Large-scale remote sensing testing in four cities in Scotland 2021– 2023: Key findings

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International Council on Clean Transportation (ICCT)

NCTCOG Heavy-Duty Diesel Vehicle Inspection and Maintenance Working Group Meeting

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Air Remote Sensing Project

- To deploy remote sensing systems in four major cities in Scotland to collect vehicular emission data in various seasons and roadways over 3 years
- To analyze data to drive informed decisions and policies aimed at reducing vehicle emissions
- To form the first network of cutting-edge remote sensing air quality monitors in a low emission zone
- The most extensive vehicle remote emission sensing data collection carried out in Europe to date

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The Real Urban Emissions (TRUE) initiative

FIA FOUNDATION

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

TRUE seeks to supply cities with data regarding the real-world emissions of their vehicle fleets and equip them with technical information that can be used for strategic decision making.

ENVIRONMENT | Wed Mar 29, 2017 | 10:44am EDT

Paris and London mayors announce scheme to gauge car emissions

London Mayor Sadiq Khan (L) and Paris Mayor Anne Hidalgo attend a meeting on air pollution in Paris, France, March 29, 2017. REUTERS/Gonzalo Fuentes 1/2

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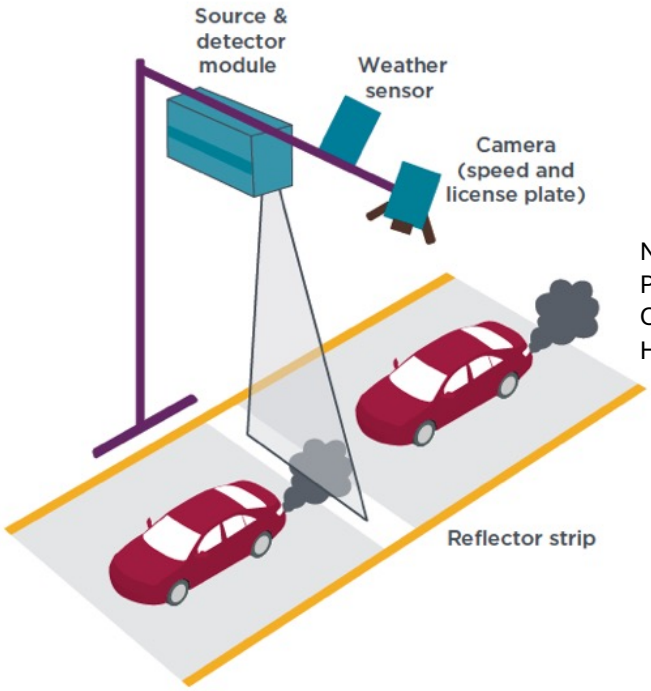
What is remote emissions sensing?



Nitrogen oxides (NO + NO_2)
Particulate matter (PM)
Carbon monoxide (CO)
Hydrocarbons (HC)

