improve air quality and health. COVID has caused significant delays but there are now a reasonable number of sensors deployed in the local area gathering data. More progress can still be made though.

State Of Sensors

Before this project started there were no local sensors on the Sensor.Community global sensor network map.



This has changed and there are now sensors in Tonbridge, and one in Tunbridge Wells.



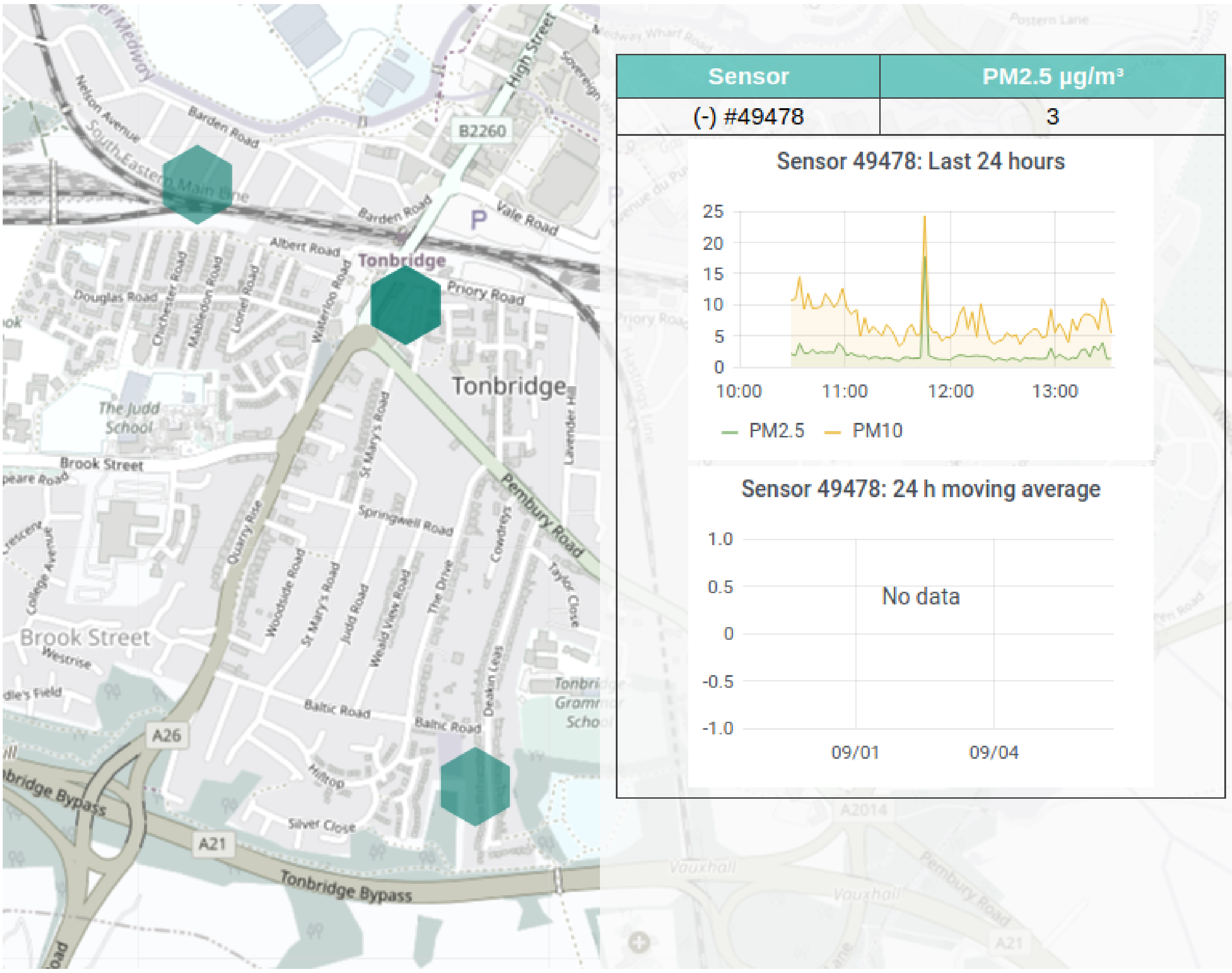
Taking a closer look, the Tonbridge reading is made up of multiple sensors.

Not all of these local sensors are part of this project, which shows that there is interest. If the sensor near Pembury Road belongs to you then please get in touch (air@tonbridge.net)!

