

# The Air Remote Sensing Project: Large-scale remote sensing testing in four cities in Scotland

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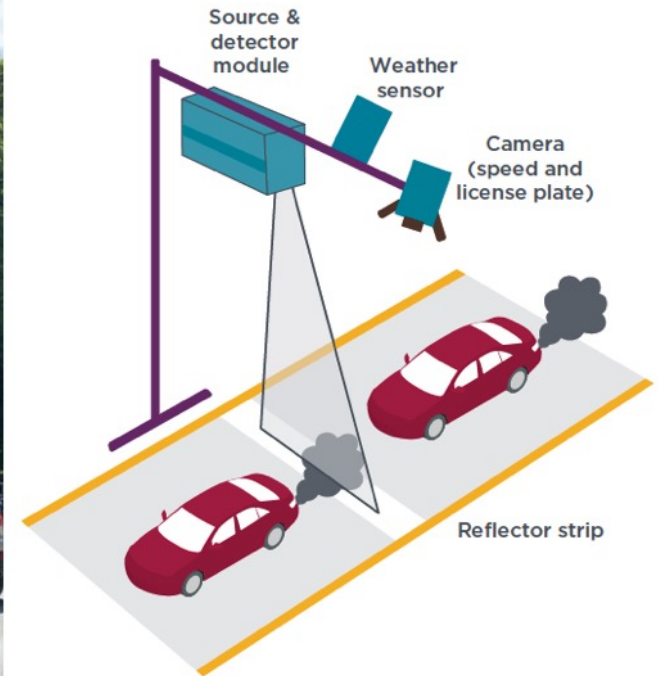
# The Air Remote Sensing Project

- Consortium of Transport Scotland, Hager Environmental & Atmospheric Technologies (HEAT), ERM (formerly Element Energy), International Council on Clean Transportation (ICCT)
- The most extensive vehicle remote emission sensing data collection carried out in Europe to date
- To form the first network of cutting-edge remote sensing air quality monitors in a low emission zone



# Data collection

- Emission Detection and Reporting (EDAR) system deployed measuring vehicle emissions continuously unmanned over a month
- Testing campaigns in 4 Scottish cities implementing low-emission zones over 3 years (Aberdeen, Dundee, Edinburgh, and Glasgow)
- Sites with different mixes of fleets selected



