



Ricardo  
Energy & Environment

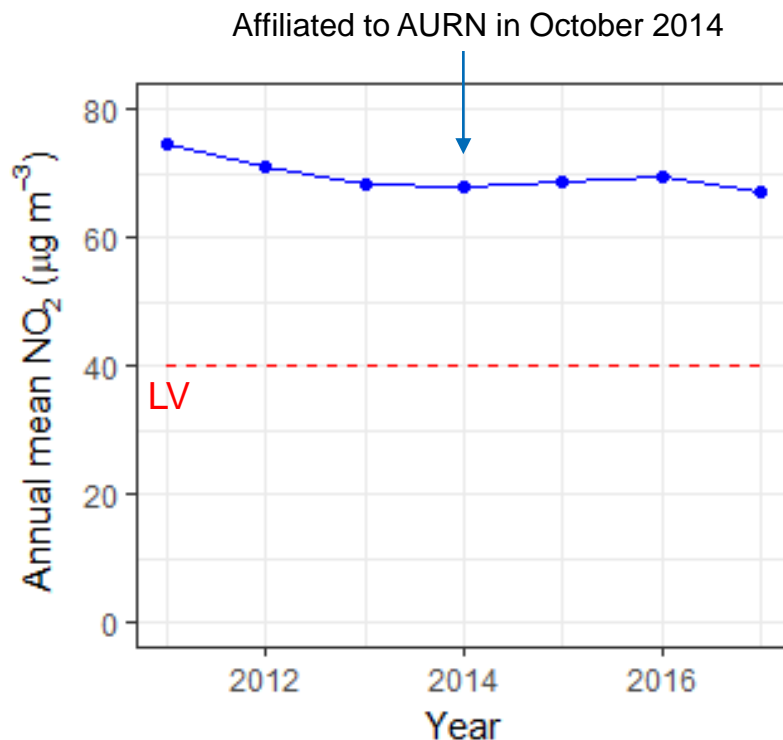
## Vehicle Emissions Remote Sensing

Preliminary results from Measurements on  
A472 Hafod Road

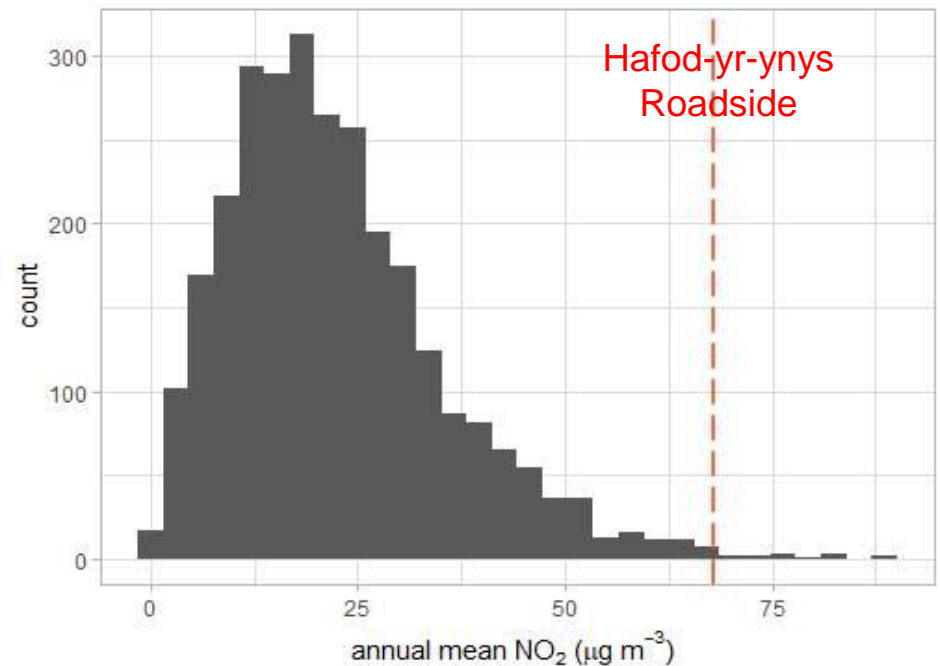
Rebecca Rose  
WAQF, 12<sup>th</sup> October 2017

