CLEANER AIR FOR SCOTLAND – NATIONAL MODELLING FRAMEWORK

Low Emission Zone: Edinburgh Report Addendum

December 2021

Section 1: Consideration of Carbon Dioxide changes within an LEZ scheme

The main objective of the Low Emission Zone (LEZ) is to improve air quality to meet current statutory air quality standards and objectives. There is also a statutory obligation to consider the contributions made towards greenhouse gas emissions (Transport (Scotland) Act 2019).

The Euro Classification of vehicles is designed to control Nitrogen Oxides (NO_x), Total Hydrocarbons, Non-methyl Hydrocarbons, Carbon Monoxide and Particulate Matter (PM) emissions (EUR-Lex - 32012R0459 - EN - EUR-Lex (europa.eu). Nitrogen Oxides and Particulate emissions (which are mostly by-products of the combustion process) are the main areas of concern as they either exceed or are at risk of exceeding Air Quality Standards. Therefore, LEZ's in Scotland will restrict access within the zone to lowest emitting Euro Class vehicles. These are Euro 6 for all vehicles, except petrol cars which are Euro 4.

Carbon Dioxide emissions are not currently controlled by the Euro Classification system. The introduction of Euro 7 standards by the European Union, expected to come into force in 2025, will include targets to reduce Carbon Dioxide emissions.

CO_2 emissions are linked the quantities of fuel burnt by a vehicle (e.g. miles per gallon), and reductions in CO_2 emissions are mainly linked to improved fuel efficiency. New vehicles tend to be more efficient than older vehicles, this is most noticeable for cars. Larger Euro 6 vehicles (e.g. buses) may emit fractionally more CO_2 than older buses, as the technology required to reduce NO_x and Particulate emissions requires energy to run. As there are no CO_2 abatement systems on vehicles, significant changes in CO_2 emissions are not expected as a result of the introduction of the LEZ.

Reducing Carbon Dioxide emissions will be achieved by modal shift, introduction of alternative vehicle fuels (e.g. electric, hydrogen) or reducing the number of vehicle journeys using diesel/petrol. This move to zero carbon emissions could be achieved by actions set out in CAFS2 or the introduction of zero emission zones.

Emissions Standards for Vehicles

Emissions Standards are currently based on European Union emissions standards. These regulate emissions of Nitrogen Oxides (NO_x), Total Hydrocarbons, Non-methane hydrocarbons, Carbon Monoxide (CO) and Particulate Matter (PM). Carbon Dioxide (CO_2) is not part of this framework.

Euro Class emissions standards are outlined in Table 1, Table 2 and Table 3 for Cars, LGVs and HGVs. Note that the same Euro 6 standards apply to all Euro 6 sub classes, however the move from laboratory testing to Real World Driving assessment (Real-driving emissions test procedure for exhaust gas pollutant emissions of cars and light commercial vehicles in Europe (theicct.org))

Table 1: Car Emission Standards (NO_x and PM) for different Euro Classes

g/km	Diesel Car		Petrol Car	
	NO_x	PM	NO_x	PM
Euro 1	-	0.14	-	-
Euro 2	-	0.08	-	-
Euro 3	0.5	0.05	0.15	-
Euro 4	0.25	0.025	0.08	0.005
Euro 5 (incl 5a and 5b)	0.18	0.0045	0.06	0.005 (5a) 0.0045 (5b)
Euro 6 (incl 6b, 6c, 6d-TEMP and 6d)	0.08	0.0045	0.06	0.0045

Table 2: LGV Emission Standards (NO_x and PM) for different Euro Classes

g/km	<1305kg		1305-1760kg		1760-3500kg	
	NO_x	PM	NO_x	PM	NO_x	PM
Euro 1	-	0.14	-	0.19	-	0.25
Euro 2	-	0.08	-	0.12	-	0.17
Euro 3	0.5	0.05	0.65	0.07	0.78	0.10
Euro 4	0.25	0.025	0.33	0.04	0.39	0.06
Euro 5 (incl 5a and 5b)	0.18	0.0045	0.235	0.005 (5a) 0.0045 (5b)	0.28	0.005 (5a) 0.0045 (5b)
Euro 6 (incl 6b, 6c, 6d-TEMP and 6d)	0.08	0.0045	0.105	0.0045	0.125	0.0045