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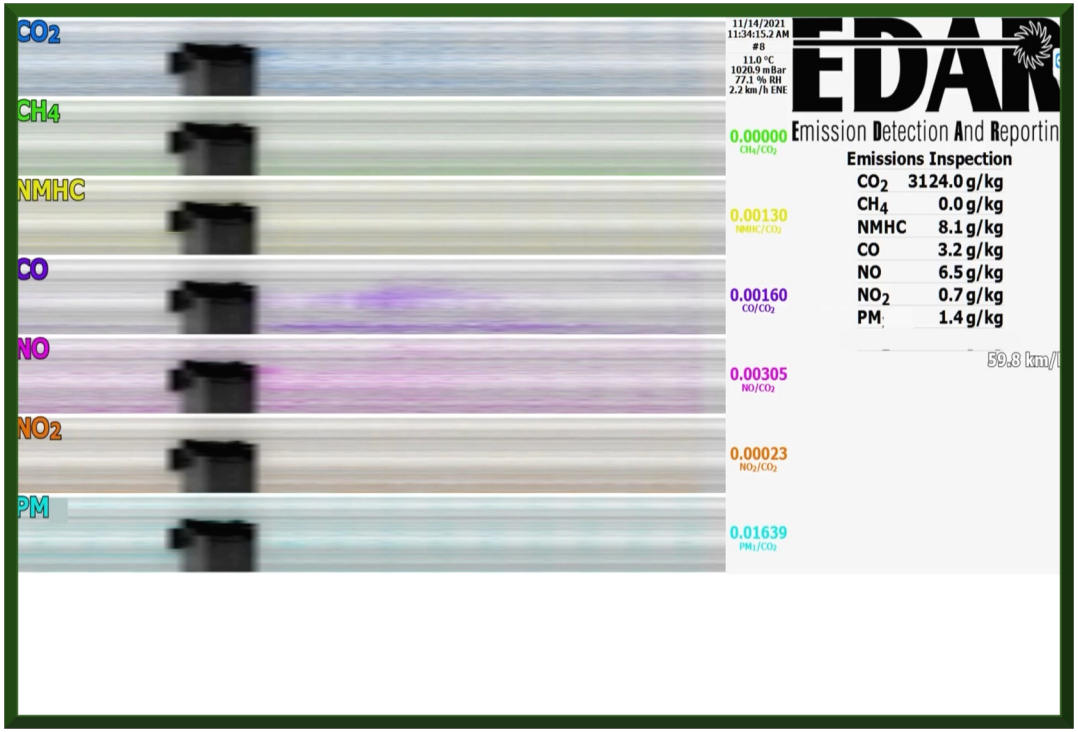
Emission Detection and Reporting (EDAR) systems

- Laser-based, aerial remote sensing technology
- Data collection 24/7, unmanned, possible for almost all weather conditions and roadways
- An interface showing emissions in real-time
- Emissions data integrated with Driver and Vehicle Licensing Agency database enabling the access of full vehicle records



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1.4 million emission measurements collected over 3 months from 2021 to 2023

Campaign	Cities	Testing months	# of measurements
2021	Edinburgh, Glasgow	Oct – Nov	~ 225,000
2022	Edinburgh, Glasgow, Aberdeen, Dundee	Apr – May Sep – Oct	~ 660,000
2023	Edinburgh, Glasgow, Aberdeen, Dundee	Jun – Jul	~ 559,000
2021 – 2023			**~ 1,444,000**

