

Policy assessment using real-world emissions data from vehicles in Scottish cities

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Vehicle emissions are an important source of urban air pollution and of the resulting health problems. Although Scotland has achieved a significant improvement in air quality owing to various legislation regulating emissions from industry, domestic heating, and transport, there remain air pollution hot spots, particularly in densely populated urban areas where the health risk of air pollution is high.¹ Air pollution still poses a significant health risk and is estimated to cause 1,700 premature deaths annually in Scotland.² Edinburgh and Glasgow, two major cities in Scotland where air pollution predominantly stems from road transport, have implemented or plan to introduce various policies to curb emissions from on-road transport, such as low-emission zones or age limits on taxis and private hires. Understanding real-world emissions of the fleets in these cities could therefore provide insight into the impact of such policies on emissions and inform future policies to effectively address air pollution problems.

Emissions testing of the Scottish fleet was conducted in November–October 2021, led by Transport Scotland in conjunction with Hager Environmental & Atmospheric Technologies (HEAT), International Council on Clean Transportation (ICCT), and Element Energy. Over a month-long trial, over 225,000 real-world emissions measurements were collected using the EDAR commercial remote sensing instruments in the streets of Edinburgh and Glasgow. More testing campaigns will follow until 2024, including in Aberdeen and Dundee where the first round of emissions measurements was conducted in 2022, and will contribute to the development of a network of Scottish remote sensing data at a scale which is already the largest of its kind in Europe. This technical note presents the assessment of real-world nitrogen oxides (NO_x) emissions from passenger car vehicles, including taxis and private hires, in Edinburgh and Glasgow in 2021 and estimates the potential impacts of emissions-based policies planned to be put in place to address air quality.

Our results show that the first step of the Scottish low-emission zones targets the highest emitting vehicle groups. More importantly, the LEZ requirements impact

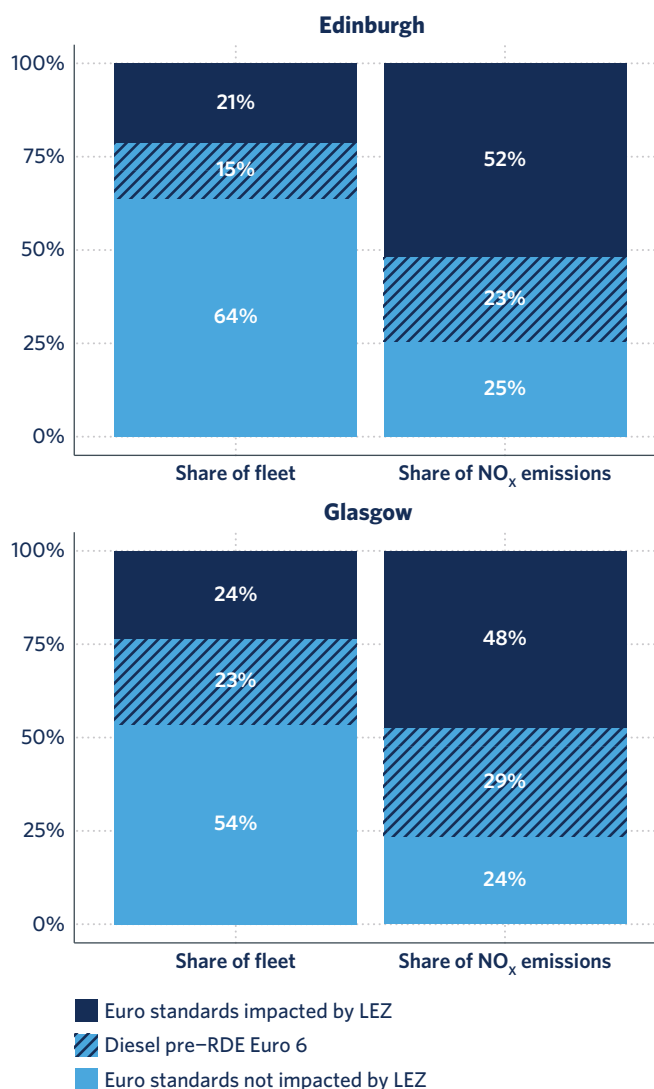


Figure 1. Share of fleet and emissions impacted by the proposed low-emission zone restrictions in Edinburgh and Glasgow based on the measurements collected in 2021. Hatched parts show shares of fleet and emissions of diesel pre-RDE Euro 6 vehicles that are not scheduled to be impacted by the low-emission zone.