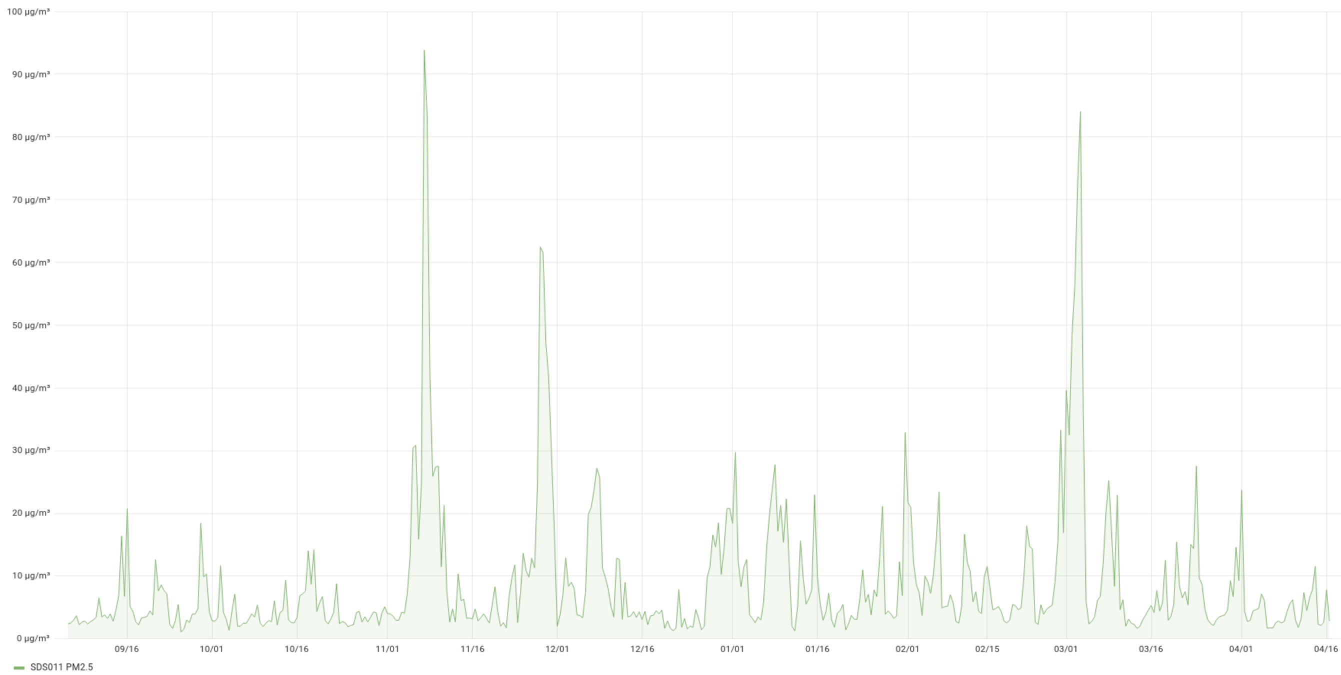
There are disappointingly still no official realtime measurements in Tonbridge since the station was removed in June 2020 (kentair.org.uk). There is however a site in Tunbridge Wells (A26 roadside), although this is conveniently separated from traffic by a bus lane.

Central Sensor

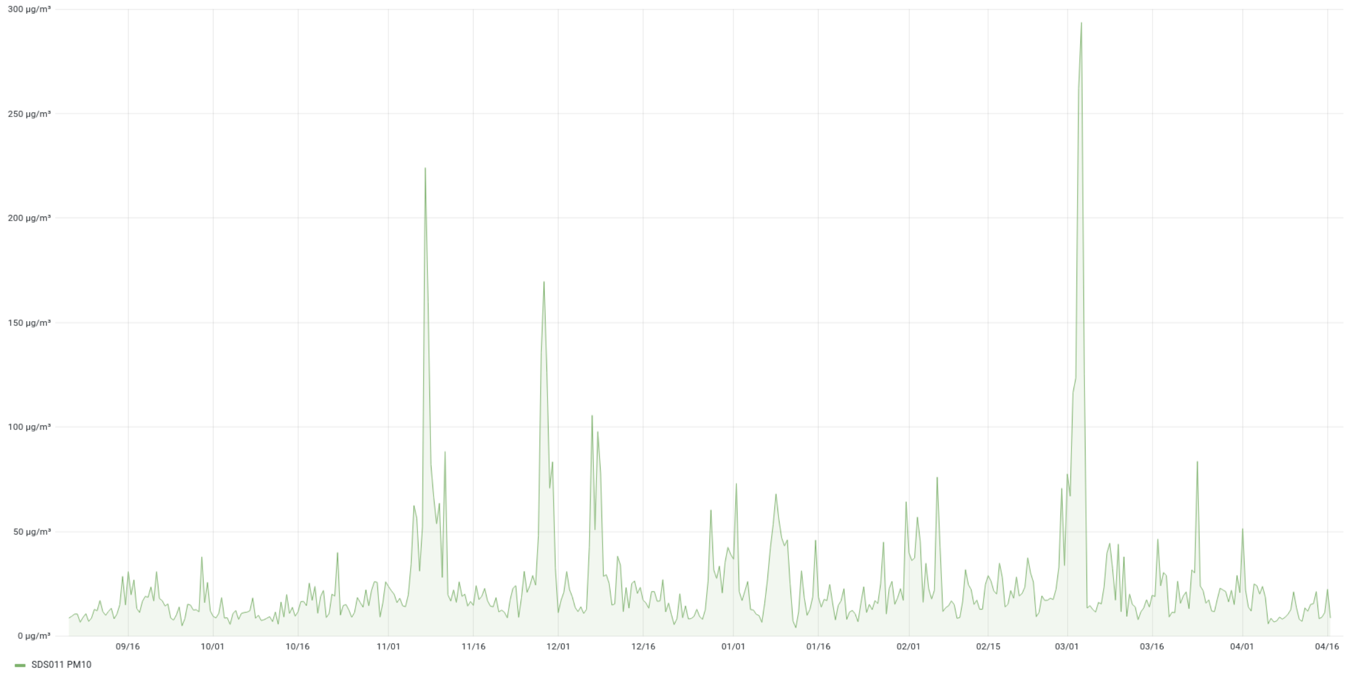
A sensor was installed by Clean Air Tonbridge at a busy location near the station between Sep 2020 and Apr 2021.



