THE REAL URBAN EMISSIONS INITIATIVE

Real-world emissions from passenger vehicles using remote sensing

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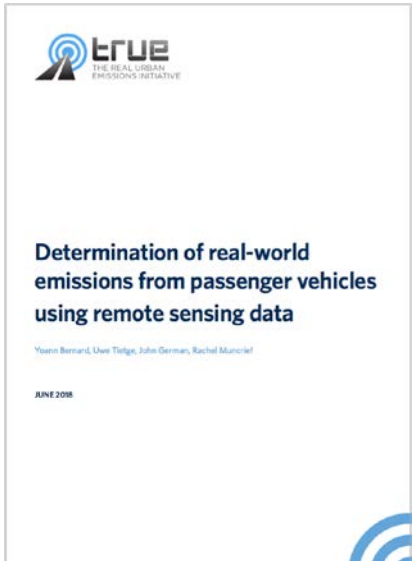
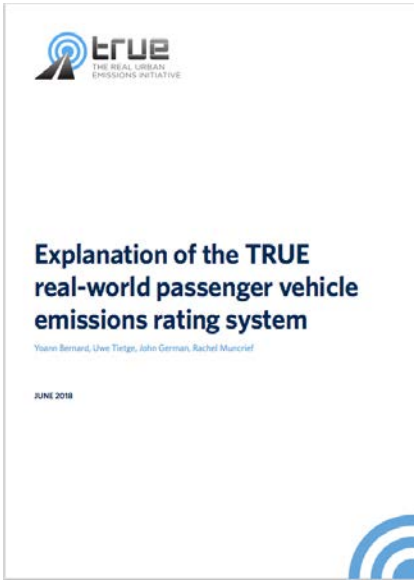
Two recent TRUE publications on remote sensing

- Can we use remote sensing data to quantify the real world emissions of individual vehicle models?



Link: www.trueinitiative.org/data/publications/determination-of-real-world-emissions-from-passenger-vehicles-using- remote-sensing-data

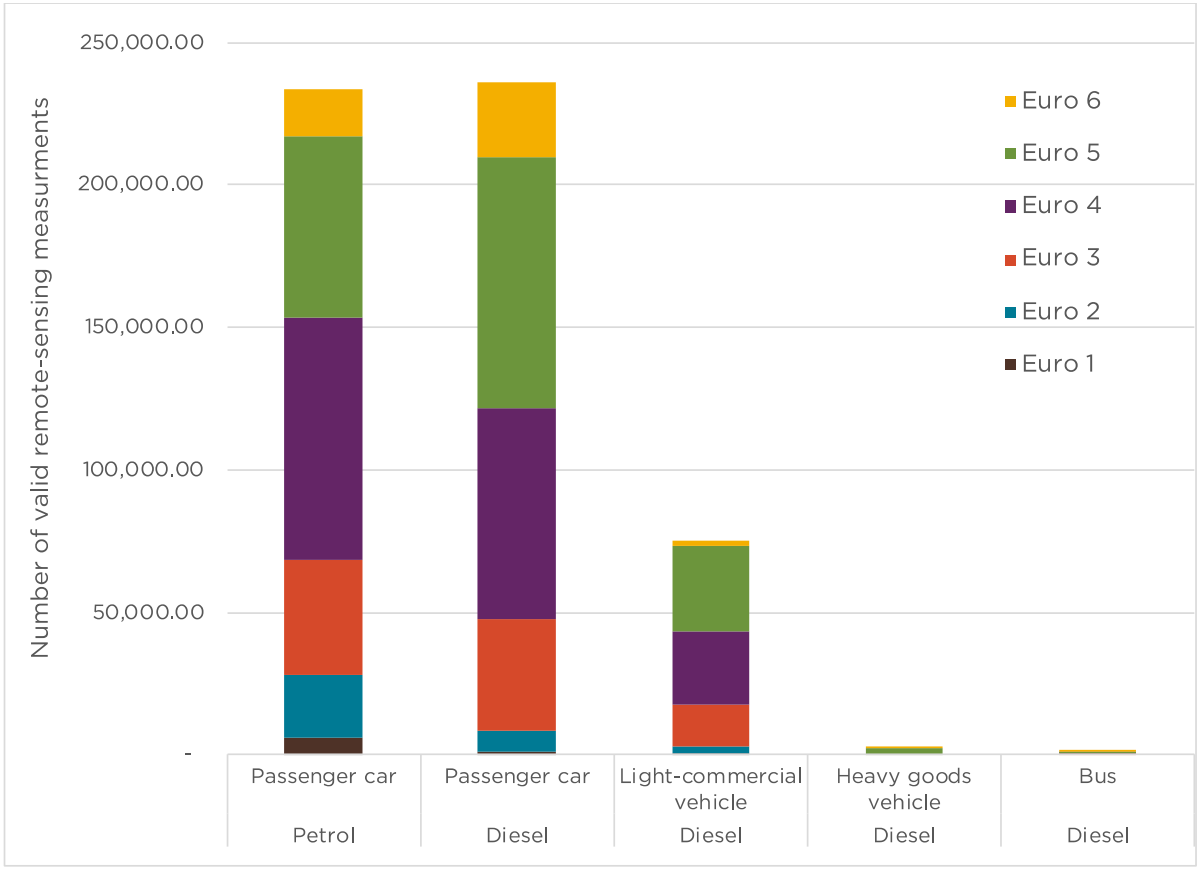
- How can we use remote sensing data to inform the public about their vehicle's real world emissions?



Link: www.trueinitiative.org/data/publications/explanation-of-the-true-rating-scheme

All data is based on the “CONOX” remote sensing database

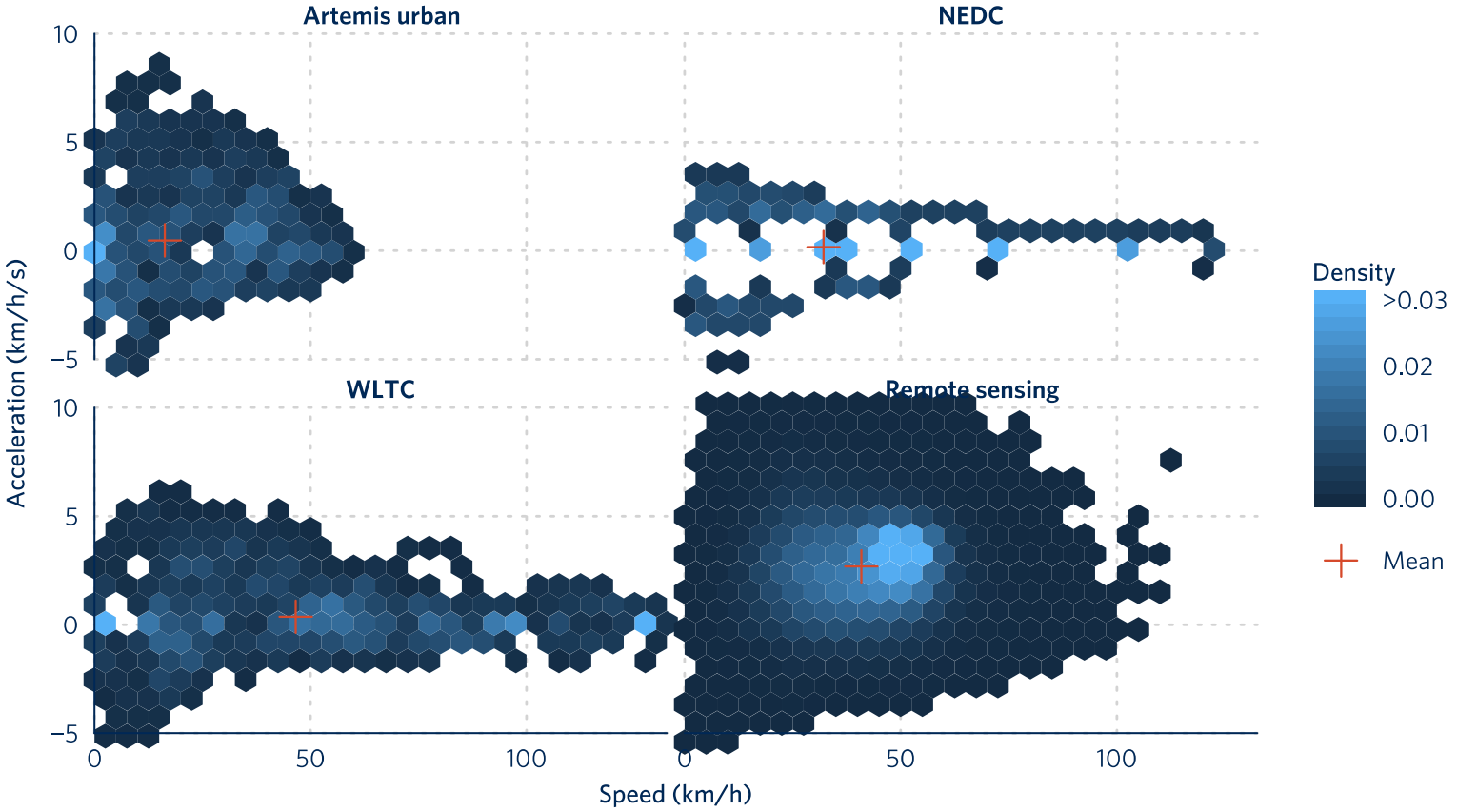
- Remote sensing data from around Europe taken over the last ~5 years was pooled together to create a database of over 700,000 records