1 Air Quality in Scotland, "About air quality," (2021), <https://www.scottishairquality.scot/air-quality>

2 Air Quality in Scotland, "About air quality."

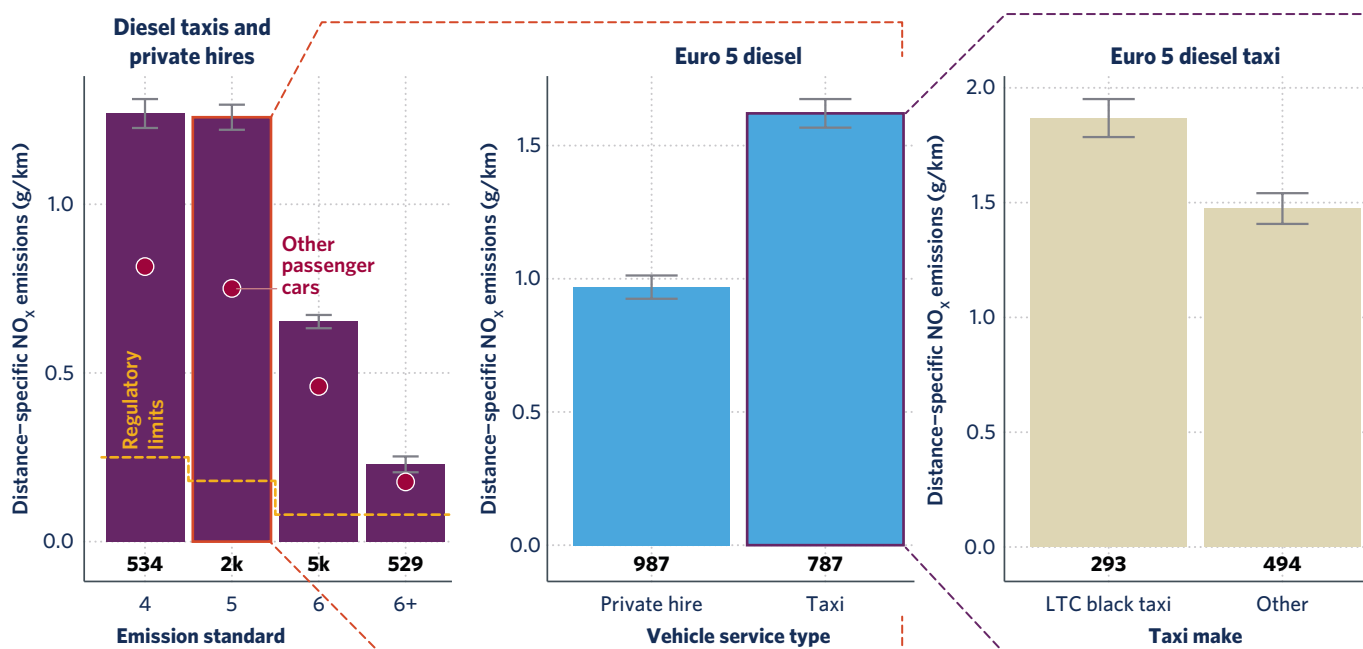


Figure 2. Average distance-specific NO_x emissions from the diesel taxi and private hire fleet in Edinburgh and Scotland (left), those from Euro 5 diesel private hires and taxis (center), and those from Euro 5 diesel taxis, excluding private hires (right). Red dots indicate the average distance-specific NO_x emissions from other private passenger cars for comparison (left). Whiskers represent the 95% confidence interval of the mean.

diesel vehicles certified to Euro 5 or earlier which, in real-world operations, show NO_x emissions 2–4 times the type-approval limits, which are the regulatory emissions thresholds manufacturers are required to meet on the testing bed.³ The LEZ requirements will also impact the oldest petrol vehicles existing in the fleet, certified to the Euro 3 standard, which in urban driving conditions emit more than double the NO_x emissions allowed on the testing bed and nearly double the emissions limit of the Euro 4 standard. As shown in Figure 2, overall the LEZ would prevent access by vehicles responsible for around 50% of the total passenger car distance-specific NO_x emissions but making up only around 20% of the total vehicle activity on the streets of Edinburgh and Glasgow.

