A LOW EMISSION ZONE FOR LONDON.

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INTRODUCTION

London's air quality is the worst in the UK. Levels of pollution cause serious health impacts, which have led to UK and EU air quality targets. A considerable proportion of London will not meet these targets, particularly for nitrogen dioxide (NO_2) and particulate matter (PM_{10}). To achieve the air quality targets, significant additional action is needed, particularly to reduce road transport emissions. The Mayor's Air Quality Strategy is part of this action [1].

There is a limit to what can be achieved with traffic reduction. Major improvements can be gained by increasing the numbers of modern, cleaner vehicles and removing old polluting ones. One of the ways of doing this is through a low emission zone (LEZ), where older, more polluting vehicles are excluded from an area, thereby increasing the speed that cleaner vehicles come into the area

The Mayor of London, together with the Association of London Government (ALG), London boroughs and the Government commissioned a feasibility study into LEZs in London [2]. It investigated the costs and benefits of various LEZ options, what it could achieve and how it could be implemented. It modelled the air quality impact of different scenarios, but also the practicalities of implementing them. At the time of writing, the Mayor of London has stated the intention to implement a low emission zone over the whole of London, to include lorries, buses, coaches and taxis by 2007 [3].

One feasibility study recommendation from the was to look at the impact of NO_x reduction technologies that were starting to be developed at the time of the study, as they were not sufficiently developed to include in the feasibility study. This paper looks at the air quality and emissions impact that these technologies might have.

LOW EMISSION ZONE

An LEZ is a defined area that can only be entered by vehicles meeting certain emissions criteria or standards. LEZs have already been successfully implemented for many years in Sweden, and more recently in Japan. This paper covers the main findings of the London feasibility study, together with some more recent work. The study recommends the following scheme, should a LEZ for London be taken forward.

- **Area**. The most appropriate option for a London LEZ would be a scheme including all of the Greater London area. This is an area covering around 1,600km^2, a

population of 7.4 million, 33 local authorities, Heathrow airport and 13,550km of roads.

- **Vehicles**. The LEZ should start with a scheme that targets lorries, London buses and coaches. These vehicles have disproportionately high emissions per vehicle and targeting them produces greatest emissions reductions for least cost. However, the study recommends that the zone be potentially extended in later years to include vans (subject to further investigation of the socio-economic effects of such a scheme on small companies/owner drivers) and taxis (though taxis are currently being addressed through the licensing process). The study recommend that cars are not included in the scheme, but recommends that some action is taken alongside any LEZ, to target the removal of pre-Euro cars in London.
- **Legislation and Enforcement**. The legal basis for an LEZ should be a Traffic Regulation Order. A manually enforced scheme, where offenders are pursued through the courts, targeting heavy-duty vehicles only, would enable the quickest introduction of an LEZ. However, automatic enforcement using cameras would ensure higher compliance and so greater air quality benefits. Automatic enforcement would also provide a revenue stream that could help support the additional running costs [1], and would be needed if the LEZ were to include vans. It is recommended that the certification scheme for a LEZ be based on age of first registration, as a proxy for Euro standard with a certification database for exemptions and retrofitted vehicles.
- **Implementation Date.** The work necessary to set up the legal basis for a London LEZ would make it extremely difficult to implement a fully operational scheme before the middle of 2006, and more realistically before late 2006. While this date would not assist with EU 2005 PM_{10} [2] or UK NO_2 targets [3], the advantage is that it ties in with the availability of much cleaner Euro IV vehicles. Earlier introduction would increase numbers of Euro III vehicles, and actually have a negative impact on longer term air quality, and 2007 may be both more realistic and better in terms increasing numbers of Euro IV vehicles. Should an LEZ be introduced, it would be best to be progressive, with tighter emission criteria in future years. Any scheme would need to give operators adequate notice, be clear about these future criteria, for operators to plan vehicle purchases. Earlier introduction of Euro IV heavy-duty vehicles would improve the air quality impact of an LEZ, and give manufacturers who did so a marketing edge.
- **Costs of Implementing and Operating an LEZ.** The costs of setting up and running a London LEZ vary with the exact scheme and the types of vehicles included. A manually enforced scheme for lorries would have the lowest cost to set-up (an estimated £2.8m to set-up, with running costs of around £4m each year). An automatic enforcement approach should use the existing Central London

[1] Automatic enforcement would require a decriminalised system, where penalties can be kept by the scheme, as opposed to a criminal system where penalties are kept by the Treasury.

