TPS Event, NTA Dublin, 27 June 2018

# Modelling Clean Air Zones

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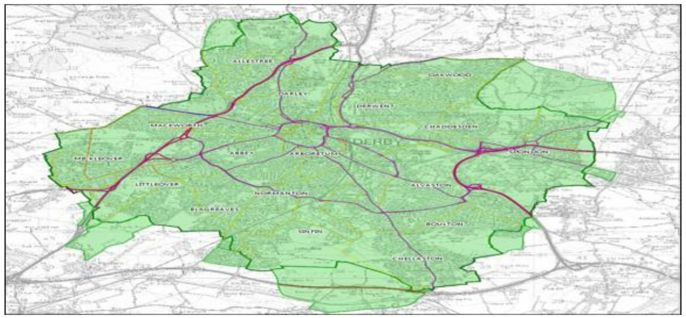

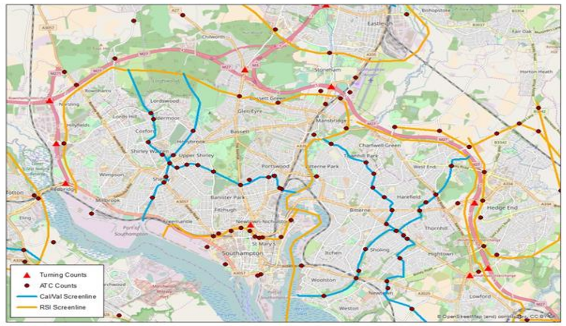


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# Overview

1. **Background**
2. **Overview of the Required Modelling**
3. **Issues/Challenges**
4. **Concluding Remarks**

# Background

- Poor Air Quality is the biggest risk to public health in the UK
- Air pollution also results in damage to the natural environment
- WHO-based EU limits (40 μg/$m^3$) on annual average concentrations of $NO_2$ were exceeded at one or more locations in 37 out of 43 (86%) air quality modelling areas covering the UK in 2015
- Concentration of $NO_2$ is heavily influenced by the emission of $NO_X$ (= NO & $NO_2$) by road traffic
- UK emissions of $NO_X$ fell by almost 70% between 1970 and 2015 (1.5% pa) and are likely to continue to fall as the latest EURO6 emissions technology spreads through the fleet
- $NO_2$ not decreased as quickly as expected due to a number of factors
  - increase in % of diesel cars
  - increase in % of primary $NO_2$ in $NO_X$ emissions
  - failure of EURO_5 and early EURO_6 technology to work 'on-street'
- 75 UK Local Authorities predicted to exceed the 40 μg/$m^3$ limits in 2017, and 42 predicted to be still over this limit in 2020
- DEFRA/DfT set up Joint Air Quality Unit (JAQU) in April 2016 to tackle the problem
- Commitment to introduce Clean Air Zones in **5 UK Cities** (in addition to London's ULEZ Initiatives) - other cities may need to consider similar measures
- JAQU have provided a number of Guidance documents, including Clean Air Zone Framework https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/612592/clean-air-zone-framework.pdf

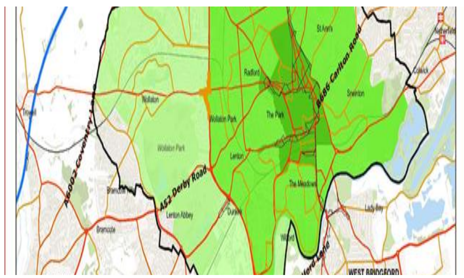
# The Clean Air Zone Cities

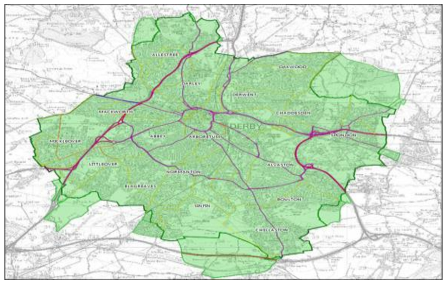
**London Ultra-Low Emission Zone (ULEZ) (currently 103 µg/m³)**

- Currently covers the same areas as the congestion charge
- May be extended
- Will come into force in September 2020 (or earlier)
- Minimum Emissions Standard for Exemption and Proposed Charge
  - Petrol car: >= EURO 4 or better (>=Jan 2006): £12.50
  - Diesel car: >= EURO 6 (>= September 2015 ): £12.50
  - Diesel van: >=EURO6 (>= September 2016): £12.50
  - HGV & Buses: >=EURO6 (>=January 2014): £100

**5 Clean Air Zone Cities (& their highest average $NO_2$ concentrations in 2017)**

- Birmingham (60 µg/m³)
- **Derby (57 µg/m³)**
- Leeds (60 µg/m³)
- **Nottingham (57 µg/m³)**
- **Southampton (57 µg/m³)**



# Questions to Be Answered by the Modelling

- **Potential Variants of Charging -CAZs**
  - A = buses, coaches, taxis & PHVs
  - B = A + HGVs
  - C = B + vans
  - D = C + cars, motorcyles & mopeds
- Boundary of the CAZ
- Daily Charge (by vehicle class)
- Any Discount/Exemptions for Residents & Others?
- Can we avoid creating more air quality problems than we solve?