How well does remote sensing data represent the real world?

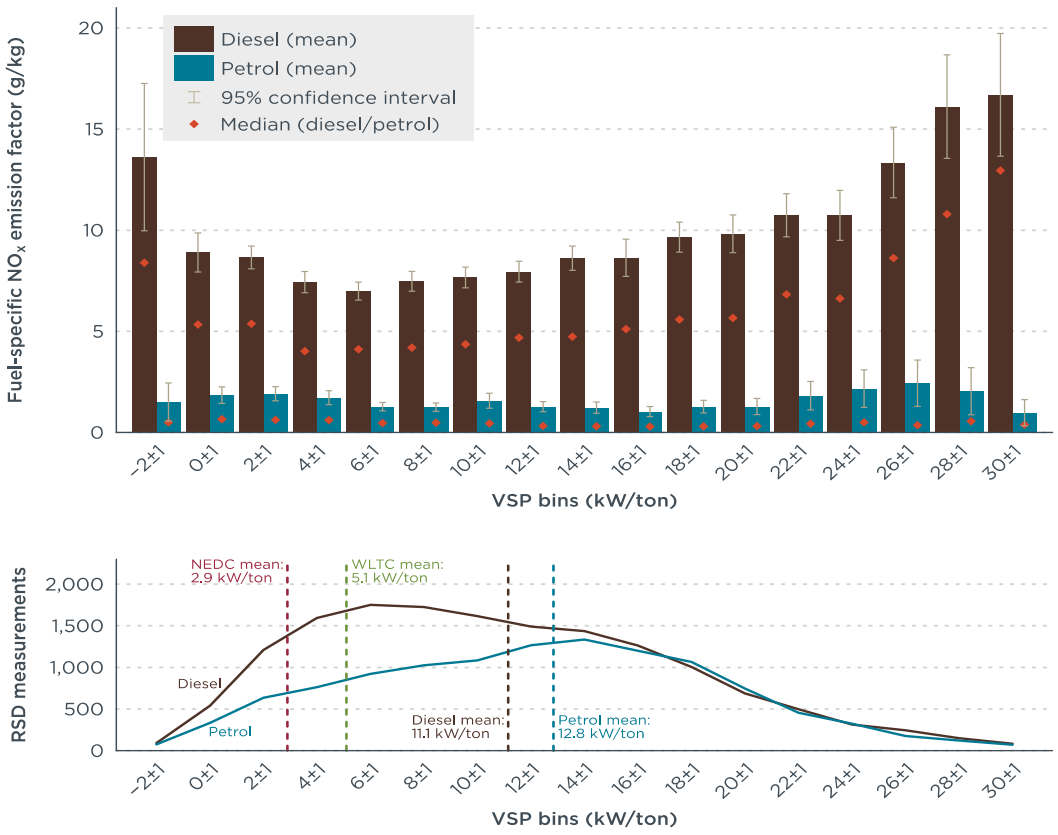
Remote sensing data show a wider range of driving conditions than typical laboratory test cycles

- Comparison of speed versus acceleration over different cycles and for remote sensing measurements.



Vehicle specific power (VSP*) influences real world NOx emissions, especially for diesel cars

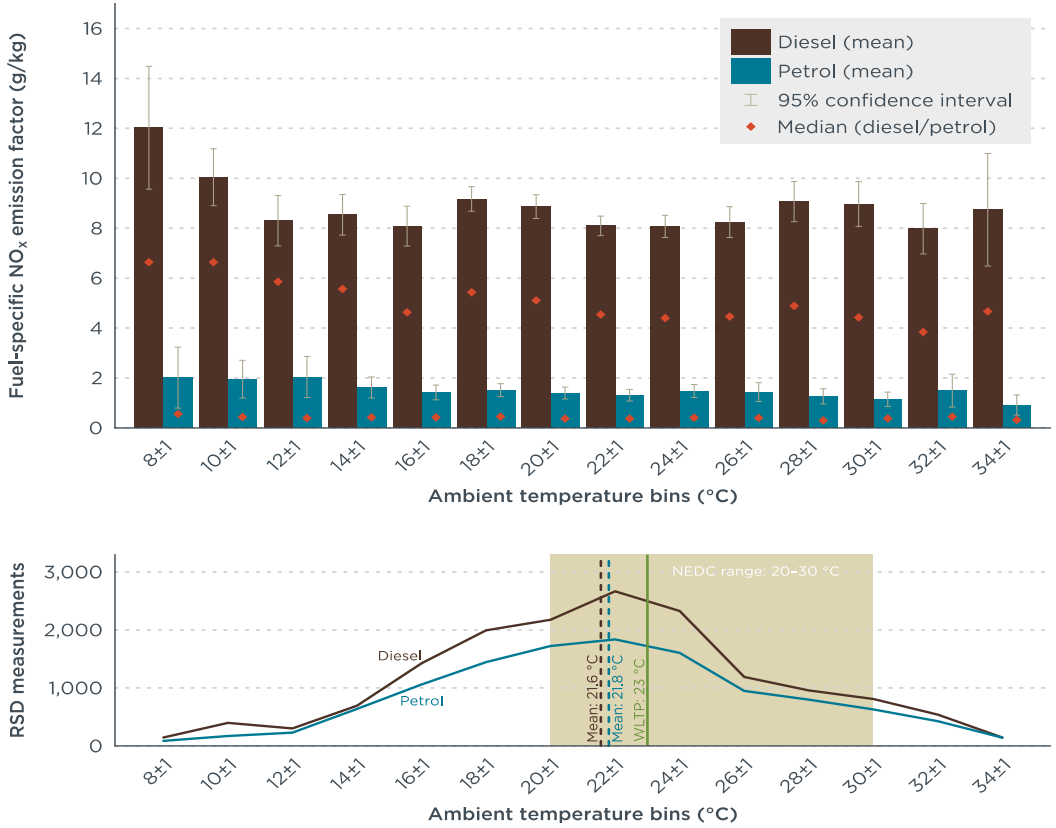
- Top figure shows average NOx emissions vs VSP for petrol and diesel Euro 6 cars
- Bottom figure indicates the number of samples for each VSP we had available in our database



**VSP can be thought of as a surrogate for the power demand*

Low ambient temperature influences real world NOx emissions

- Top figure shows average NOx emissions vs ambient temperature for petrol and diesel Euro 6 cars
- Bottom figure indicates the number of samples for each ambient temperature we had available in our database