[2] The PM_{10} Limit Value is a 24-hour mean of 50µg/m^3 not to be exceeded more than 35 times a year and an annual mean of 40µg/m^3 by 1/1/2005, (in the UK taken as 31/12/2004). In 2010 this is 7 exceedences of the 24-hour mean and an annual average of 20µg/m^3.

[3] The UK NO_2 objective is set at the same concentration as the EU Limit Value (40µg/m^3), but set 31/12/2005, and not 1/1/2010.

Congestion Charging Scheme (CCS) infrastructure, combined with the use of mobile ANPR (automatic number plate recognition) cameras, and possibly a small number of additional fixed cameras outside this area. This type of scheme is estimated to cost £6m to £10m to set-up, with running costs of around £5m to £7m each year, but might generate revenues of £1m to £4m per year from penalty charges for non-compliance. None of the LEZ schemes are likely to be self-financing.

- **Emission Criteria.** The emission criteria set for a London LEZ will dictate the air quality benefits and costs to operators. The study recommends that for lorries, buses and coaches the criteria are based on Euro standard (using age as the first proxy) together with other emission standards. The preferred "other emission standard" is the Reduced Pollution Certificate (RPC). The RPC is awarded to vehicles that meet strict PM_{10} emission standards, usually by fitting a particulate trap. This is a Government scheme and gives reduced vehicle excise duty. Vehicles should meet an initial criterion of Euro II plus RPC (or equivalent) in the first stage of implementation, 2006 or 2007. It also recommends that this criterion be tightened to Euro III plus RPC (or equivalent) in 2010. However, there are two additional conclusions put forward alongside this latter recommendation. Firstly that a NO_x based RPC scheme would help the effectiveness of the scheme and could allow greater NO_2 improvements. Secondly that it might be beneficial to introduce the Euro III plus RPC criterion earlier than 2010 using a rolling approach (applying the RPC to Euro III vehicles based on age). The study recommends a different approach for vans, taxis and private hire vehicles, should these vehicles be included, using a rolling ten-year-old age limit.
- **Costs to industry**. The number of vehicles affected by a London LEZ is potentially very high, as a large proportion of the national fleet operates in London at some point during each year. The cost to vehicle operators is likely to be significantly higher than the costs of setting up and operating a London LEZ. For example, the costs of introducing the recommended LEZ in 2007 could have a cost to industry of £37m to £95m [4] (the range reflects the possible number of vehicles that operate in London). Costs would depend on operator behaviour in response to the zone. Existing Government grants, should these be available, would offset some of these costs to operators. Costs to operators would be significantly reduced if Government vehicle excise duty rebates for RPC vehicles is continued in future years.
- **Stakeholder consultation.** Survey work has indicated that operators would be broadly supportive of a London LEZ. Most operators would comply with the zone, possibly by rearranging their fleet, transferring older vehicles out, and newer vehicles into London. Any LEZ would be likely to have greatest impact on operators of specialist vehicles and smaller companies. The impact on van operators is particularly difficult to assess, due to the lack of information on the use of these vehicles.
- **Comparison of costs and benefits**. A London LEZ would improve the health of Londoners by reducing air pollution related impacts. It would also have small

[4] Based on later work undertaken for the GLA after the end of the feasibility study including more recent data by the consultant that undertook the feasibility study.

benefits in reducing noise. In later years, it could potentially lead to reduced CO_2 emissions. The benefits of the schemes are likely to be broadly similar to the overall costs (for example the estimated health benefits in London from the recommended scheme for 2007 are estimated at £100m).