# Hafod-yr-ynys Roadside monitoring station

- Annual mean concentration of NO<sub>2</sub> is one of the highest in UK and in the top 0.5% of sites across Europe
- High number of exceedances of the hourly limit value for NO<sub>2</sub> of 200 µg m<sup>-3</sup>
  - 18 allowed exceedances, 126 in 2016 and already 95 in 2017



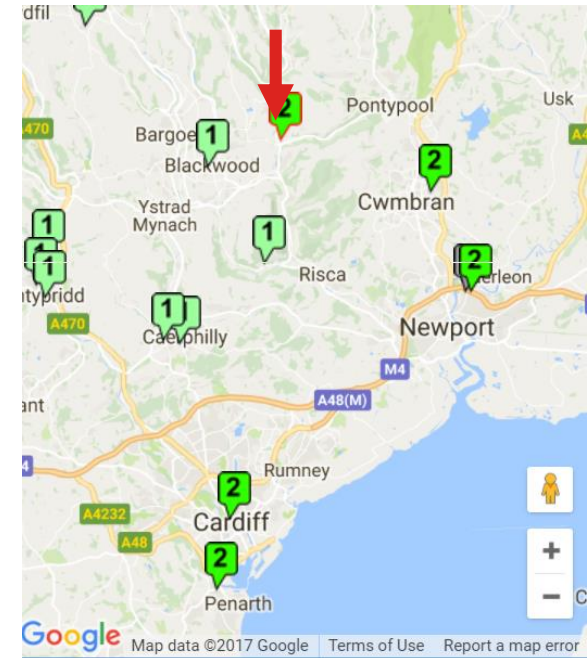
2015 annual mean NO<sub>2</sub> concentration from sites across Europe



# Hafod-yr-ynys Roadside monitoring station

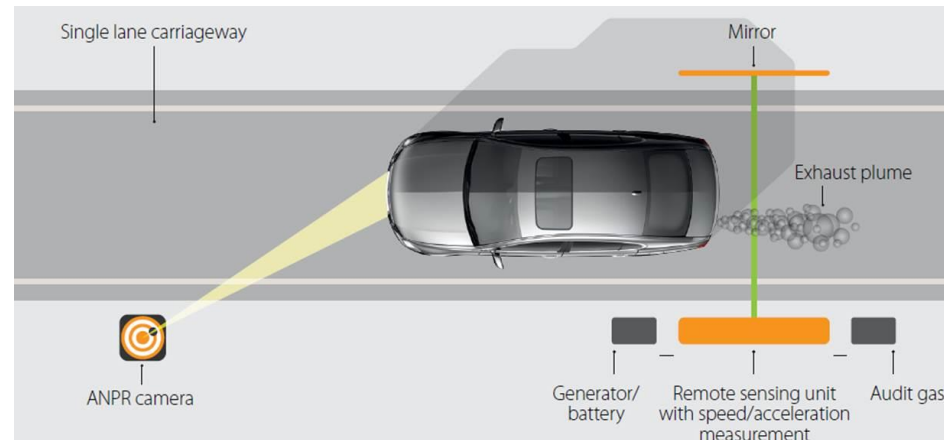
- Monitoring station is located on the roadside of A472 Hafod Road
- Row of houses on one side and wall on the side form a street canyon
- Road has significant gradient so vehicles require additional power to travel up the road
- Congested with a high volume of traffic

Aim to use remote sensing measurements to provide further insight to understand the high levels of pollution recorded at the monitoring study in a one week trial.