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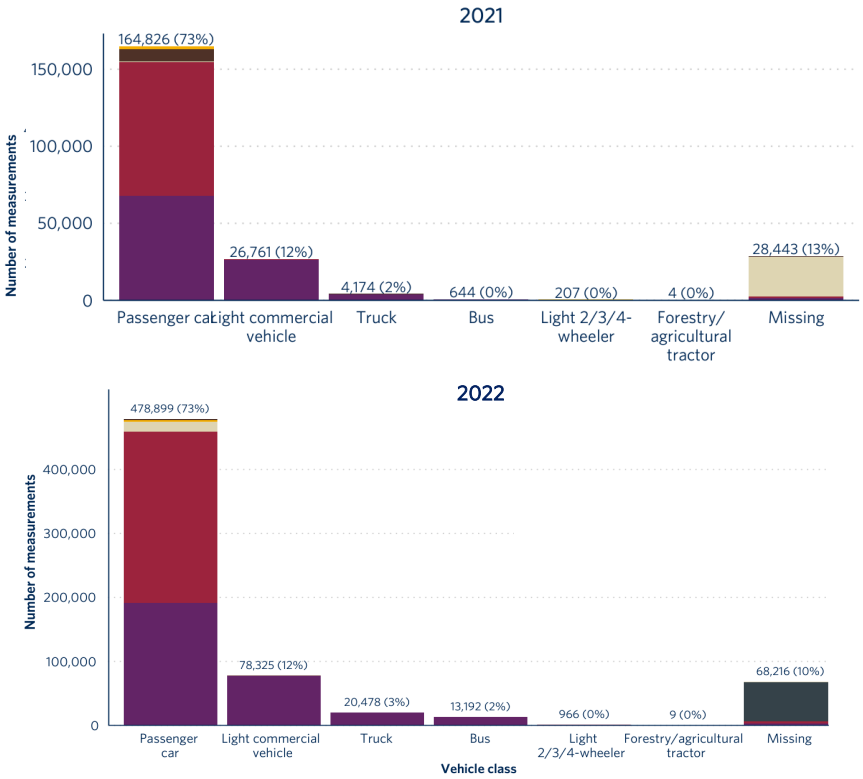
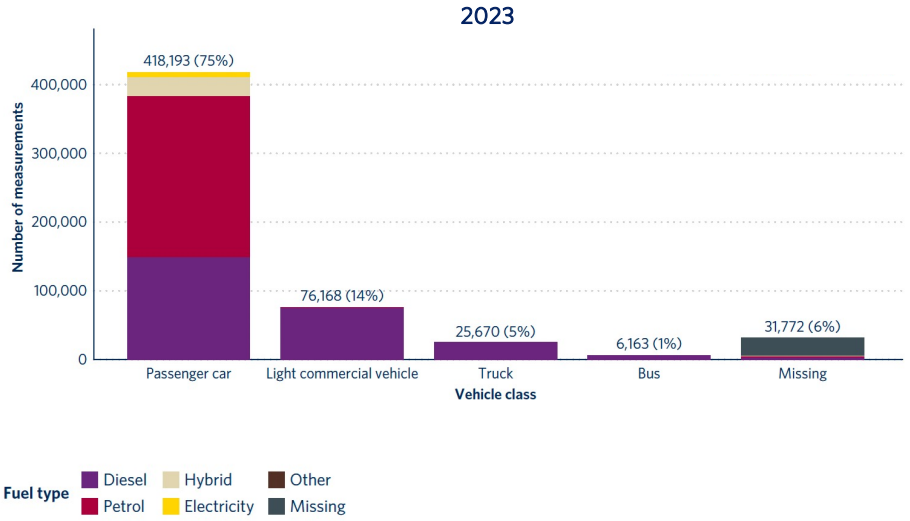
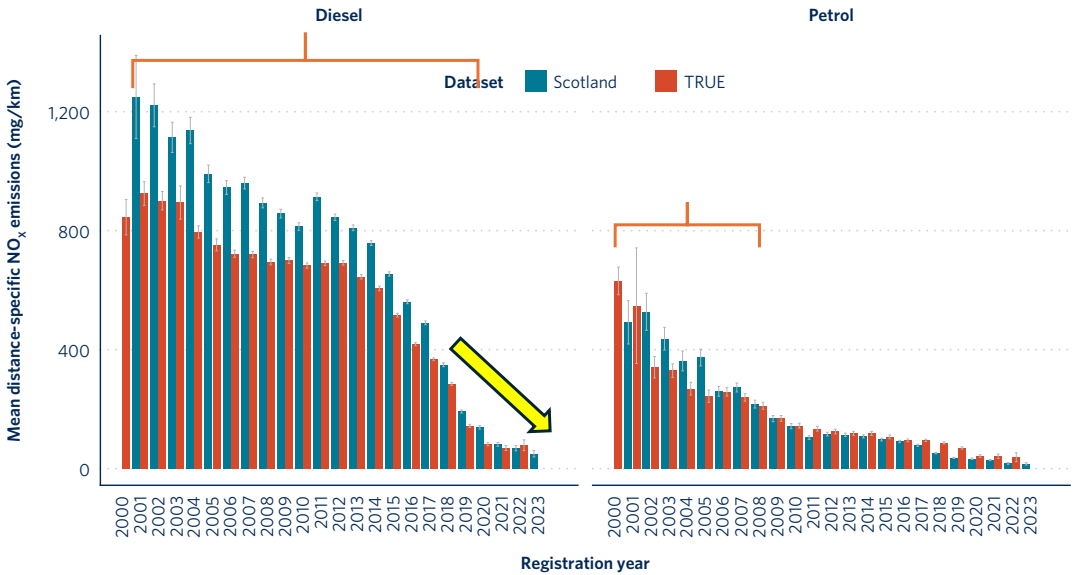
Similar fleet compositions measured in 3 different years





