Planning and Environmental Policy Group

Part III of the Environment (Northern Ireland) Order 2002

Draft Local Air Quality Management Policy Guidance – LAQM PGNI (09)

A consultation document

December 2009

Department of the
Environment
www.doeni.gov.uk

Consultation on draft Local Air Quality Management Guidance.

Policy Guidance – LAQM PGNI (09)

Stephen Kerr
Air and Environmental Quality
Planning and Environmental Policy Group
Department of the Environment

E mail: stephen.kerr@doeni.gov.uk
Tel No: (028) 90254887

Dear Consultee,

Consultation on draft Local Air Quality Management Policy Guidance in Northern Ireland, LAQM PGNI (09)

You are invited to respond to this consultation on draft policy guidance which district councils in Northern Ireland must have regard to in carrying out their local air quality management duties under Part III of the Environment (NI) Order 2002.

The draft guidance is intended to enable district councils to improve on the service they already provide in tackling poor air quality by targeting resources in a cost-beneficial way where possible, and in a cost-effective way where this is necessary in order to work towards air quality objectives.

The fourth round of district councils Review and Assessment of air quality commences in April 2009, and the aim of this document is to guide district councils towards further improving the management of air quality in their areas, focussing on what really matters and providing quantitative data, wherever possible, to demonstrate progress.

The consultation documents can be found on the Department of the Environment website at:-
http://www.doeni.gov.uk/index/protect_the_environment/local_environmental_issues/air_and_environmental_quality/local_air_quality_review_and_assessment.htm

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Following this consultation, it is proposed that final guidance will be issued by the Department of the Environment and district councils shall have regard to this guidance when carrying out their local air quality management duties, as is required under Part III of the Environment (NI) Order 2002.

This final guidance updates and replaces the local air quality management Policy Guidance and the Progress Report Guidance, LAQM.PGNI (03) published in 2003.

Alternatively if you respond to this letter by providing an e-mail address, I will arrange for a version to be e-mailed to you. If you do not have e-mail facilities and prefer a hard copy arrangements can be made to have one posted to you.

You can also request further copies of this document by telephone (028 90254887) by fax (028 90254732) or in writing. Should you require a copy of the document in an alternative format, it can be made available on request in large print, disc, Braille or audiocassette. The document may also be available on request in minority ethnic languages to those who are not proficient in English.

We would like to hear the views of any stakeholders interested in the draft Local Air Quality Management Policy Guidance and you are therefore invited to provide your comments on the proposals. We would be grateful if you would clearly indicate in your response which part or parts of the consultation paper you are responding to as this will aid our analysis of the responses received.

Responses should be sent to arrive no later than 26th March 2010.

By email to:

Stephen.kerr@doeni.gov.uk

Alternatively if you do not have access to email you can send your response to:

Stephen Kerr
Air & Environmental Quality
DOE Climate and Waste Strategy Division
23 Castle Place
BELFAST
BT1 1FY

When responding, please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

The Department would be grateful if you could clearly indicate in your response which part or parts of the consultation paper you are responding to as this will aid our analysis of the responses received.

FREEDOM OF INFORMATION ACT 2000 – CONFIDENTIALITY OF CONSULTATIONS

The Department will publish a summary of responses following completion of the consultation process. Your response, and all other responses to the consultation, may be disclosed on request. The Department can only refuse to disclose information in exceptional circumstances. **Before** you submit your response, please read the paragraphs below on the confidentiality of consultations and they will give you guidance on the legal position about any information given by you in response to this consultation.

The Freedom of Information Act gives the public a right of access to any information held by a public authority, namely, the Department in this case. This right of access to information includes information provided in response to a consultation. The Department cannot automatically consider as confidential information supplied to it in response to a consultation. However, it does have the responsibility to decide whether any information provided by you in response to this consultation, including information about your identity should be made public or be treated as confidential.

This means that information provided by you in response to the consultation is unlikely to be treated as confidential, except in very particular circumstances. The Lord Chancellor's Code of Practice on the Freedom of Information Act provides that:-

- the Department should only accept information from third parties in confidence if it is necessary to obtain that information in connection with the exercise of any of the Department's functions and it would not otherwise be provided;
- the Department should not agree to hold information received from third parties "in confidence" which is not confidential in nature;
- acceptance by the Department of confidentiality provisions must be for good reasons, capable of being justified to the Information Commissioner.

For further information about confidentiality of responses please contact the Information Commissioner's Office (or see the website at: http://www.informationcommissioner.gov.uk/).

Yours sincerely

Stephen Kerr

Department of the Environment
Climate and Waste Strategy Division

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Section 1: Local Air Quality Management- Overview of processes and principles

Consultation on draft Local Air Quality Management Guidance under Part III of the Environment (Northern Ireland) Order 2002

Section 1: Local Air Quality Management- Overview of processes and principles

Introduction

Who will be affected?

The draft policy guidance will primarily affect the following organisations:

- district councils of Northern Ireland
- Northern Ireland Planning Service
- Roads Service (Northern Ireland)

Introduction

What is this guidance for?

This policy guidance is principally for district councils in Northern Ireland to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part III of the Environment (Northern Ireland) Order 2002 (the Order). This guidance is intended to enable district councils to improve on the service they already provide in tackling poor air quality. Part 1 of this Policy Guidance provides an overview of the local air quality management system and the various considerations that district councils should bear in mind. Part 2 points the reader towards other sources of advice, as well as Practice Guidance on some of the more effective and ambitious measures that district councils may wish to consider. This guidance compliments the revised Technical Guidance, LAQM TG (09)
.
Throughout the next round of Review and Assessment, it should be possible for the UK Government to demonstrate the impact that many local measures have on air quality. The UK is legally required to meet EU limit values for a number of pollutants, and local measures are one of the most important means by which the UK Government can meet these limit values. More importantly, improved air quality has significant health benefits, and district councils together with relevant authorities are best placed to improve air quality at localised hotspots and deliver both health benefits and improved quality of life.

On completion of the consultation process the final version of this guidance will be **issued by the Department under article 16 (2) of the Order, and district councils shall have regard to this guidance when carrying out their local air quality management duties, as required under article 11 of**

the Order. The guidance will also be of interest to relevant authorities and other bodies associated with air quality management.

This policy guidance and the previously issued Technical Guidance are the primary guidance to which district councils should have regard when managing local air quality. Some of the other sources of guidance to which district councils may or should have regard are referenced in these guidance documents. This guidance replaces the local air quality management Policy Guidance LAQM PGNI (03) and the Progress Report Guidance which were published in 2003.

The chapters in this guidance covering transport and planning are relevant to those working in various government and local government departments, such as environmental health, land-use, planning, economic development and transport planning. This guidance should therefore be taken into account by those departments, and any other relevant departments, when carrying out their duties.

In the light of current Government policy, it is particularly important that climate change and air quality policies are joined up. There will be situations where policies to reduce greenhouse gas emissions will have benefits for air quality, and vice-versa. However, there may be situations where potential actions and policies do not necessarily achieve these win: win situations. For example it is essential that alternative energy technology used to reduce greenhouse gas emissions is used in the right place, and not in an area where such technology will impact on the ability of the district council to pursue the achievement of air quality objectives.[1]

District councils are at the forefront of public service, and should continue to set priorities according to local need. They have the opportunity to demonstrate leadership in improving local air quality by introducing measures which go beyond the minimum required...

Why air quality matters

Air quality and health

As stated in the current Air Quality Strategy for England, Scotland, Wales and Northern Ireland[2], poor air quality reduces life expectancy in the UK by an average of 7 – 8 months, with equivalent health costs estimated to be up to £20 billion a year. Improvements between 1990 and 2001 have helped avoid an estimated 4,200 premature deaths a year, and 3,500 hospital admissions a year. The UK Air Quality Strategy aims to reduce the affect on life expectancy to 5 months by 2020. It should be remembered that health effects do not relate solely to the direct impacts of air pollution. By encouraging the use of non-motorised means of transport, such as cycling and walking, as a means

[1] For example, see chapter 5 of the UK Biomass Strategy - www.defra.gov.uk/Environment/climatechange/uk/energy/renewablefuel/pdf/ukbiomassstrategy-0507.pdf

[2] Published on 17 July 2007 - www.defra.gov.uk/environment/airquality/strategy/index.htm

of reducing local emissions of pollutants, measures in air quality action plans can help directly improve the health and fitness of local populations. In turn, this may also help individuals to be more resilient to direct ill-effects from air pollution.

Air quality and climate change

The UK Air Quality Strategy acknowledges that there will often be co-benefits for air quality and climate change policies where certain measures are taken. All measures should be given careful consideration to ensure that the benefits for local air quality and climate change are maximised, where possible. Without proper consideration, there is the possibility that some policies to mitigate climate change will have a negative impact on air quality and vice-versa. Where practicable, synergistic policies beneficial to both air quality and climate change should be pursued.

Air quality and the environment

Poor air quality also impacts on the environment, harming ecosystems and biodiversity. It should however also be noted that measures to tackle air quality can have undesirable consequences, for example speed restrictions, may also have an impact on noise pollution, and vice-versa.

This illustrates the importance of developing integrated policies and the need for co-ordination between district councils and relevant Northern Ireland authorities in tackling air pollution.

When reading this document, please bear the following questions in mind, when considering whether you would like to submit opinions to the Department as a stakeholder:

Part 1 - Policy Guidance

1. Is there any aspect of the Policy guidance that you would disagree with?

2. Is there any aspect of the Policy guidance that you think should be clarified?

3. Is there anything additional that you think should be included in the Policy Guidance?

Equality Issues

Under Section 75 of the Northern Ireland Act 1998, public authorities have a statutory duty to promote equality of opportunity. The Department has completed an equality screening of the draft policy guidance, and have concluded that it does not impact on equality of opportunity on any of the groups specified in section 75. A copy of the screening paper is attached as Annex C.

The Equality Commission will receive copies of this consultation document as part of the consultation exercise. We will take into account any comments that the Equality Commission might have.

Human Rights Issues

The Human Rights Act 1998 implements the European Convention on Human Rights. The 1998 Act makes it unlawful for any public authority to act in a way that is compatible with these Rights. Since the implementation of the Human Rights Act 1998, all legislation must be checked to ensure compliance with the European Convention rights.

The Department has completed a Human Rights screening of the proposed policy guidance document, and have concluded that it is compatible with the Human Rights Act, but would welcome any views that consultees may have. A copy of the screening paper is attached at Annex D.

The Human Rights Commission will receive copies of the consultation document as apart of this consultation. The Department will take into account any comments the Human Rights Commission may have.

Rural proofing

It is considered that there are no negative impacts on rural productivity or the provision of services to the rural community as a result of these proposals.

Chapter 1: Local Air Quality Management process – an overview

This chapter provides an overview of the local air quality management process and the procedures that district councils should follow when carrying out their duties under Part III of the Environment (Northern Ireland) Order 2002 (the Order). The Technical Guidance on local air quality management should be consulted for detailed information on Updating and Screening Assessments, Detailed Assessments, Progress Reporting and Further Assessments and Action Plans.

The UK Air Quality Strategy established the system of local air quality management (sometimes shortened to LAQM), which commenced in 2002.

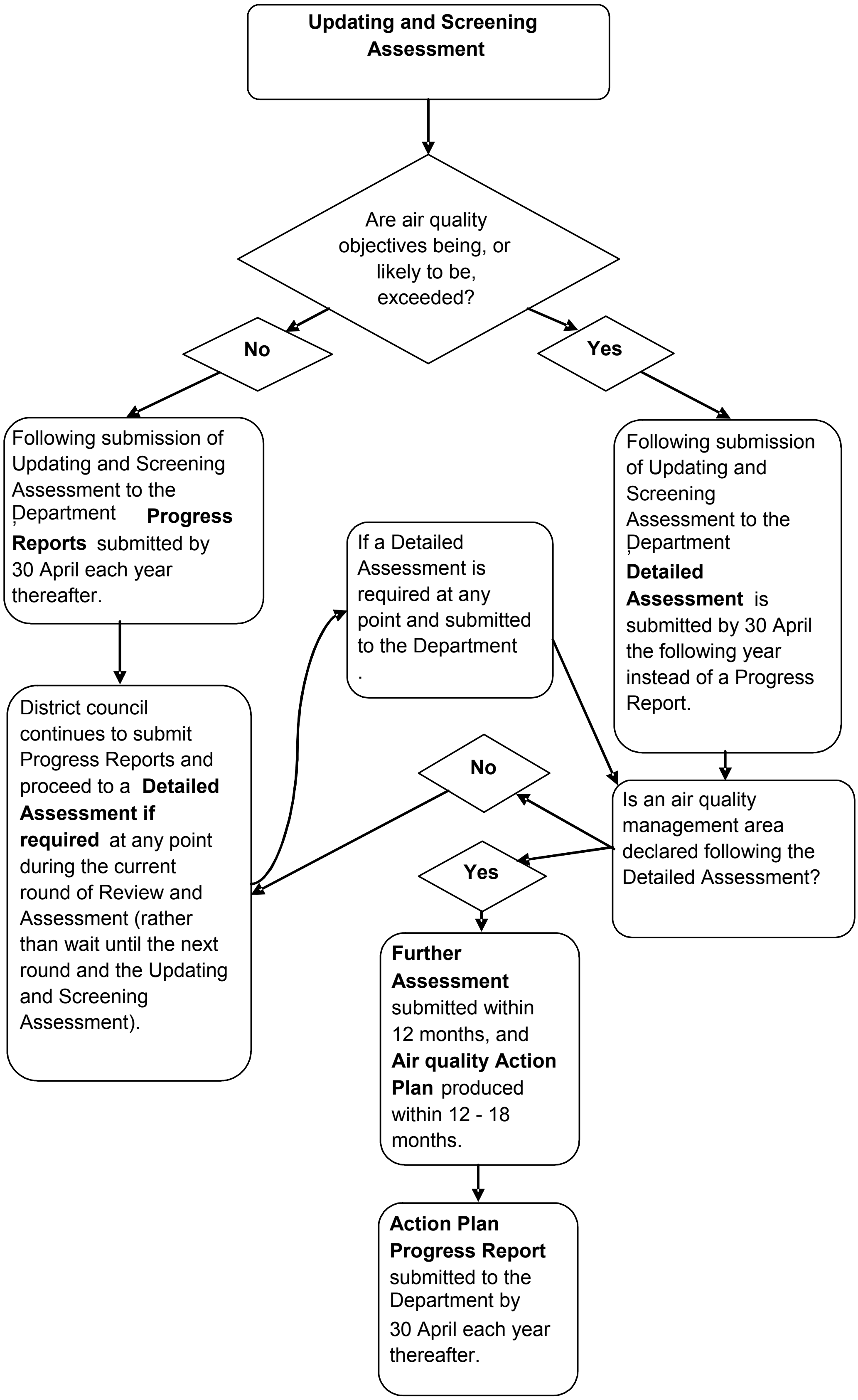
Air Quality Objectives

The Air Quality (Northern Ireland) Regulations 2003 (the Regulations), provide the statutory basis for air quality objectives which are required to be achieved under local air quality management (see **Table 1**). The Regulations are derived from European Directives and also prescribe the dates by which the air quality objectives should be met.

