Emissions screening assessment of the long list of measures

LestAir Technical Paper 3

Report for Leicester City Council

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1 Introduction

This paper sets out a brief review of the emissions modelling results for the long list of measures that were defined in the previous task. The measures modelled are summarised below. The emissions results are set out in the follow sections:

- Baseline results for 2011 and 2016
- The regulatory LEZ scenarios
- Bus scenarios
- HGV scenarios
- Area wide measures

Brief conclusions are drawn and a recommend package a LES measures proposed for the CBA analysis.

1.1 Modelled scenarios

A range of scenarios were developed and agreed with LCC to take forward into this modelling phase. The scenarios were grouped as:

- LEZ regulatory scenarios as potential formal LEZ options,
- Bus scenarios to reflect the core of a bus emissions strategy
- HGV scenarios to reflect the core of an HGV emissions strategy
- Area wide measures reflecting some wider measures applied across the city

These scenarios are summarised in Table 1 below. In addition to the agreed scenarios one additional scenario was added as a refinement of the Bus 1 voluntary emission standard. The Bus 1 retrofit scenario assumes the same Euro 4 threshold but compliance is entirely by SCR retrofit along the lines of the 'Clean Bus Technology Fund' project being implemented in Leicester.

Table 1 Long List Modelling Scenarios

ID	Measure	Description
Regulatory LEZ		
Corridor based LEZ		LEZ defined for key corridors (AQMA) into Leicester. Applies to bus and HGV and is regulated by ANPR.
LEZ1	Base LEZ	Euro 3 standard for all Bus and HGV in 2016
LEZ2	Mid LEZ	Euro 4 standard for all Bus and HGV in 2016
ULEZ	Ultra low Emission Zone	Euro 6 standard for all bus and HGV by 2016. Sensitivity scenario to see what highest Euro standard could achieve.
EcoPass system		Normal LEZ is applied to all bus lanes on key corridor. Emissions charging scheme is applied to HGVs – target emission limit is free, two charges for low emission standards
EP1	Base EcoPass	Bus at Euro 4 HGV Euro4 – free HGV Euro2-3 –Low charge, shift 50% to Euro 4 + HGV <Eruo2 – High charge, shift 70% to Euro 4 +
EP2	Ultra Low Ecopass	Bus at Euro 6 HGV Euro6 – free HGV Euro3-6 – Low charge, shift 50% to Euro 4 + HGV <Eruo3 – High charge, shift 70% to Euro 4 +

Bus strategy measures		
Bus 1	Voluntary emission standard	Agree a voluntary emission standard for all buses operating in the city. Set standard to Euro 4 of better. Assume 80% compliance.
Bus 1 Retrofit	Partnership working to roll out SCR retrofit	Essentially the same as bus 1 above but compliance is do entirely through retrofit, with the Council supporting the retrofit programme,
Bus 2	Gas bus scheme	Gas buses operating from the main Arriva depot. Apply to Melton road and Devonshire road. Also apply to Uppingham road to compare with TRL work.
Bus 3	Quality corridor measures	Use approach for Aylstone corridor to estimate roll out to all corridors.
Bus 4	Ecodriving scheme	Assume a roll out to all bus use in city. Long term average improvement on CO_2 assume to be 6%.
Freight strategy measures		
HGV1	Voluntary emission standard	Agree a voluntary emission standard for all HGVs operating in the city. Set standard to Euro 4. Assume 50% compliance.
HGV2	CNG HGV scheme	CNG scheme linked to bus depot. Assume 30% of HGV's are gas on the same corridors as used for gas bus scenario.
HGV3	Low emission delivery bays	All loading bays in central area are low emission. Need to be Euro 4 or better to use. Compliance by traffic warden. Assume 80% compliance. Assume 15% of HGVs on roads coming in access the centre.
HGV4	Low emission freight corridor	Freight only route into the city on Glenfield road. Assume 50% HGVs on Hinckley road and Gorby road use this route and 30% of HGVs on Narborough road. Assume 100% car traffic shifts to adjacent routes (Hinkley and Gorby, split equally). HGV's using route are Euro 4 or better
HGV5	DSP	Assume target rollout to affect 20% of businesses in area. Estimate a 15% reduction in traffic for this group. Gives estimated freight traffic reduction by 3%.
HGV6	Ecostars/eco driving	Roll out of driver training through Ecostars. Assume 50% of fleet work with scheme. Assume 6% improvement in fuel use for this group, gives 3% overall.
Area measures		
Taxi1	Taxi emission standards	Euro 4 for all taxi's. Assume taxi flows are 2% in centre 1% elsewhere.
Taxi2	Ecodriving for taxis	Assume 50% of fleet work with scheme. Assume 6% improvement in fuel use for this group, gives 3% overall. Assume taxi flows are 2% in centre 1% elsewhere.
EV	EV strategy for cars and vans	Consider current plugged in places work, explore ideas around low cost EV parking and related infrastructure. Also link to planning on EV charge points. Model EV target – 3% of all cars and vans
Smart	General smarter choices package	This can be considered as an overall target for trip reduction. Suggest 3% overall to match bus measures in Bus3 and to present non-bus measures. Could do 5% as sensitivity test.