Despite the improvement in emission performance, NO_X emissions from old diesel cars remain largely a problem



- Improvement in real-world NO_X emissions over time for both fuel types
  - Decline in emissions 2018 – 2020 thanks to Real Driving Emissions (RDE) testing
- Comparison with other European cities
  - 30% higher NO_X from Scottish diesel vehicles before 2020 (Euro 3 – 6a-c)
  - 20% higher NO_X from Scottish petrol vehicles of 2000 – 2008 (Euro 3 – 4)
- Average real-world NO_X from RDE vehicles below RDE limits

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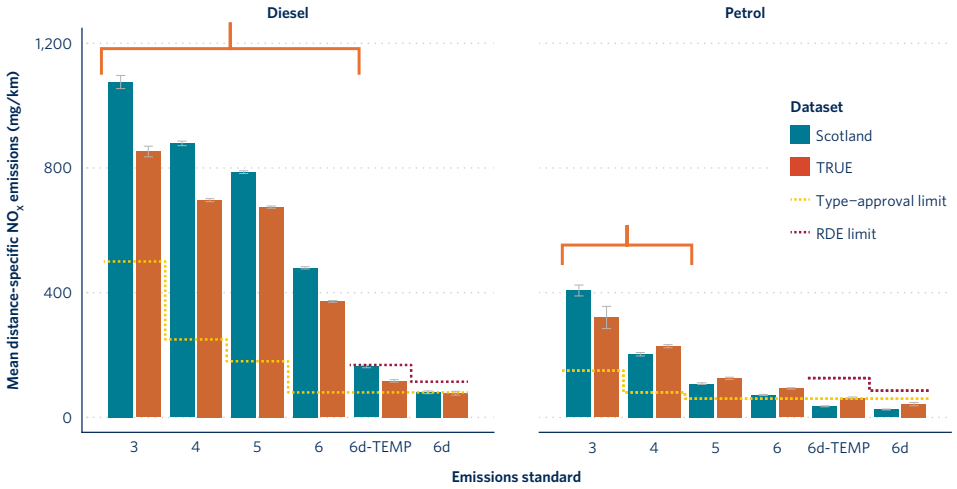