Schematic of remote emissions sensing technology

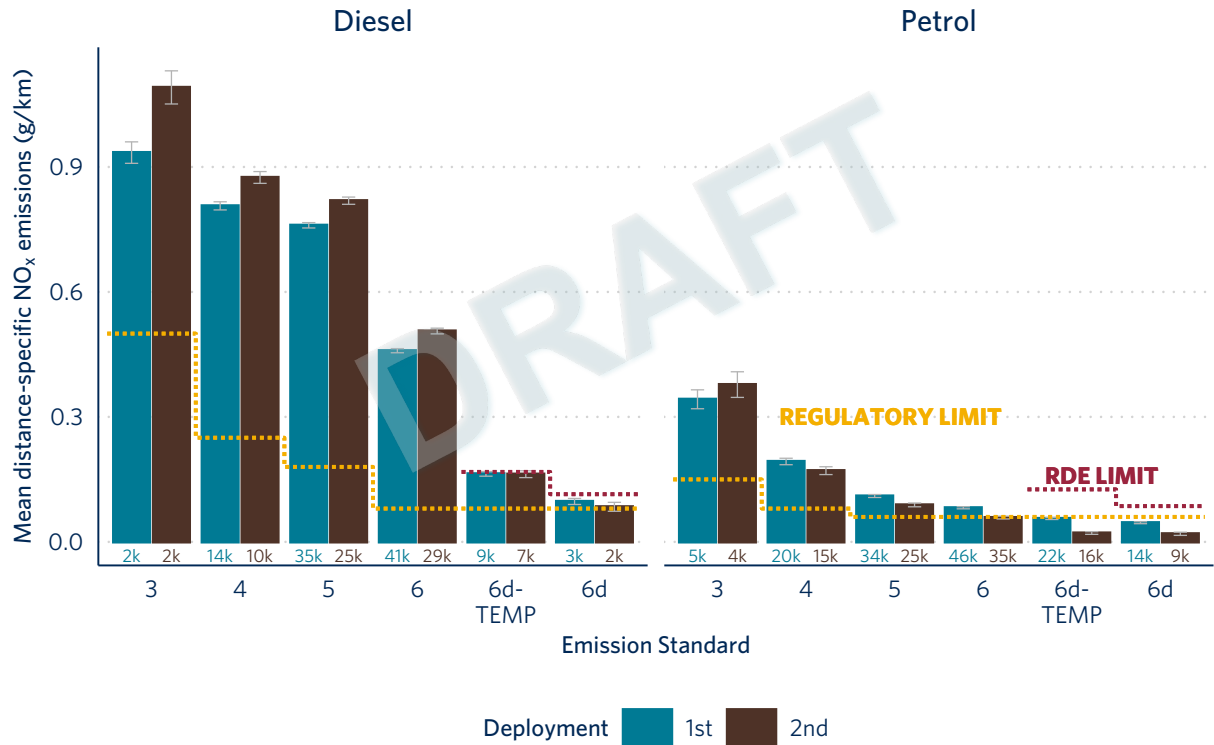
# Data overview

- 885,144 measurements from the first two deployments

City	# of measurements
Aberdeen	307,132
Dundee	195,391
Edinburgh	337,725
Glasgow	44,896

