EDAR Pilot Project

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EDAR Pilot Project

1. Why do we need emissions evidence
2. What we did
3. What we have found
4. What others are doing
5. Next steps

Determine that the thing can and shall be done and then we shall find the way.
– Abraham Lincoln
We are on the brink of a clean industrial revolution, and all sectors will be impacted. Digitalisation, decarbonisation, investment and the needs of people will be core elements in that change, all being pushed ahead by innovation and investment.     EU Transport Commissioner, Violeta Bulc
10.12 An effective local NMF model will rely on accurate, high-quality, local fleet composition data (especially in densely populated city centres) and up-to-date emission factors. To achieve this we will follow a two-phased approach. The first phase will ensure that data is collected over a sufficiently large area to inform the model build. The second phase will involve collecting more detailed traffic categorisation data, including Automatic Number Plate Recognition and tailpipe monitoring at specific locations of particular concern. This will ensure that local models – for city centres and surrounding areas of all four major cities in Scotland – are produced at a resolution that offers accurate, insightful information. We will also include future prediction modelling to:

- evaluate the impact of planned improvements to the fleet; and
- develop a national cost/benefit analysis process for assessing actions related to potential scenarios.
The Scottish Government is proposing that the primary objective of LEZs in Scotland will be to support the achievement of Scottish Air Quality Objectives that focus on nitrogen dioxide and particulate matter. As our learning around LEZs matures, the focus could widen to incorporate additional Scottish Air Quality Objectives pollutants and support the reduction of greenhouse gas emissions.
One of a series of techniques to tailpipe monitor

- Trials taken forward by East Central Scotland Vehicle emissions Partnership (ECSVEP) and North Lanarkshire Council.
- Work part of continuous engagement with others on developing applied technology.
1. Support the work of the Vehicle Emissions Partnerships
2. Gather fleet emission data
3. Gather data on high polluting sections of the fleet
4. Consider the use of instantaneous vehicle emission data in LEZ awareness raising and enforcement

**Project Objectives**

- Using vehicle emission data to contact high polluters on emissions, using the powers of the Road Traffic (Vehicle Emissions) (Fixed Penalty) (Scotland) Regulations of 2003.
- Accurate factors for the NMF
- Collate results and conduct structured discussions with bus, freight, and taxi fleets. Present findings in forums to manage change.
- Real time information.
- Link to decision making.
- Collate data for performance monitoring
EDAR - Snapshot

PEMS - Continuous analysis

Preliminary results, verification required
EDAR – Benchmarking Performance

Real-world comparison

Drive-through comparisons

- PEMS
- SNIFFER (car chaser)
EDAR – Benchmarking Performance

PEMS (one vehicle) - good agreement (within experimental limits) $R^2$ 0.8-0.95

In Earlier work

SNIFFER (car-chaser) less certain but highly encouraging for multiple vehicles (vehicle types)
EDAR – Benchmarking Performance

In recent work, we are also starting to see other similar independent evaluations by others, e.g. JRC as part of CONOX…

Preliminary indirect comparison based on data collected by Emissions Analytic.
EDAR – Preliminary results

• Diesel NOx emissions higher than expected

• Appears to be a higher than expected incidence of excess polluters in the local fleet.

• Several, relatively young vehicles emitted 3- to 6-times higher than the median level for similar vehicles.

Local Authorities | West Lothian, and North Lanarkshire
Sites | 3, Maybury A8, Broxburn A89, and Coatbridge A725
Total Vehicles | Over 100,000
Time | 3 Weeks
Broxburn, Average NOx by Euro Class for 22 Diesel manufacturers

One group with Euro 3, 4, and better than 6 (group 5)

Many groups with Euro 3 and 4 better than 5 (2 to 5, 8, 10 to 15, 17, 18, 20 to 22)

All groups worse than standard

Preliminary results, verification required
Ranked NOx (g/Kg) for all Euro 6 diesel vehicles

Though the top 5% are the highest 313 readings, etc. This too small of a sample for a meaningful analysis, but it serves for illustrating the concept.

Data analysis – working towards more robust high emitter assessment (for EDAR and other remote sensing methods).

(Coatbridge data; HEAT analysis)
Pareto analysis of HGV PM

(Edinburgh and Broxburn data; Leeds & Birmingham analysis)

Note e.g. MAKE:0101
• Most pronounced high emitter contribution
• But relatively low average emission

Data analysis – working towards more robust high emitter assessment (for EDAR and other remote sensing methods)
Possible Applications – Feedback for retrofitting projects

Example: comparing TfL and other buses and coaches

Typically, have lower CO EURO4 onwards and NO emissions EURO3 onwards (although now not a lot in it)

... Had higher NO₂ emissions up to EURO5 but EURO6 look cleaner...