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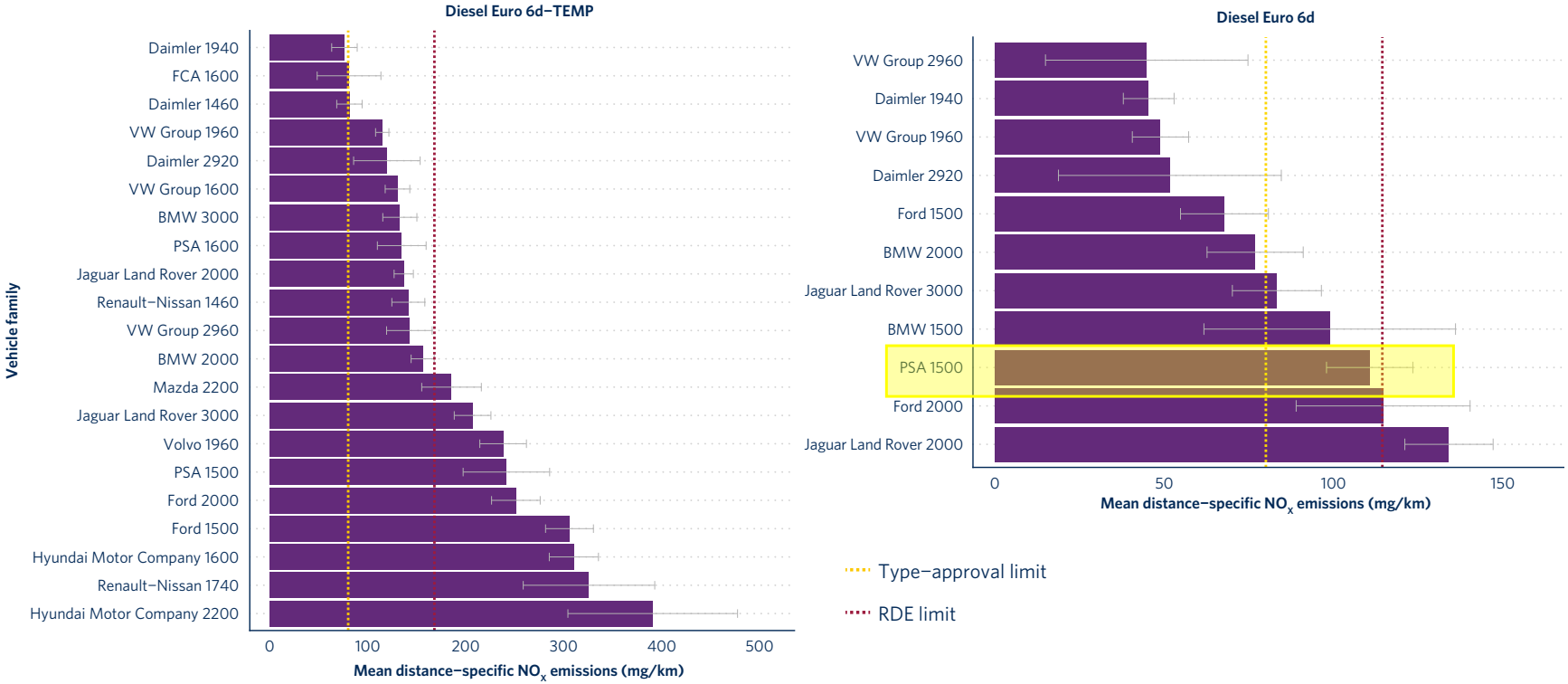
And NO_X emission performance of diesel RDE vehicles varies by manufacturers (OEMs)



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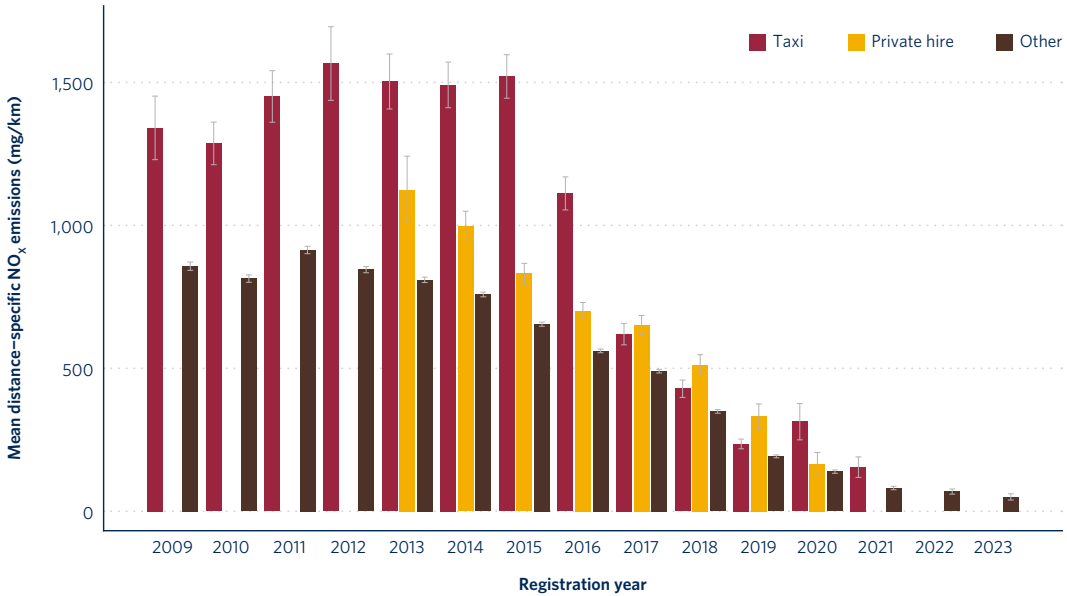
High-usage vehicles like taxis and private hires show significantly higher real-world emissions than other passenger cars