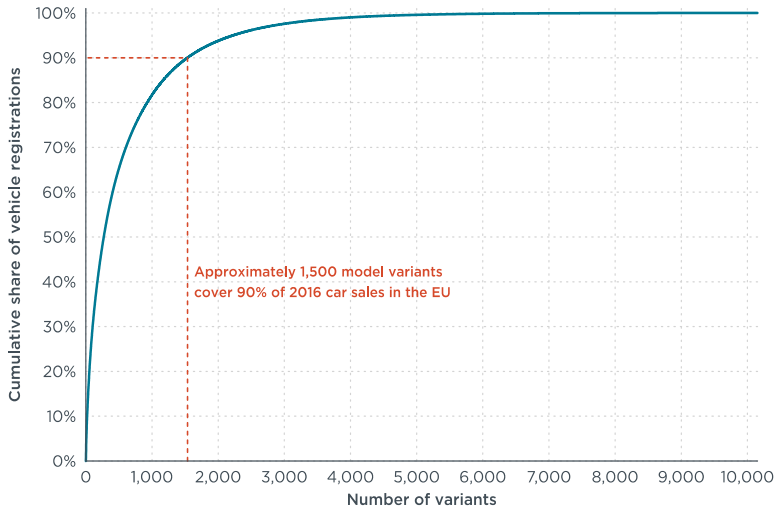
Grouping vehicles for remote sensing analysis

For grouping vehicles – we balance vehicle characteristics and data quantity available

10,000 Different "variants" sold in 2016

1,500 90 percentile of sales

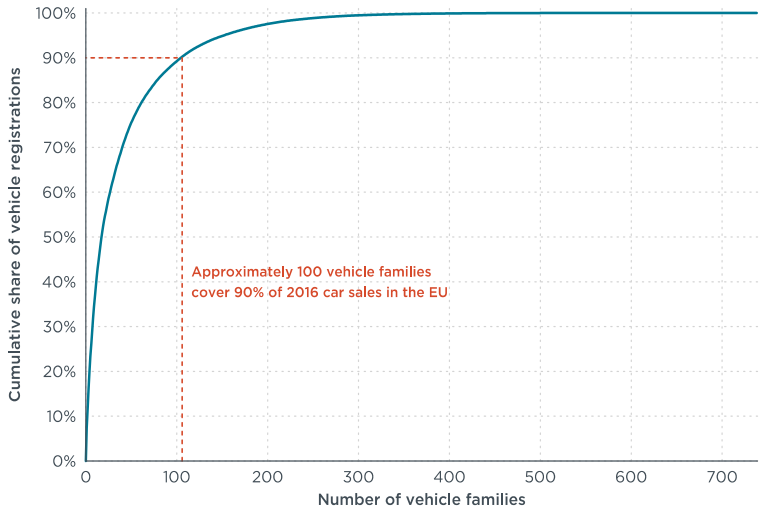
- Fuel type
- Manufacturer
- Model name
- Engine displacement
- Power rating
- Transmission
- Driven wheels
- Euro standard



700 Different "families" sold in 2016

100 90 percentile of sales

- Fuel type
- Manufacturer group
- Engine displacement
- Euro standard



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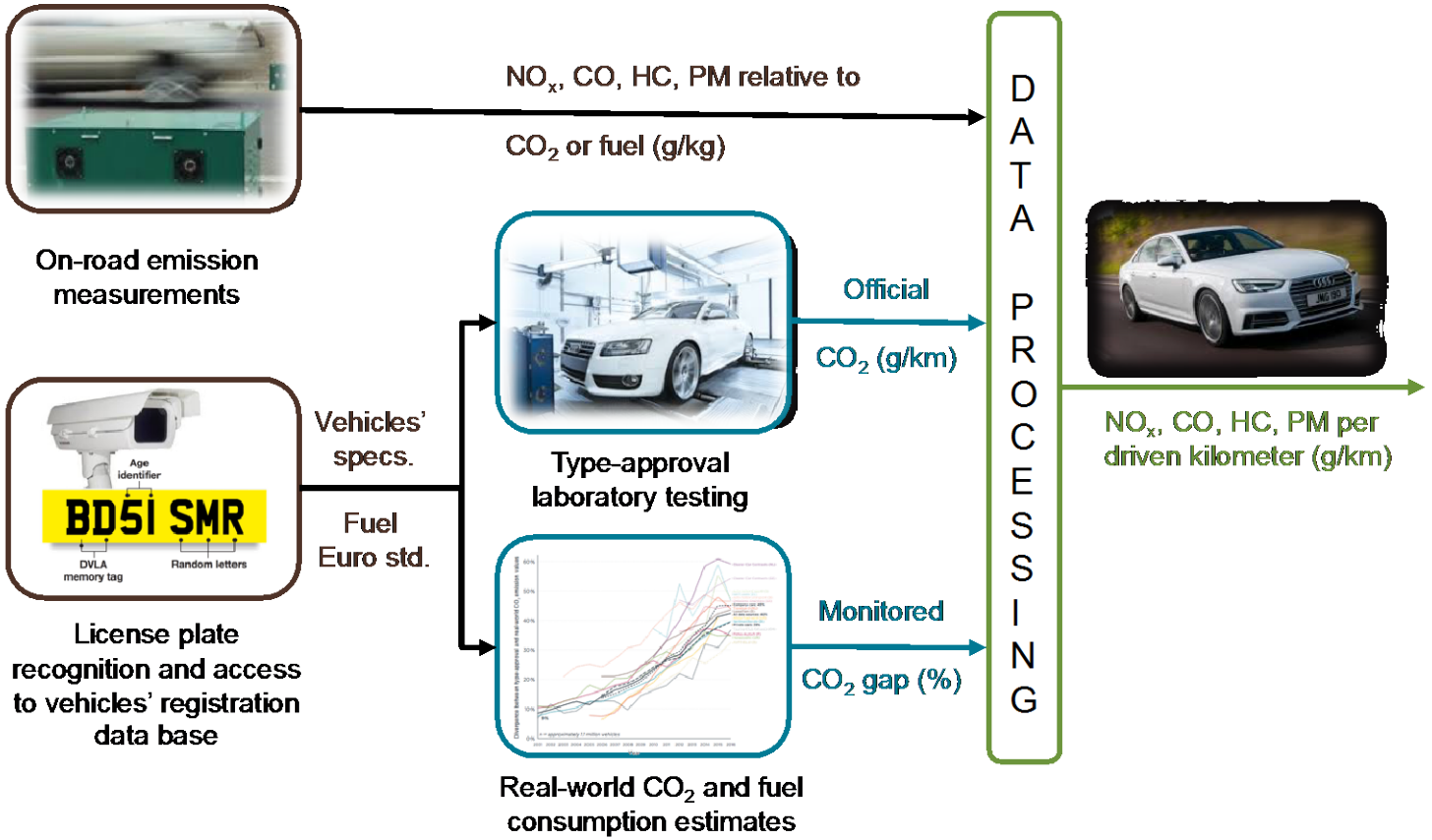
For certain vehicle groupings we can convert the data to a distance based metric