Not all of the objectives contained in the Air Quality Strategy are included within the local air quality management system, for example the new limit value for $PM_{2.5}$ contained in EU Directive 2008/50/EC on ambient air quality. Although district councils are not being asked to work towards the achievement of a $PM_{2.5}$ objective, measures to reduce emissions and concentrations of PM_{10} will also reduce levels of $PM_{2.5}$.

Article 11 of the Order provides that every district council shall review the air quality within its area at the present time and assess the likely future quality. Article 12 requires district councils to designate an air quality management area where air quality objectives are not being achieved, or are not likely to be achieved within the relevant period, as set out in the Regulations. Article 13 then requires a district council to develop an Action Plan for the air quality management area.

Further detail on local air quality strategies, air quality management areas and Action Plans is contained in subsequent chapters within this guidance document.



Note that a Detailed Assessment is only required where an air quality objective is, or is likely to be, exceeded outside an existing air quality management area (AQMA) and there is relevant exposure, or where a significant amendment or revocation of the AQMA order is required. If a new source of pollution has been identified or concentrations have changed significantly within an existing AQMA, the district council is required to carry out a Further Assessment rather than a Detailed Assessment.

Table 1: Air quality objectives

Pollutant	**Air Quality Objective**		**Date to be achieved by**
	Concentration	**Measured as**	
Benzene	16.25 µg/m^3	running annual mean	31.12.2003
	3.25 µg/m^3	running annual mean	31.12.2010
1,3 Butadiene	2.25 µg/m^3	running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	maximum daily running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3	annual mean	31.12.2004
	0.25 µg/m^3	annual mean	31.12.2008
Nitrogen dioxide	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 µg/m^3	annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 µg/m^3	annual mean	31.12.2004
Sulphur dioxide	350 µg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31.12.2004
	125 µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31.12.2004
	266 µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31.12.2005

Review and Assessment reporting cycles

A Review and Assessment of air quality is the first step in the local air quality management process. District councils have to consider the current and likely future air quality in their areas, and assess whether the objectives as set out in the Air Quality Regulations are, or are likely to be exceeded. Where the objectives are unlikely to be met, the local authority must take action to work towards meeting the objectives. District councils also have a duty to continue to meet the air quality objectives beyond the deadlines set out in the regulations. An objective, for example, which was due to be met by 2005, must be met each subsequent year.

All district councils are expected to carry out a Review and Assessment every 3 years and in doing so should undertake the following 2-step approach:

Step 1 - Updating and Screening Assessment. All district councils are required to undertake **an Updating and Screening Assessment** (sometimes shortened to **USA**). Where this identifies a risk that an air quality objective will be exceeded at a relevant location[3] the district council is required to proceed to Step 2. Note that in the years when they are not carrying out an USA district councils are required to prepare **Progress Reports** (PR).

Step 2 - **Detailed Assessment.** If following the conclusion of step 1 it has been identified that there is a risk that an air quality objective will be exceeded then a Detailed Assessment (DA) is required to be undertaken. This is not required where a new source has been identified or concentrations have changed significantly within an existing air quality management area, in which case a district council is required to carry out a Further Assessment where a DA is being undertaken, it should include a short PR for those areas not covered by the DA.

Note: this differs from previous rounds of review and assessment, where authorities proceeding to a Detailed Assessment were not required to submit a Progress Report in the same year.

Where a new air quality management area is required, or an existing air quality management area needs to be significantly amended or revoked, the Detailed Assessment should also clearly identify areas of exceedence (or where there was formerly an exceedence) and possible boundaries for the new or amended air quality management area.

For the fourth, fifth and sixth round of Review and Assessment, district councils should carry out their local air quality management duties according to the timescales in **Table 2**.

[3] The air quality regulations require that likely exceedences of the objectives should be assessed at locations which are situated outside of buildings or other natural or man-made structures, above or below ground and where members of the public are regularly present. See the Technical Guidance for further advice.

Table 2: Timescales for Review and Assessment			
Year	**Updating and Screening Assessment**	**Progress Report**	**Detailed Assessment**
Round 4 – Completion Dates			
2009	30 April 2009	-	Whenever necessary
2010	-	30 April 2010	Whenever necessary
2011	-	30 April 2011	Whenever necessary
Round 5 – Completion Dates			
2012	30 April 2012	-	Whenever necessary
2013	-	30 April 2013	Whenever necessary
2014	-	30 April 2014	Whenever necessary
Round 6 – Completion Dates			
2015	30 April 2015	-	Whenever necessary
2016	-	30 April 2016	Whenever necessary
2017	-	30 April 2017	Whenever necessary

[a] Detailed Assessments are due 12 months from the date they are initiated, which can be at any time.

If following a Detailed Assessment a district council considers that one or more of the air quality objectives for each of the seven pollutants is not being met, they must declare an **Air Quality Management Area (AQMA). The AQMA must** cover the full extent of the area where the exceedence is expected and the district council must then prepare and implement a remedial **Action Plan** to tackle the problem.

If at any time during the reporting years a district council identifies a risk of air quality objective exceedences, it should proceed to carry out a DA to formally identify the need to declare an AQMA and its appropriate size and location. District councils in this situation should not delay until the next full round of Review and Assessment.

Article 13(1) of the Order requires district councils to carry out a **Further Assessment (FA)** of existing and likely future air quality in an AQMA. Following designation of an AQMA, an **air quality Action Plan** should be completed within **12 months of** the date of designation. Once a district council has produced its final action plan, a first **Action Plan Progress Report** must be submitted by the end of the following April.

District councils are required to submit all relevant air quality reports to the Department and other statutory consultees[4] **by 30 April in each reporting year.**

Appraisal Process

If the Department does not accept the conclusion of a district councils report, then the council will be invited to provide written comments justifying their decision within a specified deadline set out in the appraisal letter. This will be a short deadline in keeping with the need to complete the process as quickly as possible.

Helpdesks for District Councils

District councils who wish to seek clarification on the findings of the appraisal process should in the first instance contact the relevant **air quality helpdesk** for further help. The helpdesks established by Defra and the Devolved Administrations can discuss the details of individual cases and can provide advice on responding to any points raised in the appraisal. The helpdesks can also provide advice on Review and Assessment, monitoring, emissions data, modelling and action planning see details provided in the table below.

Helpdesk	Operated by	Contact Details
Monitoring, Modelling, Emissions Inventories and Action Planning	AEA	0870 1906050 lasupport@aeat.co.uk www.laqmsupport.org.uk
Review & Assessment	University of the West of England and Air Quality Consultants	0117 328 3668 aqm-review@uwe.ac.uk

Further information is available from the Air Quality Archive at:

www.airquality.co.uk/archive/laqm/helpline.php

and the Defra website at:

www.defra.gov.uk/environment/airquality/local/index.htm .Helpdesk.

[4] Statutory consultees are those set out in Schedule 2 (1) of the Environment (Northern Ireland) Order 2002.

Chapter 2: Local air quality strategies

Strategies for improving local air quality can be quite simple and short documents outlining fundamental principles as agreed with other departments within a district council and with other relevant authorities. These proposals could also be incorporated into other strategies, particularly those on climate change and/or transport. The Department of the Environment would endorse such a strategic approach to managing air quality. It is recommended that all councils, particularly those that have not had to designate air quality management areas (or do not expect to do so in future), but who have areas close to the exceedence levels, should consider drawing up a local air quality strategy.

Why develop a local strategy?

Developing a local air quality strategy, or including air quality management as part of another strategy (perhaps a strategy for reducing CO_2 emissions); will help councils to deliver services in an integrated manner. A strategy can provide over-arching principles, agreed at a high-level, that will ensure a wider range of benefits and risks are considered when implementing different policies. This provides a consensus on which to develop individual plans, such as air quality Action Plans, containing measures that are 'proofed' to avoid policies in one area creating unwelcome or unintended impacts upon another. It is for this reason that district council officers and Northern Ireland Environment Agency officers leading on the management of industrial pollution should work closely together to ensure that environmental permitting considers the risks to local air quality in a holistic manner.

A local strategy could, or may need to, also involve neighbouring district councils, and a regional air quality strategy developed between a number of district councils will often be useful, or indeed required, to manage the impact of pollutants in one area upon another.

Developing a strategy

District councils are free to develop strategies in the manner considered most appropriate to them. However, it is recommended that a steering group be established for the purpose. Furthermore, strategies should be developed in a multi-disciplinary manner involving all relevant departments, such as planning and transport, those leading on climate change and any other district council departments that are to be involved in the strategic approach. Other external organisations that are relevant and organisations in the Local Strategic Partnership should also be consulted.

Format of a local air quality strategy

District councils are free to determine the format that their strategy takes, but as a minimum it is expected that the following general rules would apply:

- Strategies should be concise, containing fundamental principles that have been adopted by all parties involved with the full understanding of the legal and other drivers behind these principles;
- Strategies should outline the management structure for delivering on air quality improvements, and identify consultation groups that will be engaged;
- Agreement on integration of functions, such as transport, land use planning and air quality action planning.

The fine detail will be included in air quality and other plans. When deciding on who to engage with, key partners such as Health Care Trusts, the Northern Ireland Environment Agency, the Department of Regional Development Roads Service, local schools, businesses and community groups should be included.

Learning exchange is also a useful tool for district councils to develop strategic approaches to improving air quality, and a number of regional and national groups have been established. More information is available on the Air Quality Archive at:

www.airquality.co.uk/archive/laqm/ap_learningexchange.php

Chapter 3: Air quality management areas

District councils have a duty under article 12(1) of the Environment (NI) Order 2002 (the Order) to officially designate by means of an ‘order’ those areas, where the air quality objectives are **unlikely** to be, or are not being met, as air quality management areas (AQMA). These areas have to be designated.

Setting the boundaries of air quality management areas

Setting the boundary of an AQMA involves an element of judgement, considering the extent of the predicted areas of exceedence, locations of relevant receptors, the nature and location of relevant sources, and other local factors. In some cases this has resulted in the designation of the entire administrative area, isolated buildings, single streets, road networks or parts of motorway or trunk road junctions. A number of councils have chosen to designate more than one individual AQMA. In short, it is for district councils to draw on their own expertise when designating an AQMA but it **must** encompass **all known and predicted areas of exceedence where there is relevant exposure**. Advice may also be provided as part of the consultation that district councils are required to carry out in relation to air quality reviews, Action Plans and Action Plan revisions under schedule 2 (1),(2) of the Order .

In deciding where to draw the boundaries of an AQMA, district councils might wish to consider some of the following points:

- It may be administratively much simpler to designate a wider area, based on existing boundaries and natural features. This avoids the need to draw artificially precise lines on maps;

- Wherever the boundaries of the air quality management area are drawn, it is likely that the Action Plan will need to cover a wider area;

- Designating a number of smaller air quality management areas, rather than one single large area, can allow a council to demonstrate progress by ‘ticking off’ individual areas as air quality improves there;

- Declaring smaller, individual air quality management areas may provide a clear focus on the hot spot locations within a district council. This may prove particularly important for informing district council and relevant authority planning processes of the sensitivities involved and the appropriateness of any proposed future development; and

- A more focussed approach to declaring air quality management areas may provide a better indication of where resources need to be allocated in terms of equipment and overall effort.

District councils should work in partnership with each other where a joint air quality management area is proposed. They will also need to explain and justify their proposed boundaries to the Department of the Environment (the Department)

What should an air quality management area order look like?

The exact wording to be included in an AQMA Order is at the discretion of the individual district council, although a model example of an AQMA Order can be found in Annex A of this guidance. It is recommended that district councils include a map showing the area to be designated and include a description of the area. For example, a larger AQMA may be described according to its boundaries near to major roads/motorways. A smaller AQMA may need a more detailed description listing individual streets or other physical features. In some cases it may be appropriate to list the individual properties affected, but there is no legal requirement to do so.

The AQMA Order should include the date on which it is intended that the AQMA should come into force and a list of the pollutants and the **actual objective/s** for which it has been designated. District councils should notify the Department as appropriate by submitting a copy of the AQMA Order.

District councils should also ensure that the information on the AQMA Order and its objectives is readily accessible to enquirers.

Further Assessment of air quality within an air quality management area

Article 13(1) of the Environment (Northern Ireland) Order 2002 (the Order) requires district councils to carry out a Further Assessment of existing and likely future air quality within an air quality management area. Under article 13(3) of the Order, District councils are required to report on the Further Assessment to the Department and each relevant authority before finally determining the content of an action plan. They must also consult on it as part of the Action Plan and make it available in accordance with the requirements of schedule 2 article 1(2) of the Order. Detailed advice on Further Assessment is provided in the Technical Guidance.

The Department does not consider the preparation of further assessments within AQMAs to be an onerous or difficult task, as they should form an integral part of the more detailed assessment required under Article 11(2) of the Order. Much of the information required will already have been gathered as Councils by this stage will have already identified which sources are responsible for the problem, and calculated how much of an emissions reduction from each would be necessary to achieve compliance with the prescribed objectives. AQMA assessments should be taken forward in parallel with the development of air quality action plans, and might usefully be seen as a technical annex to the action plan, providing a scientific justification for the measures in the main body of the plan.

Article 13 of the Order also requires that a report of the results of the further assessment shall be completed. The Department advises that district councils should forward AQMA assessment reports with the action plan and submit them within 12 months following the designation of any AQMAs. Reports on AQMA assessments should also be made available to the public.

Amendments to, and revocations of, air quality management areas

District councils are able to amend or revoke the terms of an existing AQMA at any time as set out under article 12(4) of the Order. Where it is considered necessary to do so, the Department expects the council to consult all relevant authorities in accordance with schedule 2 article 1 (2) of the Order.

However where it is proposed to make a significant amendment or revoke an AQMA the district council is required to submit a Detailed Assessment report. The report should clearly outline the evidence supporting changes in the likelihood of exceedence of the AQMA objectives occurring and demonstrating the cause of these changes. For example it may be due to a change to the source of the pollution and/or better monitoring/modelling information.

A full Detailed Assessment is not required for minor amendments such as the addition of another measure for a pollutant already covered by the AQMA Order. However if a new source has been identified or concentrations have changed significantly within an existing AQMA, the district council is required to carry out a Further Assessment rather than a Detailed Assessment. In cases where an existing AQMA is to be varied by a more substantial change, such as moving to a whole borough designation, the authority will be expected to undertake a more comprehensive Further Assessment.

District councils should submit to the Department, for appraisal and comment, their revised Detailed / Further Assessments containing the monitoring results and other evidence to justify their decision to take action. Where it is accepted by the Department that the revocation or amendment is justified, district councils will be expected to take the relevant action **within 4 months** of receipt of comments from the Department.