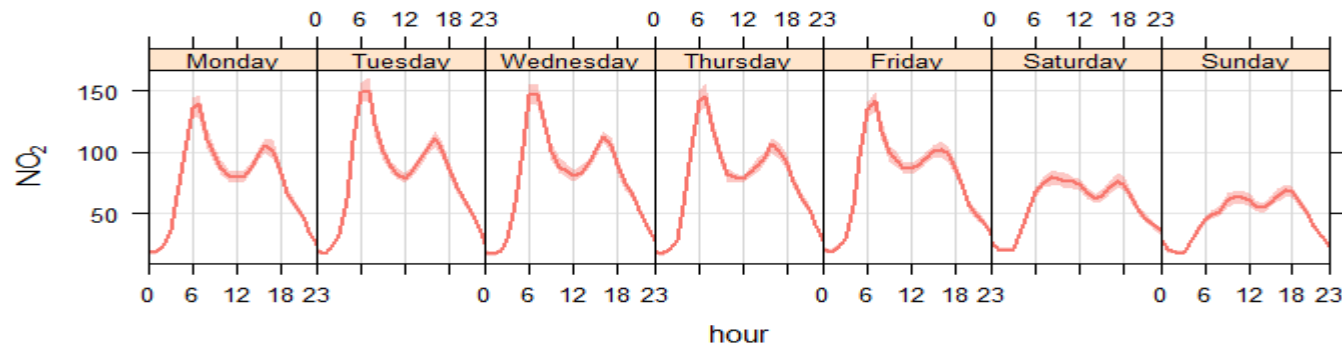
# Vehicle Emission Remote Sensing

- We have been trialling remote sensing for 6 months
- The technique:
  - UV/Infrared beam to measure emissions – different gases absorb in different wavelength regions
  - Measure 1000s of vehicles in a day
  - Provide ‘real’ real world emissions data (literally don’t need to touch the vehicle being measured)
  - Measure NO, NO<sub>2</sub> (hence NO<sub>x</sub>), CO, HC, PM and NH<sub>3</sub>
  - Provides fuel-based emission factors e.g. g NO<sub>x</sub> per kg fuel
- Photograph each vehicle to obtain number plate
  - Detailed cross reference with SMMT-derived databases...more than 80 vehicle characteristics, down to the colour of the vehicle!
  - Will soon add MOT mileage data and quantify vehicle degradation effects on emissions systems



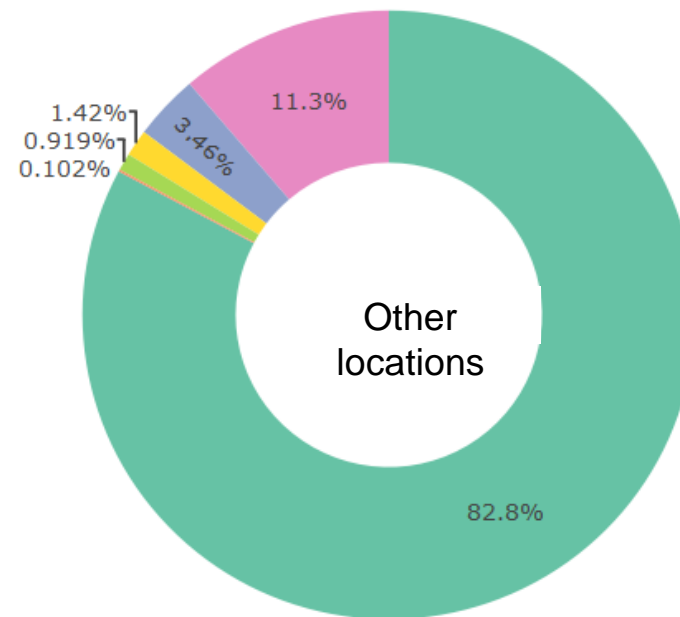
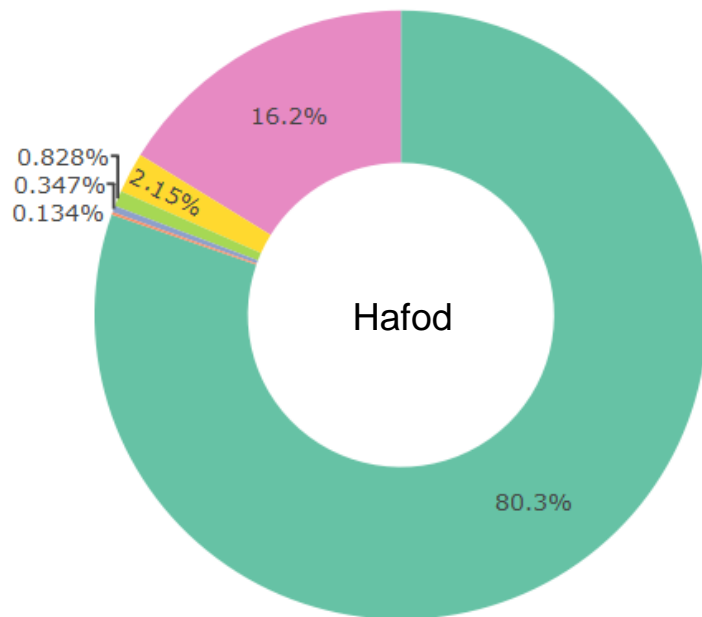
# Vehicle emissions remote sensing – Hafod measurements