... PM? (not enough data)
EDAR – Application

- Lochwynd very efficient at deployment.
- Gantry system easy to deploy.
- Power and road cut out could be made permanent if system on rotation.
- Signs encouraged some vehicles to avoid the lane.
- Data capture and link to other datasets could be developed.
1. Derive representative CO2 (g/km) values for the fleet and use these to convert EDAR measured ratios.

3. Perform a Pareto style analysis on the complete data set of emissions and compare results between Scotland sites.

5. Categorise by emissions management technology.

6. Undertake specialist analysis of the buses subset of the EDAR dataset.

7. Understand variability of repeat measurements (same vehicle).

8. Assess EDAR's capability to measure exhaust temperature data.

9. Assess absolute emissions (g/km) measurement capability (sensor in correct position).

10. Determine prevalence of UHEVs and Gross Emitters.

11. Comparison of Emissions Analytics and EDAR.
The CONOX Project

A European and US collaboration to analyse how large datasets from remote sensing can be used as a complement to existing approaches to measure road vehicle emissions to achieve a better understanding of the European issue of air pollution from road transport.
Review article

Remote sensing of on-road vehicle emissions: Mechanism, applications and a case study from Hong Kong

Yuhan Huang\textsuperscript{a}, Bruce Organ\textsuperscript{a,b}, John L. Zhou\textsuperscript{a,*}, Nic C. Surawski\textsuperscript{a}, Guang Hong\textsuperscript{c}, Edward F.C. Chan\textsuperscript{b}, Yat Shing Yam\textsuperscript{d}

**Table 1**
Comparison of vehicle emission measurement techniques under real-world driving conditions.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Method</th>
<th>Advantage</th>
<th>Disadvantage</th>
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</thead>
<tbody>
<tr>
<td>PEMS</td>
<td>Measures target vehicle emissions by carrying measurement instruments on-board</td>
<td>High accuracy</td>
<td>Small sample size</td>
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<tr>
<td></td>
<td></td>
<td>Emission data of a journey</td>
<td>Extra weight of PEMS may bias the measurements, especially for light vehicles</td>
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<td>Individual vehicles &amp; vehicle classes</td>
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<tr>
<td>Plume chasing</td>
<td>Measures target vehicle emissions by a following laboratory vehicle carrying measurement instruments</td>
<td>Emission data of a journey</td>
<td>Small sample size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individual vehicles &amp; vehicle classes</td>
<td>Limited speed and minimum distance for safety</td>
</tr>
<tr>
<td>Tunnel measurement</td>
<td>Measures pollutant concentrations at tunnel’s entrance and exit</td>
<td>Large sample size</td>
<td>Difficult to determine emissions of specific vehicle classes or individual vehicles</td>
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<tr>
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<td>Well-defined wind</td>
<td>Limited driving conditions (steady speed)</td>
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<td>Induced wind by large vehicles</td>
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<td>Non-exhaust emissions (e.g., tyre and brake wear)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Difficult to determine emissions of specific vehicle classes or individual vehicles</td>
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<td></td>
<td></td>
<td>Non-exhaust emissions (e.g., household and industry)</td>
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<td></td>
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<td></td>
<td>Indirect measurements</td>
</tr>
<tr>
<td>Ambient measurement</td>
<td>Measures ambient pollutant concentrations at roadside</td>
<td>Large sample size</td>
<td>Only measures ratios of pollutants over CO\textsubscript{2}</td>
</tr>
<tr>
<td></td>
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<td>Emission data measured in half a second</td>
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<td></td>
<td>Limitations in site selection (positive road grade, single lane and free flowing traffic)</td>
</tr>
</tbody>
</table>
Carl Fulper’s inverted pyramid of data gathering activities for better informing emission modeling work
What others are doing

Other passing-vehicle measurements

Example: OHMS/SHEL (Used by Denver; TTI)
Expertise at the University of Birmingham
Full Life Cycle of Pollutants

Collaboration

EDAR Sniffer van

Field data
Field data
Field data Statistical methods
Field data Aerosol mass spec
PE measurements
Toxicology Epidemiology

Emissions
Near-field dispersion
Physical Transformations
Chemical Transformations
Airborne particles
Personal Exposure
Health Effects

Lab data Mech Eng
Street canyon models
Field data Lab studies Numerical models
Receptor modelling
PE modelling
Human Challenge studies

A possible approach for Scotland
Integration and storage

Key Approach

- Develop Standards
- Collect the data in the National Transport Data System
- Align our work with the ITS Strategy to inform traffic management decisions
- Link to other data storage projects such as the CONOX Project

Next steps
Why we need emission evidence.

• To give an accurate picture of the situation enabling the correct strategy to improve things.
• To enable arguments to be put forward with hard facts and confidence.
• Gain the public’s trust.

What we are doing.

• Trying to improve AQ but still not doing it together (enough).

Collaboration.


Next Steps.

• Data analysis, building database, working with others.