1.2 Methodology

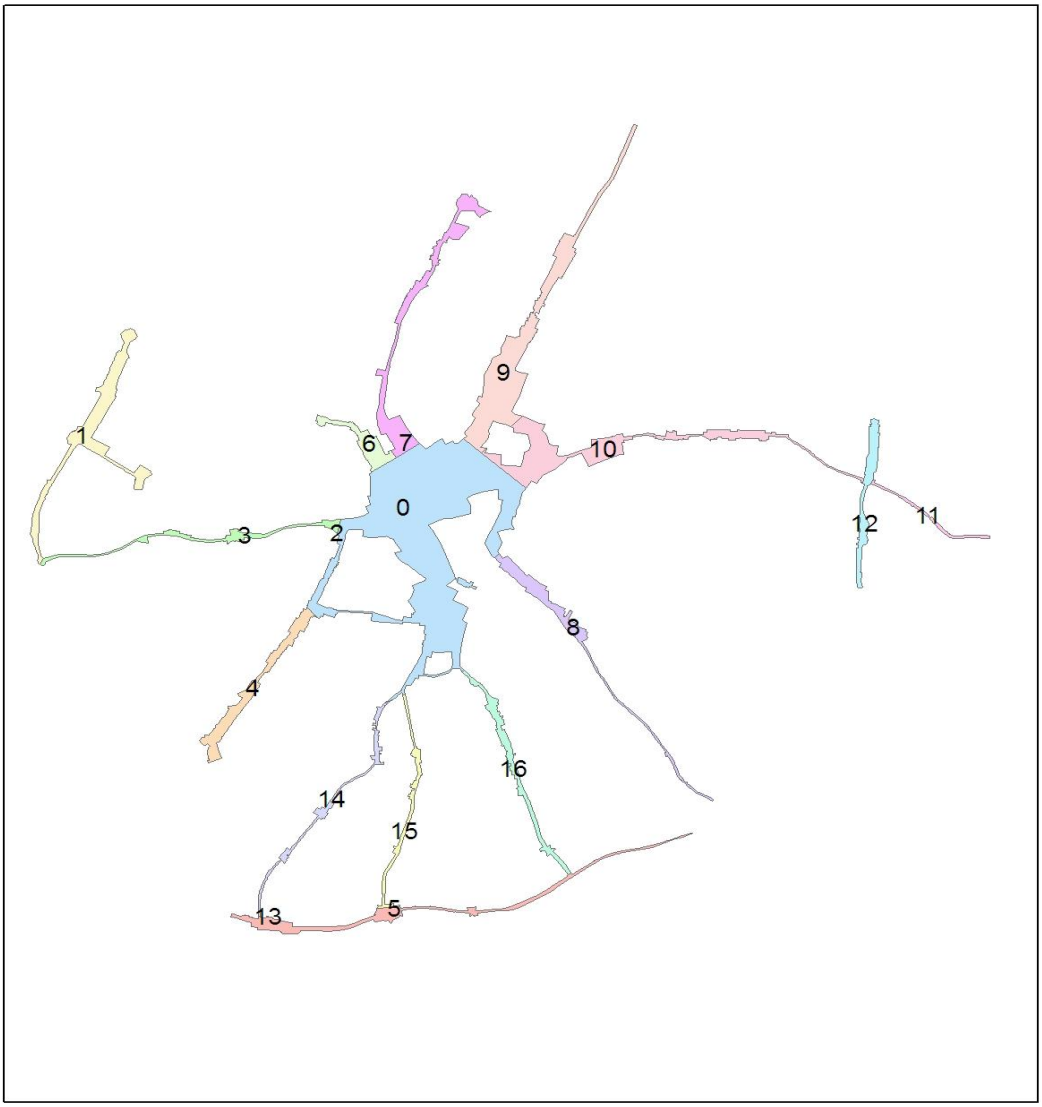
Details on of the emissions modelling approach are provided in a previously provided working paper. In summary the key points of the method are:

- Traffic data is taken from the Leicester and Leicestershire Integrated Transport Model (LLITM)

- Vehicle fleet data is taken from DfT classified counts on key roads and the NAEI Euro distribution, with the exception of the bus fleet which is taken from the TRL Bus Emission Study
- Speed data is taken from Traffic Master information supplied by LCC
- Emissions modelling is done with the DEFRA Emission Factor Toolkit (EFT)

The emissions are modelled for all the links in the LLITM, but to simplify the analysis the results have been group for the AQMA and individual zones within the AQMA as illustrated in Figure 1 below.

Figure 1 AQMA and summation zones used in the emissions modelling



0	Central	9	Melton Road
1	New Parks Way	10	Humberstone Road
3	Hinckley Road	11	Uppingham Road
4	Narborough Road	12	Goodwood Road
5	Asquith Way	14	Aylestone Road
6	Groby Road	15	Saffron Lane
7	Loughborough Road	16	Welford Road
8	London Road	2&13	Unassigned

2 Emissions baseline

The baseline emissions modelling was done for:

- 2011 baseline – giving an estimate of the current situation and used with the monitoring data to provide the source apportionment results already provided.
- 2016 baseline – providing a 'do-nothing' forecast based on the LLITM traffic flows and the fleet composition changes from the NAEI, with the exception of the buses.

In addition a 2016 sensitivity case was carried out which assumes that Euro 6/VI does not provide the emissions benefit expected but performs the same as Euro 5/V. This was done as Euro 6/VI vehicles have a significant impact on the results and their real world performance is yet to be proved.