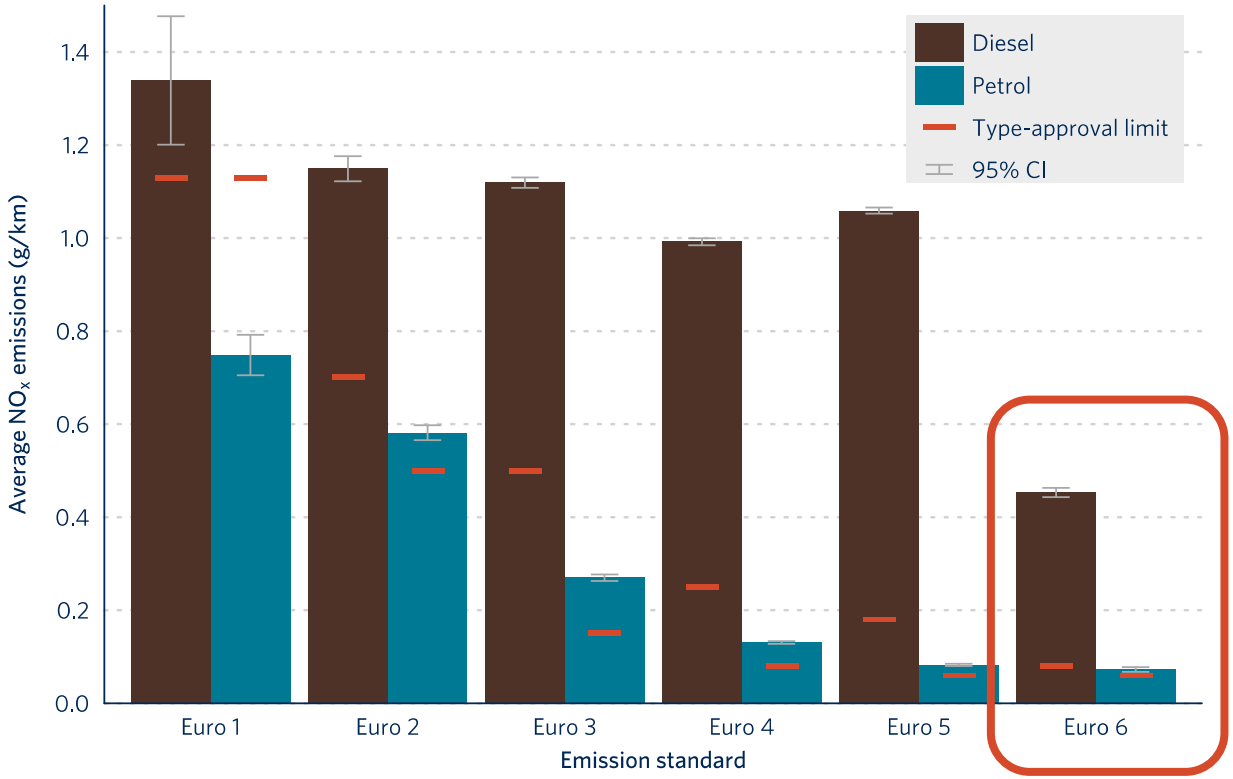
- g(pollutant)/km is the metric that is most widely used when discussing vehicle emissions



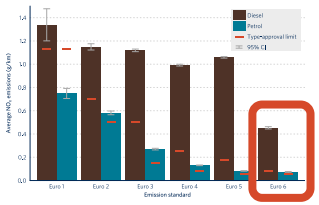
Results by more and more granular groupings