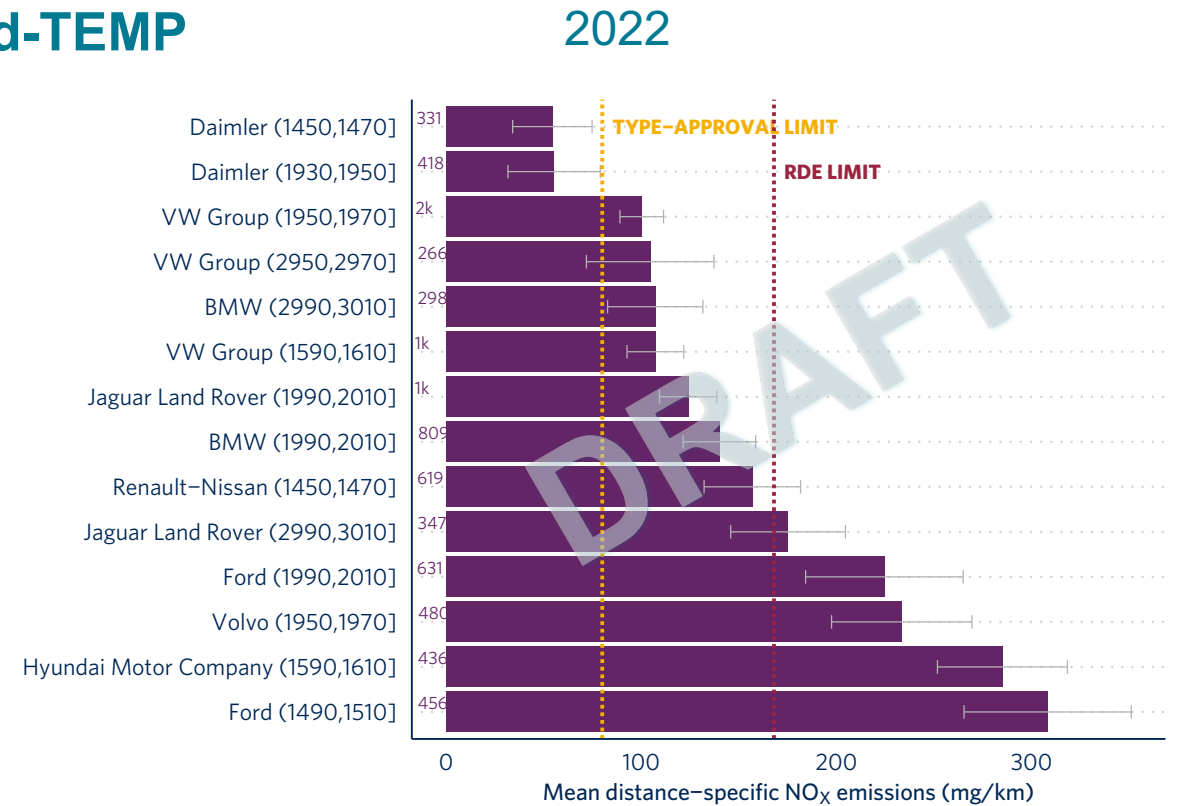
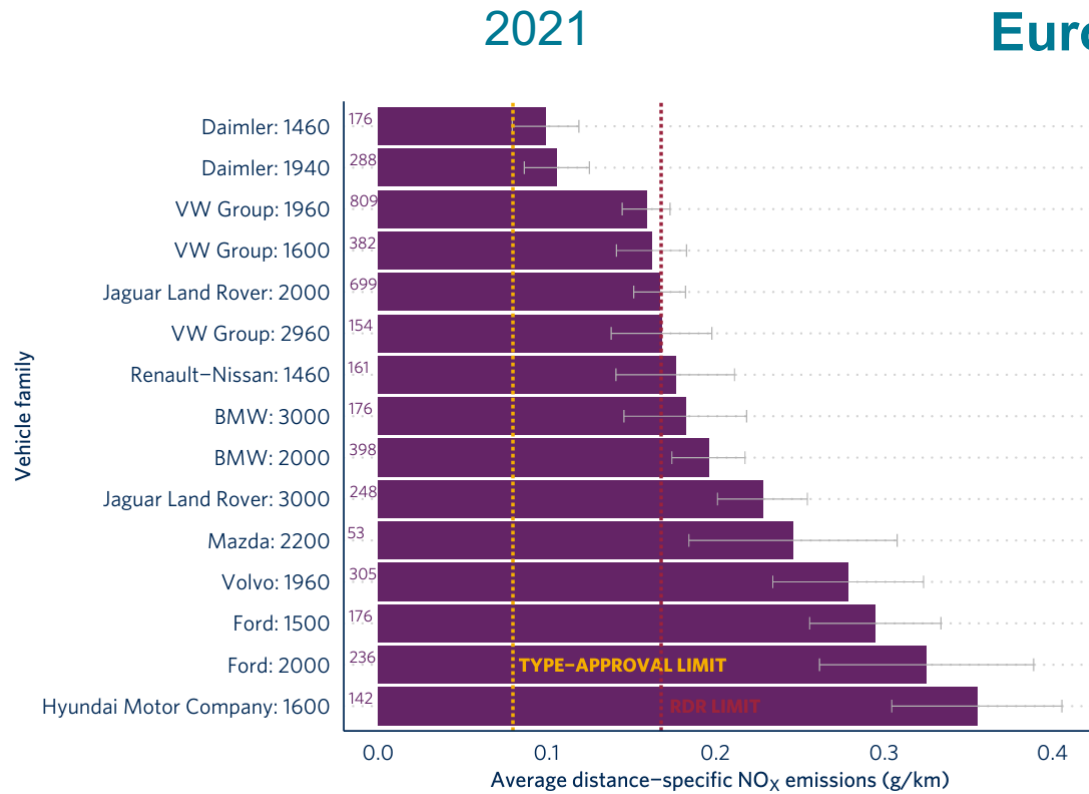
- 643,725 from passenger cars
  - 25,447 from trucks
- } FOCUS