# Modelling Steps

- Build/re-base your traffic/transport model – (Base year validation data <5 year old)
- Consider the need for segmentation by income
- Estimate the current local compliant/non-compliant proportions by vehicle type
- Forecast the 'Business as Usual' Compliant/Non-Compliant %Splits
- Decide on one or more charging regimes to be considered
- Forecast the Do Something Compliant/Non-Compliant %Splits (as a function of £charge?)
- Identify one of more Clean Air Zone Cordons
- Model the Business as Usual and Do Something (ie 'Non-Compliant Vehicles Pay Once per Day')
- Estimate the Future Year Emissions (BaU and Do Something) – eg ENEVAL/EFT
- Use an Air Quality Dispersal Model to predict impacts on future air quality – eg RapidAir
- Refine the scheme to derive a Preferred Option which achieves the required future air quality
- Appraise the Costs and Benefits of the Preferred Option

# Difficulties/Challenges

- Not every air quality problem area is covered by an up-to-date traffic model
- Local fleet age profiles can vary significantly from national averages
- Predicting the Business as Usual Fleet (Petrol vs Diesel split and uptake of EV’s etc)
- How will the introduction of the Clean Air Zone affect the compliant/non-compliant %split
  - Home location – inside vs ‘close’ vs ‘far away’
  - Frequency of travel within the cordon
  - Level of the charge
  - Availability of alternatives
  - Relative cost of upgrading to compliant
- Accurately modelling the ‘All Day Charge’ (including discount for residents of CAZ)
- Complex interactions between detailed cordon location, charging regime, the level of charge & Do_Something %compliance assumptions

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**} More research needed?**

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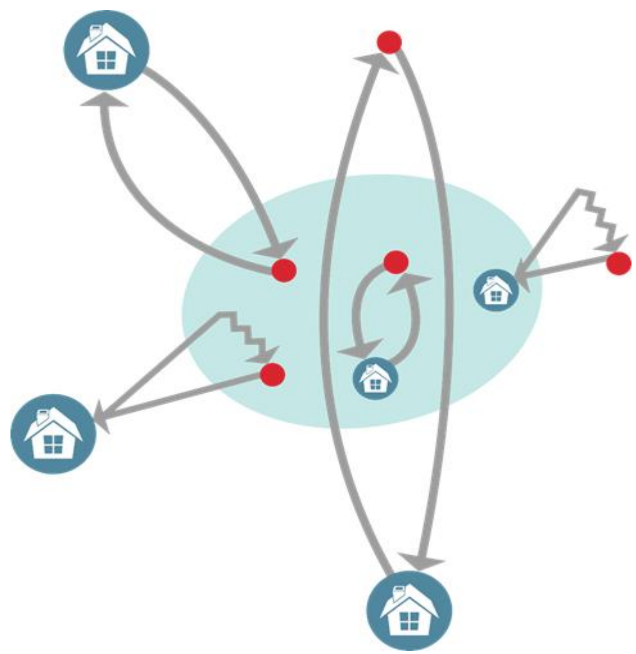
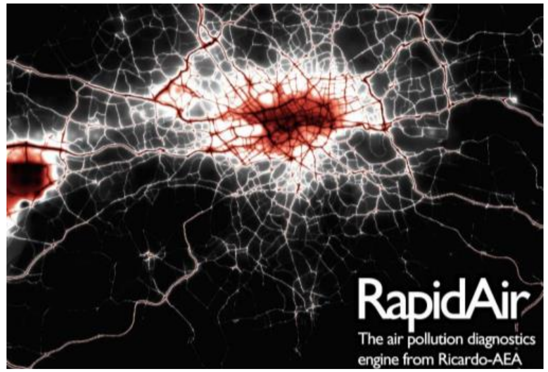
# Modelling an £X/day discounted to £Y/day for Residents

- +£X/2 toll for non-compliant vehicles on all inbound links entering the CAZ
- Simple home-based pairs
  - Internal-to-Internal: +£Y to the 2-way car cost in the demand model
  - Internal-to-External: +£Y - £X/2 to the 2-way car cost in the demand model
  - External-to-Internal: +£X/2 to the 2-way car cost in demand model
  - External-to-External: No charge (just the inbound cordon tolls)
- 1-way trips From-Home (eg parts of triangles):
  - From Internal to anywhere:  +£Y/2 in the demand model
  - From External to anywhere: No charge in the demand model
- 1-way To-Home
  - Internal-to-internal: +£Y/2
  - External-to-Internal: £Y/2 - £X/2
  - External-to-External: No charge
- Non-Home-Based trips: No charge