Differentiate the fleet by emissions standard and fuel type

- Quantity of remote sensing records necessary →thousands

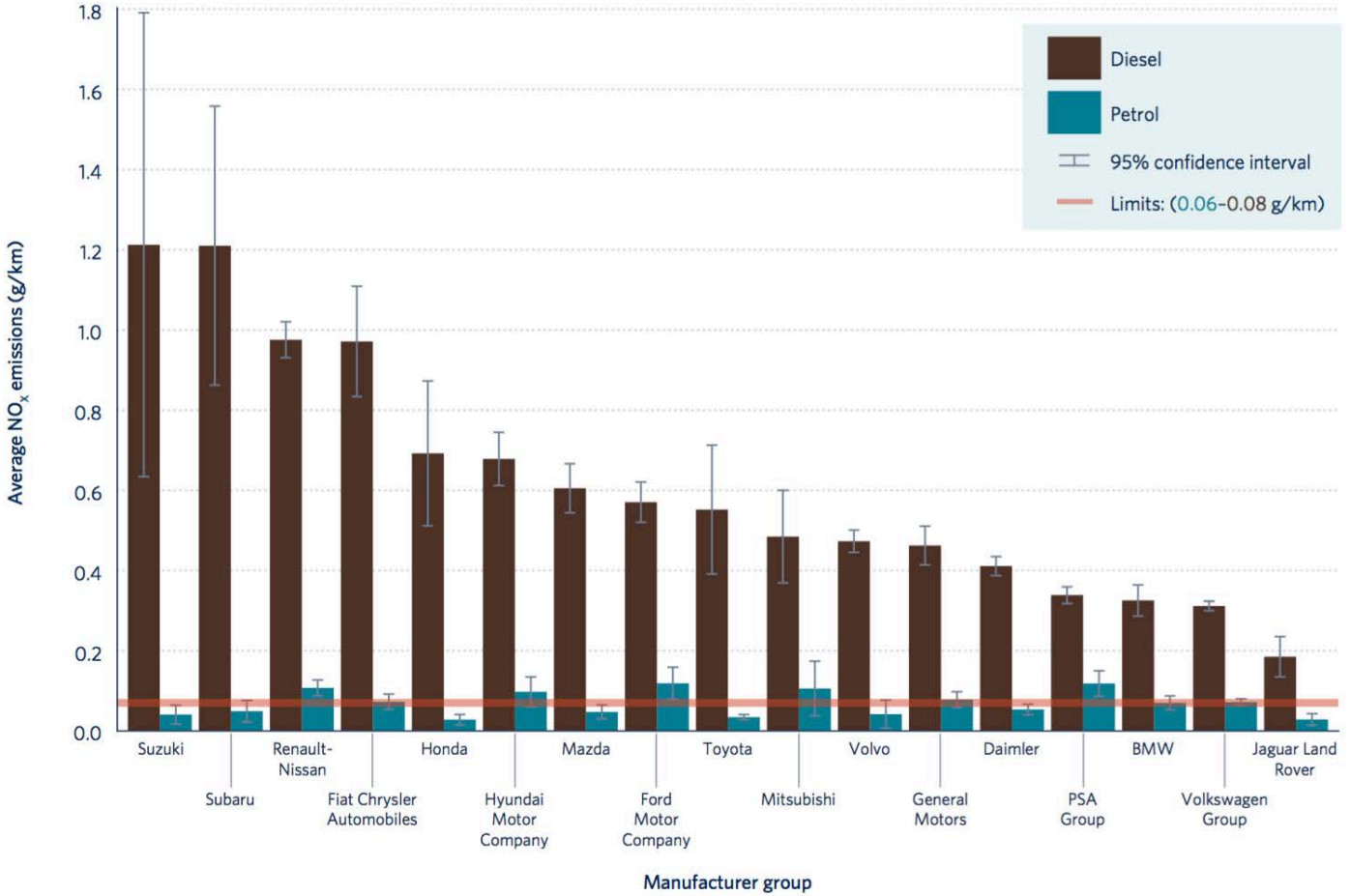


Differentiate the fleet by emissions standard, fuel type, and manufacturer group

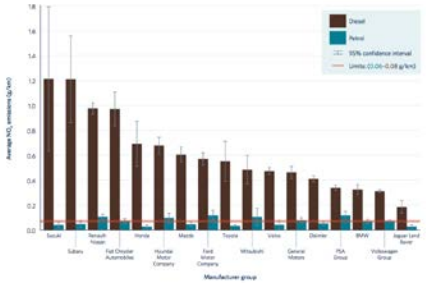


- Quantity of remote sensing records necessary

  →tens of thousands

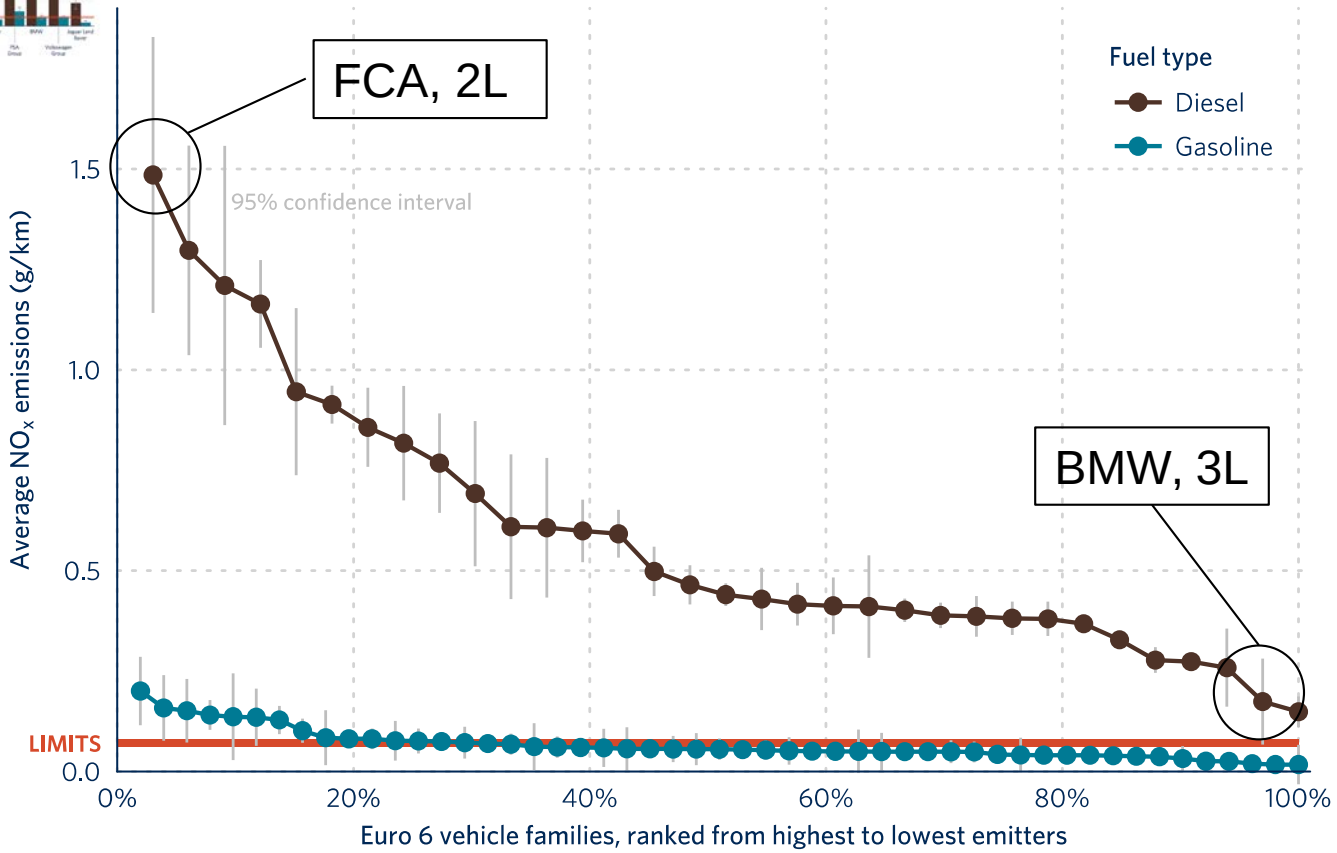


Differentiate the fleet by emissions standard, fuel type, and manufacturer group, and engine displacement



- Quantity of remote sensing records necessary

  →hundreds of thousands



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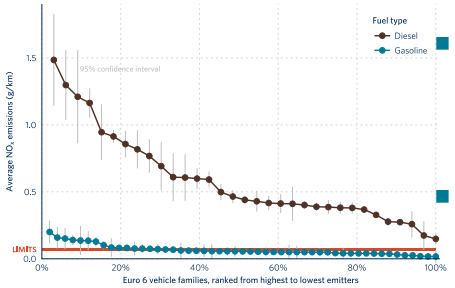
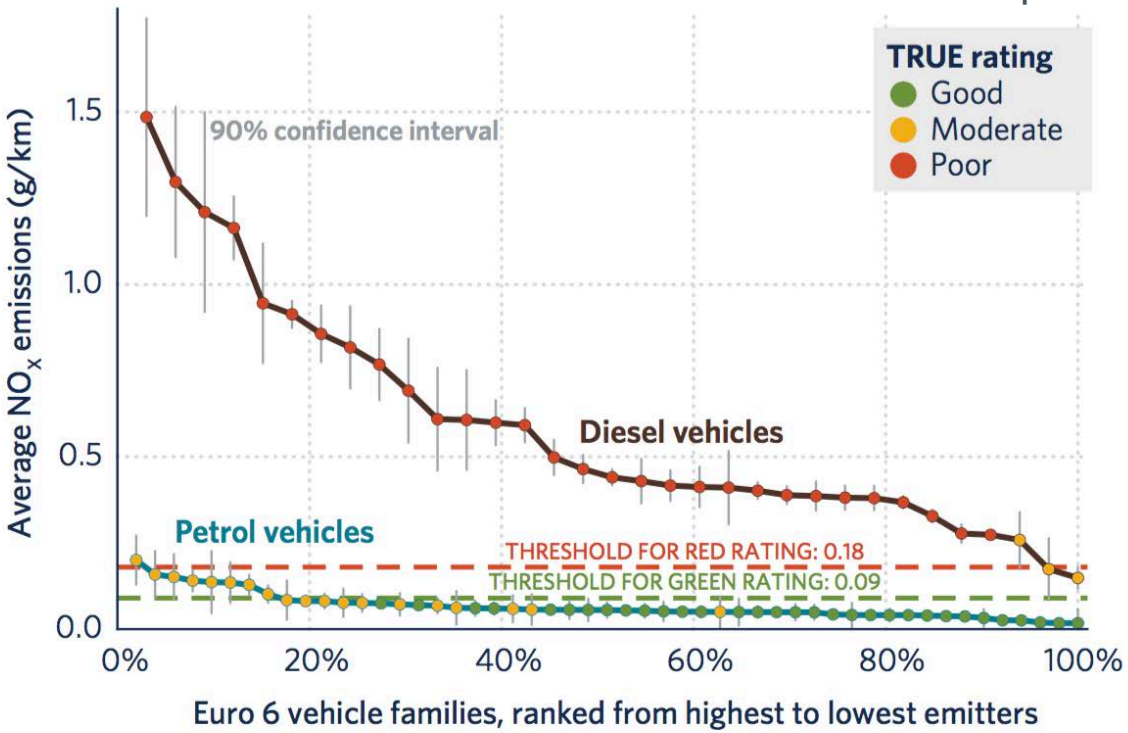
Making a rating scheme

A green, yellow, red vehicle NOx rating system was developed



Green rated vehicles are those with real world emissions in line with the most stringent EU standards

Red vehicles are those with real world emissions over emissions standards that have been in place since 2009