The following charts show the recorded levels of Particulate Matter. The first shows the smaller PM 2.5.

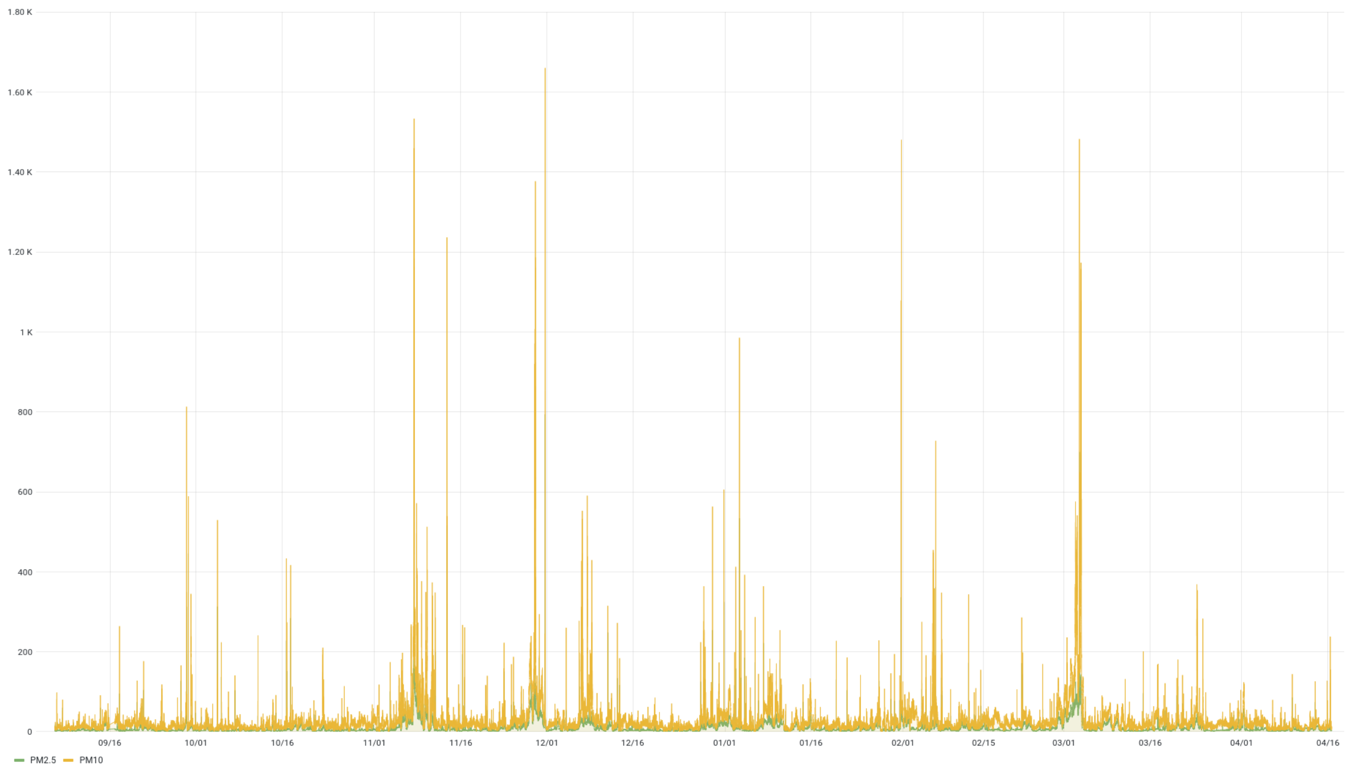


The second shows the larger PM 10. We can see that they correlate, as expected.