- High real-world NO_X emissions from 2009 – 2016 taxis (Euro 5 – 6)
  - 84% higher than other passenger cars
  - 56% higher than private hires
  - emission deterioration attributable to high mileage

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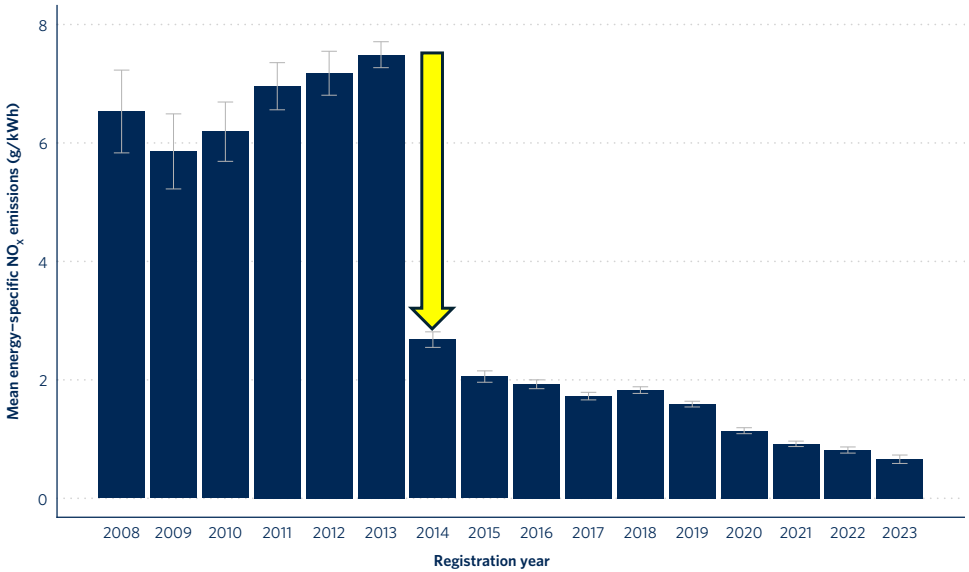
NO_X emissions from trucks have decreased substantially with Euro VI standards

- A large fall in NO_X emissions from 2014 (introduction of Euro VI)
- Subsequent decrease in NO_X throughout Euro VI – VI-D – VI-E due to updates to the in-service conformity (ISC) testing requirements
- Highest mean NO_X emissions from Euro V trucks (2011 – 2013)
    - 3.5 times regulatory limit
    - Natural degradation past durability period
    - Possible indication of tampered or malfunctioning emission control systems