- **Air Quality.** A London LEZ would have modest benefits in improving overall emission levels and absolute air quality concentrations in London, but it would make a larger contribution to reducing exceedences of the air quality targets. A summary of the air quality results is shown in Table 1 below. The reason for the smaller impact on NO_2 is twofold. Firstly a particulate trap reduces PM_{10} emissions, and there was no similar technology included for NO_x emissions. Secondly, is the fact that NO_x emissions do not reduce significantly for heavy-duty vehicles between Euro standards 1 and 3, especially under urban stop-start conditions.

	Reduction in Emissions (relative to baseline)			*Reduction in Area Exceeding Targets (relative to baseline)*		
Pollutant	2007 [5]	2010 A) [6]	2010 B) [7]	2007	2010 A) [5]	2010 B) [6]
NO_x (NO_2)	1.5%	2.7%	3.8%	4.7%	12%	18.9%
PM_{10}	9.0%	19%	23%	0% [8]	32.6% [9]	42.9% [8]

Table 1 Air Quality Benefits of the Recommended LEZ.

It is stressed that the results of this study have to be seen in the context of a changing scenario with respect to the technical options, the reliability of the air quality predictions and estimation of vehicle numbers entering London, and a number of other uncertainties. A number of key tasks have been identified, that would need agreement and collaboration before the introduction of any LEZ. These include:

- Agreement of the involved parties on whether to implement the zone;
- Public consultation over the scheme, and agreement over any proposed modifications;
- Agreement on the format of the TRO and any associated Bill, and if relevant, regulations to decriminalise offences;
- Agreement on the national certification system; and
- Agreement over the funding and division of responsibilities.

NO_x REDUCTION SCHEME FOR THE LEZ

Including a NO_x reduction equivalent of the particulate trap within the LEZ was assessed as reasonably cost-effective – second only to particulate traps. This is due to both the lower costs of retrofit compared to buying a new vehicle, and the greater NO_x reductions gained. During LEZ study, technologies such as selective catalytic reduction (SCR) was not sufficiently developed to be able to be included, as there were too many uncertainties on the costs and likely emissions reduction. However, in order to get an idea of the impact that

[5] the 2007 scheme only includes lorries, buses and coaches with emissions standards of Euro II plus RPC
[6] includes lorries, buses and coaches with emissions standards of Euro 3 plus RPC
[7] B), in addition to 2010 A) includes vans and taxis with a 10 year rolling age limit
[8] London should meet the relevant air quality for PM_{10} for this year without any additional action for an average year's weather
[9] exceedence of the annual mean PM_{10} objective for 2010

such a scheme might have, an air quality study on the likely impact was undertaken using the same methodology and assumptions as the LEZ study [4]. It should be stressed that these scenarios are intended only to give an indication of what could be achieved, and the actual impact would very much depend on the particular technologies that are developed and covered in such a scheme.

A range of emissions reduction was modelled because the likely impact of the various potential technologies was still not clear at the time of this work. Experts in the field estimated the possible range of emissions reduction from SCR as being from 30-90%. The pessimistic and optimistic range of emissions reduction modelled in this work was 40% and 70%. As of June 2004, an example of current SCR NO_x reduction is around 87% in preliminary trials at TfL London Buses. Other technologies such as exhaust gas re-circulation (EGR) may well also cover the lower range modelled.

The scenario investigated was the recommended LEZ scenario, in addition requiring both a particulate trap and SCR instead of just a particulate trap, with Euro II vehicles allowed to continue operating in 2010, i.e.:

- In 2007 all heavy-duty vehicles (lorries, buses and coaches) to be at least Euro II, with a particulate trap and NO_x abatement.
- In 2010 as above, plus NO_x abatement fitted to Euro III vehicles.

This would require an LEZ as envisaged in the study to be implemented, and an additional requirement for NO_x abatement technology. This modelling assumes that the van and taxi option is not implemented (these would lead to further reductions). Costs of a NO_x abatement requirement for all heavy-duty vehicles would be in addition to that of the recommended LEZ for the first phase (2007). However, allowing Euro II vehicles to continue after 2010 would, however, significantly reduce the costs to operators in the second phase.