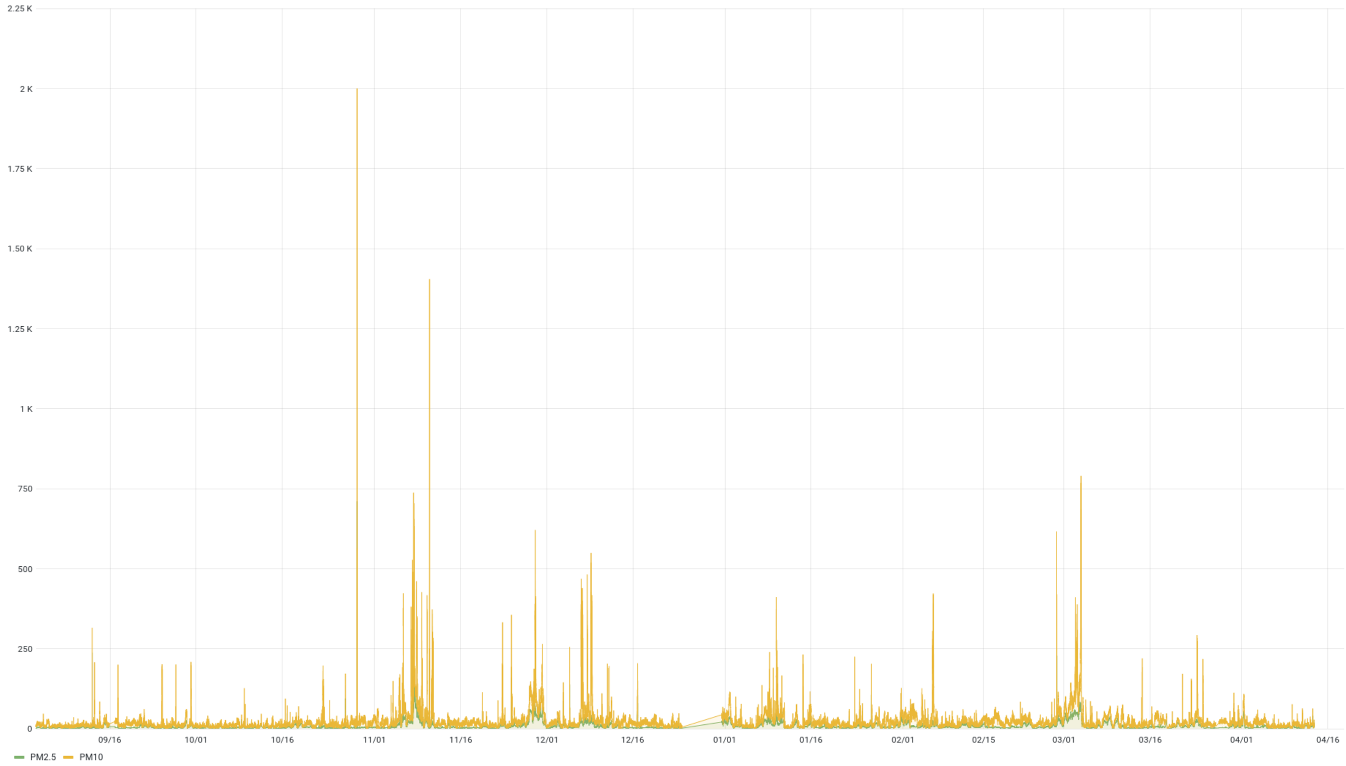


The absolute values of the readings may not be completely accurate but the relative levels can be useful. We can also compare the readings to other devices located at project members' homes to control for background levels of air pollution.

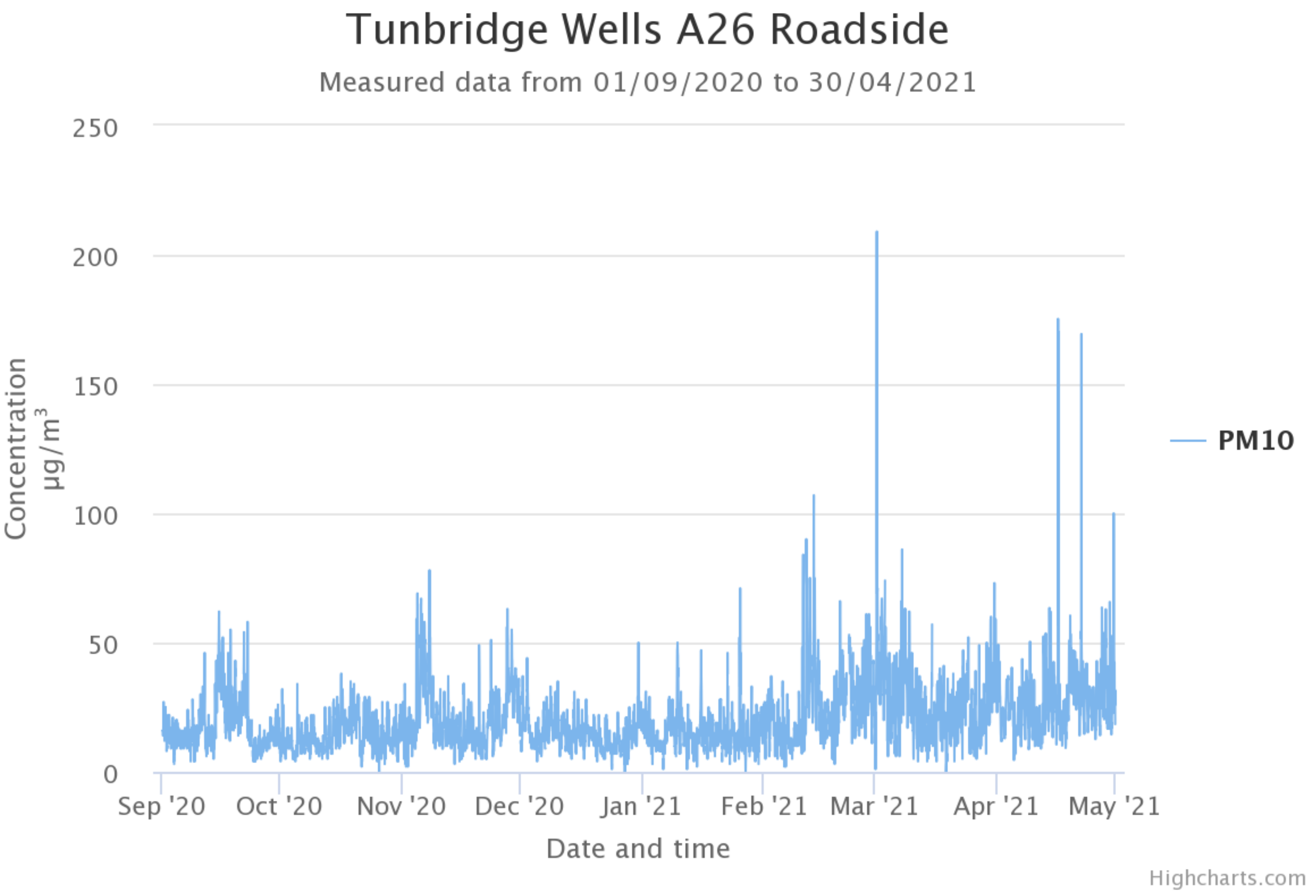
For example, we can see raised readings in the following graph of the central sensor.