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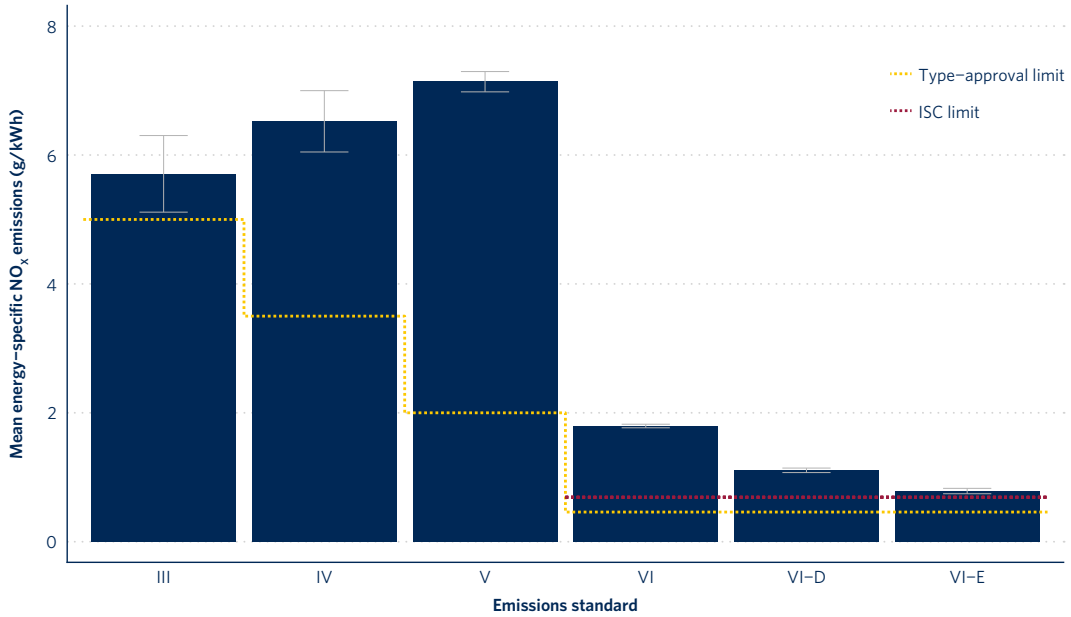


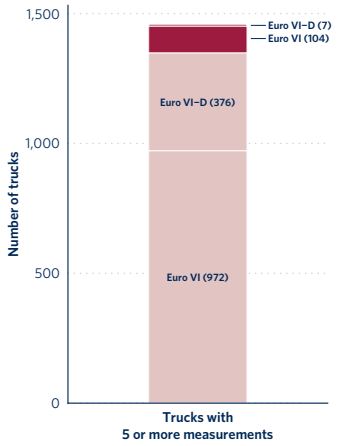
Defining a threshold for detecting trucks with defective or tampered emission control systems

- **Instantaneous emissions are not sufficient to determine whether a vehicle is a high emitter or not**
  - High-emission events are possible for normally behaving vehicles (e.g., cold engine, vehicle under high load, etc.)
- **Emission levels may vary by country due to atmospheric conditions, etc.**
  - Unsuitability of thresholds defined in studies conducted in other countries

- **Sample of vehicles repeatedly measured (> 5) over the three years**
  - Little variance in emissions from Euro VI trucks; more notable difference in emissions from high emitters and normally behaving vehicles

- **Core assumptions:**
  - Normally behaving vehicles can show high emissions in some instances
  - BUT high emitters would show consistently high emissions

Emissions standard	Number of measurements	Number of unique vehicles
VI	10,788	1,076
VI-D	4,419	383
Total	15,207	1,459



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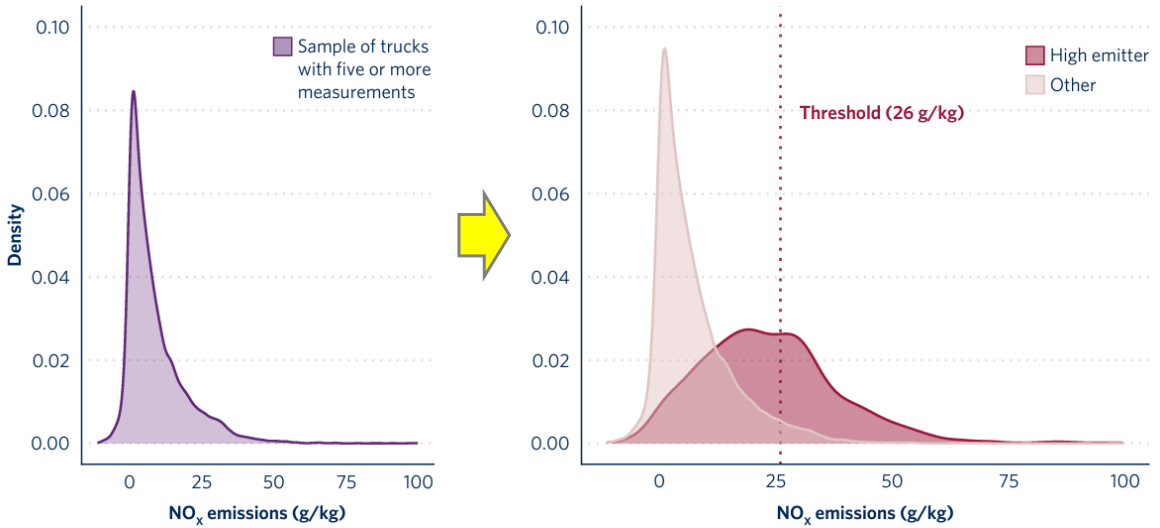
The identified threshold of 26g(NO_X)/kg(Fuel) can be used for real-world enforcement settings