2.1 Baseline fleet composition

In order to help understand the results is is useful to look at how the fleet composition, in terms of Euro standards is reflected in the modelling and how it changes between 2011 and 2016. These data are shown in Table 2 and figures 2 and 3 below. As noted above all vehicles except buses use the distribution in the NAEI and EFT. The buses are based in TRL data

Table 2 Euro fleet distribution 2011 and 2016

	2011					2016				
	Petrol Cars	Diesel Cars	Rigid HGV	Artic HGV	Buses	Petrol Cars	Diesel Cars	Rigid HGV	Artic HGV	Buses
Euro 0	4%	0%	0%	0%	1%	1%	0%	0%	0%	0%
Euro 1	2%	1%	0%	0%	1%	0%	0%	0%	0%	0%
Euro 2	10%	4%	8%	2%	19%	2%	0%	0%	0%	4%
Euro 3	38%	28%	35%	21%	68%	16%	9%	10%	2%	35%
Euro 4	36%	47%	25%	27%	7%	29%	25%	10%	4%	19%
Euro 5	11%	20%	32%	50%	3%	35%	44%	33%	31%	34%
Euro 6	0%	0%	0%	0%	0%	17%	21%	47%	64%	8%
Total check	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Figure 2 Euro fleet distribution for 2011

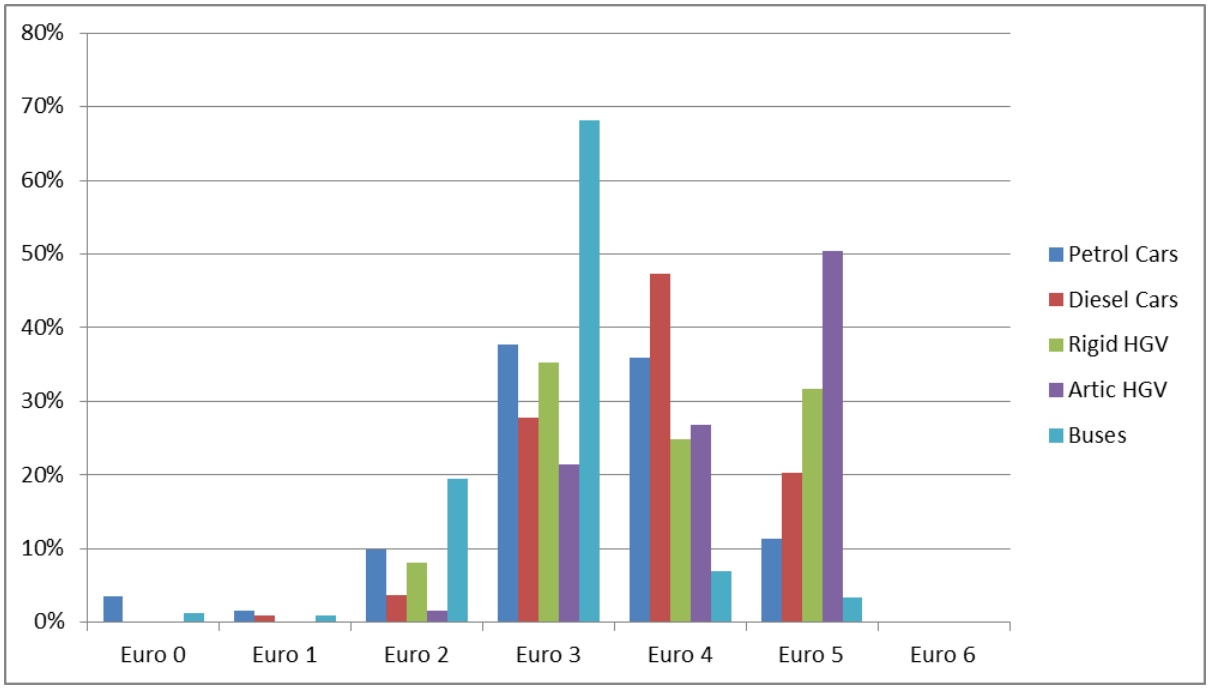
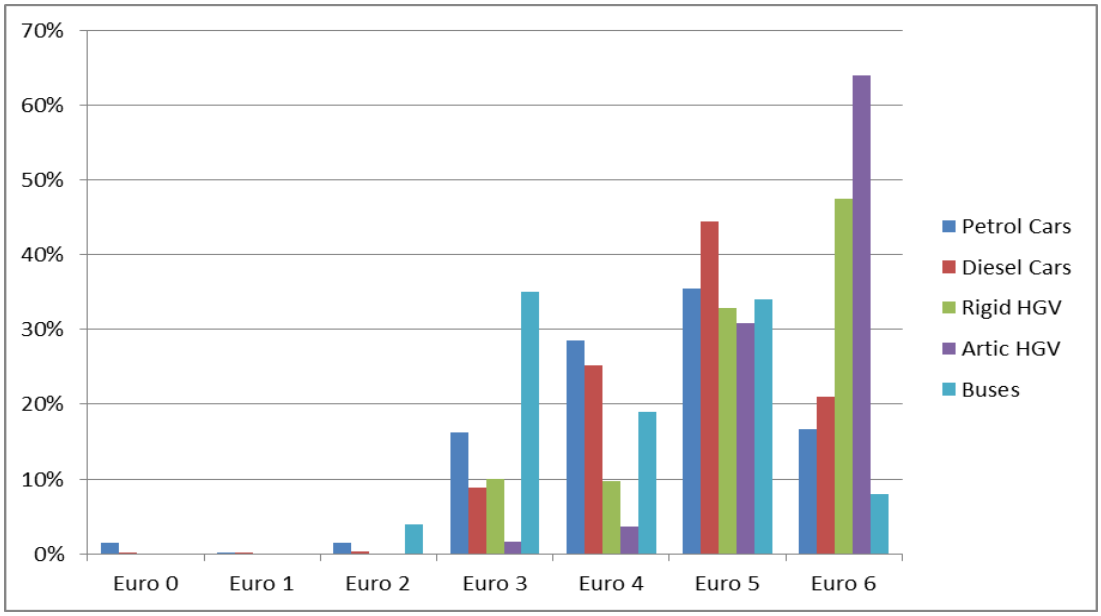