Table 3: Bus and HGV Emission Standards (NO_x and PM) for different Euro Classes. Note that Bus and HGV emissions standards are defined as g/kWh)

	Vehicle Type	NO_x (g/kWh)	PM (g/kWh)
Euro I	All	8	0.36
Euro II	All	7	0.15
Euro III	EEV	2	0.02
	Non EEV	5	0.1
Euro IV	All	3.5	0.02
Euro V	All	2	0.02
Euro VI	All	0.4	0.01
Note: EEV is Environmentally Enhanced Vehicle			

Emission Factors for Vehicles

The Emission Factor Toolkit (EfT) is published by Defra and the Devolved Administrations (Emissions Factors Toolkit) so that emission rates and emission factors can be calculated for NO_x, PM and CO_2 for different vehicle types. This attempts to take into account real world emissions.

Further information can be found in the EfT user guide (EFTv10.1-user-guide-v1.0.pdf). These are derived from the EU standard vehicle emission calculator COPERT (COPERT | EMISIA SA)

For the purpose of this report, emission factors for different vehicle types have been extracted from EfT (version 10.1) for vehicles traveling at an average speed of 20 km/hr.

It is possible to directly compare NO_x and PM emission standards and emission factors for Petrol Cars, Diesel Cars and LGV's, but not for Buses and HGV's. It is not possible to make this comparison for CO_2 emissions for any vehicle type.

Comparison of NO_x and CO_2 Emission Factors

Figure 1 and Figure 2 show emission factors for NO_x and CO_2 for each Euro Class

Diesel Cars:

- **NO_x:** Emission factors fall by a factor of 3 when moving from Euro 5 to 6d
- **CO_2:** Emission factors fall by 8% when moving from Euro 5 to 6d

Petrol Cars:

- **NO_x:** Emission factors increase by 12% when moving from Euro 5 to 6c. It is important to note that emission factors are 4 times lower than Diesel car emissions
- **CO_2:** Emission factors fall by 8% when moving from Euro 5 to 6d. They are slightly higher than diesel cars

Diesel LGVs:

- **NO_x:** Emission factors fall by a factor of 10 when moving from Euro 5 to 6
- **CO_2:** Emission factors are unchanged when moving from Euro 5 to 6