# NO<sub>x</sub> emissions from diesel largely a problem

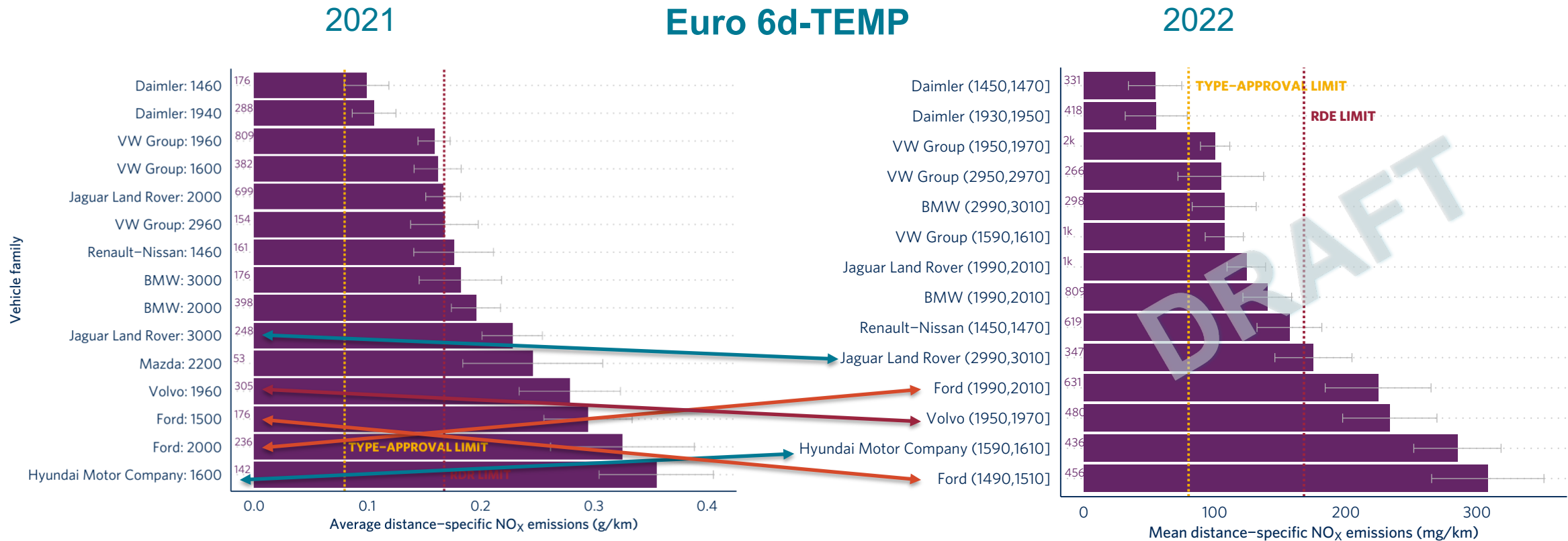


- Euro 3 – 6 diesel: exceedances of regulatory limits by multiple times
- Diesel RDE (Euro 6d-TEMP & 6d): 70% - 85% lower than Euro 6 + compliance with RDE limits
- Petrol exceedances of regulatory limits in Scotland more minor
- RDE petrol vehicles performed exceptionally well in 2022