Figure 3 Euro fleet distribution for 2016



In terms of the buses the TRL data suggests that they are significantly older than the national average, by as much as 4 years. So for the bus fleet we have used the actual TRL data, from their ANPR counts, for the 2011 base year and the slightly adjusted NEAI 2012 profile to reflect how the bus fleet would be in 2016.

With regards the 2016 fleet profile an import point is the significant proportion of the fleet that is expected to be Euro 6/VI. This is especially true for the HGV's with 47% of rigids and 64% of artics being Euro VI. This has a big impact on the results for diesel vehicles as the Euro 6/VI emission factors for NOx are significantly lower than Euro 5/V vehicles. This is because the Euro 5/V vehicles are now widely accepted to have not performed in real world and this has been reflected in the emission factors. The expectation is that Euro 6/VI will perform due to the new in-use compliance testing. However, their true performance still remains to be seen.

To help assess the impact of this we have also run a sensitivity analysis with a scenario where we assume all Euro 6/VI vehicles only perform the same as Euro 5/V. This scenario is labelled 2016 baseline Euro5 in the analysis.

2.2 Baseline emissions results

The baseline results are summarised here in relation to road links in the AQMA. The results show the percent reduction in emission from 2011 to 2016, and are shown in relation to the main 2016 baseline and the 2016 Euro 5 sensitivity scenario.

Table 3 Emission reductions 2011 to 2016 baseline scenarios

	Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Rigid HGV	Artic HGV	Bus/Coach	Total
Reduction 2011 base to 2016 base								
Nox	53.2%	-4.9%	50.3%	22.4%	41.3%	57.2%	22.5%	23.5%
PM25	13.7%	4.8%	29.1%	40.2%	35.8%	40.2%	30.1%	20.7%
PM10	13.6%	-7.3%	28.7%	29.4%	25.3%	29.1%	23.0%	12.5%
CO2	20.6%	-31.6%	28.7%	-7.9%	-5.4%	-5.6%	-6.3%	-0.4%
Reduction 2011 base to 2016 base Euro 5								
Nox	53.2%	-16.9%	50.3%	16.4%	3.1%	3.8%	11.3%	7.5%
PM25	13.7%	4.8%	29.1%	40.2%	35.8%	40.2%	29.1%	20.6%
PM10	13.6%	-7.3%	28.7%	29.4%	25.3%	29.1%	22.1%	12.4%
CO2	20.6%	-31.6%	28.7%	-7.9%	-5.4%	-5.6%	-6.3%	-0.4%