Where an AQMA is revoked, district councils should consider drawing up a local air quality strategy to ensure air quality issues maintain a high profile locally and to respond to any public expectations. See chapter 2 of this guidance.

Notification of amendment or revocation of an air quality management area order

Once an amendment or revocation has been introduced, the district council should submit the AQMA Order to the Department for information. District councils should also notify statutory consultees and publicise the amendment or revocation widely through the local media to ensure that the public and local businesses are fully aware of the changes made.

Chapter 4: Air quality Action Plans – legal framework, principles and processes

Where possible, air quality Action Plans should include a quantified projected outcome with timescales for reporting progress against. A low emissions zone is a good example of a scheme on which quantified progress could be reported in terms of the reduction in emission levels. However, it is likely that for many of the measures contained in an Action Plan progress cannot easily be quantified. In these cases, qualitative information, along with any quantifiable information as far as is possible, will be expected. For example, it may not be possible to calculate the impact on concentrations of PM_{10} and NO_2 that a permitting scheme to encourage low emission vehicles will have. In this case the definition of low emission vehicle that is used (relevant Euro standards, for example) and the number of permits issued will be useful information to report. While it is clear that this and other measures, such as car sharing or encouraging cycling, may be impossible to quantify in a meaningful way, this should not dissuade a local authority from implementing such measures.

Air quality Action Plans

An air quality Action Plan must include the following:

- quantification of the source contributions to the predicted exceedences of the relevant objectives; this will allow the Action Plan measures to be effectively targeted;

- evidence that all available options have been considered.

- how the district council will use its powers and also work in conjunction with other organisations and relevant authorities in **pursuit** of the air quality objectives;

- clear timescales in which the district council and other relevant authorities propose to implement the measures within its plan;

- where possible, quantification of the expected impacts of the proposed measures and an indication as to whether the measures will be sufficient to meet the air quality objectives. Where feasible, data on emissions could be included as well as data on concentrations where possible; and

- how the district council intends to monitor and evaluate the effectiveness of the plan.

Action Plan timing.

While the Environment (Northern Ireland) Order 2002 does not prescribe any timescale for preparing an Action Plan, the Department expects them to be completed within **12 months following the designation of any air quality management areas.** Air quality officers should take a joined up approach towards air quality management, working with others within their district council and with relevant authorities. The legal imperative to protect air quality should not be displaced with political imperatives if this means the district council is not working towards compliance with the Air Quality Regulations (Northern Ireland) 2003, as amended.

Some district councils may need to work with each other due to the nature of the air quality problem they face, or because measures they wish to take may have a knock-on effect elsewhere. Such an approach is welcomed, and indeed often necessary, and therefore it is recommended that district councils consider drawing up regional air quality action plans where appropriate.

Setting up a steering group

District councils may wish to set up a steering group to take forward the development and implementation of an Action Plan. The steering group can also play a key role in formulating the annual Action Plan progress report. The members of the steering group should include district council and relevant authority officers. The steering group would decide on how to consult with, and gain support from, other outside bodies, businesses and local community groups to take the process forward.

Other relevant authority departments should be constructively engaged in agreeing measures to improve air quality and meet the legal requirement to work towards air quality objectives. In particular the relevant authorities prescribed under the Air Quality Regulations (Northern Ireland) 2003, should be involved in establishing and acting on measures to improve air quality:

- Department of Enterprise, Trade and Investment;
- Department for the Environment
- Department of Health, Social Services and Public Safety
- Department of Regional Development;
- Department of Social Development
- Northern Ireland Authority for Energy Regulation
- Northern Ireland Housing Executive;

The involvement of the district council Chief Executive, or equivalent, with these meetings would help ensure a fully corporate approach.

A number of commercially available models exist to help local authorities to develop integrated action plans. Details of these are held by the relevant helpdesks found at www.laqmsupport.org.uk who can advise on their applicability and relevance to district council/relevant authority individual circumstances.

Format of the Action Plan

The introduction to the Action Plan does not need to include a lengthy description of the district council's duties under Part III of the Order. It is enough to simply state that 'this Action Plan has been developed in recognition of the legal requirement on the district council to work towards air quality objectives under the Environment (Northern Ireland) Order 2002 and relevant regulations made under it", or words to that effect. The Action Plan itself should take a practical approach focussing on what really matters – the detailing of measures to improve air quality and quantifying, as far as possible their impact over time.

Impact assessment

An Action Plan should include quantification, where possible, of the improvement to air quality that each measure, proposed or implemented, is expected to have over time, with a clear date for meeting this target. For example, within the AQMA an 'x' per cent reduction in emissions from 2009 levels by 2011, with the reduction in concentration of pollutants concerned if this is possible. It is recognised that for, many measures it will not be possible to accurately quantify benefits but it is important that district councils continue to implement measures which are known to have benefits in terms of air quality and climate change goals and in this case, detailed information on implementation targets should be provided. Examples would include schemes to encourage car sharing and / or cycling or the use of cleaner vehicles. Taking the latter of these the provision of information in the Action Plan on say a measure to encourage the uptake of cleaner vehicles through differentiated parking charges, the Euro standard(s) or the vehicle type that the measure is linked to, and the number of vehicles that are expected to be covered by the measure would be appropriate.

Guidance on the impact assessment of certain measures that a district council/relevant authority may wish to take forward is contained in **section 2 of this guidance**.

In developing and assessing an Action plan district councils should consider wider economic, social and environmental impacts, bearing in mind other legal requirements and policy drivers from central Government

Chapter 5: Consultation

The Order provides the statutory basis for consultation and liaison in respect of local air quality management. In order to address and improve local air quality the Department expects district councils to comply with the Order and continue to work closely with other district councils/relevant authorities, agencies, businesses and the local community. District councils need to exchange data with other relevant authorities, agencies and neighbouring district councils.

Schedule 2 of the Order requires district councils to consult:

- the Department;
- all neighbouring district councils;
- other public authorities as appropriate; and
- bodies representing local business interests and other organisations as appropriate.

For the purposes of the Order, district councils must consult on their:

- air quality review and assessment;
- further air quality assessment in an air quality management area; and
- preparation or revision of an air quality action plan.

District councils are also expected to consult on the declaration, amendment or revocation of any air quality management areas.

Consultation on Reviews and Assessments

On the **Updating and Screening Assessments**, district councils will need to consult the Department and other statutory consultees as set out in Schedule 2 of the Order. Although district councils should use their own judgement to determine whether there is a need for a full public consultation they should, in any case, make these assessments available to the public.

On the **Detailed Assessments**, district councils will need to consult the Department and the other statutory consultees. They should also consult the public, local businesses and other appropriate stakeholders and relevant authorities more fully at this stage. They may also choose to disseminate copies within the other district councils for information.

On the **Review and Assessment Progress Reports**, district councils need to submit these to the Department for appraisal. District councils may choose who they wish to circulate these reports but it would be good practice to make copies available to the public, local stakeholders, the Agencies, relevant authorities and the other district council departments for information. For those councils with air quality management areas, it is advised that where possible, Review and Assessment Progress Reports are submitted in a single report at the same time as the action planning Progress Reports. **Similarly,**

with the Review and Assessment Progress Reports, district councils may wish to make the action planning Progress Reports available to local stakeholders and the general public for information.

Consultation on air quality Action Plans

District councils must consult on their preparation of an air quality Action Plan. This is best undertaken when the district council consults on the completion of the further assessment of air quality in the designated area as it provides an opportunity to consult on a draft Action Plan at the same time. This in turn would allow district councils to finalise the plan in the light of consultees' comments. Action Plans may operate over long timescales and councils may only be able to specify broad proposals in the first draft. It is an important principle, therefore, that they carry out a further consultation if they revise their initial proposals while carrying out the plan.

Consultation on a draft Action Plan should include:

- details of which pollutants the council will be taking action on, and an indication of the pollutant emission source/s;
- what other relevant authorities are doing or will need to do to meet the action plan's objectives;
- the timescales for implementing each proposed measure and the emissions (and concentration, if possible) reductions expected by the end of the relevant review and assessment round (or by the specified date in the 2003 Regulations); and
- details of other individuals, bodies or agencies whose involvement is needed to meet the plan's objectives and what the council is doing to encourage their co-operation.

District councils should decide the timescale for consultation. While best practice would suggest that twelve weeks would be appropriate, it is recommended that no consultation exercise should last for less than eight weeks.

Exchanging information is important throughout the local air quality management process. Many district councils have successfully established local steering groups to oversee the process.

Where appropriate, these steering groups should include:

- district council/ relevant authority representatives, including transport and land use planners;
- the Northern Ireland Environment Agency;
- representatives of local businesses and community groups;
- representatives of Health Boards; and
- any other local interest groups and local residents.

Consultation and liaison across district council departments

It is very important to ensure there is effective consultation and liaison across district councils and relevant authority departments. Steering groups and committee meetings should have the support of the Chief Executive or equivalent if possible. This is to ensure that air quality is dealt with consistently across the departments, with a clear understanding as to what the legal requirements and policy drivers are.

Co-operation between authorities

Co-operation between authorities can be greatly helped by the establishment of regional air quality groupings. These groupings can assist with the sharing of experiences and good practice.

Consultation with the Department of Regional Development Roads Service

The Roads Service is committed to the local air quality management process and appreciates fully the importance of working with district councils and other relevant authorities. When consulting the Roads Service on air quality management issues, district councils should continue liasing with established contacts made during the first phase of Review and Assessment or seek advise for new contacts.

Consultation with the Northern Ireland Environment Agency

The Northern Ireland Environment Agency continues to provide a range of support to district councils. The Agency's' Industrial Pollution and Radio Chemical Inspectorate can be contacted for data, information, advice and consultation by phoning (028) 9056 9296 or by emailing enquires to ipri@doeni.gov.uk

Consultation with the Public, Local business and other Stakeholders

District councils should look for innovative ways of engaging local stakeholders, including residents and community groups, as well as local businesses. If people feel personally involved in air quality issues, they are more likely to change their behaviour and support proposed measures to improve air quality locally.

Effective consultation may involve the following:

- Providing user-friendly information so the recipients can fully understand the situation and how they can become involved with the process;

- Involving the local stakeholders at an early stage in the whole process;
- Making full use of existing networks or local community groups and, where possible, extending those networks to capture a diverse range of stakeholders; and
- Setting up participative workshops or forums to make the stakeholders feel part of the consultation process.

It is important that district councils provide information on local air quality in a clear and accessible way. District councils are ideally placed to inform the public about the causes and effects of air pollution. Many district councils have experience of health education and they should consider exploring links with the Health Boards. They should use their contacts with local newspapers, radio and libraries, to reach as wide an audience as possible. Some local authorities have already developed local air quality information strategies and provide regular information. They publish and make monitoring reports available to the public or publish data in local newspapers.

Within the Order there is provision for public access to information. As well as the Review and Assessment reports on which they are required to consult, district councils should proactively make available copies of:

- Orders designating an air quality management area;
- Action plans;
- Other relevant authorities proposals for measures to be included in the action plan; and
- Any directions given to the council by the Department.

Action Plan Progress Reports and review of Action Plans

District councils have a duty to keep their Action Plans up to date. Section 13 (6) of the Order states that a district council may from time to time revise an Action Plan. Whenever an Action Plan is revised, district councils must consult the Department and each relevant authority.

In order to ensure that measures within an Action Plan are implemented by the timescales indicated, the Department expect district councils to submit annual Progress Reports. These Progress Reports list the measures within the Action Plan and include the timescales by when they are/were due to be implemented and give an update on progress in terms of implementing or developing them. Where possible the quantifiable impacts of the measures undertaken should be included.

Action planning Progress Reports should be submitted by **30 April** each year. It is strongly advised that district councils submitting Action Plan Progress Reports should, where possible produce a single Progress Report covering progress on both the Review and Assessment and Action Plan.

Chapter 6: Air Quality and Transport

Introduction

Road transport is a source of local air pollution, and in urban areas contributes significantly to the total emissions of nitrogen dioxide (NO_2) and particulate matter (PM_{10}) – the pollutants for which targets are the hardest to meet.

There were approximately 1,024,396 vehicles licensed in Northern Ireland at 31 December 2006. Of these, 84% were Private Light Goods (PLG) vehicles (cars, lights vans, taxis etc). Over the period from 1992 to 2008 licensed vehicle stock in Northern Ireland increased by 77%, compared with 42% in Wales, 41% in Scotland and 34% in England. The car is the predominant travel mode for households: The Travel Survey for Northern Ireland 2006 - 2008 reports that 81% of the total distance travelled in Northern Ireland was by car. The car's flexibility and convenience enables more people to travel further, with a corresponding increase in vehicle usage.

District Council measures

Emissions from road vehicles are the most common reason for the designation of Air Quality Management Areas. In Northern Ireland currently 17 of the 24 AQMAs list pollutants from roads (traffic) as the main source of poor air quality. Reducing the contribution of road transport emissions is therefore a key part of local air quality management. There are a number of practical measures that councils can consider implementing to reduce levels of pollutants from vehicles. However it should be remembered that while reducing pollution from road based transport is a significant factor in the improvement of air quality road transport is not the only source of pollution and a balanced approach to tackling air quality should be adopted.

Council officers dealing with air quality duties will therefore need to liaise fully at all stages of air quality assessment and action planning with Roads Service, Planning Service and public transport operators where the pollution arises from roads and traffic.

National Context

The national policy framework has already led to significant improvements in local air quality policy and will continue to lead to further improvements. Key transport initiatives include: -

- Regulatory measures and standards to reduce vehicle emissions and improve fuels;

- Tax based and other financial measures that encourage people to supply and use cleaner fuels and also encourage them to buy more environmentally-friendly vehicles; and
- Aviation and shipping policies and regulations.

Regulatory Measures to cut Vehicle Emissions

The vehicles on our roads are becoming progressively cleaner due to the tighter EURO standards on both vehicles and fuels imposed by the European Union's auto-oil programme, which was set up in partnership with the oil and motor industries. These standards alone helped reduce emissions of PM10 and NOx from road transport by 50% between 1990 and 2000 and are expected to lead to a further reduction of some 30% by 2010. The trend of declining emissions is expected to slow down considerably from about 2010 as engine and fuel improvements are offset by continuing traffic growth.

To make sure that vehicles do not produce excessive emissions, new vehicle standards are backed up by emissions tests as part of the MOT. In addition the Driver Vehicle Agency carry out around 1000 vehicle emissions checks each year as part of their roadworthiness enforcement check programme. To improve emissions performance still further, all new cars and light goods vehicles will be required to be fitted with on board diagnostic systems from 2007 which will immediately alert the driver to any irregularities in the vehicle's emissions.