# A closer look into diesel RDE vehicles shows the performance varies by vehicle family...



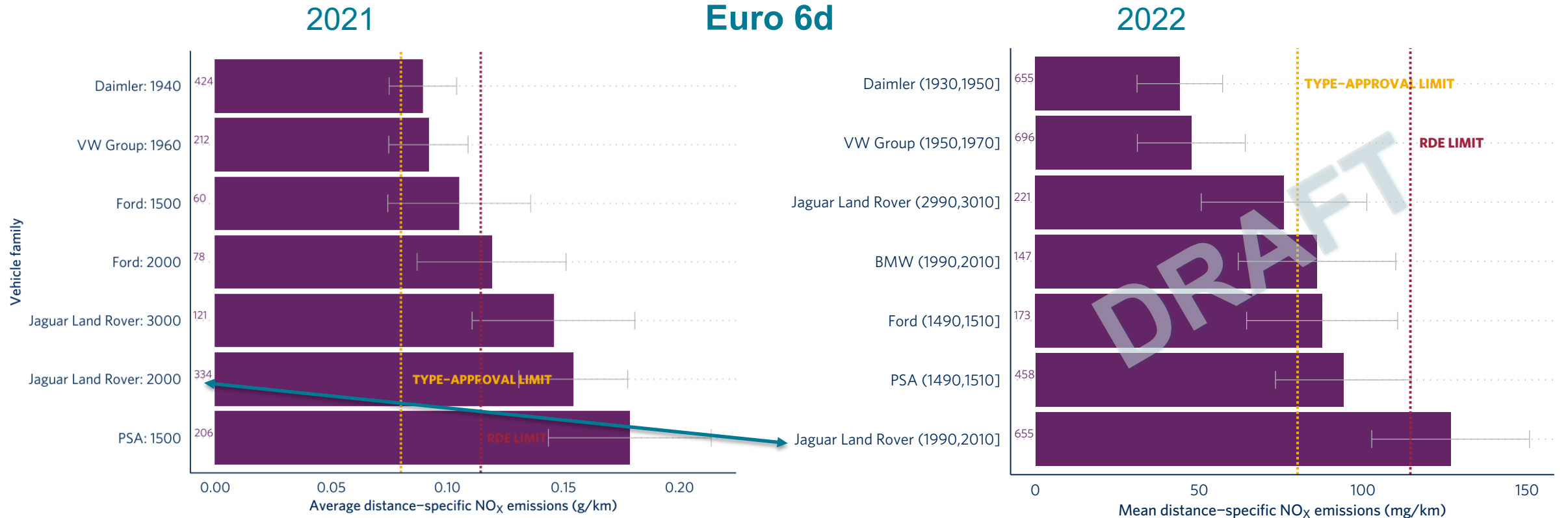
# ... and some vehicle families emit consistently high



High-emitting vehicle families from 2021& 2022:

- Ford 1500cc, 2000cc
- Hyundai Motor Company 1600cc
- Volvo 1960cc
- Jaguar Land Rover 3000cc

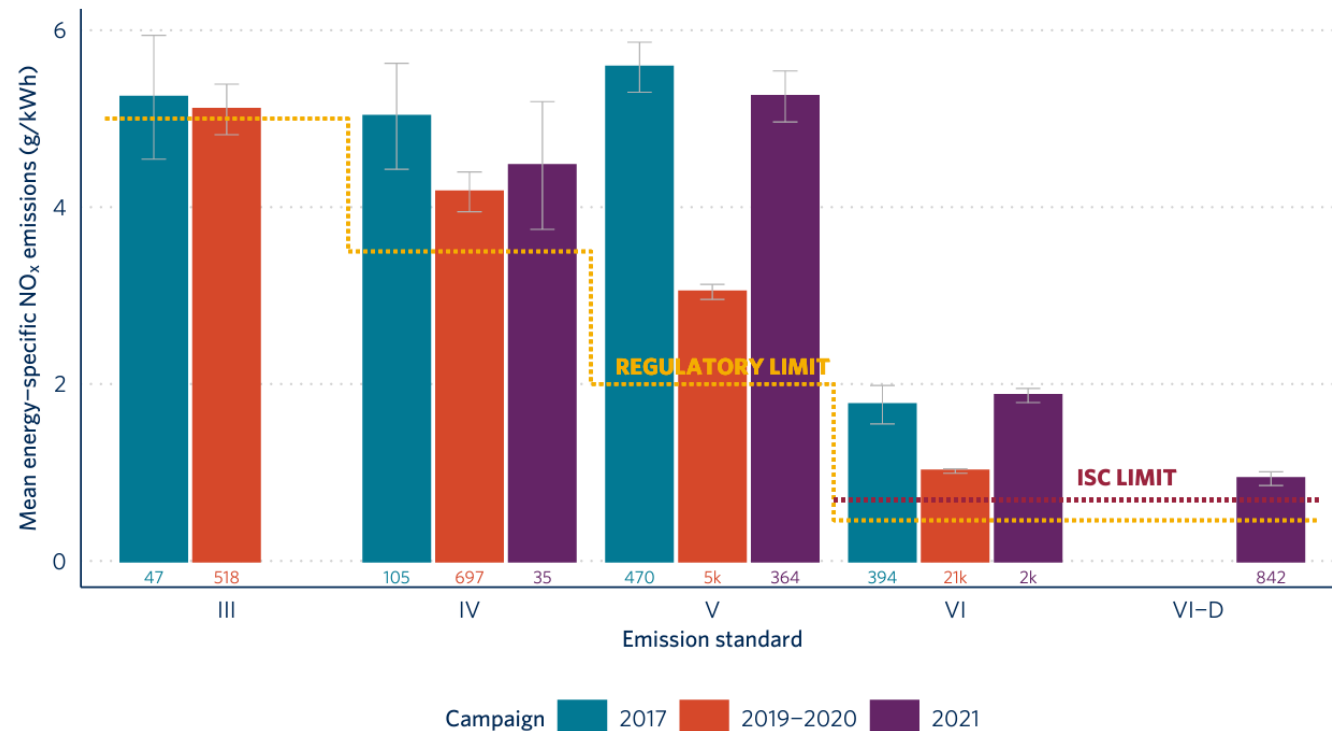
# A larger sample of Euro 6d vehicles available to refine results from 2021