Figure 4 Emission reductions 2011 to 2016 baseline

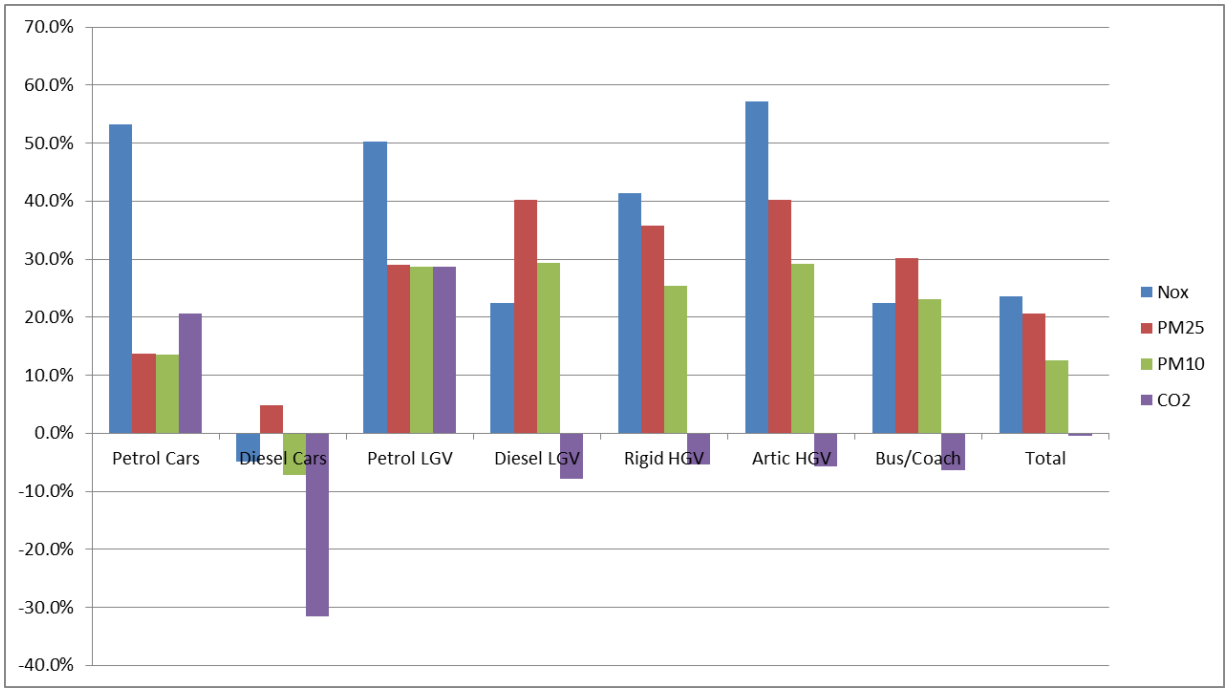
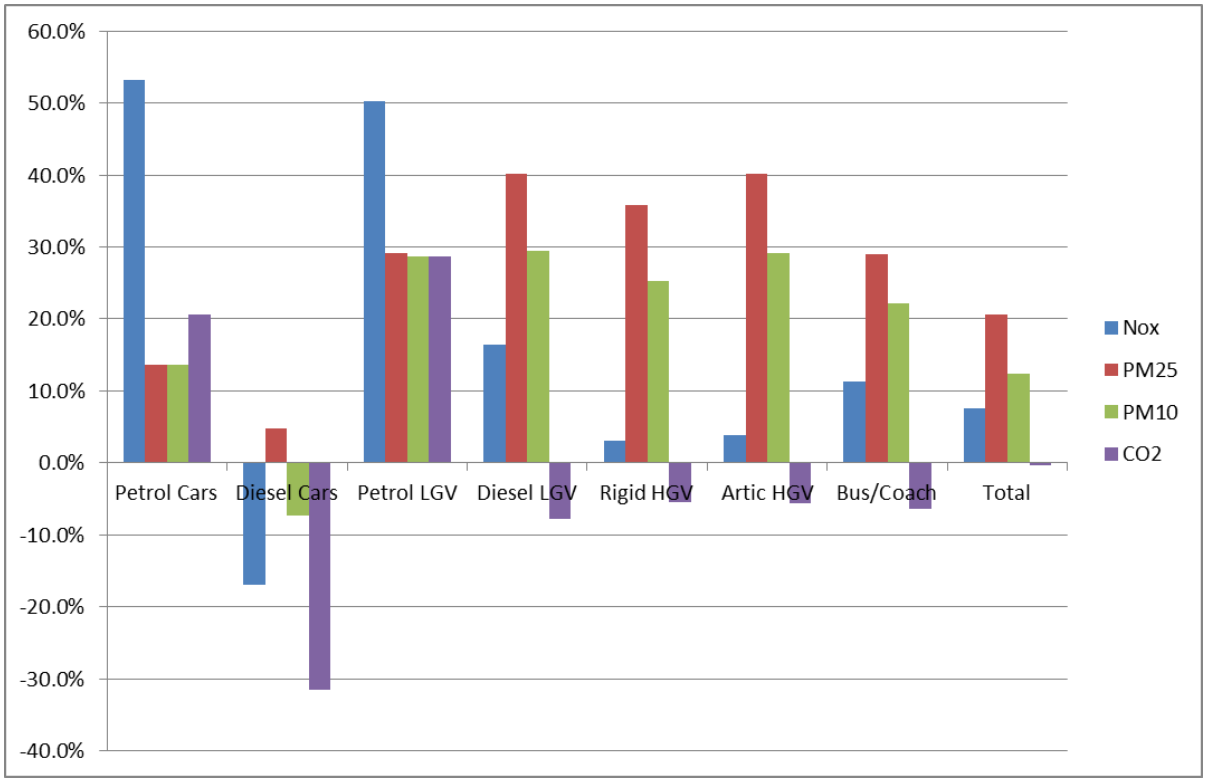


Figure 5 Emission reductions 2011 to 2016 baseline Euro 5 sensitivity scenario



The comparison with the main 2016 baseline shows a significant reduction in emissions in the AQMA from 2011 to 2016 with reduction of 23% in NOx, 20% in $PM_{2.5}$ and 12% in PM_{10}. There are significant reductions across all vehicle types except diesel cars. The reduction are particular significant for HGV's and petrol cars. The results for cars reflect a growth in the diesel car park, the particular poor performance of Euro 4 and 5 diesel cars and good

performance of petrol cars. The results for HGV's reflect the better performance of Euro standards with heavy vehicles and the significant proportion of Euro VI vehicle sin the fleet.

The results when compared to the Euro 5 sensitivity scenario only show a difference with respect to NOx emissions. In this case the overall reduction compared to 2011 is only 7%, with minimal reduction in emissions from HGV's and a significant increase in emissions from diesel cars. These results show the impact of Euro 6/VI vehicles on the results. If their real world performance is as hoped then they will have significant benefits for air quality in cities.

In all cases there is no real improvement in CO_2 emissions.

For the remaining analysis the emission reductions are shown only in relation to the 2016 baseline. Therefore in assessing these results we need to bear in mind baseline data and the Euro distribution set out above.