Tax-based Measures

The UK Government continues to use tax-based measures to reduce vehicle emissions. They include:

- Fuel duty differentials to encourage people to use cleaner fuels, including alternative fuels such as bio diesel, liquefied petroleum gas (LPG), and natural gas.
- Since 1 April 2001, Vehicle Excise Duty (VED) for cars has been graduated according to the level of carbon dioxide (CO_2) emissions, with the least polluting paying less in road tax.
- A similar CO_2-based system for taxing company cars has been in place since April 2002, linking the tax charge on the benefit of a company car to the level of its CO_2 emissions. This is intended to incentivise the purchase of more efficient vehicles.
- In December 2001 the Government implemented a new structure of Vehicle Excise Duty for goods vehicles, reflecting more closely the environmental impacts and road wear that different types of goods vehicle cause. The Reduced Pollution Certificate, under which goods vehicles and buses meeting stringent standards for particulate emissions pay a lower rate of VED, continues in force. Further discounts under both the Company Car Tax and VED regimes are available for alternatively powered vehicles, such as electric, hybrid and LPG/natural gas.

The majority of these measures have been aimed primarily at tackling emissions of CO2, one of the major greenhouse gases contributing towards climate change. However, air quality considerations have also been taken into account and it is expected that these changes will also have a beneficial effect on local air quality by encouraging the purchase of cleaner, more efficient vehicles.

The latest VET tax based measures can be found at http://www.direct.gov.uk/en/Motoring/OwningAVehicle/HowToTaxYourVehicle/DG_4022118

Transport information and guidance programmes

The Department for Transport in England and Wales provides funding to the Energy Saving Trust (EST) for their work in reducing CO2 emissions from transport. EST advice centres provide information and guidance to consumers on smarter driving and greener vehicle choices as well as advice to businesses on their transport operations including:

* Green Fleet Reviews
* Motorvate
* Small fleet services
* Smarter Driving

The advice to businesses listed above are funded by DFT (England and Wales only) or the Scottish Government and as such do not currently run in Northern Ireland. Local funding would be required to provide these services in NI.

Centres of Excellence for Integrated Transport Planning

The Department for Transport set up the Centres of Excellence for an Integrated Transport Planning initiative in March 2001. The initiative aims to highlight good practice in integrated local transport planning as well as encouraging the sharing of good practice and experiences. See www.local-transport.dft.gov.uk for more information. DRD Roads Service will keep this initiative under review.

Regional Context - Regional Transportation Strategy for Northern Ireland 2002 – 2012

The Northern Ireland Assembly approved the strategic direction and underlying principles of the Regional Transportation Strategy (RTS) 2002 – 2012 (RTS) in July 2002. This 10 year strategy, with a funding requirement totalling £3500 million, presents a clear framework for action to facilitate implementation of a range of initiatives aimed at bringing about a step change in the quality of transport infrastructure and services.

The level of public expenditure for the RTS will be determined and reviewed through the normal ongoing budgetary process. However, the Assembly's approval confirms a level of commitment to providing the sustained investment that is designed to deliver the outcomes set out in the RTS.

Delivery of the RTS is progressed through 3 Transport Plans (Belfast Metropolitan Transport Plan, Sub-Regional Transport Plan and Regional Strategic Transportation Network Transport Plan) that were informed by comprehensive transport studies undertaken, where timescales allowed, in conjunction with the local Development Plans. These transport studies considered a wide range of transportation measures fashioned to local needs and objectives.

Transport Plans and Air Quality Action Plans (AQAP)

Transport Plans identify proposed measures for walking, cycling, public transport and highway infrastructure. Transport studies which play a key role in informing the Transport Plans consider the potential air quality impacts of the proposals in appropriate detail and can support the development of Air Quality Action Plans (AQAP) as necessary. Published Transport Plans can provide a framework for delivery of measures within an AQAP.

In developing an AQAP where vehicular traffic has been shown to be a major pollution source, the AQAP will likely involve the use of one or more transportation measures from the 'toolkit' available to the traffic engineer / transport planner.

The following local 'toolkit' measures generally reduce traffic volumes directly:

- Traffic regulation orders – e.g. restricting vehicular access to particular streets;
- Traffic calming schemes – e.g. schemes which would dissuade traffic 'rat-running' through residential streets;
- Reallocation of road space – e.g. reducing carriageway width for general vehicles and reallocating to buses;
- Pedestrian areas – restricting vehicular access from one or more streets to create a pedestrian only area;

The following local 'toolkit' measures seek to change other traffic characteristics to reduce emissions:

- Parking controls – e.g. modification of existing parking restrictions for on-street parking and – where appropriate – set parking charges to discourage long-stay parking and maximise the use of short stay spaces in order to dissuade traffic from circulating in search of parking spaces.
- Traffic control systems – e.g. linked signal controlled junctions to reduce traffic queuing at junctions.

The following local ‘toolkit’ measures seek to encourage a shift to alternative less polluting modes of travel:

- Improved facilities for walking;
- Improved facilities for cyclists;
- Safer routes to schools;
- Car share;
- Car clubs;
- Improved bus services;
- Park and ride;
- Park and share; and
- Road user charging and workplace parking levy;

In selecting from the local ‘toolkit’ and preparing a detailed design, attention will be needed to ensure that a balance is struck between:

- Localised improvements in air quality in the area of immediate interest;
- Changes in air quality outside the area of immediate interest; and
- The safety and efficiency of the transport networks.

The local “toolkit” covers some of the methods which can be used to reduce transport related emissions and improve air quality but there are other ways our travel patterns can be influenced. These include personalised travel planning, teleworking, teleconferencing availing of public transport and other travel information (Trafficwatchni.com, radio messages, recorded telephone alerts and emails alerts) which can reduce the need for travel, avoid congestion, or change our mode of travel when we do need to make a journey

Further details on each of the local ‘toolkit’ measures and some additional possible other local measures are given below.

Local Toolkit Measures

Traffic Regulation

Article 4 of the Road Traffic Regulation (NI) Order 1997 gives Roads Service extensive powers to make traffic regulation orders (TROs). TROs can prohibit, restrict or regulate traffic or particular types of vehicle on any part of a road, a single road, or a number of roads and may be in force for a specified time period or permanently.

The Environment (NI) Order 2002 allows the Department for Regional Development (DRD) to make TROs in pursuit of air quality objectives.

Restrictions should be carefully planned and should be fully and accurately signed, preferably indicating suitable alternative routes to avoid generating congestion and pollution elsewhere on the network.

Traffic Calming

Traffic calming schemes may include a number of separate measures including road humps, central islands, build-outs, chicanes, mini-roundabouts and priority junctions.

The objective of traffic calming schemes is to improve driver behaviour and to control speed to a level in keeping with the surrounding urban street environment. The DRD Roads Service programme of traffic calming schemes has been directed mainly at improving safety but can also help to create an environment which encourages walking and cycling by reducing the volume and speed of traffic. Traffic calming schemes may have the effect of slowing vehicles and also deterring traffic from using residential roads as a short cut.

Article 65 of the Roads (NI) Order 1993 gives the DRD the power to construct road humps and other traffic calming works. The regulations governing the installation of traffic calming measures are the Traffic Calming Regulations (NI) 1995 and the Roads Humps Regulations (NI) 1999.

It is important that traffic calming schemes are designed in such a way that encourages a smooth driving style that avoids repeated acceleration and deceleration, which may otherwise increase vehicle emissions.

Reallocation of Road Space

Reallocating road space to buses, cycles and pedestrians can make these forms of transport more attractive and may lead to an increase in bus usage or in the number of trips made by cycle or on foot. The resulting reduction in car use should lower emission levels and lead to an improvement in air quality.

The DRD uses TROs under the Road Traffic Regulation (NI) Order 1997 to designate bus and cycle lanes by reallocating road space away from cars.

It is important that any roadspace reallocation is designed in a manner which considers and minimises the impact on air quality of any increase in congestion. Permitting certain classifications of taxi and powered two wheel vehicles to use selected bus lanes can help in this regard and a review of this approach is currently taking place.

Pedestrian / Vehicle Restricted Areas

A pedestrianised area is a street or road where vehicular traffic is excluded (either totally or partially). Restricting vehicular access to town centres, through the use of pedestrianised areas, has not only resulted in improved air quality but has also made pedestrians feel safer moving around...

The Department for Regional Development (DRD) has the power under the Road Traffic Regulation (NI) Order 1997 to restrict vehicle access, thereby creating the pedestrianised area. Alternatively, DRD can use its powers under article 100 of the Planning (NI) Order 1991 to create a pedestrian area.

In designating pedestrian areas it is important to maintain accessibility and hence safeguard the economic viability of the area. Consideration must therefore be given to:

- Servicing requirements
- Public transport arrangements;
- Peripheral car parking;
- Facilities for cyclists and pedestrians;
- Access for taxis, where appropriate;
- Access for people with limited mobility.

Traffic restricted areas will be implemented by suitable traffic signs. If compliance with the access restrictions is an issue then physical measures may be required. Increasingly, rising bollards are being used to enforce selective vehicle access areas. Some guidance on the use of rising bollards is given in Traffic Advisory Leaflet 4/97.

Parking Controls

The ability to prohibit and restrict the waiting of vehicles on a road can be a key tool in controlling the volume of traffic within towns and cities. The availability and cost of parking facilities can influence whether people choose to drive to a destination or use a more sustainable mode of transport. In addition, a significant level of traffic in town centres may comprise vehicles circulating in search of parking spaces.

The Road Traffic Regulation Order (NI) 1997 enables DRD to determine where motorists can park and how much it will cost them.

The powers for the enforcement of waiting restrictions have passed from the Police Service of Northern Ireland to DRD through the Traffic Management (Northern Ireland) Order 2005. This decriminalised parking enforcement (DPE) has been in operation since 30 October 2006 and gives the DRD significantly more control over enforcement of parking and waiting restrictions to ensure that parking strategies are effective in practice. Parking compliance surveys indicate that there has been a significant reduction in the level of illegal parking since the introduction of DPE.

Traffic Control Systems

Traffic control systems using electronic detection and signalling systems can reduce traffic queues and hence vehicle emissions. In particular adaptive traffic control systems, such as SCOOT5 and MOVA6, at signal controlled junctions respond automatically to changing traffic conditions and give better traffic flows than Urban Traffic Control plans or uncoordinated signal networks.

When traffic congestion causes vehicle emissions to exceed a pre-set threshold SCOOT systems can be programmed to hold queues outside the area. This process is called gating and may be appropriate if the queue is located where relatively few people are exposed to any increased emissions. Overall journey times may well remain similar, but drivers queue for longer while approaching the area and then make faster progress through it.

The MOVA system has been developed for use at isolated, heavy-loaded traffic signal installations. In congested conditions MOVA can extend the green-times to values much longer than usual, in order to maximise capacity and therefore reduce emissions from stationary vehicles.

The powers given in The Roads (NI) Order 1993 and Traffic Signs Regulations (NI) 1997 allow the DRD to improve the road network by installing traffic signals at junctions.

Walking

Walking is an integral part of all journeys and an essential part of public transport journeys. Walking is sustainable and environmentally friendly and can provide levels of exercise to suit everyone. It is considered that many short journeys (less than one mile) currently made by car, which result in relatively high vehicle emissions, could realistically be made on foot.

DRD Roads Service recognises that walking can be made safer, easier and more pleasant and should be integrated with other modes of travel, and with health and tourism initiatives. Measures provided by Roads Service include new and widened footways, crossing facilities, measures to cater for people with disabilities and other pedestrian safety improvements. Where required the DRD uses powers under the Road Traffic Regulation (NI) Order 1997 and/or the Roads (Northern Ireland) Order 1993 to facilitate the introduction of pedestrian measures.

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[5] SCOOT Split Cycle Offset Optimisation Technique
[6] MOVA Microprocessor-Optimised Vehicle Actuation

In April 2000 the DRD established the Northern Ireland Walking Forum. The Forum brought together major organisations and bodies having an interest in walking and published an Action Plan in 2003.

Cycling

Cycling is a healthy, flexible, inexpensive and sociable means of travel. An increase in the proportion of trips made by cycle would help to improve local air quality, personal health and social well being. It is considered that many current car journeys of less than 3 miles could realistically be made by cycle.

The Northern Ireland Cycling Strategy, published in June 2000, sets targets to increase cycle use. Through the Northern Ireland Cycling Forum, the Department for Regional Development (DRD) continues to work with other public and voluntary organisations having an interest in cycling to ensure that all elements of the Strategy are successfully implemented.

Where required the DRD uses powers under the Road Traffic Regulation (NI) Order 1997 and/or the Roads (NI) Order 1993 to provide cycling facilities.

Safer Routes to Schools

Safer Routes to Schools projects encourage and enable children to walk, cycle and use public transport to travel to school through a combined package of educational and physical measures. Where required the DRD uses its powers under the Road Traffic Regulation (NI) Order 1997 to facilitate the introduction of the physical measures on the highway network.

The benefits of Safer Routes to Schools are widespread and include fewer child casualties and road traffic accidents, safer roads for all (especially pedestrians and cyclists), healthier lifestyles and reduced congestion, resulting in reduced vehicle emissions and improved air quality.

DRD Roads Service established an inter-departmental School Travel Advisory Group in 2000 to co-ordinate the introduction of Safer Routes to Schools schemes. Responsibilities lie with the DRD, the Department of the Environment, the Department of Education and the individual schools concerned.

Car Share

Car Sharing is when two or more people who are heading to the same destination, travel together by car for all or part of a journey. Car Sharing has clear benefits for an organisation and its employees, which in turn provide wider benefits for local communities.

For an organisation, car sharing will:

- save an organisation money through the removal or reduction of car parking spaces;
- help to relieve local traffic congestion and associated pollution;
- demonstrate corporate social responsibility and contribute towards sustainability and environmental targets;
- widen potential recruitment markets.

For employees, car sharing will:

- provide significant cost savings as a result of sharing the costs of petrol, car parking and other vehicle running costs (on average, commuters that car share save themselves over £1,000 a year compared to driving alone);
- enable them to travel more securely and ensure they are less stressed on the journey to work;
- allow them to enjoy the social benefits of sharing the journey, improving work/life balance and empowering them to feel they are doing their bit for the environment.

The DRD Travelwise NI Car Share Scheme has currently over 2500 members. For more information log on to **www.carshareni.com**
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Car Clubs

Car Clubs are a way of enjoying the flexibility of a car without having to own one. They offer affordable, flexible, convenient access to a choice of vehicles parked close to home or work. There are different models of car club operation but the basic principles are the same.

- Members pay a monthly fee and then “pay as they drive”.
- Cars can be hired for as little as an hour or for a few days.
- They are parked in reserved places where people live or work.
- Bookings can be made by phone or internet.
- Access to cars is by smart card.
- All vehicles are serviced and maintained by the Club.

More information about Car Clubs operating in Northern Ireland can be found by logging on to **www.carplus.org.uk**
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Improved bus services

Buses can transport large numbers of people whilst occupying relatively little roadspace. Modern buses' rates of emission are significantly low to ensure that the use of bus in preference to car can help improve air quality.