- Measurements made over a 5 day period Monday 11<sup>th</sup> – Friday 15<sup>th</sup> September
- Instrument located a few 100 m down the road from Hafod-yr-ynys Roadside monitoring station (due to setup, parking and safety requirements)
- Measurements made between 6 am and 6 pm corresponding to peak traffic flow and highest emissions



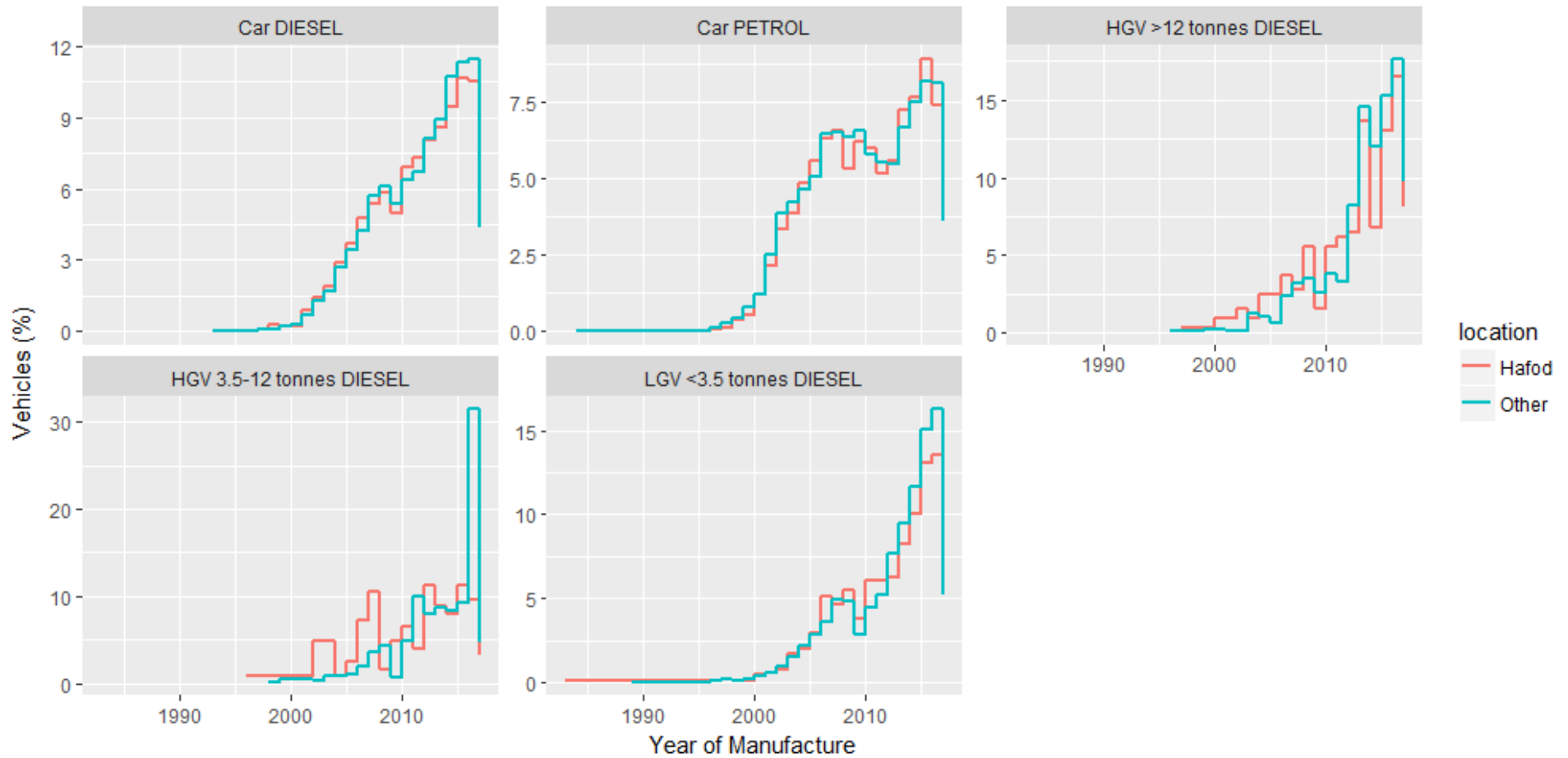
Average NO<sub>2</sub> measurements at Hafod-yr-ynys Roadside by day and time 2014-2017