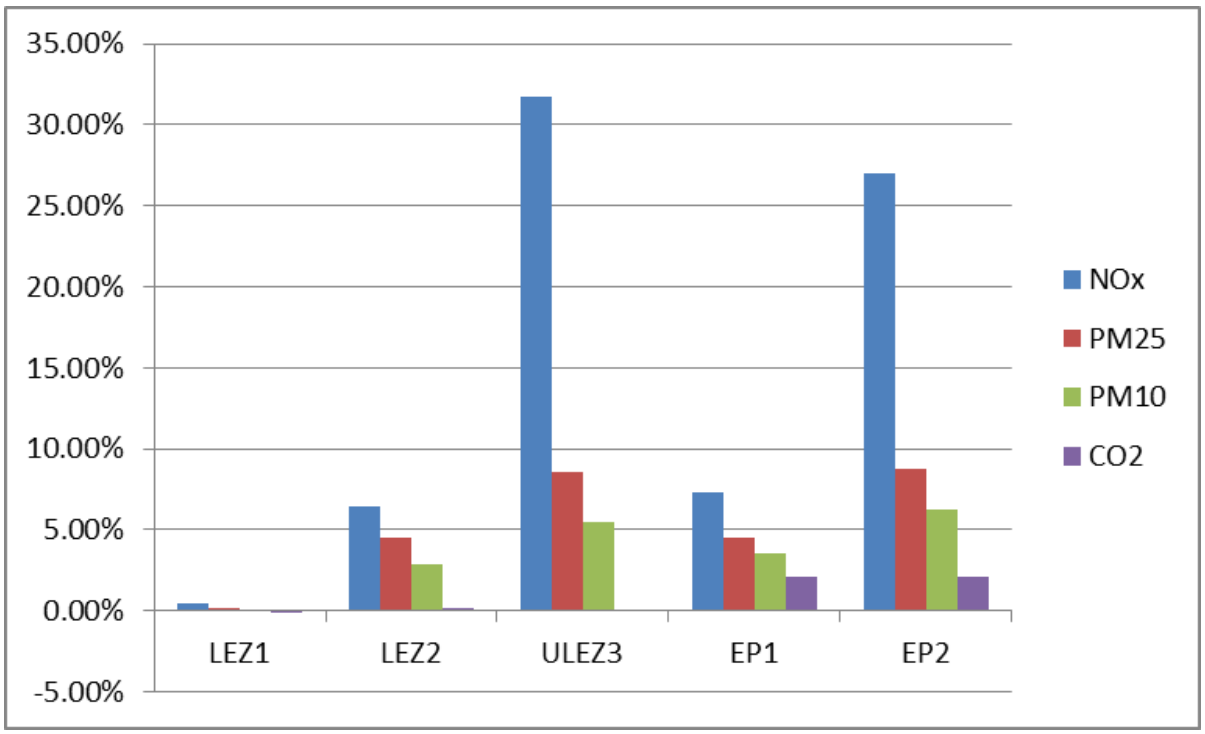
3 Regulatory LEZ scenarios

Five regulatory LEZ scenarios have been model:

- LEZ 1 – a bus and HGV LEZ with a minimum standard of Euro III
- LEZ 2 - a bus and HGV LEZ with a minimum standard of Euro IV
- ULEZ - a bus and HGV LEZ with a minimum standard of Euro VI
- EP1 – a standard LEZ for buses and a pricing based LEZ for HGV's with a standard of Euro IV
- EP2 - a standard LEZ for buses and a pricing based LEZ for HGV's with a standard of Euro VI

The reduction in emission for the AQMA against the 2016 baseline are shown in Figure 6 below.

Figure 6 Reduction in emissions in the AQMA for the LEZ scenarios



The Euro III LEZ (LEZ1) will have virtually no impact with reductions in NOx emissions of 0.43% and PM emissions of less than 0.15%. This is because by 2016 very few vehicles will be below the threshold Euro 3 standard.

The Euro IV LEZ provides a useful reduction in emissions of 6.4% for NOx, 4.5% for $PM_{2.5}$ and 2.9% for PM_{10}. The EP1 scenario with the same Euro standard has a similar impact, but slightly larger impact. The slight increase is due to the traffic reduction assumption of the pricing aspect of the scheme. The traffic reduction also provides a CO_2 benefit. These schemes are likely to be the most practical scheme in terms of Euro limit set.

The ULEZ3 and the EP2 scenarios show significant NOx savings of 31% and 27% and PM savings of 5%-8%. This reflects the significant impact of Euro VI vehicle standards and when combined with the reduction from 2011 to 2016 could show emission reduction of the order of 50% for NOx.

The follow scenarios are consider as an alternative to a full formal LEZ scheme.