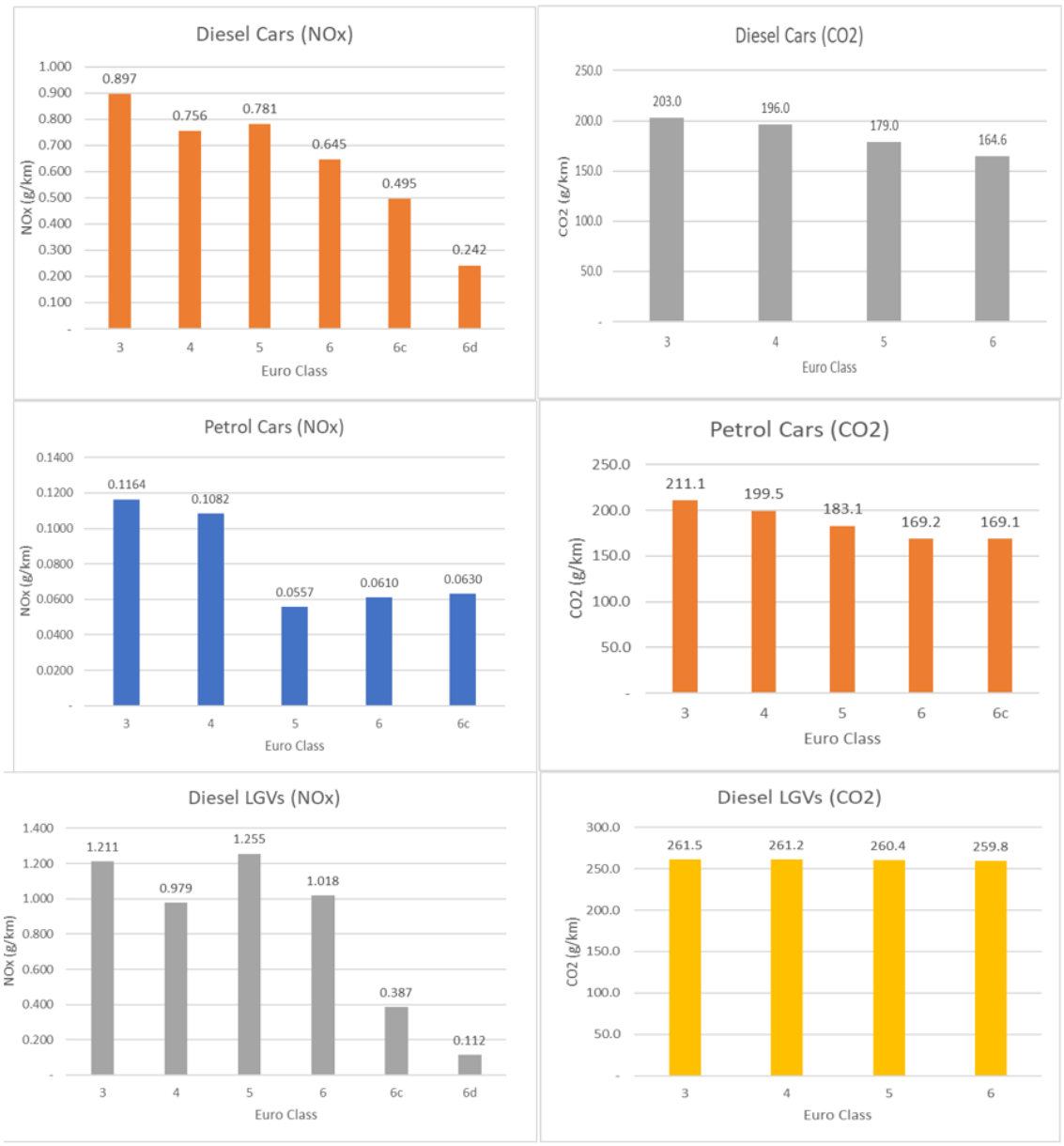

Figure 1: NO_x and CO_2 emission factors for Cars and LGV's

Buses/Coaches:

- **NO_x:** Emission factors fall by a factor of 10 when moving from Euro 5 to 6
- **CO_2:** Emission factors are unchanged when moving from Euro 5 to 6

Artic HGVs:

- **NO_x:** Emission factors fall by a factor of 8 when moving from Euro 5 to 6
- **CO_2**: Emission factors are unchanged when moving from Euro 5 to 6

Rigid HGVs:

- **NO_x:** Emission factors fall by a factor of 7 when moving from Euro 5 to 6
- **CO_2**: Emission factors are unchanged when moving from Euro 5 to 6