These raised readings also appear in other sensor measurements, suggesting that they are regional and not street-level elevations in pollutants.



We can also compare this to the PM 10 readings from the official sensor in Tunbridge Wells.



A similar correlation is present, which shows our sensors produce useful results.

Methodology

This part is quite technical so feel free to skip over it.

The following SQL query was used to retrieve the particulate data points for the central sensor from the Sensor.Community InfluxDB instance for the deployed period. The timestamp is included by default so does not need to be selected.

```
SELECT sds011_p1 AS PM_10, sds011_p2 AS PM_2_5
FROM "feinstaub"
WHERE ("node" =~ /^49478$/)
AND time >= 1599099790168ms
AND time <= 1618772569065ms
```

These data were then extracted to a CSV file using the following `curl` command. The quotes in the query need to be escaped.

```
curl -H "Accept: application/csv" \
-G "https://maps.sensor.community/grafana/api/datasources/proxy/3/query" \
--data-urlencode "db=feinstaub" \
--data-urlencode "q=SELECT sds011_p1 AS PM_10, sds011_p2 AS PM_2_5
                    FROM \"feinstaub\"
                    WHERE (\"node\" =~ /^49478$/)
                    AND time >= 1599099790168ms
                    AND time <= 1618772569065ms" \
--data-urlencode "epoch=s" > data.csv
```

This results in almost 120,000 records so the data was aggregated to the mean value every hour with the following query.

```
SELECT mean(sds011_p1) AS PM_10, mean(sds011_p2) AS PM_2_5
FROM "feinstaub"
WHERE ("node" =~ /^49478$/)
AND time >= 1599099790168ms
AND time <= 1618772569065ms
GROUP BY time(1h)
```

These data were then saved to a CSV file using the following command.

```
curl -H "Accept: application/csv" \
-G "https://maps.sensor.community/grafana/api/datasources/proxy/3/query" \
--data-urlencode "db=feinstaub" \
--data-urlencode "q=SELECT mean(sds011_p1) AS PM_10, mean(sds011_p2) AS PM_2_5
                    FROM \"feinstaub\"
                    WHERE (\"node\" =~ /^49478$/)
                    AND time >= 1599099790168ms
                    AND time <= 1618772569065ms
                    GROUP BY time(1h)" \
--data-urlencode "epoch=s" > data_hourly.csv
```

This results in about 5000 records that were then imported into LibreOffice Calc. The timestamps were converted to the correct date format using the following formula:

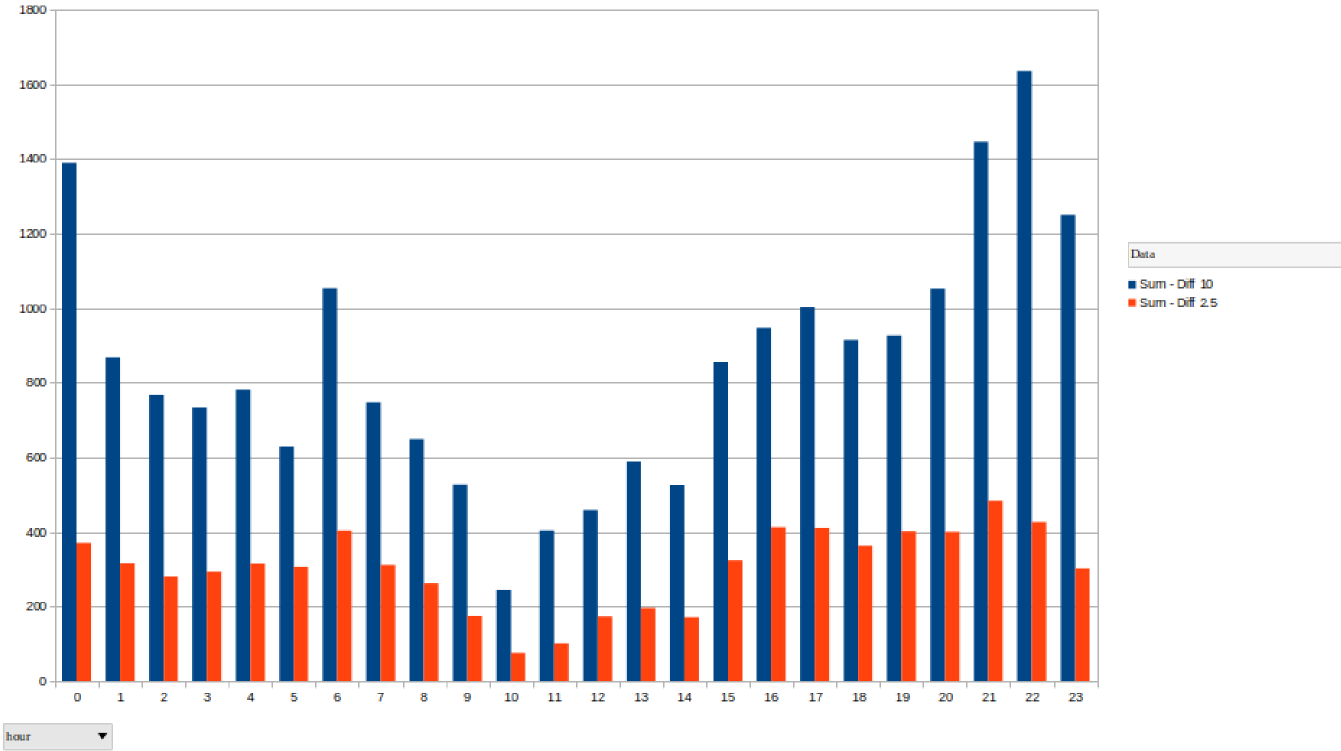
$$date = (t_e/86400) + 25569$$

Where t_e is the number of *seconds* since the Unix epoch.

The same data were extracted for a residential sensor and this was subtracted from the readings to compensate for background levels of pollution. The readings were then examined for patterns and trends using pivot tables and charts.

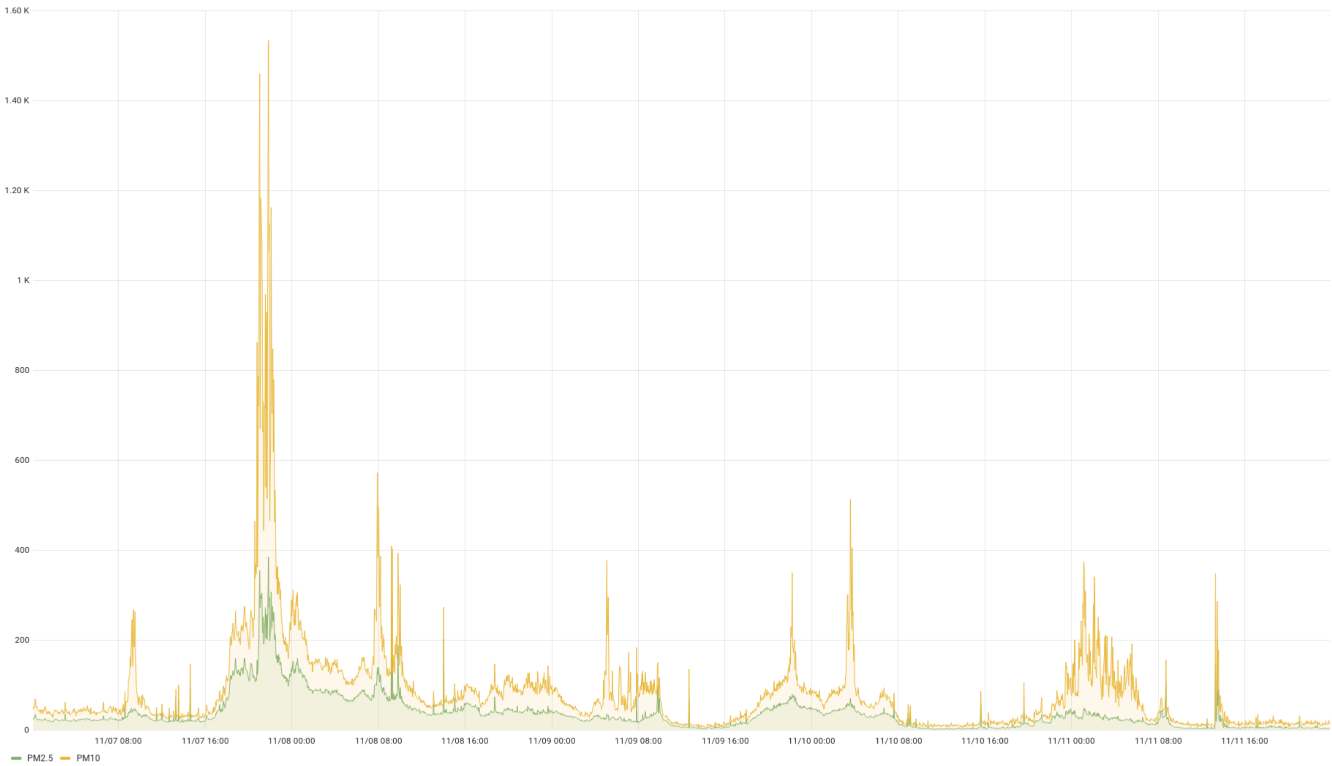
Findings

When broken down by the hour of the day, the data appear to suggest that particulate pollution is lowest in the morning after rush hour. This was a surprising finding, as there is noticeably more traffic during the day.