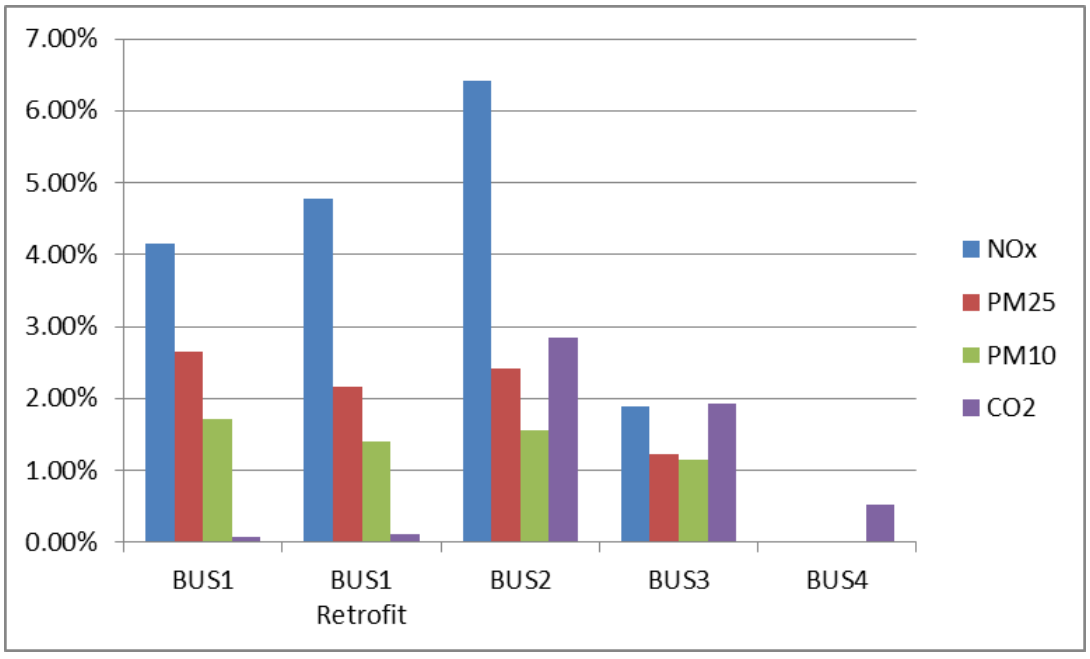
4 Bus scenarios

The bus scenarios that were modelled are as follows:

- Bus 1 – a voluntary Euro IV emission standard agreement with bus operators with an 80% compliance rate
- Bus 1 retrofit – as above the compliance done through a retrofit programme such
- Bus 2 – s scheme for biomethane buses operating on three AQMA corridors: Melton Road, Devonshire Road and Uppingham Road
- Bus 3 – quality bus corridor schemes in line with the Aylstone corridor scheme on all the AQMA corridors
- Bus 4 – Eco-driver training rolled out to all bus drivers

The emission reduction results for these scenarios with regards the AQMA are shown in 7 below.

Figure 7 Reduction in emissions in the AQMA for the Bus scenarios



The bus 1 and bus 1 retrofit scenarios show similar benefits as might be expected. The retrofit scenario has slightly higher NOx savings from the full uptake of the SCR retrofit systems, but slightly lower PM benefits. They also show similar if slight lower benefit compared to the LEZ 2 scenario, as they as based on the same Euro standard. It also shows that the majority of the benefit from the LEZ 2 scenario is generated by bus emission saving.

The biggest NOx benefit is for the biomethane bus scenario bus 2, with a 6.4% reduction in NOx emission for the AQMA as a whole. The gas buses effectively operate at Euro VI emissions performance and so offer very low emissions. The scenario assumes full uptake, so a full renewal, of the bus fleet to gas buses on three corridors. Therefore on these specific corridors the benefits are much more substantial with NOx savings as follows:

- Devonshire (zone 7) – 7% reduction
- Melton (zone 9) – 18% reduction
- Humbestone/Uppingham (zone 10) – 26% reduction

Also being a biofuel this scenario will generate significant CO_2 savings.

The quality bus corridors provide a useful emission saving between 1 and 2%, which is largely related to the traffic reduction benefits of the scenarios on these corridors. The eco-driving scenario provide a simple reduction in bus CO_2 emissions with generate a 0.5% saving across the AQMA as a whole.

5 HGV scenarios

The results of the HGV scenarios are shown in Table 4 below and cover 6 measures:

- HGV1 – a voluntary Euro IV emission standard with an assumed 50% compliance
- HGV2 – a gas HGV scheme operating along the same three corridors as for the bus scheme but with only 30% of HGV participating
- HGV 3 – a low emission delivery bay scheme for the centre which would affect an estimated 15% of fright movements in the city
- HGV 4 – a low emission freight corridor on the Glenfield road
- HGV5 – a programme of delivery and servicing plans rolled out in the AQMA to reduce fright movements by an estimated 3%
- HGV 6 – an eco-driver scheme as part of a programme such as Ecostars

Table 4 Reduction in emissions in the AQMA for the Bus scenarios

Scenario ID	NOx	PM25	PM10	CO2
HGV1	0.77%	0.62%	0.40%	0.02%
HGV2	0.75%	0.17%	0.17%	0.49%
HGV3	0.23%	0.19%	0.12%	0.00%
HGV4	-0.01%	0.02%	0.01%	-0.05%
HGV5	0.89%	0.72%	0.71%	0.70%
HGV6	0.00%	0.00%	0.00%	0.31%

Overall the impact of any of these schemes for the AQMA as a whole seems limited. The two key reasons for this would appear to be:

- By 2016 the HGV has significantly improved as noted in section 2, so that any Euro standard limits are already largely complied with in the baseline scenario and the fleet is already significantly cleaner than in 2011;
- We are assuming a much lower level of compliance/participation with these voluntary schemes as there will be a wide range of operators to engage with.

The low emission freight corridor on the Glenfield road seems to have no real effect at all for the AQMA as a whole. The emissions are redistributed rather than significantly reduced. There is a small (1%) reduction on the Hinckley and Gorby roads associated with a shift of HGVs from these roads but reduce by shift of cars from the Glenfield road. There is then an increase of some 3% in emissions on New Parks as HGVs adjust their routes to use the Glenfield Road.