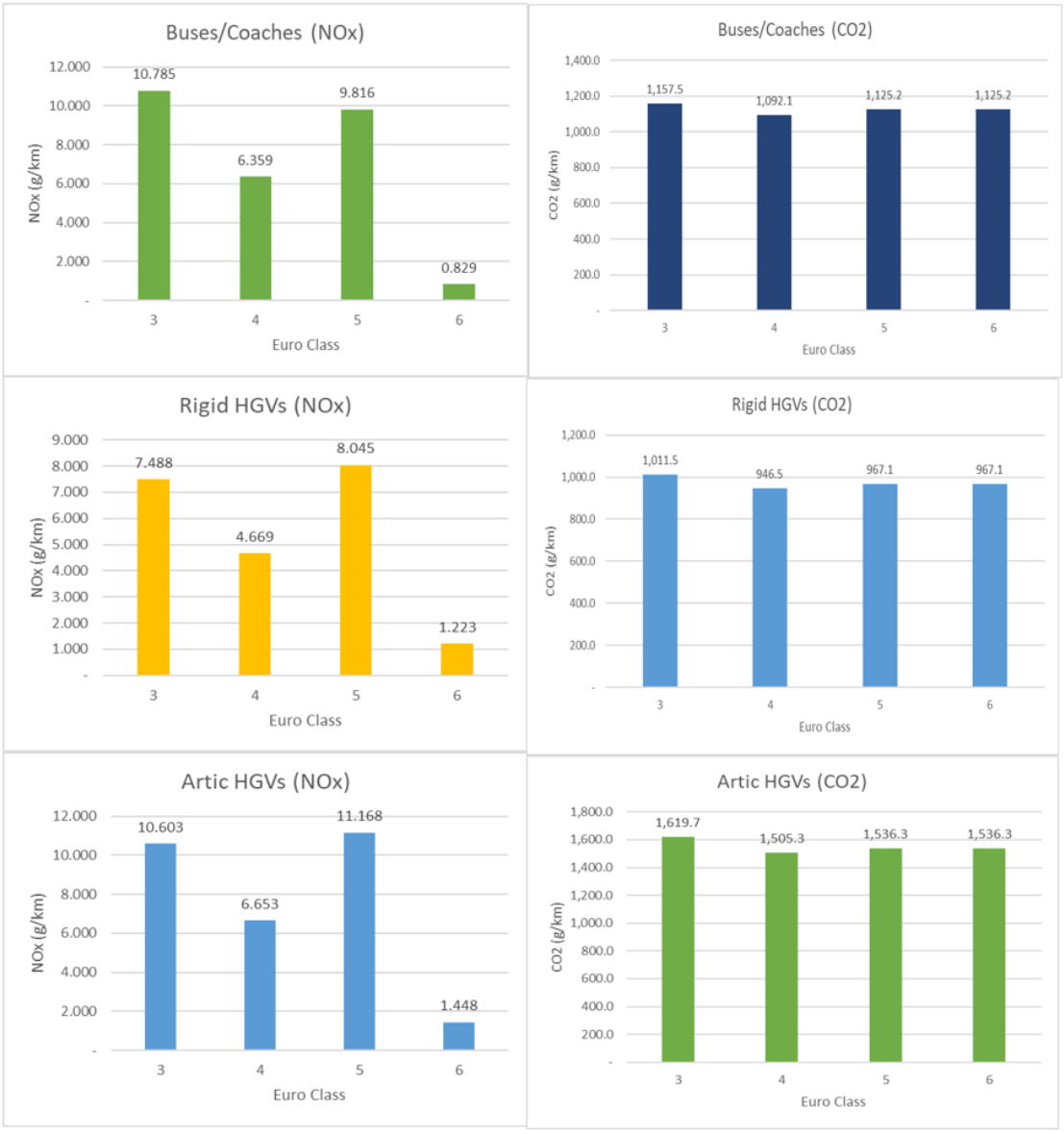

Figure 2: NO_x and CO_2 emission factors for Buses and HGV's

Section 2: Carbon Dioxide Emissions in Edinburgh NMF Model

Using the same methodology as was used to calculate NO_x and PM emissions in the National Modelling Framework (NMF), CO_2 emissions have been calculated for each road in the model. Note that this analysis only considers roads in the Edinburgh NMF model and should not be considered as total road traffic CO_2 emissions for the entire City of Edinburgh.

In this analysis it is assumed that all Buses and Taxis will be compliant (as is the case for the LEZ scenarios in the main report). A comparison has been made with the Base and LEZ scenario.

CO_2 emissions for LEZ

When looking at all the roads in the model, the net result is that there is negligible difference (0.04%) in CO_2 emissions due to the introduction of the LEZ (Figure 3).