- ~15,000 vehicle measurements, adding to a database of ~80,000 vehicle measurements from locations across the UK
- Results are presented providing an insight into the fleet and vehicle emissions at this location, comparison is made to measurements at other UK locations
- All results presented are provisional and subject to change



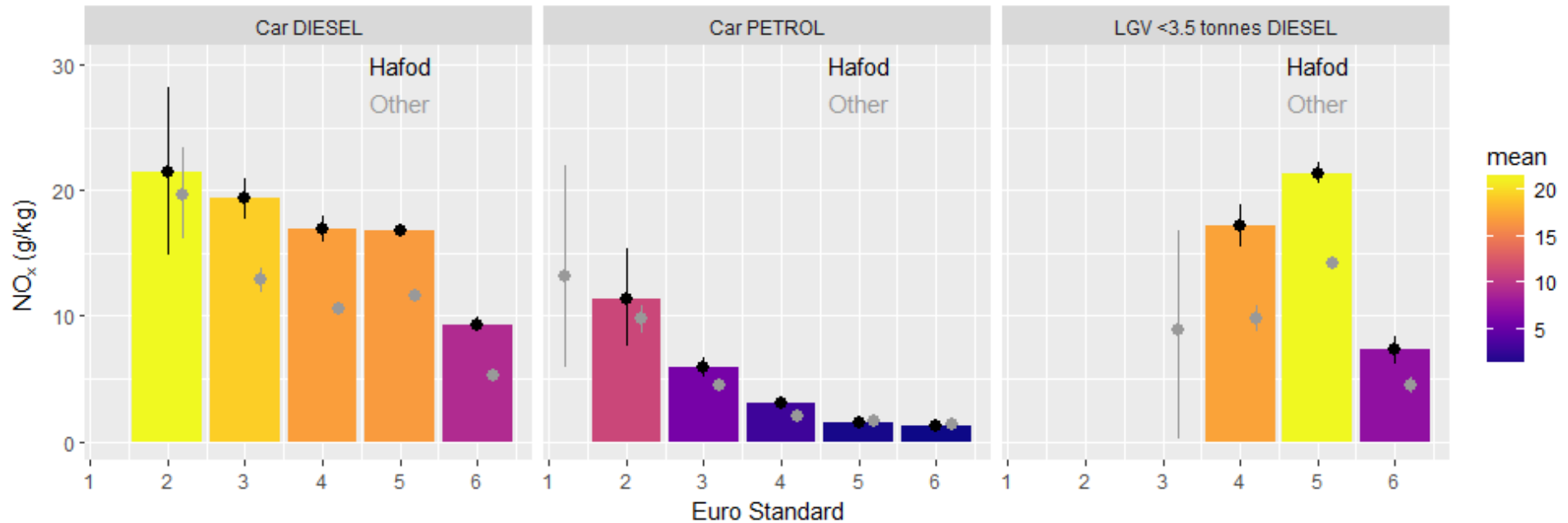
- Photographs of vehicle number plates matched to vehicles properties provides fleet info
- Fleet is dominated by cars (close to 50:50 diesel/petrol split)
- Higher proportion of vehicles are LGVs and HGVs at Hafod than at other locations
- Smaller proportion of buses
- Note that a small proportion of number plates are not captured by camera and this may impact on the fleet mix