The operation of buses in Northern Ireland is predominately controlled by Translink but responsibility for roadside infrastructure remains with the Department for Regional Development (DRD). Translink continually monitor the performance and availability of alternative fuels and have examined the latest technological developments in the use of diesel engines. Translink's current preference is to use low sulphur diesel in conjunction with continuous regeneration trap (CRT) exhaust systems. The CRT system renders bus exhaust emissions smokeless and odourless and gives a better result than that currently available from gas powered vehicles. However, it is anticipated that there is significant potential for the use of bio-diesel and diesel-electric engined buses.

Where appropriate, DRD Roads Service develops schemes to reallocate road space and use traffic signal technology to assist buses to maintain journey times by giving them priority over other traffic. This will encourage motorists to use buses, reduce congestion and also help cut bus emissions by reducing stop-start driving. To gain maximum benefit from bus lanes it is essential that they are adequately enforced. Responsibility for moving traffic offences currently rests with the Police Service of Northern Ireland.

Public transport information such as using Passenger Information Points (PIPS) usually housed within Bus Shelters and the provision of journey time information on electronic message signs (EMS) have an important role to play in improving service facilities.

Park and Ride

There will always be many journeys to city-centre locations, which must commence by car because of the widespread distribution of journey origins and which cannot be served practically by bus services. However, Park and Ride can be an effective policy to assist in reducing city-centre traffic congestion by intercepting these journeys and encouraging people to complete their journey by public transport. Park and Ride schemes should be seen as just one of a number of measures making up an integrated transport policy.

Park and Ride schemes will generally be most successful where:

- They are some distance from the town centre, ideally where radial and orbital routes intersect;
- The town centre is served by a number of high quality sites on the outskirts, with lighting, staff, information for users and CCTV; and
- Bus priority measures complement park and ride services, whilst cars are restricted in the town centre.

More information about Park and Ride sites operating in Northern Ireland can be found by logging on to **www.translink.co.uk/parkandride2007**

Park and Share

Park and share is similar to car-sharing but is aimed at commuters who travel long distances or those who live in rural areas and work in the city. The arrangements can typically involve:

- Teaming up with friends or colleagues who work with or near each other and who live in the same general direction.
- Selecting a suitable meeting point on the outskirts of the city or where the route that's common to sharers starts. Driving individually to the designated meeting spot, then sharing one vehicle to drive into the city.
- Taking it in turns to drive the city leg of the journey. This saves money on petrol as well as the tiredness associated with driving long distances every day.

Park and share need not take place every day but when operating will have an immediate impact on the number of cars driving on your route to work. More information about Park and Share sites operating in Northern Ireland can be found by logging on to **http://www.travelwiseni.co.uk/index/commuters/parkandshare.htm**

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Road User Charging and the Workplace Parking Levy

Road User Charging is a demand management measure where drivers are charged a fee when they cross a cordon and enter the city limits. Workplace Parking Levies involve businesses located within city limits being charged a fee for each employee that drives to work and parks all day.

In the face of rising car ownership and congestion, pricing instruments such as road user charging and workplace parking levies are increasingly seen as effective components in an integrated strategy to reduce traffic and raise revenue. The area-wide reduction in traffic may result in a decrease in vehicle emissions and consequently an improvement in air quality.

The Department for Regional Development (DRD) has undertaken an initial assessment of road user charging and workplace parking levy options for Northern Ireland. Various charging scheme options (including both road user charging and workplace parking levy variants) were considered for Belfast, and workplace parking levies were investigated in other Northern Ireland towns and cities.

The Regional Transportation Strategy for Northern Ireland 2002-2012 (RTS) recognises that, in the short term, Belfast is the only urban area in Northern Ireland, which could potentially be considered for road user charging. Although studies undertaken on the introduction of road user charging suggest that it is technically feasible, the Belfast Metropolitan Transport Plan has not proposed road user charging or workplace parking levies for Belfast in the period to 2015. It is important to note that the introduction of any charging scheme will require new primary legislation.

The DRD continues to monitor developments in the use of road user charging and workplace parking levies in Great Britain and Europe (including the London Congestion Charging Scheme) to contribute to an informed decision on whether proposals should be made for such charges in Northern Ireland.

Other Local Measures

In addition to the above ‘toolkit’ there are a number of other measures, which could potentially have a role in the preparation of an Air Quality Action Plan. These measures are outlined below.

Low Emission Zones

Low Emission Zones are areas where certain types of vehicles are prohibited from entering towns or cities. A low emission zone would ensure only vehicles meeting minimum emission standards would be allowed to enter pollution hotspots. The main purpose of the zone would be to improve air quality, though it may deliver additional "liveability" and congestion benefits by reducing traffic noise and overall traffic volumes. They may however divert the more polluting vehicles elsewhere.

Home Zones

Home Zones are residential streets in which the roadspace is shared between drivers of motor vehicles and other road users, with the wider needs of residents (including pedestrians, cyclists, and children) in mind. The aim is to change the way that streets are used and to improve the quality of life in residential streets by making them places for people, not just for traffic. Further information on Home zones can be found at www.homezones.org

Clear Zones

The Government supports the Clear Zones initiative, which ran between 1995 and 2005, and which was designed to encourage solutions to traffic problems in towns and cities while making sure town centres retain their accessibility, vitality and economic viability. A clear focus of the initiative was to reduce congestion and improve air quality by developing an integrated transport policy to meet local needs. A number of authorities have continued to apply and develop the concept, and further information can be found at http://www.dft.gov.uk/pgr/roads/tpm/clearzones/

DRD Roads Service will monitor developments with counterparts in GB.

High Occupancy Vehicle Lanes

High Occupancy Vehicle (HOV) lanes are, in principle, a means of using the road network more efficiently and encouraging car sharing. They work on the basis of giving priority to vehicles with more than a pre-determined number of occupants. The introduction of HOV lanes will require new primary legislation.

Rail

Within urban areas, heavy rail and light rapid transit systems are likely to be limited to radial services in the larger conurbations. They may be well suited to serving outlying residential areas, or to substituting for the private car for the final leg of the journey into the town centre through park and ride arrangements. Rail-based park and ride depends on there being enough secure off-street parking at the station. Traffic authorities will also have to consider the capacity of the road network around the station.

Heavy Goods Vehicles (HGVs)

HGVs contribute to road transport emissions and to congestion in some town and district centres. To minimise this the DRD, the Freight Transport Association and others interested parties formed a Freight Quality Partnership to produce "Delivering the Goods in Belfast". HGVs are required to meet European standards and their emissions are regularly tested. Authorities can also encourage local HGV operators to apply for Government grants to retrofit pollution reduction devices.

Public Health

The DRD is a member of the Northern Ireland Physical Activity Implementation Group (NIPAIG), a group facilitated by the Health Promotion Agency established to co-ordinate action on the Northern Ireland Physical Activity Strategy and associated Action Plan. The aim of the Plan is to increase levels of health related physical activity, particularly among those who exercise least.

Powered Two Wheel Vehicles

Motorcycles and mopeds can provide an alternative means of travel when public transport is limited and where journey length makes walking unrealistic, and they may contribute to a reduction in congestion. While they have some air quality advantages over cars and their engines are small and usually fuel-efficient, their emissions are largely unregulated and the use of catalytic converters is not widespread. There may also be some concerns with regard to noise and safety.

Workplace Travel Plans

A Workplace Travel Plan is a general term for a package of measures tailored to the needs of an individual organisation or site and aimed at promoting more sustainable, cleaner travel choices and reducing reliance on the car. It involves the development of a set of mechanisms, initiatives and targets that together can assist an organisation reduce the impact of travel and transport on the environment.

Speed Limits

The Road Traffic Regulation (NI) Order 1997 enables the DRD to set speed limits on roads or for particular classes of vehicle. The speed limits are set in conjunction with the Police Service of Northern Ireland, who are responsible for enforcement. Whilst the reduction of speed limits in urban areas may improve road safety and reduce severance impacts, it is unlikely that improvements in air quality will result.

Airports

All operators of airports in England and Wales with 1,000 or more scheduled and charter passenger air transport movements a year are responsible for setting up Airport Transport Forums (ATFs), whose objective is to improve surface access (including public transport) to airports , by co-ordinating the activities of various regional and local authorities, agencies and other delivery bodies **.** They are also responsible for preparing airport surface access strategies (ASAS), which feed into the Local Transport Plan. ASAS should include challenging short and long-term targets for increasing the proportion of journeys made to airports by public transport; strategies to achieve these targets; and a system to oversee implementation of the strategy. ATFs should include representatives from local authorities, transport operators, local people and other interested parties.

In Northern Ireland, responsibility for strategic transport planning and for delivery of road and public transport services rests with the devolved administration. There is no requirement upon airports to establish Airport Transport Forums. Land connections to key transport gateways such as airports will be considered as part of the review of the Regional Transportation Strategy.

Partnerships between Businesses and District Councils

Partnerships with other Departments, Councils and private sector organisations are beneficial to DRD in it’s monitoring of the effects of transportation measures and the level of service provided. Where possible the impact of transportation measures should be reduced to improve air quality and the environment.

Chapter 7: Air quality and related areas

Land Use Planning

The land use planning system can positively contribute to the improvement of Air Quality and therefore help to secure the air quality objectives set out in the Environment (Northern Ireland) Order 2002 as well as assisting District Councils in carrying out their statutory air quality management duties.

Planning Control can contribute to the realisation of air quality objectives through consideration of the location of development which may give rise to pollution, and by ensuring that other developments are, as far as possible, not affected by major existing, or potential future, sources of pollution;

The Relationship between the Planning and Pollution Control Regimes

The planning and pollution control systems are separate but complimentary systems of control and regulation designed to protect the environment from harm as a result of development and related operations.

Planning control focuses primarily on the acceptability of the use of the land for the particular development, rather than the control of the processes or substances involved; and the regulation of the location of development in order to avoid or minimise adverse effects on people, the use of land and the environment.

The pollution control regime is concerned with the control and regulation of proposed operations and processes and their day to day operation. The objective is to ensure that operations can be carried out without endangering human health or causing harm to the environment.

Planning control, however, should not be used to duplicate other statutory controls or be used to achieve objectives relating to other legislation. Planning decisions will therefore be made on the basis that the pollution control regimes will be properly applied and enforced. The relevant expertise and statutory responsibility for pollution control rests with the relevant pollution control authorities.

Nevertheless the dividing line between each system of control is not always clear cut. Planning control is not an appropriate means of regulating the detailed characteristics of potentially polluting activities, while matters relevant to pollution control authorisation may be material planning considerations.

Close consultation is essential to a proper understanding of the scope and requirements of the two regimes. Decisions based on adequate information can minimise costly delays in the decision making process. The Department of the Environment will continue to work closely with pollution control authorities and take their advice into account when developing policy, in decision taking and in avoiding duplication between the planning and pollution control systems.

Planning and Local Air Quality Management – Information Issues

The LAQM Policy Guidance requires that councils be provided with Information from the planning authority with regard to new local developments or anticipated development that might affect local air quality and hence inform ongoing assessments and progress reports to be carried out by councils. The input expected from the planning authority is summarised as follows:

- Information on new local developments that have taken place or been granted planning permission and that may affect air quality. Examples include industrial developments likely to give rise to harmful emissions, development which may result in a significant intensification of traffic in a local area, new landfill sites or quarries.
- A list of planning applications for development that has the potential to affect local air quality. This would include all applications for which an air quality assessment has been requested.
- Decisions on major planning applications, such as the location of a new bypass or airport runway.
- New regional planning policy which may impact on air quality, for example on renewable energy.

It is important that there is a two way flow of information and in this regard the provision of information on local air quality to the planning authority will assist in the delivery of planning frameworks and decisions which take appropriate account of this issue.

Planning Policy and Development Plans

The following are some of the issues that may be considered in the preparation of Planning Policy Statements and Development Plans with a view to achieving positive impacts on local air quality or curtailing the negative land use impact of poor air quality. Such issues may also be material in the consideration of individual planning applications:-

- ensuring that the land use planning system makes an appropriate contribution to the achievement of national air quality objectives;
- on the appropriate location for new development, including reducing the need to travel and promoting public transport;

- the need to identify land, or establish criteria, for the location of potentially polluting developments and the availability of alternative sites;
- the need to separate potentially polluting and other land uses to reduce conflicts, for example, by identifying, where necessary, areas around existing sources of pollution, including roads, in which other developments should be carefully considered;
- existing and likely future air quality in an area, including any Air Quality Management Areas (AQMA) or other areas where air quality is likely to be relatively poor. The findings of air quality reviews and assessments will be important in the consideration of local air pollution problems and the sitting of certain types of proposals.

The Planning (Amendment) (Northern Ireland) Order 2003 requires development plans to be in general conformity with the Regional Development Strategy 2025 (RDS). The RDS was published by the Department of Regional Development and provides the regional context for area plans. The RDS sets out 4 Strategic Guidelines in relation to the improvement of air quality (SPG-ENV 6.1).

Planning Applications - Air Quality as a Material Consideration

Any air quality consideration is capable of being a material planning consideration in so far as it affects land use. Whether it actually is and how much weight should be attached to it will depend upon the facts of each individual case[7].

Wherever a proposed development is likely to have significant air quality impacts, close co-operation between Planning Service and those with responsibilities for air quality and pollution control will be essential. The impact on ambient air quality is likely to be particularly important:-

- where the development is proposed inside, or adjacent to, an AQMA;
- where the development could in itself result in the designation of an AQMA;
- where the development, including associated traffic, is likely to result in the deterioration of local air quality; or
- where to grant planning permission would conflict with, or render unworkable, elements of an air quality action plan.

It is not the case that all planning applications for developments inside or adjacent to AQMAs should be refused if the developments result in a

[7] Over the last three years this has been tested through the English courts with regard to the location of residential developments near to major roads,

deterioration of local air quality. Such an approach could sterilise development, particularly where authorities have designated their entire areas as AQMAs.

Planning Service may be faced with numerous individual, small planning applications which separately might not be considered to have a significant impact on air quality but which cumulatively would have a significant impact. Each planning application should be determined on its individual merits and having regard to the development plan as a material consideration. In practice, this should mean that individual small-scale applications continue to receive approval until such time as one reaches the unacceptable mark.

All planning applications should be supported by such information as is necessary to allow a full consideration of the impact of the proposal on the air quality of the area. Circumstances might arise within an AQMA where in order to allow development to proceed the developer may bring forward measures to offset any increase in local pollutant emissions as a consequence of the proposed development, such as funding of better public transport links, or the purchase of monitoring equipment.

In considering whether a site inside an AQMA is an appropriate location for new housing development, Planning Service will seek advice from the local Environmental Health Officer and consider where, within the AQMA likely exceedences have been identified and by how great a margin the air quality objectives are currently exceeded, as well as when they are forecast to be achieved. It may be that in some cases, housing development might best be delayed until the relevant air quality objectives have been achieved or the layout modified to avoid the area of the exceedence. The Planning Service will in the course of determining the outcome on any such scheme put before them consider what weight to give such exceedences as a material consideration.