<90 mgNOx/km

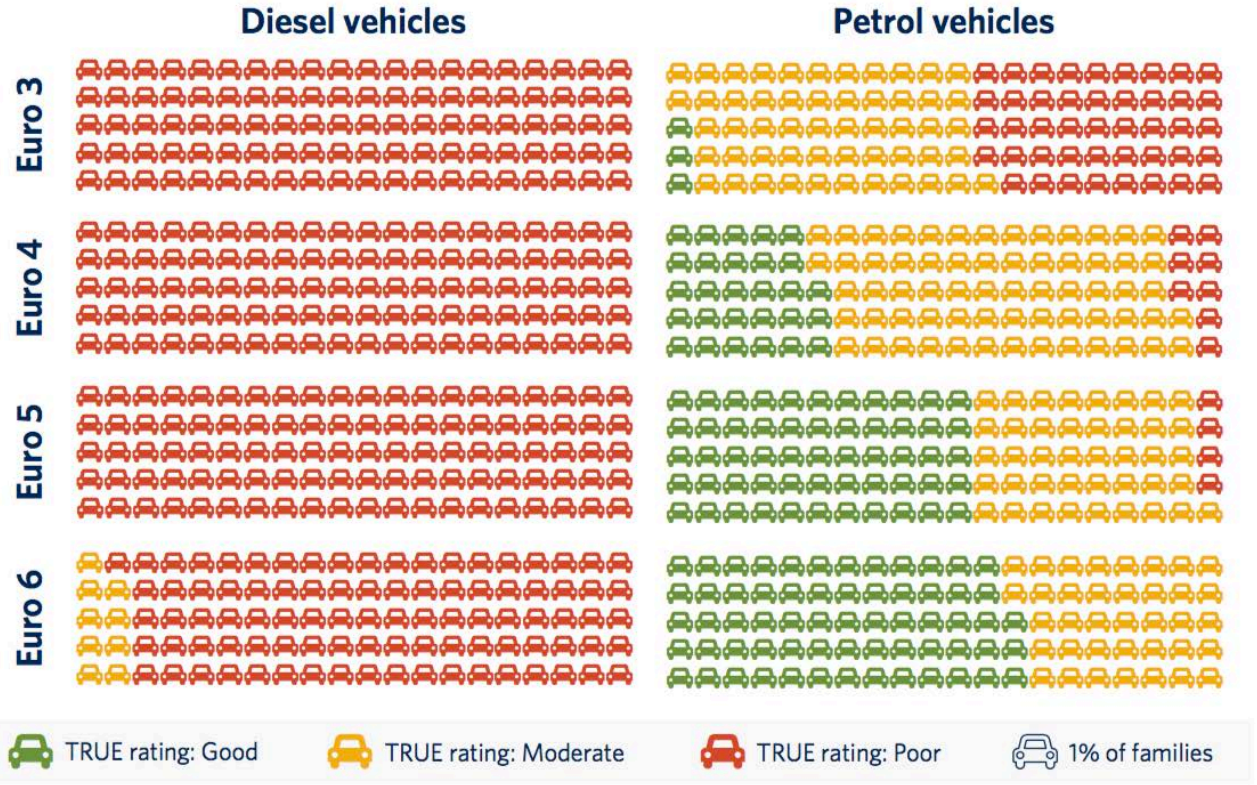
90-180 mgNOx/km

>180 mgNOx/km

Yellow rating: vehicles that we are confident emit between 90 and 180 mg/km of NOx in a wide range of driving conditions, as well as vehicles that do not clearly fall into green or red rating bin.

NOx ratings for diesel vehicles are mostly red – even on the newest vehicles measured

- This figure shows nearly all diesels (except for 10% of Euro 6) on European roads today received a “poor” rating. Conversely, no Euro 6 petrol vehicles received a poor rating.
- The ratings are subject to change as the latest data is incorporated



Recent testing in London

An additional ~100K remote sensing records were recently taken in London

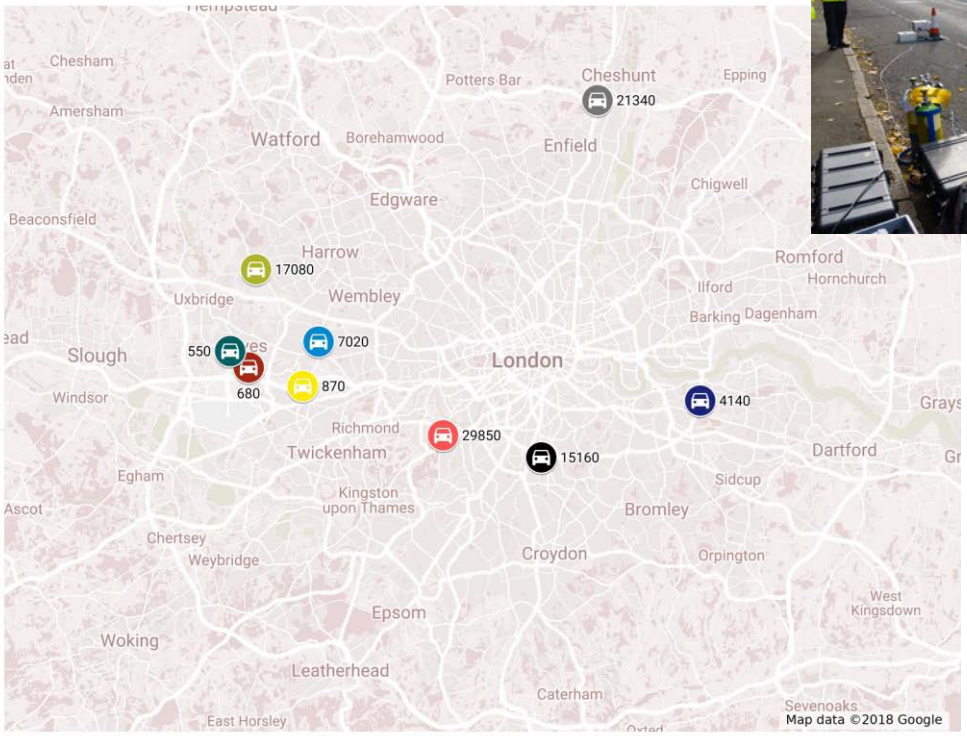
- Sampling from Nov. 2017 through March 2018
- 9 sampling sites in Greater London

London remote sensing sites

Site name

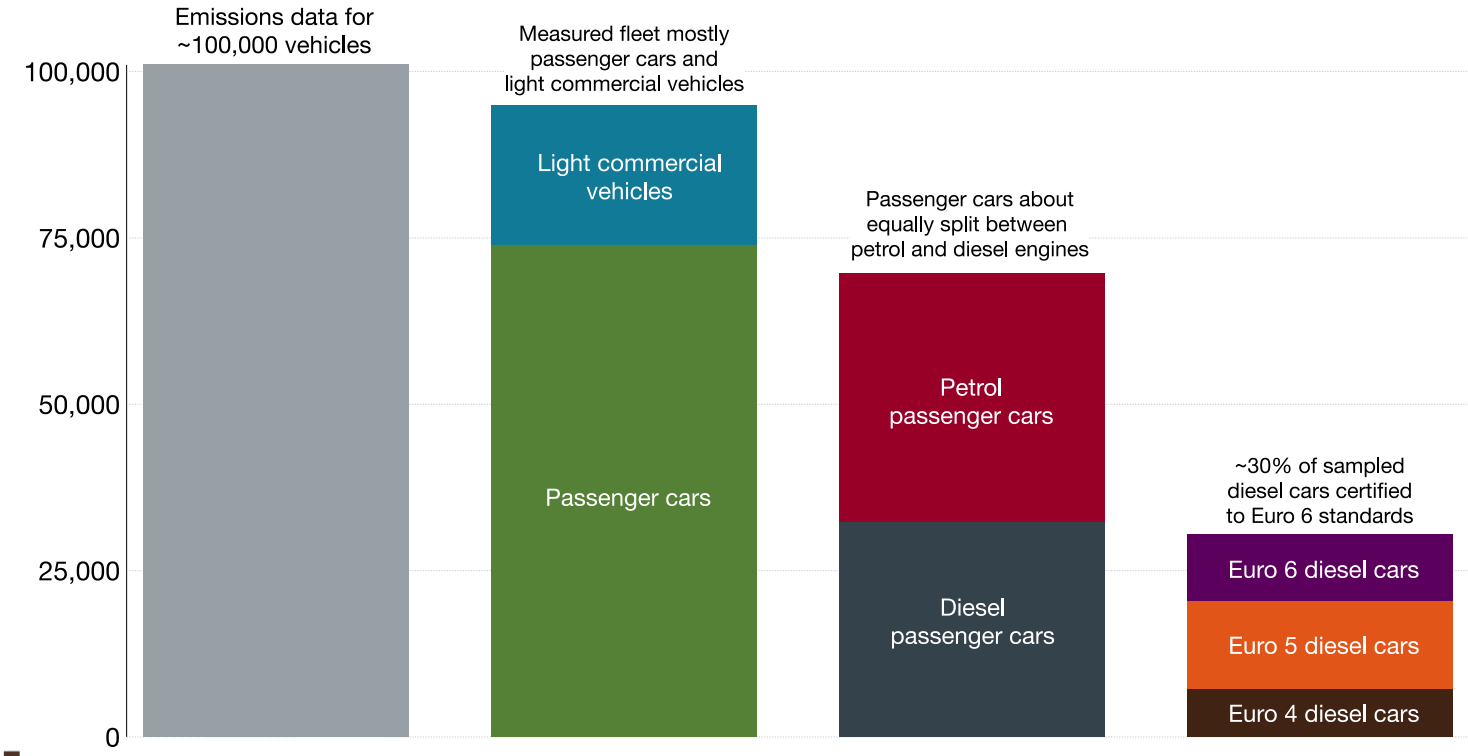
- Greenford Rd., Ealing
- Dawley Rd., Hillingdon
- West End Rd., Hillingdon
- Stockley Rd., West Drayton
- A10/M25 Junction
- Heston Rd., Hounslow
- A205 S. Circular/Circular Way
- A205 S. Circular Christchurch Rd./Hillsdale Rd.
- Putney Hill, Wandsworth

Sampling locations for the TRUE London vehicle remote sensing measurement campaign (November 2017 to March 2018). Data labels indicate number of valid measurements at each site.