# Fleet age



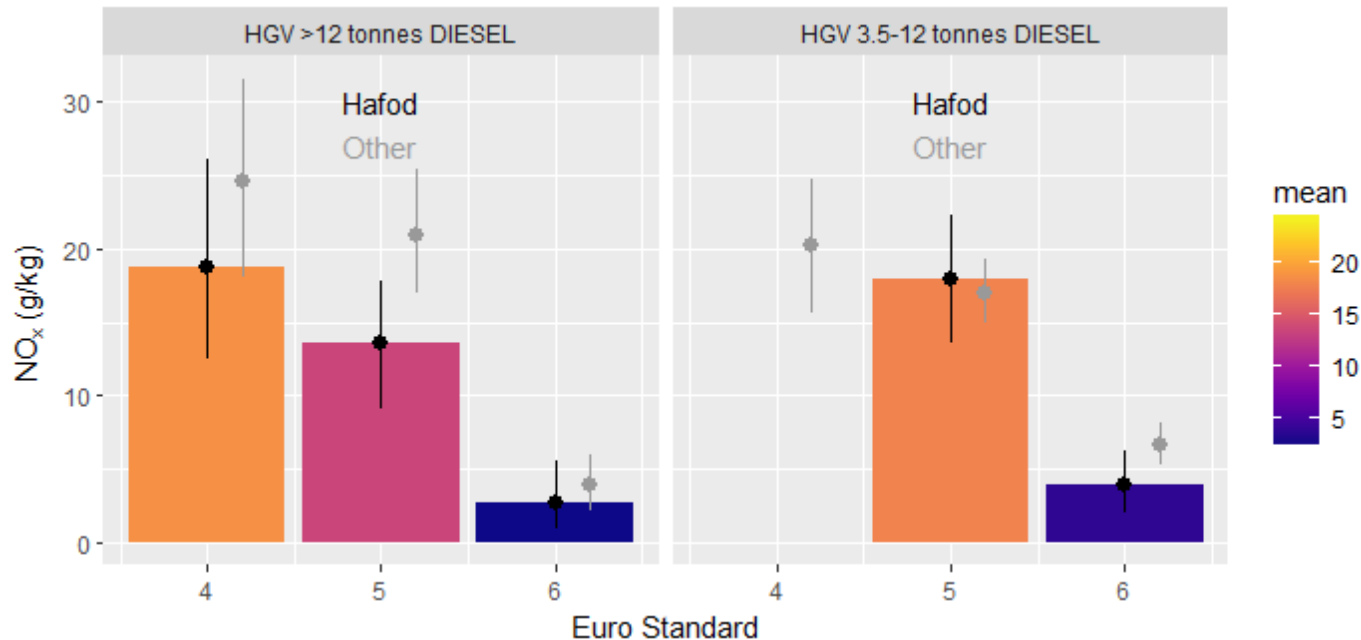
- Generally the fleet age distribution is similar to that recorded at other locations
- Higher proportion of older HGVs and LGVs in Hafod

# NO<sub>x</sub> emission – light vehicles



- Measured NO<sub>x</sub> emissions in g NO<sub>x</sub> per kg fuel
- Results presented by Euro standard and require > 10 vehicle/euro standard category
- Little change in NO<sub>x</sub> emissions up to Euro 5, significant signs of improvement for Euro 6
- Evidence that diesel vehicles have **higher** NO<sub>x</sub> emissions per kg fuel at Hafod location than at other locations measured e.g ~40% higher for Euro 6 diesel cars