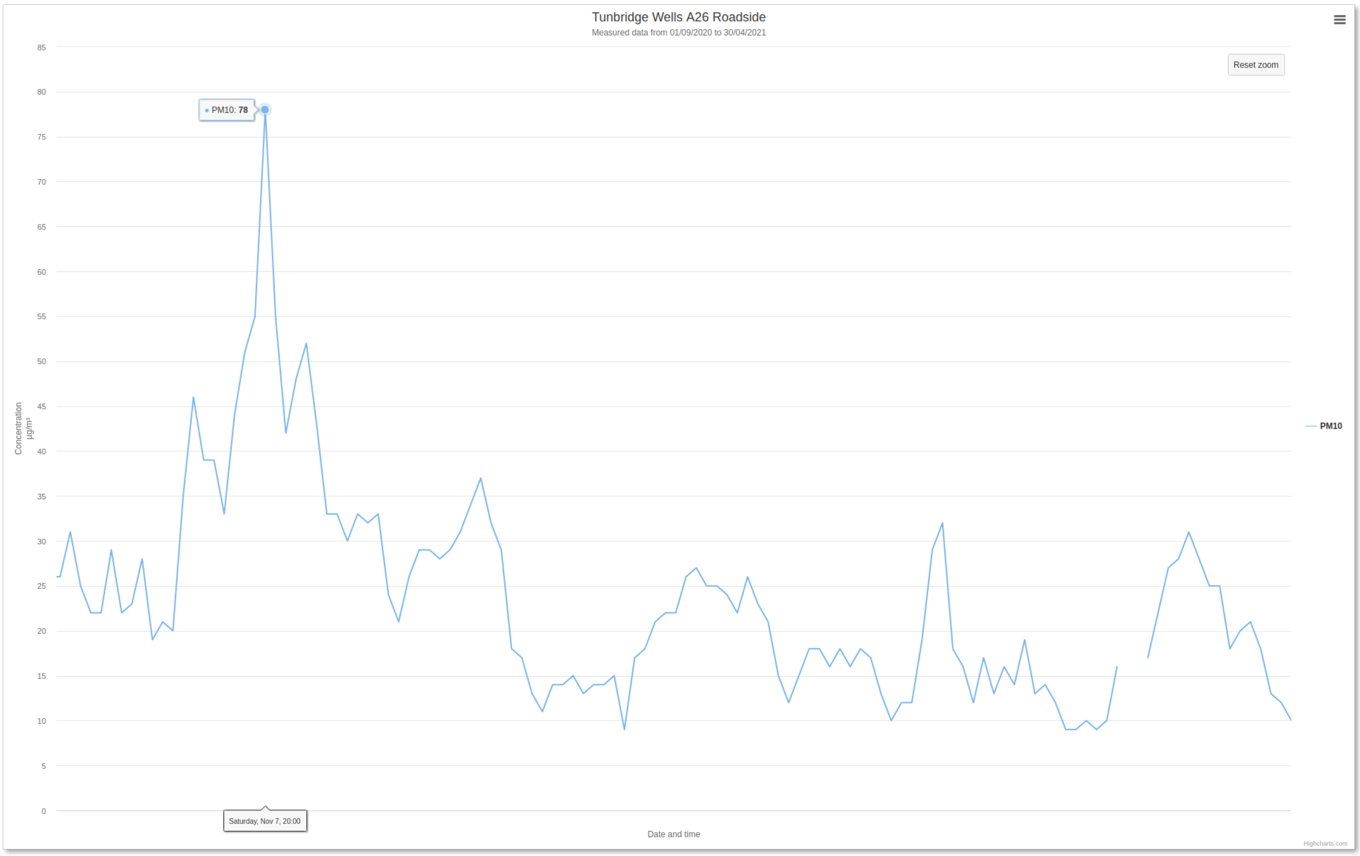


This could be caused by wood burning fires in the evening. Traffic doesn't appear to always be the greatest contribution to the particulate readings.