\*Only Jaguar Land Rover showed suspicious levels of NO<sub>x</sub> in both years

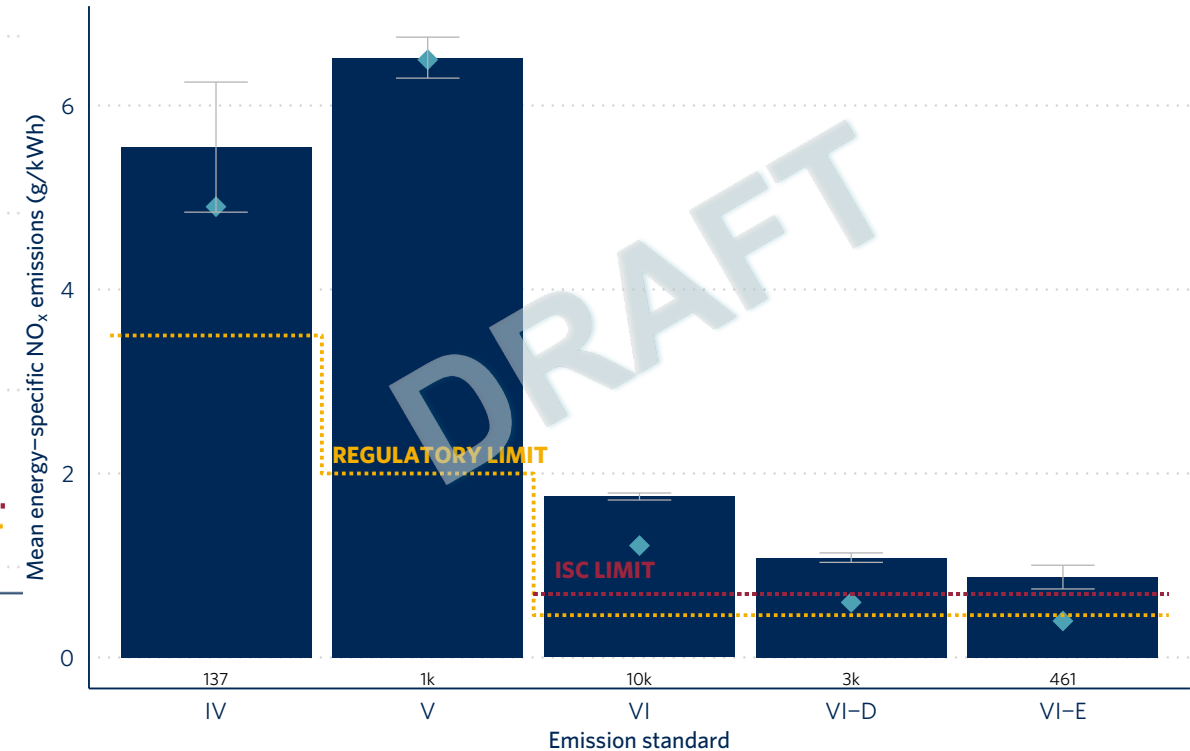


# Real-world performance of trucks has improved with newer standards...