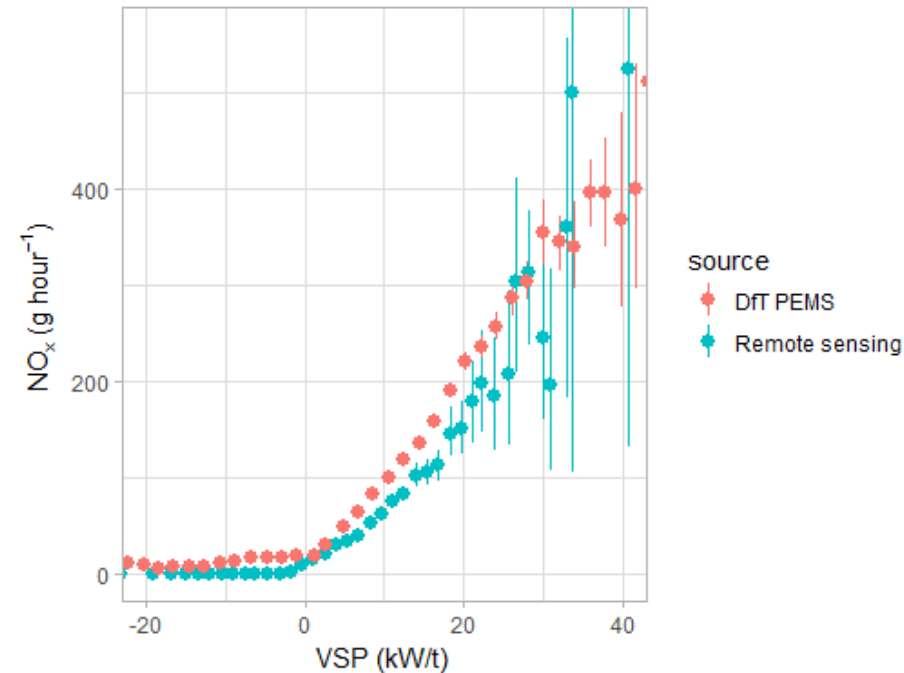




- Measured NO<sub>x</sub> emissions in g NO<sub>x</sub> per kg fuel
- Results presented by Euro standard and require > 10 vehicle/euro standard category
- NO<sub>x</sub> emissions for Euro 6 vehicles are significantly lower than for earlier Euro standards
- Evidence of **similar** NO<sub>x</sub> emissions per kg fuel at Hafod location compared to other locations measured

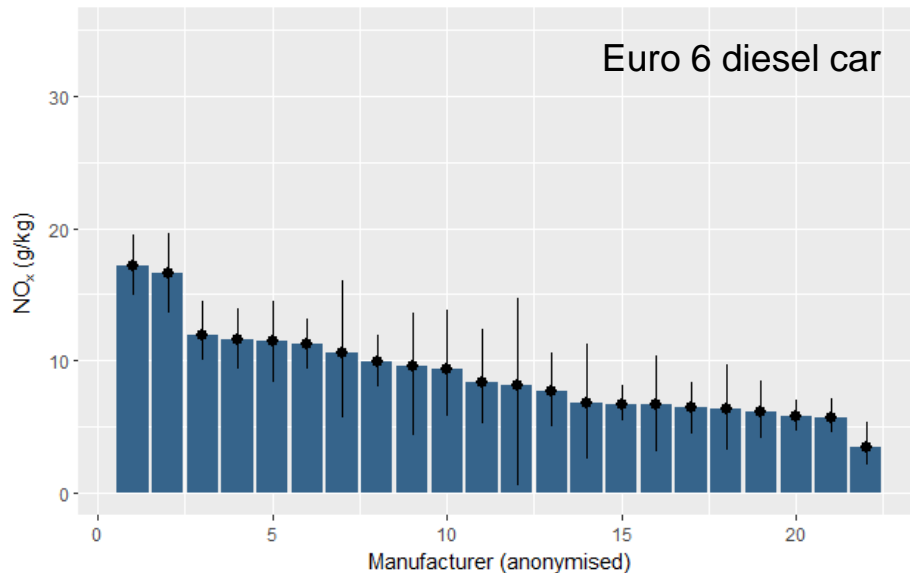
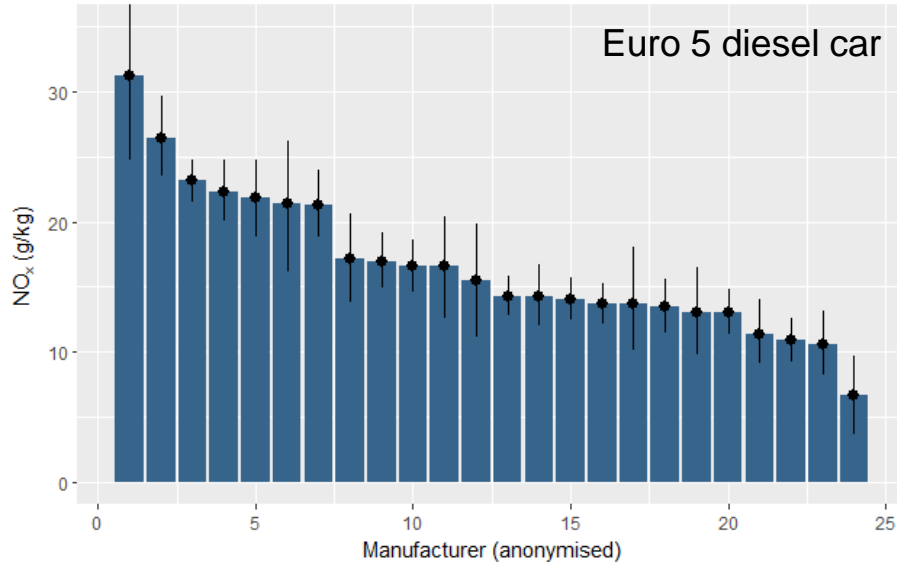
## Link with emission factors and inventories