- **7.6% high emitters** with median NO_X emissions nearly **5 times** those of normally behaving vehicles
- Newly updated threshold: **26g(NO_X)/kg(Fuel)**
  - Low false positive rate of 3%
- Correct detection rate can be improved with multiple measurements
  - 36% with 1 measurement
  - 90% with 5 measurements
- Long-term monitoring with remote sensing can be used to flag trucks for inspection or repair

- *Threshold = μ + 2σ*
- *μ = median of clean vehicle emission distribution*
- *σ = standard of deviation, or spread, of clean vehicle emission distribution*
  - *Hooftman, Ligterink, and Bhoraskar (2020)*



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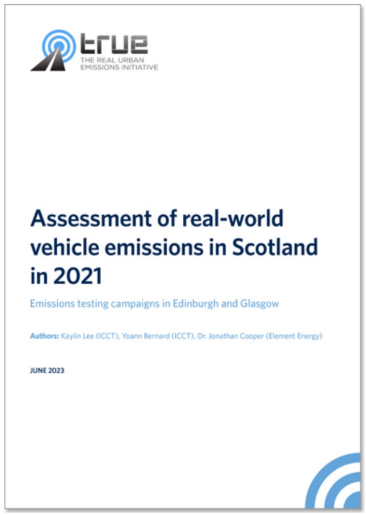
Conclusions and policy recommendations

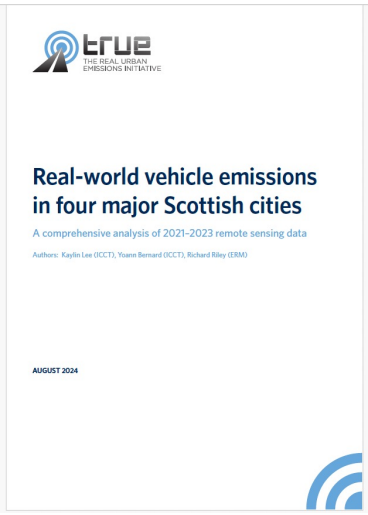
- To address persistent excess NO_X emissions from diesel vehicles and accelerate the uptake of cleaner vehicles
  - Update MOT testing to include NO_X testing and address NO_X emission control technology deterioration
  - Scrappage programs to support the scrapping of old cars and subsidize the purchase of cleaner vehicles
  - Feebate at car purchase; a fee on the purchase of high polluting vehicles and a rebate on BEVs

- To reduce NO_X emissions from trucks
  - Restrict the use of Euro V trucks (covered in the low emission zones)
  - Identify Euro VI trucks with defective or tampered emission control systems for repair
  - Remote sensing systems can help to identify tampering or malfunction and assist on-road inspection

- On the EU level,
  - Require NO_X and PN testing during periodic technical inspection (PTI)
  - Harmonize PTI criteria across EU Member States

All three reports on ***real-world vehicle emissions in Scottish cities*** are available on https://www.trueinitiative.org/





Thank you for your attention!

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