Diesel vehicles certified to the Euro 6 standard, but not including Euro 6d-TEMP and Euro 6d, are the group with the second biggest share of NO_x emissions following diesel Euro 5 in both cities, and will continue to be allowed on the road according to the planned LEZ restrictions. This group of diesel Euro 6 vehicles is not subject to additional Real Driving Emissions (RDE) testing, which sets limits for on-road emissions and is required for Euro 6d-TEMP and Euro 6d vehicles. These pre-RDE Euro 6 vehicles show real-world NO_x emissions 2–4 times the average emissions from vehicles certified to subsequent, post-RDE standards. Limiting the use of vehicles disproportionate contributions

to NO_x emissions; they are responsible for 23% and 29% of NO_x emissions while accounting for 15% and 23% of passenger car activities in Edinburgh and Glasgow, respectively.

Our remote sensing data also highlighted the importance of emissions from taxis and private hires, a type of vehicle highly used in cities. For example, in Glasgow, 38% of passenger cars measured, which represents vehicle activity, were taxis or private hires. Almost 90% of all taxis and private hires measured were diesel-powered and showed significantly high real-world NO_x emissions. Although their average age was about a year younger than that of other private passenger cars, NO_x emissions from diesel Euro 4 to Euro 6 taxis and private hires, which made up some of the highest shares in the taxi and private hire measurements, were 42%–68% higher than private passenger car counterparts. This may be attributable to higher annual mileage, since aftertreatment systems' performance is more strongly linked to total miles driven rather than simply age in years.

Scottish cities have implemented policies addressing emissions from taxis and private hires but decided against removing some of the highest-emitting groups from the fleet. In 2021, the minimum standard for taxis and private hires in Edinburgh was Euro 5, determined at the annual test with some exemptions, and Glasgow put a 7-year age limit on only private hires. This policy setup does not restrict the use of one of the highest-emitting taxi and private hires, namely the diesel Euro 5 group that emits NO_x

³ Euro standard information of the measured vehicles was based on the data provided by the Drivers and Vehicle Licensing Agency (DVLA) of the UK, rather than the manufacturer data.

emissions 2-5 times those from diesel vehicles certified to subsequent standards. Diesel Euro 5 was, however, the second most common emissions standard from the taxi and private hire fleet and was responsible for over 35% of the total NO_x emissions from taxis and private hires in both cities. In Glasgow, the exception of taxis from the age limit allowed a greater proportion of older diesel taxis, resulting in the taxi fleet showing 38% higher average NO_x emissions than the private hire fleet.

The taxi fleet also included high-emitting black taxis manufactured by the London Taxi Company (LTC) which, on average, showed significantly more elevated levels of real-world NO_x emissions compared to other taxi makes. A previous study identified Euro 5 black taxis as the highest-emitting taxi group in London.⁴ In Scotland, LTC black taxis certified to Euro 5 had an average NO_x emissions level 64% higher than that of the rest of taxis and private hires certified to the same standard. They also showed a significant share of 17% in the Euro 5 taxi fleet, making the taxi fleet a bigger contributor to NO_x emissions than the private hire fleet. Even LTC taxis certified to the newer Euro 6 standard showed little improvement in emissions

⁴ The Real Urban Emissions Initiative, "NO_x and particulate emissions from London's taxis [fact sheet]", (2018), <https://www.trueinitiative.org/media/597546/true-london-taxi-fact-sheet.pdf>

performance, emitting only approximately 15% less NO_x than, Euro 5 diesel vehicles, despite Euro 6 in theory mandating a NO_x emissions reduction of over 50%.

As evidenced by the examples of Edinburgh and Glasgow, taxis and private hires are an important source of emissions that, in order to be effectively managed, require more stringent and harmonised rules. Our analysis shows that if a 7-year age limit, which currently applies to only private hires in Glasgow, is placed on both taxis and private hires, it could bring about greater emissions benefits than the impact the low-emission zone would have on taxis and private hires in 2024 in Edinburgh and in 2023 in Glasgow. Such a policy would additionally impact taxis and private hires responsible for 9% and 29% of the fleet's 2021 NO_x emissions in Glasgow in 2023 and in Edinburgh in 2024, respectively, which would otherwise be on the streets despite the LEZ implementation. Additional advantages of an age limit include a gradual phase-out of the oldest vehicles in the fleet which tend to show the highest real-world emissions.

As Scotland moves forward with initiatives to address vehicle emissions, such as the low-emission zone, it will be important that its cities continue to monitor existing policies and prepare future policy actions based on real-world data.



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For more information on TRUE, visit www.trueinitiative.org.