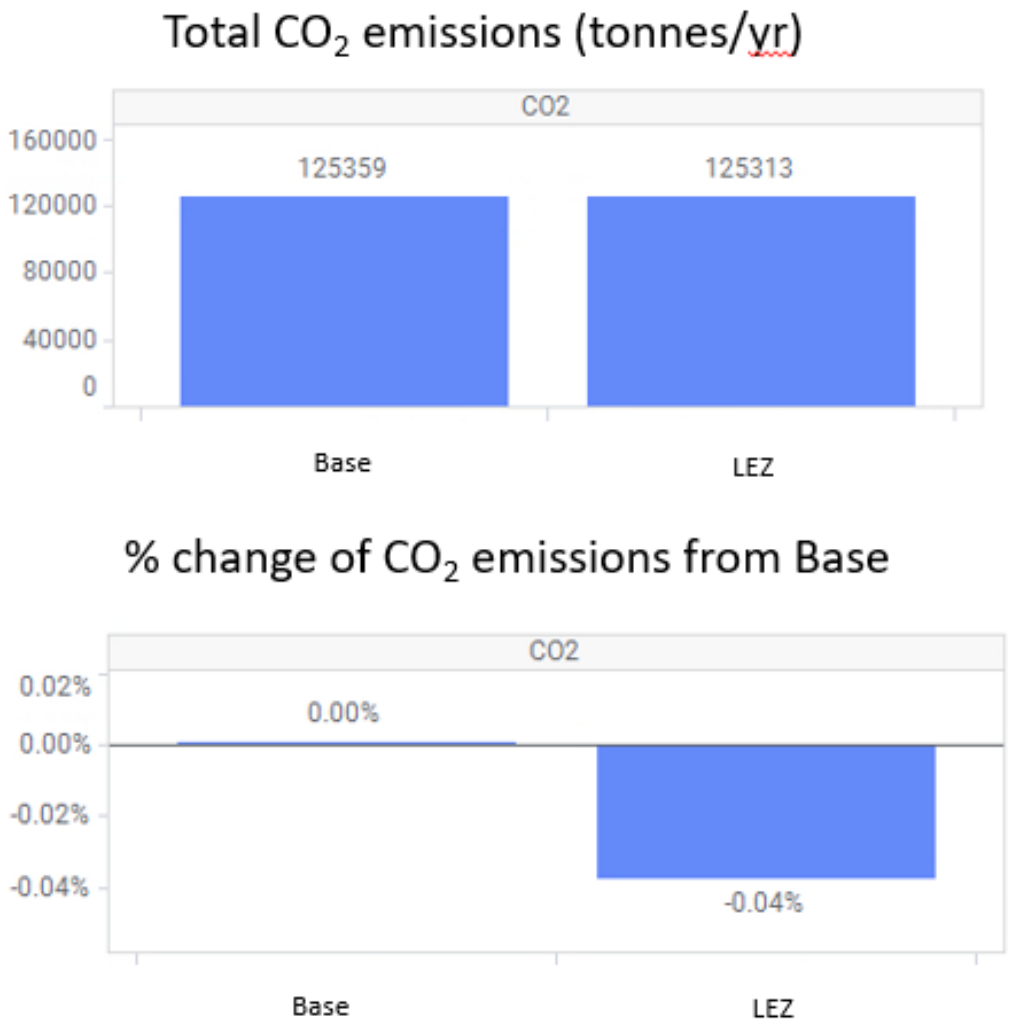

Figure 3: CO_2 emissions (tonnes per year) and percentage change from the Base scenario for 2 scenarios (Base, LEZ) for all roads in model

CO_2 emissions changes for Other Scenarios

Extended Urban Areas LEZ option – all roads in model

In this scenario, due to no traffic modelling data being available, it has been assumed that traffic flows are the same as the Base scenario. The fleet composition reflects the rules for this scheme (all vehicles compliant within the city centre boundary; all non-private cars compliant in rest of city).

A small reduction (0.58%) in CO_2 emissions is predicted when compared to Base (Figure 4).

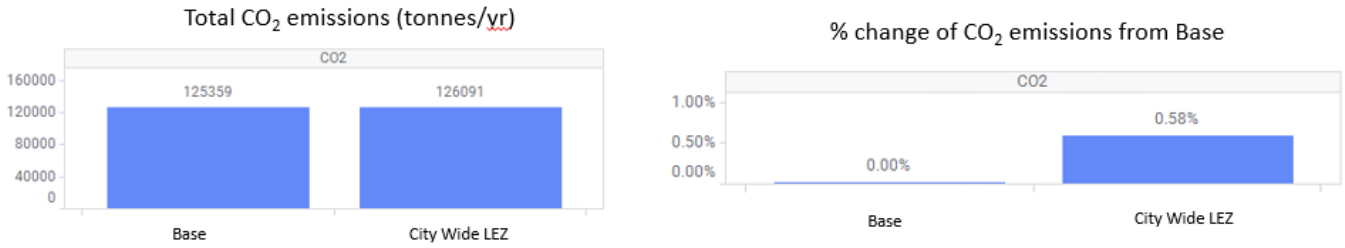

Figure 4: CO_2 emissions (tonnes per year) for 2 scenarios (Base and City Wide LEZ)

All Vehicles Compliant – all roads in model

In this hypothetical scenario, it is assumed that all vehicles are compliant (the highest Euro Class possible has been selected). The difference between this case and the Extended Urban Areas LEZ scenario is that all cars are considered compliant. Like the Extended Urban Areas LEZ, it is assumed that traffic flows are the same as the Base scenario

A small reduction (2.5%) in CO_2 emissions is predicted when compared to Base (Figure 5).