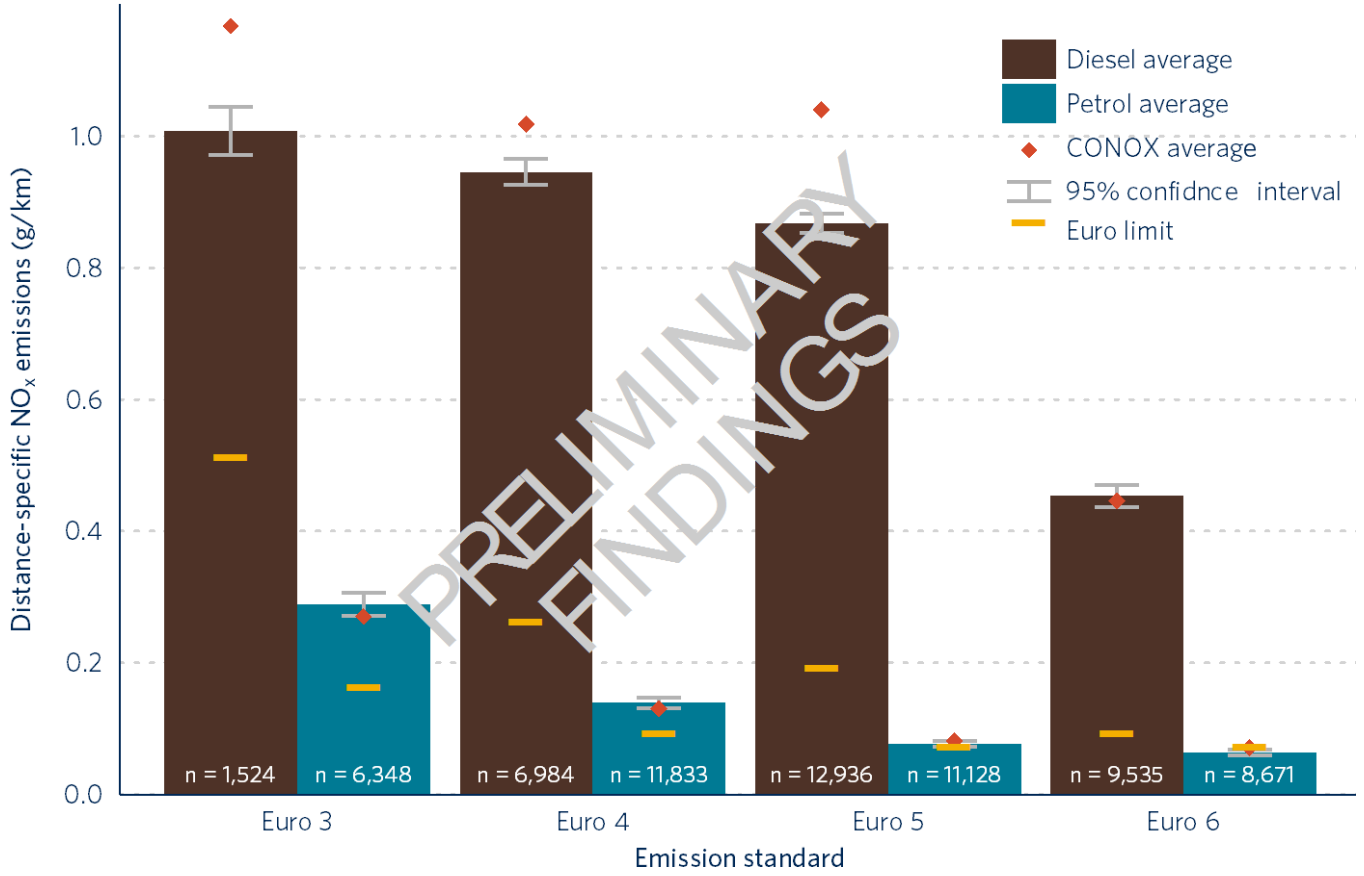
A diverse range of vehicle types was captured during the London testing campaign

- Petrol and diesel passenger cars accounted for the majority of vehicles, but we also captured emissions data from light commercial vehicles (vans), as well as trucks, buses, and motorcycles



Initial results show average emissions of the newest vehicles is in line with our previous findings

- We will be conducting extensive analysis of this data and will publish the findings



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Thank you

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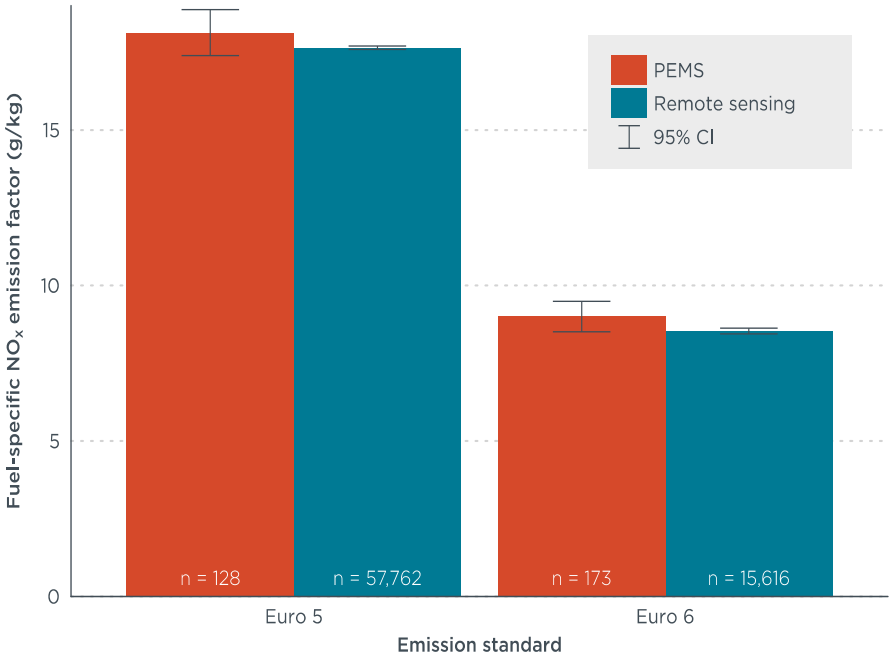
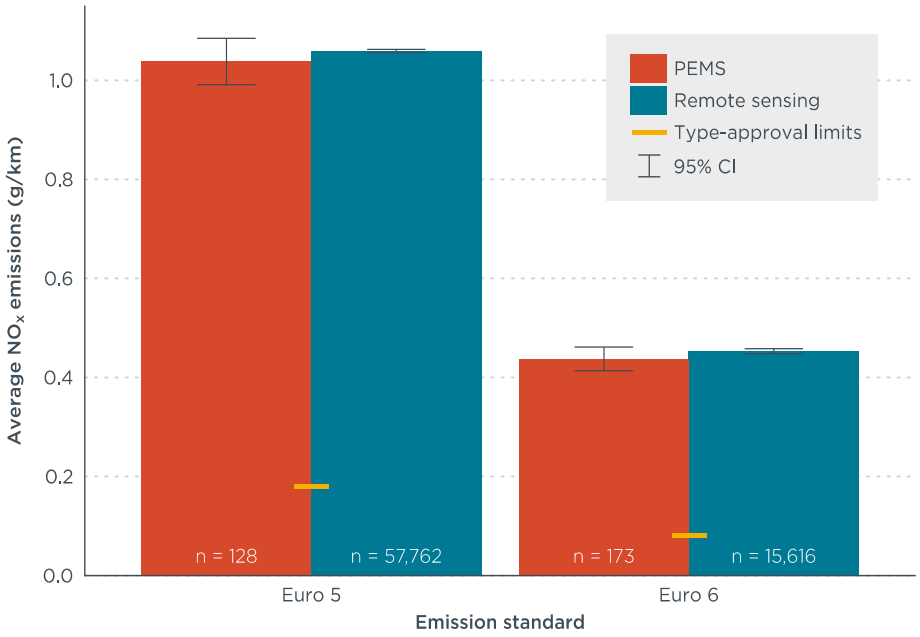
extra