In these early days of development, the costs of retrofit NO_x abatement technology are uncertain, however, indications as of 2004 from industry suggest that costs for retrofitting SCR to heavy goods vehicles are likely to be around £4,000 (to achieve around 80% NO_x emissions reduction). However, there may also be an option for cheaper versions of SCR, or EGR, that achieve around 40% emissions reduction and costing around £2,500, which would be more cost effective, even though less successful in terms of emissions reduction.

Due to the additional NO_x abatement, these scenarios give greater NO_2 reduction than would be achieved through the recommended LEZ scenarios. The results are summarised in Table 2 below.

Scenario	**% NO_2 area exceeding compared to base case [10]**	**% PM_{10} area exceeding compared to base case [11]**
Recommended LEZ 2007	- 4.7 % area	-
SCR retrofit + LEZ 2007 (pessimistic)	- 14.7 % area	Same as recommended LEZ
SCR retrofit + LEZ 2007 (optimistic)	- 30.5 % area	Same as recommended LEZ
Recommended LEZ 2010 A)	- 12 % area	- 32.6 % area
SCR retrofit + LEZ 2010 (pessimistic)	- 35.0 % area	-33.1 % area
SCR retrofit + LEZ 2010 (optimistic)	- 52.1 % area	-33.1 % area

[10] the concentration reductions are less than the reductions in area exceeding the objectives, due to passing thresholds

Table 2. Percentage reduction in area exceeding the national NO_2 and PM_{10} objectives compared with the base case.

CONCLUSIONS

The introduction of a low emission zone in London would start to make an important improvement in air quality – it certainly makes more impact than any other local measure could do. The Mayor has announced his intention to implement a low emission zone in June 2004 [5]. At the time of writing the exact nature of the scheme that would be implemented is not yet decided, as it has been 18 months since the study reported and technologies move on. The feasibility study was a technical report and political issues must now also be taken into consideration. It is intended that taxis would now be included due to synchronisation of strategies. It may also be that other issues that the study recommended looking at further, such as NO_x abatement, particularly for later years, may now be able to be included as the technology may now be sufficiently developed.

There is much work to do in the three years before a LEZ would implemented in London in 2007. Discussions on funding are particularly important. There will be many discussions and negotiations between the many different organisations that would needed to be involved. The feasibility study was intended to provide the answers to assist making a decision as to whether or not to implement an LEZ, but not tackle all the issues that will arise before implementation.

A LEZ would have greater impact on air quality if the introduction of Euro IV vehicles is brought forward. The LEZ may cause this to happen through supply and demand, as early Euro IV vehicles will be more attractive as they will be compliant for longer with an LEZ with criteria that tighten over time. However a LEZ with tightening criteria could be used as part of discussions with manufacturers for earlier introduction of emissions Euro IV and V vehicles.

A LEZ would make reducing emissions an issue with operators, who are very difficult to get to change with other measures. A London LEZ would have national implications, and even international implications if it assists in achieving or encouraging the issue of early introduction of Euro IV heavy-duty vehicles.

However, even with an LEZ, the EU Limit Values will not be met in London without additional, further action at local, national and international level. However it will get a very significant amount of the way there, and enable other measures, for example introducing very clean vehicles such as ‘environmentally enhanced vehicles’, or EEV’s, to have more impact in hot-spots, or others as those outlined in the Mayor’s Air Quality Strategy [1].

REFERENCES

[1] Mayor’s Air Quality Strategy, Greater London Authority, September 2002. Available from www.london.gov.uk

[2] London Low Emission Zone Feasibility Study Phase II, July 2003, by AEA Technology on behalf of the Mayor, boroughs, ALG and Government. Full report and other documents from www.london-lez.org.

[3] See the press release dated 15th June 2004 on the press section of www.london.gov.uk. Further announcements are also likely to be found on this site.

[4] The air quality impact of Water-Diesel Emulsion Fuel (WDE) and Selective Catalytic Reduction (SCR) Technologies, report for the Mayor of London. Available from www.london.gov.uk.

[5] More up to date information at the time that you are reading this paper may be able to be found on www.london.gov.uk or www.london-lez.org.