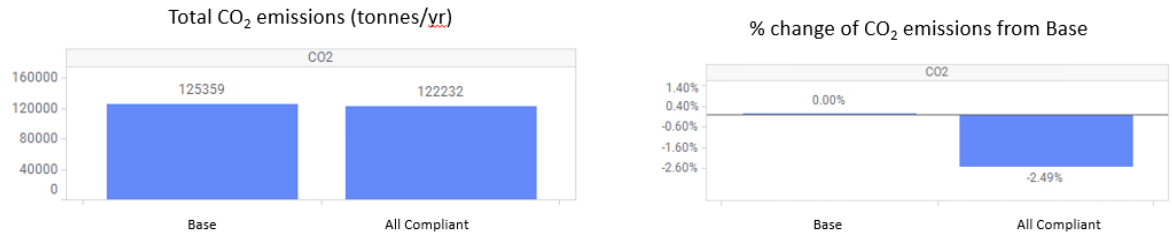

Figure 5: CO_2 emissions (tonnes per year) for 2 scenarios (Base and All Vehicles Compliant)

10% Reduction in Car Traffic – all roads in model

In this hypothetical scenario, it is assumed that 10% of cars are removed from each road section in the model for the City Wide/Extended Urban Areas LEZ and City Centre LEZ.

A reduction of 5.4% in CO_2 emissions is predicted for the City Centre LEZ option when compared to the Base (Figure 6). This is a slightly larger reduction than the City Wide LEZ option where a 4.8% reduction in CO_2 emissions is predicted when compared to the Base.

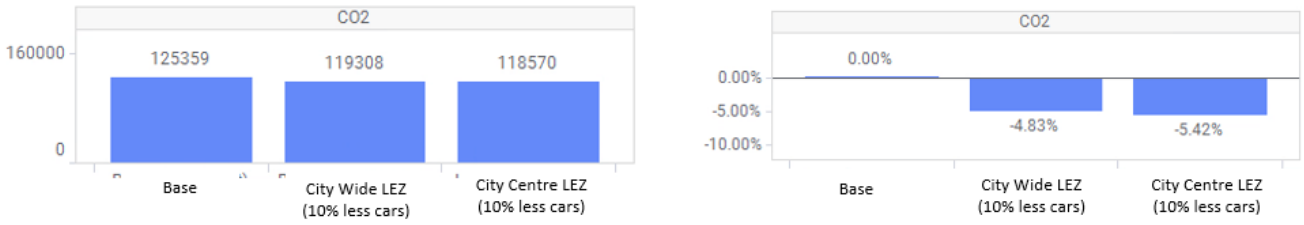

Figure 6: CO2 emissions (tonnes per year) for 3 scenarios (Base, City Wide LEZ less 10% cars and City Centre LEZ less 10% cars)

Summary of CO_2 emissions

It is predicted that there will be a negligible change in total CO_2 emissions (0.04% reduction) due to the introduction of the LEZ.

If the Extended Urban Areas approach was selected, it is predicted there will be a small increase in CO_2 emissions of about 0.6%. This is in part due to Euro 6 HGV/Buses emitting slightly more CO_2 than older vehicles.

Even in the hypothetical scenario where all vehicles are compliant, there is only a small reduction in CO_2 emissions of around 2.5%. This is mostly due to lower CO_2 emissions from newer cars.

The most effective way to reduce CO_2 emissions is to reduce fossil fuel vehicles on the road or replace with non-fossil fuel powered vehicles.

Section 3: Expanding LEZ boundary to include Calton Hill

We are not proposing to run the air quality model to account for any extension to the LEZ boundary which includes Regent Road and Royal Terrace (Calton Hill) because:

- Air Quality modelling on Regent Road predicts that air quality is compliant with air quality standards.
- The modelling was based on the LEZ boundary at the roundabout where Waterloo Place and Regent Road meet at St Andrews house. Traffic modelling used in air modelling scenarios assumes that non-compliant traffic is diverted along Queen Street, London Road and Easter Road to Abbeyhill. This will remain unchanged in the new scenario, and therefore changes in traffic flow and air quality along the LEZ diversion route will be negligible.
- Therefore, the current air quality modelling will be applicable to the scenario which includes Regent Road and Royal Terrace (Calton Hill).