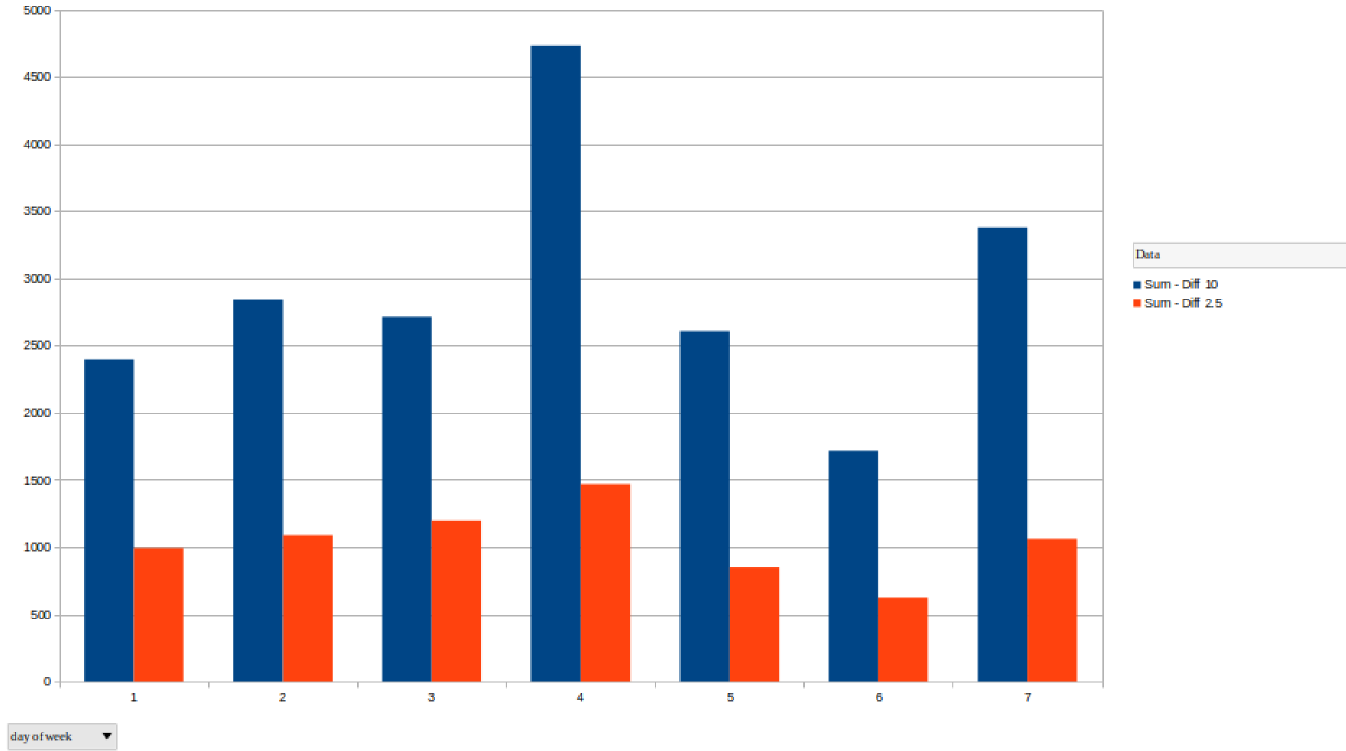
This is demonstrated by looking at the data for Sat 7th Nov 2020 - Wed 11th Nov 2020, which includes the weekend closest to bonfire night. We can see that the readings peak at 8/9pm in the evening.



We can see a similar trend by looking at the data from the official sensor in Tunbridge Wells for the same period.



There were no significant patterns when broken down by the day of the week (1 is Sunday). However, Wednesday is higher and Friday lower.



While these findings are interesting they could be artifacts of the sampling. More data is required from additional sensors over a longer time period in order to draw conclusions.

Summary and Recommendations

It has been a slow start to the project for multiple reasons but there are now sensors deployed and data collected. We will continue to monitor the deployed sensors and aim to install additional ones.

However, it is imperative that an official calibrated monitoring station is brought back. This should measure PM in addition to gases, as the one in Tunbridge Wells does. It should be sited in a realistic location and not away from traffic. Ideally it will measure ultra-fine PM 1 pollution too.

Traffic is not the only problem, and this will improve naturally anyway as the inevitable electrification of transport accelerates. Even modern fossil fuel vehicles have advanced exhaust filtering and as older vehicles are retired and removed from the road (particularly old diesel vehicles) then improvements should be felt.

Our data suggest that there are also problems with burning of solid fuel (for heating in the home or otherwise) producing pollution in the evening and overnight. This doesn't appear to have a natural solution and so action will need to be taken to improve the situation. Smoke is typically discharged into the air without any exhaust filtration at all.

Education would be useful but the economic and regulatory systems around environmental pollution should also be tweaked to make the right choices easy and the wrong choices hard. Negative externalities should be priced into the cost by using incentives and taxation.

Other areas of concern are diesel generators and Small Off-Road Engines (SOREs), as these also typically have much lower exhaust filtration than modern road vehicles. Therefore they can have a significant impact despite being less prevalent than road traffic. A recent example is the diesel generation used at the Tonbridge vaccination centre, which is particularly ironic given that the remit of the centre is to prevent respiratory illness.

Electrification can help with these other concerns too. A combination of battery energy storage, convenient grid hookup connections and renewable generation could reduce the need for these polluters.

A useful rule of thumb is that the louder an engine is the more pollutants it is emitting (as effective exhausts also control noise pollution). This applies as much to road vehicles as it does to SOREs and generators.

Further Reading

Links:

- Local Area Map on Sensor.Community
- Central Sensor Charts on Sensor.Community
- Central Sensor PM 2.5 Chart on Madavi
- Central Sensor PM 10 Chart on Madavi
- Pembury Road Sensor Charts on Sensor.Community
- Barden Sensor Charts on Sensor.Community

A good book covering this topic is Clearing the Air: The Beginning and the End of Air Pollution by Tim Smedley.