Environmental Impact Assessment and Strategic Environmental Assessment

Environmental Impact Assessment (EIA) is an important procedure for ensuring that the likely significant environmental effects (both direct and indirect) of a proposed development are fully understood and taken into account before development is allowed to go ahead. The types of development for which EIA may be required are listed in the Town and Country Planning (NI) (Environmental Impact Assessment) Regulations 1999.

These Regulations require the developer of any project which is subject to EIA to prepare an environmental statement describing the likely environmental effects of the project. Planning Service has to take account of this information before deciding the application for planning permission. The information to be included in the environmental statement is described in Schedule 4 to the Regulations. It must include a description of the development, the likely significant environmental effects (including air quality before and after the proposed development), mitigating measures envisaged, an outline of the main alternatives studied by the applicant and the reasons for his/her choice, and a non-technical summary.

DCAN 10 Environmental Impact Assessment August 1999(revised) provides guidance on the procedures to be followed

Strategic Environmental Assessment

District councils first consideration under section 13 (2)(b)of the Environment (Northern Ireland) Order 2002 is that air quality Action Plans are for the exercise of any powers exercisable by the council in the pursuit of air quality objectives. Once district councils have established what they think is needed for their Action Plan, the council should then turn to consider whether the exercise of the powers chosen would trigger a Strategic Environmental Assessment.

For stand-alone air quality Action Plans, district councils will need to determine on a case-by-case basis whether the Strategic Environmental Assessment Directive (2001/42/EC "on the assessment of the effects of certain plans and programmes on the environment") applies to their Action Plan. District councils should have regard to the criteria set out in Directive 2001/42/EC and the Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 which transpose it into UK law. Further guidance is given in the Government's "Practical Guide to the SEA Directive"

www.communities.gov.uk/publications/planningandbuilding/practicalguidesea.

In making a decision as to whether a Strategic Environmental Assessment is required, district councils will need to consider (inter alia) whether:

- the Action Plan sets the framework for future development consent of projects, including, but not limited to, projects listed in annexes I and II of the Environmental Impact Assessment Directive 85/337/EC, as amended.

- the Action Plan's likely effect on sites means that assessment under Article 6/7 of Directive 92/43/EEC (Habitats Directive) is required.

As a guide, district councils may like to take the following into consideration:

- Do they intend to include conditions within the Action Plan which will influence a Development Plan or other consent framework in ways which are likely to have significant environmental effects (for example, will the Action Plan require or preclude certain projects at certain locations)? If so, a Strategic Environmental Assessment will be required.

- Does the Action Plan only set out specific air quality measures such as traffic management schemes, parking controls and so, and there is no intention of including conditions to influence planning or development consents? If so, there is probably no need for a Strategic Environmental Assessment.

- Is the Action Plan integrated into another plan or programme (for example, a Local Transport Plan) which already requires a Strategic Environmental Assessment? If so, the Strategic Environmental Assessment Directive applies to that plan or programme.

Where a Strategic Environmental Assessment is required, to ensure that the various stages of the production of an air quality Action Plan comply with the Practical Guide to the SEA Directive, district councils should:

- Consult designated Strategic Environmental Assessment Consultation NI bodies on the scope of the Action Plan (English Heritage, Natural England in England, and the Environment Agency, as well as bodies across the Welsh and Scottish borders if actions are to be near enough to have an effect here;
- Issue the Environmental Report to accompany proposals for the Action Plan at consultation stage;
- Take wider environmental issues into account when finalising the Action Plan, and produce a statement showing how this has been done;
- Monitor the environmental effects of implementing the Action Plan. The scoping proposals and Environmental Report should include proposed monitoring arrangements, and a statement at adoption of the Action Plan should confirm what these will be.

It is important to note that the Strategic Environmental Assessment process must be carried out during a plan's preparation, beginning at an early stage, and the findings taken into account when the plan is finalised and formally adopted.

Directive 2001/42/EC "Strategic Environment Assessment" or SEA Directive, which became effective in July 2004, may be relevant to air quality management. The Directive requires a formal assessment of certain plans and programmes which are likely to have significant impacts on the environment. The Directive will apply to programmes which:-

- Set the framework (in a broad sense) for future development consent of projects listed in the EIA Directive;
- Set the framework for future development consent of projects other than those in the EIA Directive which might cause the plan as a whole to have significant environmental effects;
- Have any effects on Natura 2000 sites which might make them subject to the Habitats Directive.

There will however be provisions for exempting some plans and programmes which are concerned with small areas at local level, or which are minor modifications, where these are determined not to have significant environmental effects.

The SEA Directive also requires monitoring the environmental effects of implementing plans and programmes which have been assessed.

Summary

This chapter is intended to serve only as a summary of some of the main ways in which land use planning can help deliver air quality objectives.

The planning system does not however offer any quick-fix solutions to areas of poor air quality, but it can do much to improve local air quality in the longer term through the development plan and development control processes in that :-

- any air quality consideration that relates to land use and its development is capable of being a material consideration
- the planning system has a role to play in determining the location of development which may give rise to pollution and in ensuring that other developments are, as far as possible not affected by major existing or potential sources of pollution.

The Royal Town Planning Institute (RTPI) published a good practice guide on air quality and land use planning in April 1999. This sets out in general terms the relationship between air quality issues and planning decisions. It also tries to establish how far the planning process itself can contribute to air quality objectives.

Copies of the guide can be ordered from the RTPI, 41 Botolph Lane, London EC3R 8DL (telephone: 0207 636 9107).

Combustion Installations

Planning Policy Statement 18 'Renewable Energy' (PPS18) provides the policy context against which all renewable energy and heat generating schemes will be assessed. In addition to providing information on technology appropriate locations, PPS 18 requires that the *Companion Information and Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy'* will be taken into account in assessing proposals. The companion guide provides bespoke information on all forms of renewable energy technologies (including combustion plants such as biomass), and provides guidance on the siting, location, design and other authorisations/consents required in developing any development proposal.

The Building (Amendment) Regulations (NI) 2006 (specifically Part L, Combustion Appliances and Fuel Storage Systems) are also relevant, as well as statutory nuisance provisions under Clean Air (NI) Order 1981 may be applicable where the combustion installation is not situated in a smoke control area. These regulations can be found at www.buildingregulationsni.gov.uk.

In smoke control areas, only appliances that are exempted from the provisions of the Clean Air (NI) Order 1981 may be used. Where the Clean Air (NI) Order 1981 applies, local authorities:

- Must take action where dark smoke is emitted from a chimney of any building (subject to certain permitted periods and exemptions);
- Must take action where dark smoke is emitted from industrial or trade premises (subject to certain exemptions);
- Can require notification of installation of industrial furnaces and approve grit and dust arrestment equipment; and
- Approve chimney heights of certain furnaces

District Councils can also designate smoke control areas under the Clean Air (NI) Order 1981 (see www.uksmokecontrolareas.co.uk). The effect of this is to:

- Require people to adapt their fireplaces to burn smokeless fuel;
- Restrict the burning of unauthorised fuels except in exempted fireplaces. Details of authorised fuels and exempted fireplaces are available at the website above;
- Restrict the sale of unauthorised fuels.

In a smoke control area, it is an offence to emit smoke from any chimney. It is also an offence to acquire for use or to sell for delivery any fuel, other than an authorised smokeless fuel, unless it is to be burned on a fireplace exempted from the smoke control order, and in accordance with the conditions of use of that fireplace.

Local officers dealing with air quality should be aware of permitted development rights and the impact that these might have when, for example, a biomass heating system is installed in a dwelling which has a flue not exceeding one metre from the highest part of a roof, among other conditions. Environmental controls, such as those under the Clean Air (NI) Order 1981, still apply; as does the power of the local authority to make ‘Article 4’ directions in order to withdraw permitted development rights where there is a material impact on, for example, air quality.

SECTION 2: Measures to improve air quality

Introduction

This section provides guidance to district councils and relevant authorities on some of the measures they might like to consider to make improvements to air quality. It is not an exhaustive guidance on measures, but provides practical guidance on how to implement certain measures and assess the impact that they have.

Part I: Using the planning system to reduce transport emissions

The Beacons Low Emission Strategies Working Group has produced guidance on how to use the planning system to reduce transport emissions. Defra is considering including a version of this guidance within the final version of this policy guidance.

The Beacons Low Emission Strategies Working Group comprises representatives from the four Air Quality Beacon Authorities (Croydon, Greenwich, Sefton and Sheffield), the Greater London Authority, Kensington and Chelsea Council, City of London Corporation, Cenex and Arup. The Beacon Scheme was established to disseminate best practice in service delivery across local government. Further information is available at www.beacons.idea.gov.uk.

A draft of the Low Emission Strategies guidance is available at www.cenex.co.uk, and will be available there for the duration of this consultation. The recommendations in the guidance are those of the authors, not Defra, and Defra has not endorsed the guidance in its current form. However, the guidance on the Cenex website asks a series of questions as part of the Beacons Low Emission Strategies Working Group's own consultation exercise. Defra will be working with the group to discuss the responses received in relation to these questions, and there are additional questions that Defra would like to ask as part of this consultation exercise:

Q Is the guidance on using the planning system to reduce transport emissions useful? Are there any changes to this guidance that you would recommend?

Q Are there particular challenges that you have encountered when considering the approaches referred to in the guidance?

Q Would you support the inclusion of the Low Emission Strategies guidance in the final version of the Defra statutory guidance?

Part II: Low Emission Vehicles, Low Emission Zones, Road Charging and Retro-fitting of Abatement Equipment

Overview

Practice Guidance accompanies this Policy Guidance, and is available via www.doeni.gov.uk. The Practice Guidance points local authorities towards the more ambitious and effective measures that they can take, including:

- Establishing low emission zones
- Encouraging the uptake of low emission vehicles
- Encouraging the uptake of retrofitted abatement equipment on vehicles

Guidance is also provided on economic principles for the assessment of local measures to improve air quality.

It is not mandatory for local authorities to follow this Practice Guidance to its full extent. It is for local authorities to determine what will work best in their situation.

Part III: Further measures and further support

Introduction

This part of the guidance describes some further measures that district councils might like to consider. Although this part of the guidance does not include the level of detail that is provided in Parts I and II, and it may be difficult to quantify the impact that some of these measures will have. Nevertheless, the measures contained in the part of the guidance can be effective at improving air quality, and should be given equal consideration for implementation alongside other measures. Again, the examples provided here are not exhaustive.

Further measures and good practice

Further examples of measures (in addition to those throughout this guidance) and examples of good practice are available on the Air Quality Archive at www.airquality.co.uk/archive/laqm/ap_goodpractice.php. There is also a Learning Exchange section of this website, which enables local authorities to share their knowledge, at www.airquality.co.uk/archive/laqm/ap_learningexchange.php.

Some local authorities have established regional partnerships, such as the Care4Air partnership in South Yorkshire. See www.care4air.org/ for more information.

Trees and green spaces

Another measure that relevant authorities may like to consider, and which can have benefits beyond environmental ones, is the greening of urban spaces. Trees can play an important role in the environment for a range of reasons, including having impacts on air pollution (both positive and negative), providing shade and helping cool urban areas, reducing water volume entering drainage systems during extreme rainfall events, acting as small carbon sinks and helping to promote physical and mental well-being.

Some key areas where policies regarding trees and green space might be able to integrate with air quality action plans and strategies include:

Providing trees between pedestrian and cycle ways to help reduce pollution exposure – both by simply moving activity further away from the road, but also forming a physical barrier to block dispersion of pollutants;

- Creating green travel corridors for walking and cycling to make these travel modes more attractive; Personal safety issues should be considered in any planting design.

- Providing trees in green areas such as verges, cuttings, embankments, medians and at roundabouts to help reduce pollution exposure. There are more opportunities to plant trees in rural areas but appropriate urban locations also exist. Tree planting must ensure that tree growth will not interfere with traffic management, road safety or underground services in its lifetime.

- Choosing tree species that might maximize pollution uptake by their leaves or needles or minimize emissions of volatile compounds that can contribute to ozone formation. Planting trees is not a "quick fix" solution. Indeed planting the wrong trees in the wrong location can lead to more air pollution at certain times of the year.

Information on green spaces within towns is available at www.naturalengland.org.uk/planning/landscape/default.htm

Particles and dust from construction and demolition

District councils can use their powers to control emissions and dust from construction and other sites, including off-road vehicles, through the powers they have available to them, such as planning controls and the Pollution Control & Local Government (NI) Order.. The Greater London Authority and the London Councils have produced Best Practice Guidance on the control of dust and emissions from construction and demolition, which is available at www.london.gov.uk/mayor/environment/air_quality/docs/construction-dust-bpg.pdf. Techniques in this guidance are widely applicable and district councils should actively consider whether they are appropriate.

Further support

Details of helpdesks (which also provide examples of good practice on the reporting process) and links to further information are available on the Defra website at www.defra.gov.uk/environment/airquality/local/index.htm.

The Department is currently providing funding under a Local Air Quality Grant scheme to district councils of approximately £1M per year until 2008/09. Following completion of the grant scheme in 2008/09 the Department proposes to introduce a replacement scheme, subject to future budget outcomes. For further details on the scheme contact the Air and Environmental Quality Unit, telephone no (028) 90254887

Annex A: Model air quality management area order

The Environment (Northern Ireland) Order 2002

[Name of Council]
AQMA Order

[Name of Council], in exercise of the powers conferred upon it by Part III,Article 12(1) of the Environment(NI) Order 2002, hereby makes the following Order.

This Order may be cited/referred to as the [name of Council] Air Quality Management Area [No1, 2, 3 if more than one is being designated] and shall come into effect on [date]

The area shown on the attached map in red is to be designated as an air quality management area (the designated area). The designated area incorporates [the whole borough of said Council] or [name of street/trunk road] or [stretch of road between junction X and junction Y]. The map may be viewed at the Council Offices

This Area is designated in relation to a likely breach of the nitrogen dioxide (annual mean) objective as specified in the Air Quality Regulations (NI) 2003

This Order shall remain in force until it is varied or revoked by a subsequent order.

The Common Seal of [Name of Council}
was hereto affixed on [date] and signed in the presence of /on behalf
of said Council

……………………………

Annex B: Recommended format of an action plan Progress Report

Action plan measure/target	Original timescale	Progress with measure	Outcome to date	Comments
Roadside emissions testing				
Publicity Campaign on walking/cycling				
Park and Ride Scheme (state which area in the authority)				
Introduce revised process authorisation to limit emissions (in collaboration with the Environment Agency)				
Area speed reductions (20 mph zones in residential areas)				

Annex C

EQUALITY IMPACT ASSESSMENT

SCREENING FOR EQUALITY IMPACT ASSESSMENT

Northern Ireland Act 1998 (Section 75) – Statutory Equality Obligations

Draft Local Air Quality Management Policy Guidance – LAQM PGNI (09)

1. Introduction

Section 75 of the Northern Ireland Act 1998 requires all public authorities in carrying out their functions relating to northern Ireland to have due regard to the need to promote equality of opportunity between:

- Persons of different religious beliefs.
- Persons of different political opinions.
- Persons of different racial groups.
- Persons of different ages.
- Persons of different marital status.
- Persons of different sexual orientation.
- Men and women generally.
- Persons with a disability and persons without.
- Persons with dependants and persons without.