# Difficulties/Challenges Cont’d

- Keeping emissions modelling up to date
- Air Quality/Dispersal Modelling, including other sources of $NO_2$
  - Background/transboundary
  - Ports & Docks
  - Power stations/incinerators/big chemical plants etc
- How to quantify the costs (and benefits) of changes to the Do_Something fleet
  - Earlier-than-BaU purchase – simple present-value discounting?
  - Younger-than-BaU purchase (Costs more but a ‘better’ model)
  - Relationship between trip frequency and vehicle renewal decision
  - Costs & benefits of petrol vs diesel vs new technology
  - Impact on 2nd-hand value of non-compliant vehicles
  - Costs & uptake of scrappage schemes
- How to incorporate ‘public acceptability’ into the appraisal



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# SYSTRA'S ENEVAL /EVA Tools

- **ENEVAL** uses Emissions Factors Toolkit values to estimate traffic emissions on a link-by-link basis, including the option to separate queuing at junctions from the link-based emissions
- Ability to use local base-year fleet data as the starting point for the future-year fleet emission profiles

- **EVA** imports vehicle emissions rates from ENEVAL, network flows (by compliant and non-compliant) and allows the user to specify a revised %compliant split (by road type and vehicle type)




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# Tasks Completed (Sheffield & Rotherham)

- Air Quality Monitoring Data Time Series Analysis to scale of the problem at known locations
- 1 year's worth of ANPR data at 11 camera clusters used to determine:
  - Local fleet profiles – significantly different from national average
  - %CAZ-Compliant by vehicle type and location
  - Frequency Distribution of Sightings (Days per Year) by vehicle type and location
- Baseline and Business as Usual Emissions Modelling Completed
- 'Cartoon' tests of various potential measures completed

# ANPR Data – Trip Frequency Analysis

**Distribution of Annual Fleet (by vehicle type and trip frequency) - all ANPR Clusters Combined**

| Trip Frequency | BUSES & COACHES | CARS Ordinary | CARS Special | GOODS - HEAVY (ARTIC) | GOODS - HEAVY (RIGID) | GOODS - LIGHT | All Vehicles |
|---|---|---|---|---|---|---|---|
| Low (<1 per month) | 63% | 74% | 32% | 87% | 77% | 76% | 74% |
| LM (<1 per week) | 22% | 20% | 25% | 11% | 18% | 19% | 19% |
| MH (1 <= x < 2 per week) | 8% | 4% | 18% | 1% | 3% | 4% | 4% |
| High (>2 per week) | 7% | 3% | 25% | 1% | 2% | 2% | 3% |

**Distribution of Daily Fleet (by vehicle type and trip frequency) - all ANPR Clusters Combined**

| Trip Frequency | BUSES & COACHES | CARS Ordinary | CARS Special | GOODS - HEAVY (ARTIC) | GOODS - HEAVY (RIGID) | GOODS - LIGHT | All Vehicles |
|---|---|---|---|---|---|---|---|
| Low (<1 per month) | 7% | 16% | 2% | 36% | 19% | 19% | 16% |
| LM (<1 per week) | 20% | 33% | 10% | 36% | 36% | 37% | 33% |
| MH (1 <= x < 2 per week) | 22% | 22% | 21% | 15% | 22% | 22% | 22% |
| High (>2 per week) | 50% | 29% | 67% | 14% | 23% | 22% | 30% |

# Conclusions from the ANPR Analysis

**LGVs are a lot less compliant with the typical CAZ categories than HGVs**

**Articulated HGVs tend to make fewer regular trips through specific locations than LGVs and smaller HGVs**

**Private hire cars and car-based taxis are a lot less compliant that average cars and make a lot more regular trips**

**The proportion of vehicles which might upgrade in response to a CAZ varies significantly by location**

**In particular, motorways and strategic routes involve a high proportion of infrequent trips, making these less likely to upgrade in response to a local CAZ – typically less than 1 in 4 vehicles are both currently-non-compliant and 'regular'**

# Outstanding Tasks (Sheffield & Rotherham)

- Agreeing likelihood of vehicle upgrades based on trip frequency and level of the charge (and amount of financial support?)
- Identifying Charging Cordons that solve the current AQ problems without creating any new ones
- Identifying the most effective/cost-effective charging regime

# Concluding Remarks

- Existing models good at the mode and destination and rerouting responses, but less able to cope with vehicle replacement
- Do we need to disaggregate the vehicle owner/driver responses by income ?
- Detailed design of the CAZ boundaries likely to be tricky
- Additional research into vehicle replacement (behaviour and appraisal) would be useful
- In particular, how will the vehicle fleet in a given area (petrol/diesel/electric/hybrid) vary over time in the Business-as-Usual and Do Something scenarios?

# Questions/Discussion

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