Section 4: Expanding LEZ boundary to include Haymarket

If the LEZ boundary was extended to include Haymarket, a new air modelling assessment would be required because:

- A diversion route around the LEZ boundary is likely to include Ravelston Dykes, Roseburn, Balgreen Road and Gorgie Road. High vehicles may be required to divert even further due to low bridges, with Meadow Place Road being the nearest suitable alternative route.
- At some of these locations, air quality has not been compliant with air standards in previous years. There is therefore a risk that at some of these locations, air quality concentrations may increase.
- There is a risk that where air quality standards are now being achieved, increased traffic flows may result in a return to non-compliance.
- Therefore, new modelling would be required to assess any large changed to the boundary which includes Haymarket. This could take up to 6 months.
- Additionally, if the LEZ is larger, more vehicles will be required to divert around the LEZ boundary and the total vehicle kilometres will increase. This will result in increased overall CO_2 emissions.

Appendix 3 - Network Management Strategy (NMS)

1.1 In response to analysis of air quality (NO_2) and traffic modelling undertaken by the Scottish Environment Protection Agency (SEPA) and consultation with key stakeholders, potential displacement impacts and mitigations have been identified, as part of a wider Network Management Strategy (NMS).

1.2 Central to the NMS is to monitor and evaluate displacement impacts strategically around the entire boundary following an evidence-led approach, before specific solutions can be identified.

1.3 Consultation and engagement highlighted additional areas at/near to the boundary for which enhanced monitoring and evaluation could be utilised to inform the process of identifying potential solutions, as outlined below. Convincing evidence and wider stakeholder support for such solutions is required

1.4 Mitigation measures across all areas, including the West End, north-east and south-east, alongside previously identified measures will be further developed, following an evidence-led approach and with stakeholder support.

1.5 All mitigation measures will be delivered before LEZ enforcement begins in June 2024 and in line with other project programmes.

1.6 Intelligent Infrastructure Project (Smart Cities) will install new, moveable air quality monitoring sensors across Edinburgh's AQMAs and the LEZ. It will also install fixed camera locations (public CCTV), to analyse traffic flows. It is anticipated that project delivery will commence from December 2022 and synergies with the LEZ NMS will be sought throughout its project lifecycle to support Scheme evaluation.

West End

1.7 The West End (generally but not exclusively streets between the A8 at Haymarket Terrace and A90 at Queensferry Road) has been previously cited as an area of concern by stakeholders. The area has long-standing and historic traffic patterns and serves key routes within the city centre, despite its residential character. Potential displacement impacts of LEZ in this location should be considered strategically and in relation to wider complexities of citywide network management.

1.8 Officers recommend exploring potential solutions in the West End, considering that further traffic modelling assessments and stakeholder support would be required before design and implementation and that there are other significant projects planned in this area (CCWEL).

1.9 LEZ will collaborate with CCWEL to collect further traffic modelling evidence to inform any future potential impacts the Scheme will have on the road network. Evidence from future traffic modelling and surveys could be used to

determine a separate project, using instruments such as Experimental Traffic Regulation Orders (ETROs).

1.10 An interim solution for Tollcross Junction is being costing in the first instance, logical and effective diversion route for non-compliant traffic. Measures being costed include, re-alignment of kerbs/resizing of island, repositioning of bollard and signal heads and carriageway patch. It is recognised that a major overhaul of Tollcross Junction is required in the long term.

1.11 Changes to Morrison Street are being costed to provide a logical and effective diversion route for non-compliant traffic. Measures being costed include redesign of junction at Morrison Link/Morrison Road, redesign of junction at Torphichen Street/Morrison Street/Gardner's Crescent and road markings on Morrison Street to permit two-way traffic. Any changes would consider other requirements such as for loading and taxi rank access.

1.12 LEZ will continue engagement with Tollcross Primary School and other stakeholders in the area around planned Active Travel measures, in relation to LEZ delivery timelines.

North-East

1.13 The NMS will take on board key stakeholder concerns about displacement impacts around Calton Hill and Holyrood Park, including Historic Environment Scotland

1.14 A signposted diversion route will be made around the whole Scheme boundary. In the north-east this will follow London Road and Abbeyhill/Abbeymount to mitigate potential displacement impacts through residential areas on Calton Hill.

South-East

1.15 At Preston Street Primary School mitigations will be explored to address concerns relating to safety, improving amenity for school children and parents following lessons learned by Travelling Safely measures already in place.

1.16 Preliminary analysis has outlined various potential measures including but not limited to: permanent widening of pavements around the school, prioritisation of traffic signalling around school pick up/drop off times to pedestrians, additional traffic calming measures and others.

1.17 Such measures will be delivered as part of the Road Safety programme, in collaboration with the LEZ.