To satisfy this requirement, government departments carry out Equality Impact Assessments of policies and legislation to test whether they could have an adverse impact on equality of opportunity between any of the nine groups listed above. While it is acknowledged that Section 75 puts a duty on public authorities to look at all its policy areas and not just those relating to equality issues, it is accepted that not all policies need to be assessed to the same extent. Screening aims to identify those policies that are likely to have the greatest impact on equality of opportunity and therefore should be subject to a full Equality Impact Assessment.

2. Brief summary of the draft policy guidance

This guidance updates and replaces the local air quality management Policy Guidance LAQM PGNI (03) and the Progress Report Guidance published by the Department in 2004.

This policy guidance is principally for district councils and relevant authorities in Northern Ireland to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part III of the Environment (Northern Ireland) Order 2002.

LAQM provides the framework within which air quality is managed by District Councils in Northern Ireland. LAQM requires District Councils to review and assess a range of air pollutants against the objectives prescribed under the

Air Quality (Northern Ireland) Regulations 2003, using a range of monitoring, modelling, observations and corresponding analyses.

3. Aims of the draft policy guidance

The aim of this guidance is to enable district councils to build upon previous LAQM experience and improve on the service they already provide in tackling poor air quality in forthcoming rounds or review and assessment.

Part 1 of this Policy Guidance provides an overview of the local air quality management system and the various considerations and times frames that District Councils should bear in mind. Part 2 points the reader towards other sources of advice, as well as Good Practice Guidance on some of the more effective and ambitious measures that district councils and relevant authorities can pursue.

4. Screening Analysis

4.1 Is there any evidence of higher or lower participating or uptake by different groups within any of the nine categories?

YES		NO	✓

4.2 Is there any evidence that particular groups have different needs, experiences, issues and priorities in relation to the particular main policy area?

YES		NO	✓

4.3 Is there an opportunity to better promote equality of opportunity or god relations by altering policy or working with others in Government or the community at large?

YES		NO	✓

4.4 Have consultations in the past with relevant groups, organisations or individuals indicated that particular policies create problems which are specific to them?

YES		NO	✓

5. Equality Impact Assessment Decision

5.1 Full Equality Impact Assessment procedure is confined to those policies considered likely to have significant implications for equality of opportunity.

As a result of the screening analysis in Section 4, it is considered that there will be no significant implications for equality of opportunity arising from the introduction of the provisions contained in the Draft <u>Local Air Quality Management Policy Guidance – LAQM PGNI (09).</u> The draft policy guidance does not therefore need to be submitted for a full Equality Impact Assessment.

Annex D

HUMAN RIGHTS IMPACT ASSESSMENT

HUMAN RIGHTS ACT 1998

Draft Local Air Quality Management Policy Guidance – LAQM PGNI (09)

1. Introduction:

1.1 The purpose of this paper is to review the Human Rights implications of the proposed draft policy guidance.

1.2 The draft Local air Quality Management Policy Guidance – LAQM PGNI (09)

This guidance updates and replaces the local air quality management Policy Guidance LAQM PGNI (03) and the Progress Report Guidance published by the Department in 2004.

This policy guidance is principally for district councils and relevant authorities in Northern Ireland to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part III of the Environment (Northern Ireland) Order 2002.

LAQM provides the framework within which air quality is managed by District Councils in Northern Ireland. LAQM requires District Councils to review and assess a range of air pollutants against the objectives prescribed under the Air Quality (Northern Ireland) Regulations 2003, using a range of monitoring, modelling, observations and corresponding analyses.

2. Proposals

Throughout the next round of Review and Assessment it should be possible for the UK government to demonstrate the impact that many local measures have on air quality. The UK is legally required to meet EU limit values for a number of pollutants, and local measures are one of the most important means by which the UK Government can meet these limit values. More importantly, improved air quality has significant health benefits, and local authorities are best placed to improve air quality at localised hotspots and deliver both health benefits and improved quality of life.

3. Human Rights Assessment

3.1 Whilst the proposed policy guidance will have some effects on the work of public sector organisations in Northern Ireland, the Department considers that its proposals are fully compliant with the provisions of the European Convention on Human Rights.

ANNEX E

Planning and Environmental Policy Group

Local Air Quality Management

Practice Guidance 1

Economic Principles for the Assessment of Local Measures to improve Air Quality

December 2009

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887
Website: www.doeni.gov.uk

Information about this publication and further copies are available from:

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887

Email: Stephen.kerr@doeni.gov.uk

This document is available on the Northern Ireland Air Quality website:

www.airqualityni.co.uk

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Executive Summary

i. The objectives of this guidance are to provide advice on the general economic principles, and economic appraisal methods, which can be applied for the assessment of local air quality measures and schemes. It thereby provides a means to aid improvements in Local Air Quality Management practice and local action plan performance.

ii. Consistent with the Government's environmental goals, this guidance has been developed with a consideration of all the impacts of air pollutants including impacts on human health, climate change and the environment. Where practicable and sensible, synergistic policies beneficial to both air quality and climate change should be pursued.

iii. The guidance is advisory (not mandatory). It is consistent with government principles and appraisal approaches. However, if as guidance changes inconsistencies do arise, primacy should be given to national UK Government guidance (the Green Book). This guidance is intended for action plan assessments, but also more general policies and plans for improving air quality. It has two key elements:

- **economic instruments** look to effect the behavioural choices of agents by altering the estimated costs and benefits of different actions. There are a wide range of potential economic instruments including changes in taxes and subsidies, trading schemes, voluntary agreements and publicity campaigns; and
- **economic appraisal** is the key decision-making approach recommended by Government, and considers the overall value for money of a proposal, considering the wider costs and benefits to society.

iv. The guidance is also accompanied by a set of specific guidance notes for scheme types. Each of these schemes has been highlighted from the Air Quality Strategy 2007 as potentially having benefits in excess of their associated costs.

- Practice Guidance 2 on designating low emission zones.
- Practice Guidance 3 on encouraging the uptake of low emission vehicles.
- Practice Guidance 4 on encouraging the uptake of retrofitted abatement equipment on vehicles.

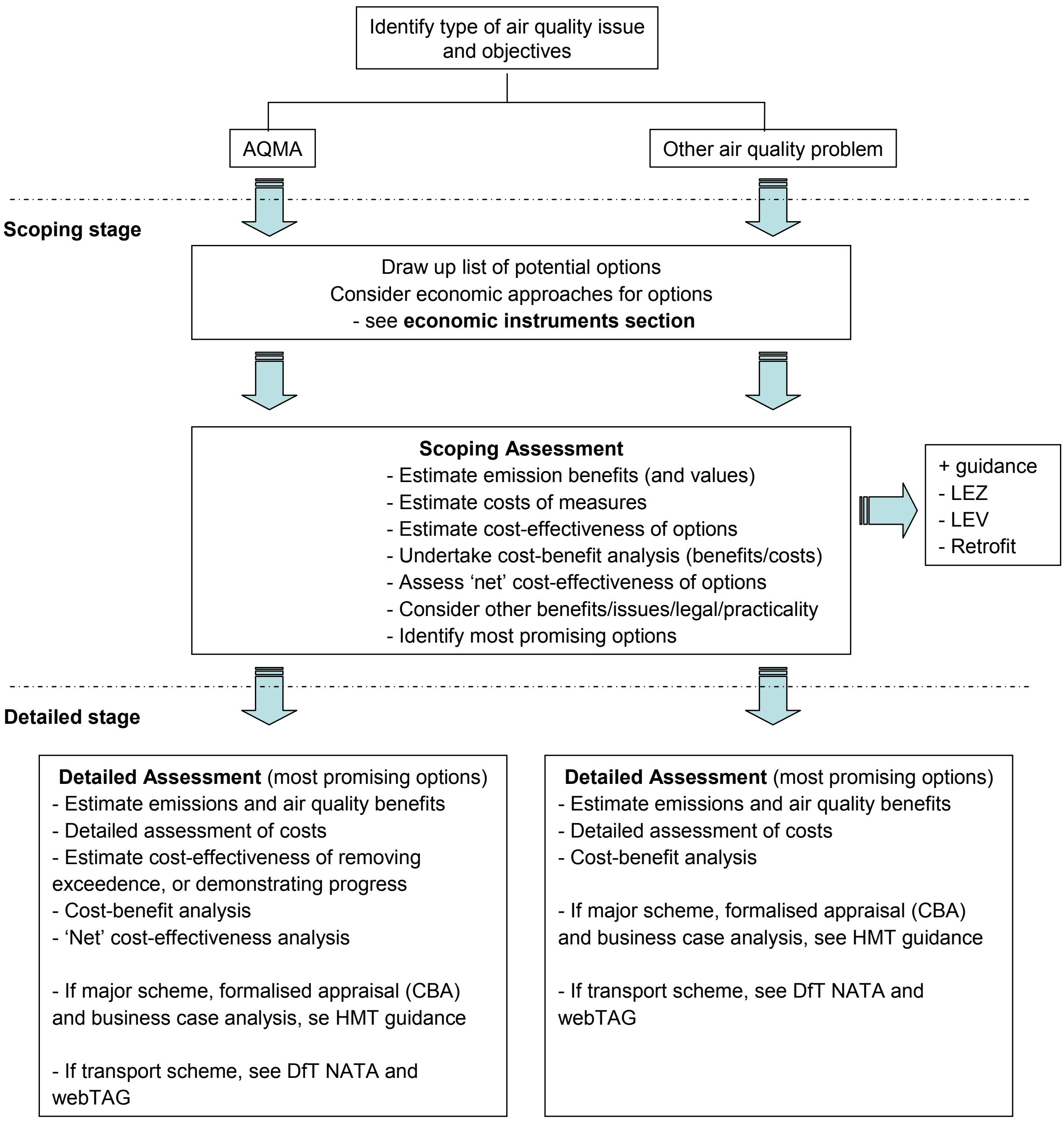
v. The guidance is set out to inform an iterative development process, in distinct stages as set out in Figure 1 below, with repeated rounds moving from a scoping assessment through to more detailed analysis. This is consistent with the development of policy proposals, and requires different levels of detail and knowledge at the scoping and detailed stages. The guidance first outlines a scoping stage which would, for example, be appropriate for use in early analysis of air quality proposals or plans, and which could be undertaken by a wide range of practitioners, even without specialist economic knowledge. This stage is used to filter down a range of options to a short-list for the second stage of more detailed analysis. Following this stage, more detailed guidance may be required for more substantial proposals (or transport projects), using existing Government guidance. This note therefore focuses on the scoping analysis only.

vi. The guidance provides advice on:

- identifying options and design of policy;
- estimating benefits, including how to estimate the monetary benefits of proposals;
- estimating costs, including which cost elements to consider; and
- comparing costs and benefits, including using cost-effectiveness and cost-benefit analysis, and how to express costs and benefits in equivalent terms.

vii. The overall process is shown in Figure 1 below. This has a slightly different route according to whether the analysis is considering an Air Quality Management Area or not. In general the approach is consistent however, there may be a slightly different emphasis or focus in cases where an Air Quality Management Area has been declared. The level of detail of the analysis, particularly in later stage, will be determined by the size of the scheme (a larger scheme will require a more in-depth appraisal). Note also that if a transport based scheme is identified initially, this should be assessed through formalised transport appraisal.

Figure 1: Policy proposal development process.



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1 Introduction

1.1. Background and Objectives of the Guidance

1.1. The objectives of this guidance are to establish general economic principles and economic appraisal methods which can be applied for the assessment of local air quality measures and schemes, and provide a means to improve Local Air Quality Management (LAQM) practice and local action plan performance.

1.2. This guidance is principally for local authorities in England in regard to carrying out their local air quality management duties under Part IV of the Environment Act 1995.[1] It is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance

1.3. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMA) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality. It provides guidance on the selection of options, and on how to assess these options.

1.4. Consistent with the Government's environmental goals, this guidance has been developed with a consideration of all the impact of air pollutants including impacts on human health, climate change and the environment. Where practicable and sensible, synergistic policies beneficial to both air quality and climate change should be pursued.

1.5. The guidance focus on two economic aspects:

- **economic instruments** look to effect the behavioural choices of agents by altering the estimated costs and benefits of different actions. There are a wide range of potential economic instruments including changes in taxes and subsidies, trading schemes, voluntary agreements and publicity campaigns; and
- **economic appraisal** is the key decision-making approach recommended by Government, and considers the overall value for money of a proposal, considering the wider costs and benefits to society.

1.6. The information in this guidance is consistent with Government recommendations. It provides the means to demonstrate that air quality proposals are cost-effective, and to justify scheme implementation.

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[1] Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance (and is included in this consultation) covers the whole of the UK.

1.6. This general economic guidance is accompanied by a set of more specific guidance for scheme types for improving local air quality.

- Practice Guidance 2 on designating low emission zones (LEZ).
- Practice Guidance 3 on encouraging the uptake of low emission vehicles (LEV).
- Practice Guidance 4 on encouraging the uptake of retrofitted abatement equipment on vehicles.

1.8. It is stressed that these specific measures, however, are not the only measures that local authorities should examine when considering how to improve local air quality. There are also a wide range of alternate transport, residential and industrial measures.

1.9. The guidance is set out to allow iterative development of proposals, in two separate stages. This is consistent with the development of policy proposals, and requires different levels of detail and knowledge.

- It has initial scoping guidance, which would for example be appropriate for use in early scoping analysis of plans, and which could be undertaken by a wide range of practitioners, even without specialist economic knowledge. This can help to filter down a range of options to a short-list for more detailed analysis.
- It has advice and worked examples on considering specific scheme types for improving local air quality (incentivising LEV, designating LEZ, incentivising retrofitting of existing fleets) – though again it is stressed that these are not the only measures that local authorities should examine when considering how to improve local air quality.
- It has some specific notes on additional issues that will be needed in detailed guidance (planning and detailed phases) and highlights the existing Government guidance for detailed appraisal (some of which is mandatory). The application of these more detailed steps is likely to require more economic knowledge.

1.10. Local authorities should have regard to the guidance here in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are:

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009.

1.11. The guidance builds on, and links through, to existing national UK Government guidance (the Green Book) and specific transport appraisal guidance from the Department for Transport (DfT), notably the New Approach for Appraisal (NATA), and the transport analysis guidance at webTAG (www.webtag.org.uk/). It is therefore consistent with appraisal undertaken by local authorities in other areas of policy. In some cases, local authorities will need to have regard directly to these other guidance sources, for example for many scheme developments, or for transport proposals.