Comparison of vehicle families with both PEMS and remote sensing measurements

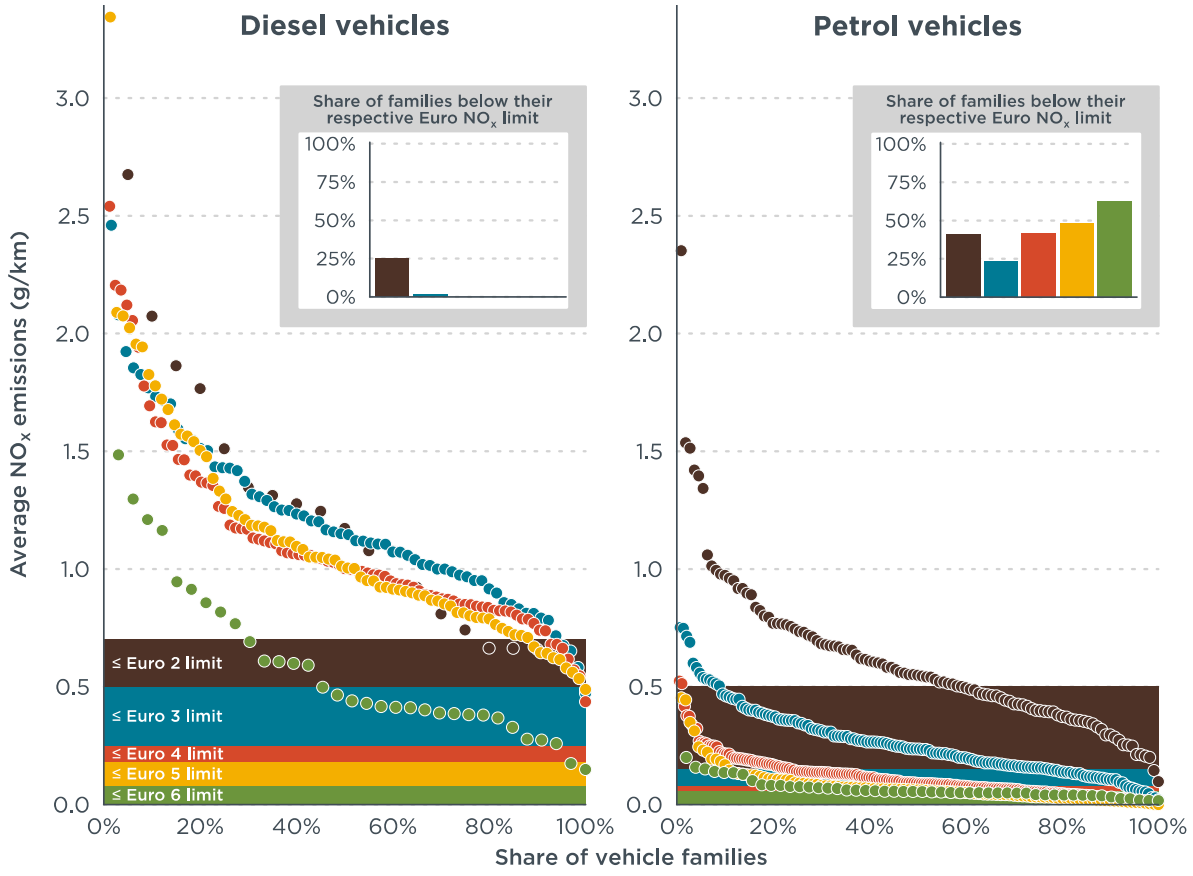


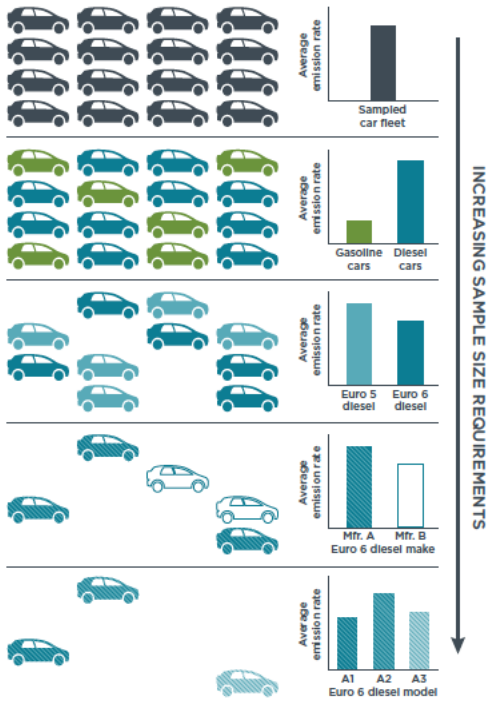


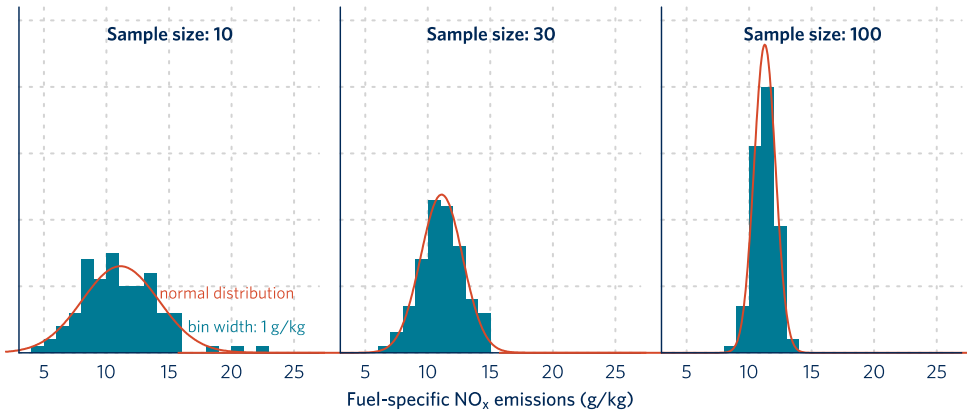
$$pollutant\left(\frac{g}{km}\right) = mean\left(\frac{pollutant\ (g)}{fuel\ (kg)}\right) \times \frac{fuel\ (kg)}{CO_2\ (g)} \times mean\ CO_2\left(\frac{g}{km}\right) \times (1 + CO_2\ gap\ (\%))$$

Fuel-specific emission factors (g/kg fuel) converted to distance-specific emission rates (g/km) using type-approval CO2 value, adjusted for real-world emissions gap

Results by vehicle family and their respective Euro standard




Average emission rate
Sampled car fleet
Gasoline cars
Diesel cars
Euro 5 diesel
Euro 6 diesel
Mfr. A
Mfr. B
Euro 6 diesel make
A1
A2
A3
Euro 6 diesel model
INCREASING SAMPLE SIZE REQUIREMENTS


Sample size: 10
Sample size: 30
Sample size: 100
normal distribution
bin width: 1 g/kg
5
10
15
20
25
Fuel-specific NO_x emissions (g/kg)