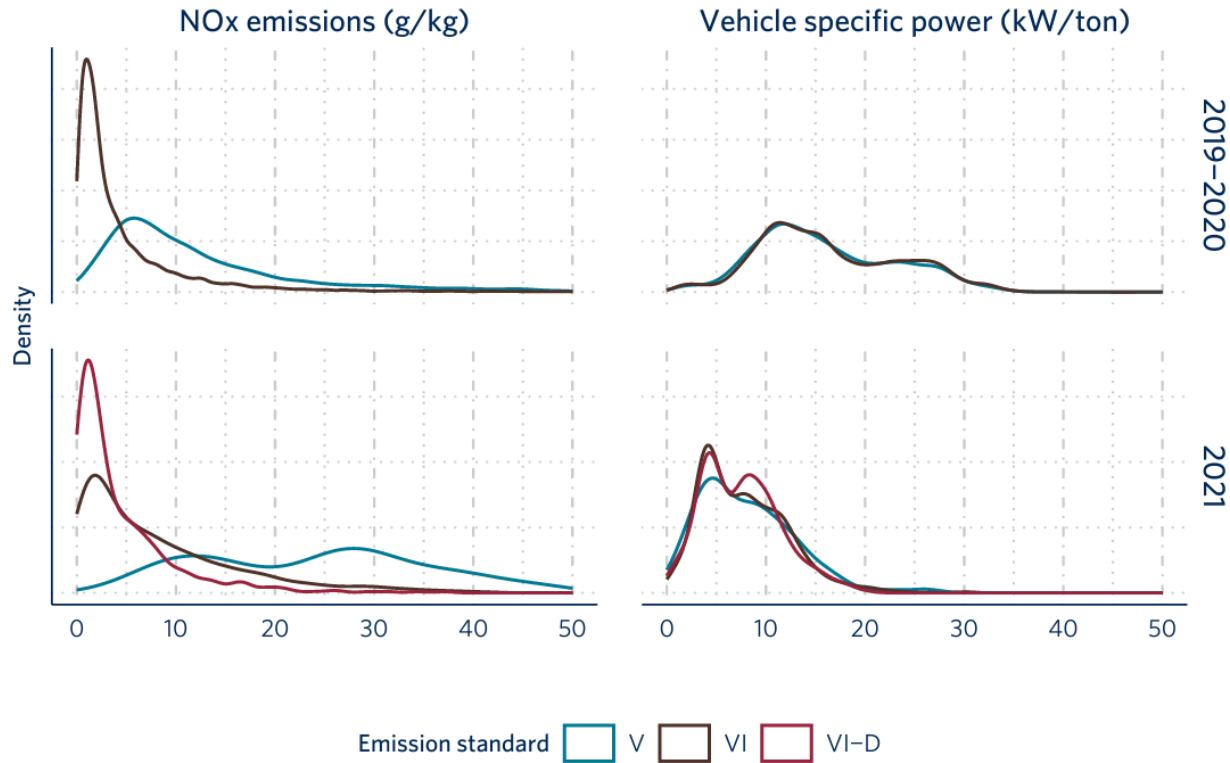


- Euro VI:
  - over 60% reduction in NO<sub>x</sub> emissions from Euro V
- Euro VI-D:
  - over 50% reduction from Euro VI
  - Exceedance of ISC limit