- Results presented are in units  $\text{g NO}_x$  per kg fuel
- Emission factors for inventories use units g per km
- Work is underway to convert remote sensing outputs to emission factors in g/km
- Fuel use depends on vehicle specific power (VSP):
  - Function of **road gradient** (among other things)
- For Hafod Road, the slope is  $\sim 6\%$ , therefore power demand of vehicle and fuel use will be high
- Therefore expect emission factors in g/km to be **higher** at Hafod than at other locations we have measured with lower gradients



[Plot provided by D. Carslaw, based on previous Remote sensing measurements in London and PEMS measurements by DfT]

# Emissions by manufacturer



- With higher numbers of measurements we can delve further into the data to extract more detailed information e.g. split by manufacturer.
- NO<sub>x</sub> emissions from vehicles made by different manufacturers vary by up to factor of 4
- The best Euro 5 vehicles are better than the worst Euro 6 vehicles
- 95% confidence intervals for Euro 6 diesel cars indicate less confidence in emissions by manufacturer compared to Euro 5 vehicles because a lower proportion of the fleet is Euro 6

## Summary and conclusions

- Undertook a one week study to measure real world vehicle emissions on A472 Hafod Road
- ~15,000 measurements recorded, adding to a database of ~80,000 vehicle measurements from locations across the UK
- Reductions in emissions of NO<sub>x</sub> for Euro 6 vehicles compared to previous Euro standards are significant
- For light vehicles emissions at Hafod will be high for two reasons:
  - Evidence that emissions of NO<sub>x</sub> (in g NO<sub>x</sub> per kg fuel) from light vehicles are higher at Hafod than at other locations across the UK
  - Significant road gradient means that vehicle emission factors in g/km will be high compared to roads with little gradient (work to quantify this is underway)
- For heavy duty vehicles the road gradient means that vehicle emission factors in g/km will be high compared to roads with little gradient
- High emission factors, high traffic volumes and street canyon effects will all contribute to high concentrations of NO<sub>2</sub>

- Development of g/km emission factors for detailed vehicle categories that could be used for sensitivity analysis of current inventory emissions factors (NO<sub>x</sub>, NO<sub>2</sub> etc.)
- Using data in more innovative ways
  - Combine local fleet data (e.g. ANPR survey data) with real world emission factors from remote sensing in local models
- Linking MOT mileage data to give an understanding of deterioration effects – is current technology going to continue to work in the future?
- Increasing sample size of newest Euro 6 diesel vehicles (RDE)
- Working with OPUS and ICCT to take 100,000 measurements in London (plus measurements in Paris and Berlin)

# And for more information...



... on emerging evidence from our measurements, see our vehicle emissions monitoring blog:

<https://ee.ricardo.com/transport/vehicle-emissions-monitoring>

The screenshot shows the Ricardo Energy & Environment website. At the top left is the Ricardo logo. The navigation menu includes: About us, Market sectors, Services, Investors, News and media, Contact us, Careers, and eStore. A search icon is on the right. Below the navigation is a blue button labeled "Login/Register". A secondary menu lists: Air quality, Climate change, Energy, Environment, Transport (highlighted with a green underline), Waste, Water, Sustainable business, and Downloads. The main content area features a large image of a car wheel and a road with the text "Vehicle emissions monitoring". Below the image is a breadcrumb trail: Home page / Transport / Vehicle emissions monitoring.

Helping you to understand real-world driving emissions and the environmental impacts

### Related news



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