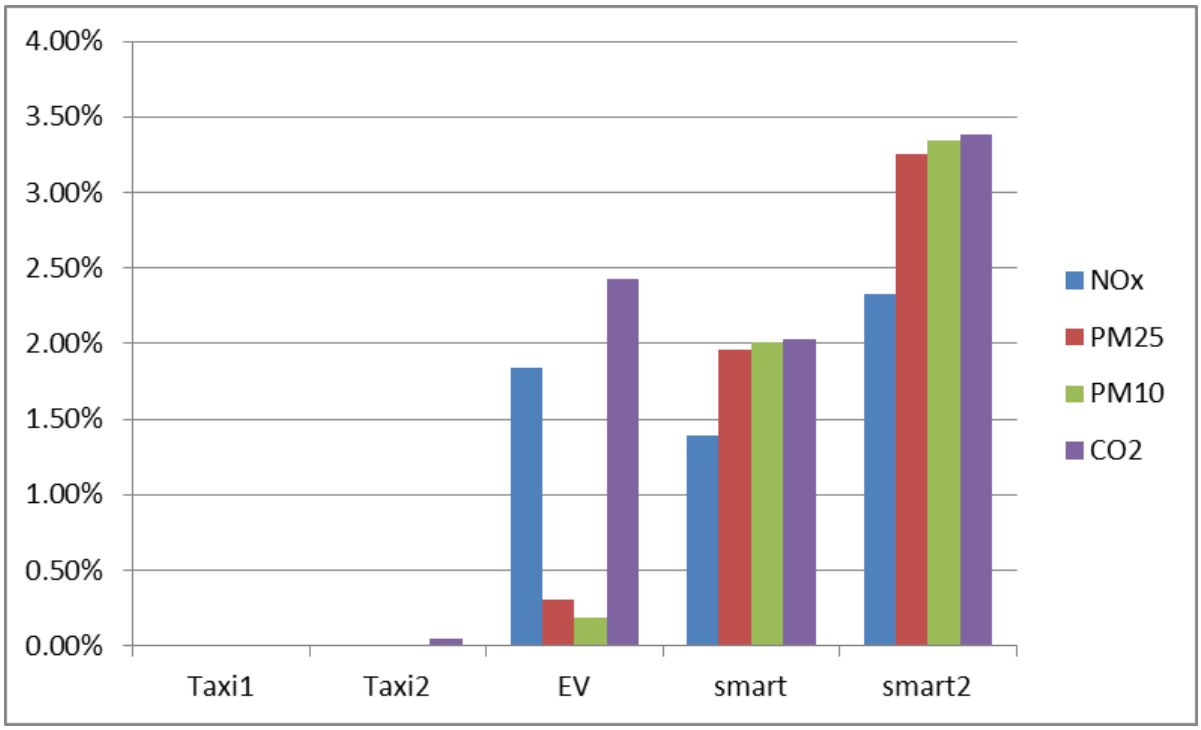
6 Area wide scenarios

The area wide scenarios comprised the following:

- Taxi 1 – a Euro 4 standards for all taxis
- Tax 2 – an ecodriving scheme for taxi drivers
- EV – a 3% uptake of EV's in the light duty fleet (cars and vans)
- Smart 1 – a 3% reduction in car traffic due to 'smarter choices' type measures
- Smart 2 - a 5% reduction in car traffic due to 'smarter choices' type measures

The results for these scenarios are shown in figure 8 below.

Figure 8 Reduction in emissions in the AQMA for the area wide scenarios



The impact of the taxi scenarios is negligible with an impact across the AQMA for all emissions of less the 0.1%. This is primarily as the taxis are such a small proportion of fleet at between 1-2%. In some specific local area their impact may be higher as they will be a higher proportion of the fleet, but this cannot be picked up in the modelling. Also some work by ITS Leeds for Sheffield suggested that taxis can have significantly higher emissions that other cars and so their emissions may be under estimated.

The EV scenario will effectively reduce emission in the light duty fleet in relation to the uptake as they are zero emission vehicles. The impact on PM will be less as the PM emissions include non-exhaust emissions such as tyre and road wear which will not necessarily be reduced by EV's.

Similarly the 'smarter choices' scenarios will reduce emissions in line with the traffic reduction assumed. However, if these kind of reduction can be generated that useful emission savings will be produced.

7 Conclusions

There are a number of key points that come out form the analysis:

- There is a significant improvement in emissions estimated between the 2011 baseline and the 2016 'do nothing' baseline, although this would be significantly reduced in Euro 6/VI vehicles do not perform as hoped.
- The bus emission measures show the great emission reductions, as the bus fleet is generally older and contributes to s significant amount of the emissions in the AQMA.
- The impact of the HGV measures is small primarily because there has been a significant improvement in their emissions between 2011 and 2016.
- The package of the non-regulatory measures is likely to provide similar or greater emission reduction when compared to the formal LEZ scenarios.

In terms of the taking the analysis forward we would suggest using LEZ 2 or EP1 as the core regulatory scenario as a comparator. With regards the other measures I don't think any need to be ruled out from the final LES. However, the core measures that are likely to have the most benefit and I suggest we take forward to the CBA are:

- Bus 1 retrofit and Bus 2 – a combination of these as a direct approach to working with the bus operators to reduce their emissions.
- Bus 3 – the quality bus corridors as a complementary bus measure to support the technology approach.
- HGV5 – as this reduces traffic and so is providing a benefit even with the cleaner HGV fleet, it also links into a smarter 'choices programme'.
- EV – urban EV provide the ultimate emissions benefit as they are emission free at point of use, although only a small uptake could be expected by 2016.
- Smart 1 – further developing the Councils work on 'smarter choices' to generate the target traffic reduction.

Using a simply additive approximation this package of measures could potentially reduce NOx emissions by 12% and PM emissions by 6% compared the 2016 baseline. This would be significantly more than a bus and HGV LEZ set at Euro IV.

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