# Real-world performance of trucks has improved with newer standards...



# ... but there may be some high-emitters



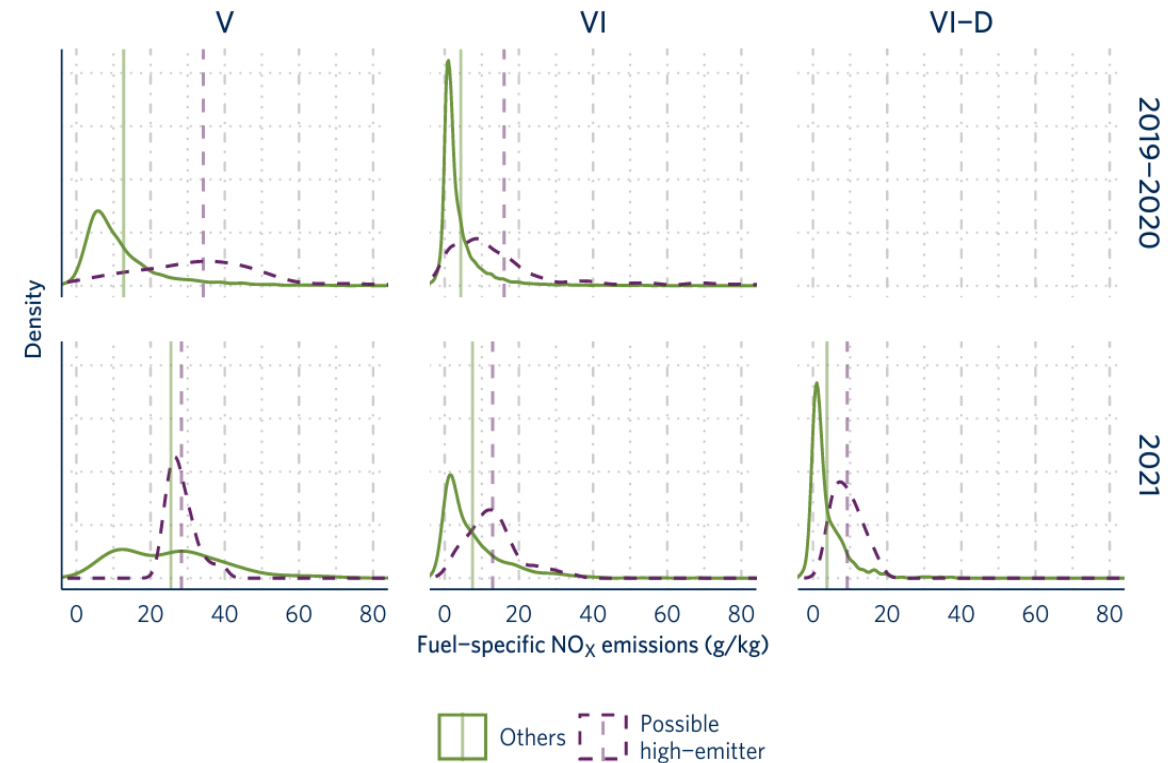
- Identifying high-emitters is difficult due to high-emission events
  - Cold engines
  - High instantaneous vehicle power
- Thresholds used in other enforcement settings may not be applicable (25g/kg for Euro V, 7g/kg for Euro VI)

Campaign	Emission standard	90 <sup>th</sup> percentile	95 <sup>th</sup> percentile
2019-2020	V	28.12	38.62
2019-2020	VI	11.71	17.96
2021	V	41.90	48.29
2021	VI, VI-D	17.755	23.54

# High-emitter identification method using repeat measurements

- Instantaneous emissions are not reliable
  - A smaller but more reliable sample of vehicles with five or more measurements
  - High emitters: times of threshold exceedances > times below the threshold

Year	Emission standard	# of high emitters	Share of high emitters
2019-2020	V	7	3%
	VI	72	6%
2021	V	1	17%
	VI	10	28%
	VI-D	1	7%



# To be evolved...

- + use of repeat measurements
- + more reliable than single instantaneous measurements

- small sample with large variance in emissions
- adequateness of the thresholds
- lack of enforcement information

## Considerations for future studies

- Goal of enforcement (minimize false positives or maximize true positives)
- Thoughtful enforcement site selection
- Different forms of enforcement
  - roadside inspection
  - Remote sensing with live access to vehicle registration database

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