1.12. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk). In many cases, such as for transport based schemes, there will also be wider local authority expertise (in other departments), that should be drawn upon.

1.13. This first guidance note provides the overall economic principles and approaches for economic appraisal. The contents of the guidance are set out as follows:

- an outline of how to use the guidance;
- guidance on economic principles, and the benefits of such approaches;
- information on scoping analysis, with estimation of benefits and costs, and appraisal (cost-effectiveness and cost-benefit analysis);
- information on where to find more detailed guidance.

1.2. Essential issues and key definitions

1.14. In reading this guidance, a number of essential issues and key definitions are highlighted. It is important for readers of this guidance to be aware of these before consulting this guidance.

Economics. Economics is the study of choice and decision-making in a world with limited resources.

Decision-making and appraisal. Good policy making considers a range of potential options prior to introduction of any proposal, and applies decision making techniques to select the best and most relevant options. This process is known as appraisal (also sometimes called ex ante analysis). Economics has a key part in this process. After policy implementation, there should also be a process of review and monitoring after introduction, known as evaluation (or ex post analysis).

Financial appraisal. A financial appraisal looks at the affordability of a proposal, and works within a typically budgetary framework, with financial costs and accounts.

Economic appraisal. An economic appraisal looks at the wider costs and benefits to society as a whole, of a proposal. This is not the same as a financial appraisal. This requires consideration of all costs and benefits, including those elements not valued directly by markets. An economic appraisal therefore provides a basis for assessing value for money.

Many practitioners confuse financial and economic appraisal. They are different because they consider different elements: a financial appraisal only considers budgetary elements, whereas economic appraisal considers wider societal elements. They also work with different frameworks, which include or exclude different elements. As an example, VAT is relevant to a financial proposal, but not an economic one. Note that both economic and financial appraisal will need to be undertaken for a detailed scheme, in order to justify that the proposal is both financially affordable (for example in relation to local budgets) and that it presents value for money (for example in terms of societal benefits being greater than costs).

Cost-effectiveness analysis and Cost-benefit analysis are both methods for economic appraisal, though they have very important differences.

Cost-effectiveness analysis (CEA) compares the costs of different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently. However, the traditional application of cost-effectiveness analysis only considers one environmental objective at a time, rather than all environmental objectives.

Cost-benefit analysis (CBA) assesses whether the total benefits and costs of a project or policy, thereby allowing their direct comparison to see if the benefit exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The technique allows consideration of multiple environmental goals. The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence.

Note that these two techniques can be complementary. The cost assessment is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals. Related to this, the results of a cost-benefit analysis can be used to undertake a '**Net cost-effectiveness'** analysis, which has the advantage of considering all environmental objectives. A 'net' cost effectiveness analysis considers costs, but also takes into account the monetary benefits of environmental improvements when comparing the relative attractiveness of options, and so provides a more holistic approach for achieving the overall objective efficiently.

Exceedences. UK air quality objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedences, within a specified timescale. EU Limit values are legally binding EU parameters that must not be exceeded. Limit values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedences allowed per year, if any, and a date by which it must be achieved. Some pollutants have more than one limit value covering different endpoints or averaging times.

2. How to use this guidance

2.1. This guidance is set out to allow an iterative development, in distinct stages, based on different user needs or stages of analysis. It is consistent with the business case guidance from UK Treasury for proposals, which outline a three stage approach:

Stage 1 – The Strategic Outline Case or scoping stage.
Stage 2 – The Outline Business Case or detailed planning phase.
Stage 3 – The Full Business Case or detailed final phase.

Note that the different levels will involve different levels of expertise and resources. The business case develops iteratively over time, with more detail being provided at each stage. **This document is primarily concerned with the first of these stages, i.e. the scoping stage.**

2.2. The **strategic outline case** or **scoping stage** is appropriate for use in early analysis of plans, and could be undertaken by a wide group of practitioners, even without specialist economic knowledge. As the guidance moves to the **business case** or **detailed phase**, a greater focus on in depth analysis including economic expertise will be required. This will require more detailed analysis using other formalised guidance (see below). For this reason, the detailed planning phase and detailed final phases above are not included in detail in this document. Note that for some very small air quality proposals, it may not be proportionate to undertake significant more detailed phases. However, for major schemes, especially transport related schemes, these latter detailed stages are likely to be mandatory (linked with DfT guidance).

2.3. In progressing proposals, there is a typical series of steps that are good practice in design and implementation of policy. These are:

- set objectives for the proposals (for example to reduce health effects of air pollution);
- identify options for achieving the objectives;
- appraise the range of options identified;
- prioritise most promising options and select the favoured option;
- develop and implement the favoured option; and
- put in place the necessary steps and monitoring for later evaluation.

2.4. The first key step in your approach should be to set out the objectives of your plans. This should be mindful of the Government's objectives as part of the Air Quality Strategy and wider Governmental objectives such as on climate change. The objectives are likely to be:

- to achieve or progress towards the limit values in cases where an exceedence is declared; or

- to improve air quality (and local public health) in cases where there are no exceedences.

2.5. Following the setting of objectives, it is necessary to identify the potential options to achieve the objective. This should include:

- consideration of a case without any policies or plans, i.e. the ‘do minimum’ scenario.
- a wide ranging list of all the potential options available.

2.6. A shortlist of options can be created, to keep the appraisal process manageable. This is usually undertaken at the scoping stage of a policy appraisal, but the short-list should always include a ‘do minimum’ scenario.

2.7. In drawing up the list of options, it is important to consider **economic instruments** as outlined in chapter 3 of this guidance. This would consider a range of approaches for any given objective. In cases where an action plan has been produced, you may already have a set of options, but the consideration should also include the actual instruments that might need to be introduced to implement your plan or project, for example for introducing cleaner vehicles, whether this would be through regulation, taxes, charges or voluntary schemes. Note that it is also important to consult widely, as this is often the best way of creating an appropriate set of options.

2.8. The next step is to appraise the options and progress the most favourable proposals. Initially this will involve a scoping analysis, considering many options. In more detailed stages it is likely to focus down and assess a few options in detail. This appraisal should draw on the guidance on **economic appraisal set out in chapters 5 to 7 of this guidance.**

2.9. The economic appraisal will need to consider the **benefits** of options. This will involve the estimation of emissions and air quality benefits consistent with the other technical air quality guidance. However, for economic appraisal, it is also necessary to extend this to analysis of the monetary benefits of options. This is set out in detail in chapter 5.

2.10. The economic appraisal will need to consider the **costs** of options. Guidance on assessing the costs of air quality proposals is not included in the other technical air quality guidance, and this document provides voluntary guidance and good practice on how to compare the costs of proposals. This is set out in detail in chapter 6.

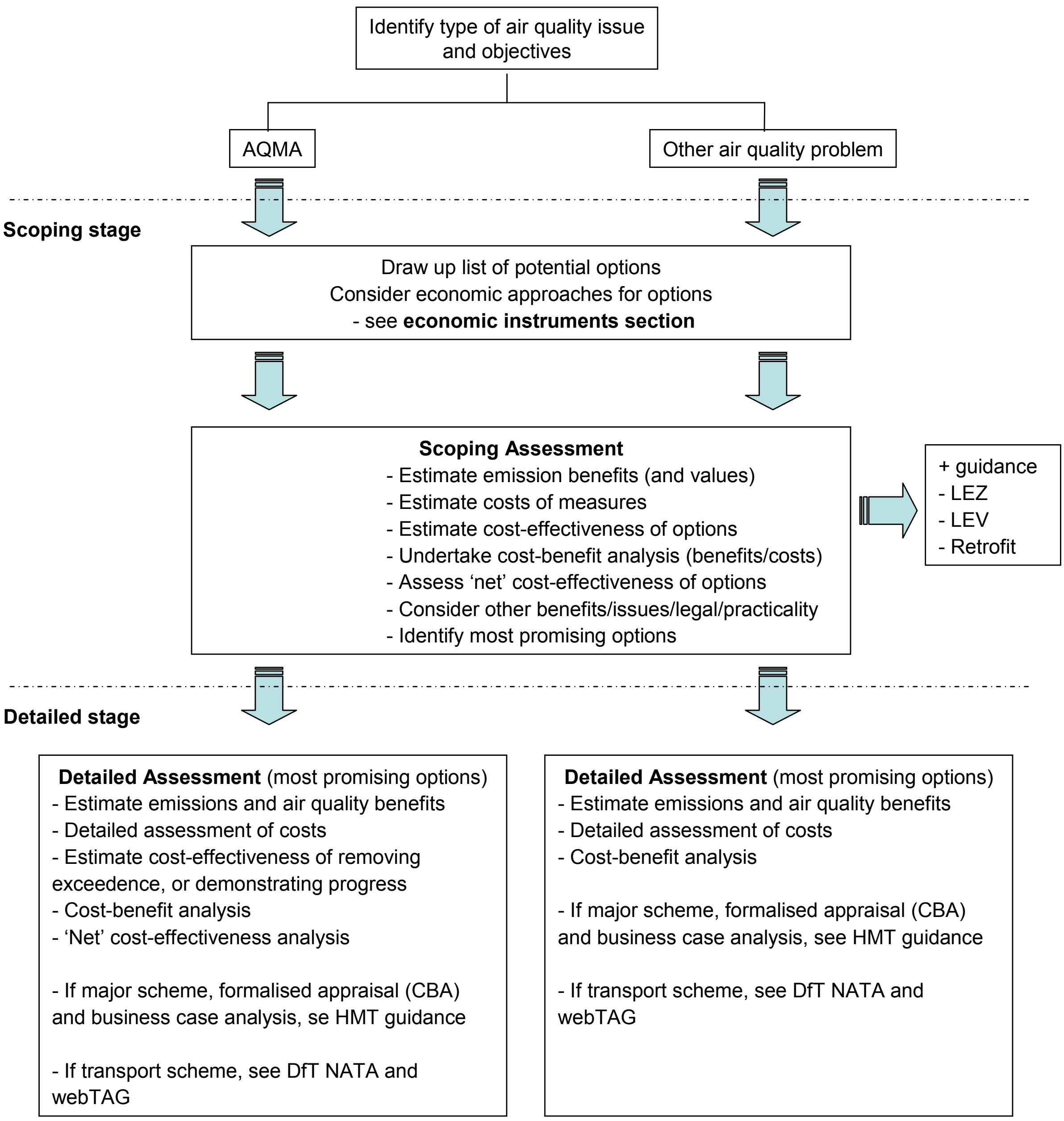
2.11. Based on these building blocks, the appraisal process can then **compare different options** and provide important information to help prioritise them. This can be through a cost-effectiveness analysis, which compares how effective different options are in terms of the emissions or air quality benefit improvement that they achieve, relative to their costs (or a ‘net’ cost effectiveness analysis which also takes into account the monetary benefits of environmental improvements when comparing the relative attractiveness of options). It can also be through a cost-benefit analysis, which directly compares the economic benefits of options against their costs, and can therefore identify the most effective options and judge the economic case for action. The process of appraisal should also consider the extent to which the options have synergies or trade-offs with other economic and social objectives and the extent to which these are acceptable. It is also important to consider how the options would be introduced in practice, and potential legal or practical issues. At the end of this stage, you should have a short-list of potential options. Further guidance on this is set out in chapter 7.

2.12. This approach to benefits and costs can be built upon in the detailed phase, working to appraise this short-list in more detail. As with the previous phase, it is good practice to consider the role of economics in your options in terms of the actual policy implementation, and to include economic appraisal to assess and compare options.

2.13. A schematic of the different stages in the guidance is presented below in Figure 2. Note that in general the approach is common. However, there may be a slightly different emphasis on focus in cases where an AQMA has been declared, and the level of detail particularly in later stage will be determined by the size of the scheme (a larger scheme will require, proportionally, a more in-depth appraisal), and whether the short-list includes a transport based scheme, which should be assessed through a formalised transport appraisal.

2.14. In general Government recommends the use of cost-benefit analysis for appraisal. In the case of improving air quality to improve health, this would allow delivery of the largest health benefit for least cost (efficiency). However, in the case of a legally binding target, as for air quality, there is also a role for cost-effectiveness analysis. The existing legislation seeks to ensure health and environmental protection by setting limits for air quality concentrations. It is therefore also appropriate to undertake cost-effectiveness to analyse how to achieve these binding set targets, however, to take into account other environmental objectives (other air quality pollutants, greenhouse gas emissions), it is recommended that ‘net’ cost-effectiveness analysis is used. For the guidance here, there is a potential separation between cases for action where there is a potential infringement, i.e. an AQMA, and where there is not, in the type of approach we recommend, though we recommend a common approach that addresses cost-benefit analysis as good practice.

Figure 2: Policy proposal development process.



2.15. While the focus in this guidance is on economic instruments and appraisal, it is highlighted that there are other important aspects to consider in the research and analysis needed to support decisions. Guidance is presented in the HMT Business Case guidance, available at (http://www.hm-treasury.gov.uk/data_greenbook_index.htm which breaks down the case into five different aspects: the strategic, economic, financial, commercial and management aspects, to enable stakeholders to ascertain that proposals are:

- applicable, i.e. are supported by a robust Case for Change – the Strategic Case;
- appropriate, i.e. optimise Value for Money – the Economic Case;
- attractive, i.e. are commercially viable – the Commercial Case;
- affordable, i.e. are financially affordable – the Financial Case; and,
- achievable, i.e. can be delivered successfully – the Management Case.

These will be most relevant when moving to the detailed part of the analysis, especially for larger schemes that require significant investment.

2.16. Similarly, if the initial options analysis identifies transport schemes, particularly larger schemes or those that involve changes in transport demand, there will a need to adopt the DfT's webTAG, available at www.webtag.org.uk/. This transport analysis guidance should be seen as a requirement for all projects/studies that require government approval. For projects/studies that do not require government approval the transport analysis guidance should serve as a best practice guide. In many cases, guidance and practical experience of applying these transport appraisal techniques will be within Local Authority Transport Departments.

3. Economic Instruments and appraisal

3.1. Economic Instruments

3.1. Economic analysis forms a key part of the evidence for policy development. Economic evidence can be used to consider if and where actions may be required, identifying potential options to achieve a desired objective, choosing between the options and ultimately the evaluation of any policies. This is true across all policy development including air quality.

3.2. This section is concerned with the first of these aspects, i.e. identifying potential options. The role of economics in appraisal is outlined in the next section. A final section outlines the benefits of considering economics in both areas.

3.3. Economic analysis and evidence suggest that, in general, markets provide an efficient means of allocating an economy's resources. There are however particular problems for the market in allocating environmental resources that lead to a misallocation of resources or "market failure". The key environmental cause of market failure for environmental goods is externalities as discussed below.

3.4. Economic instruments look to use markets to correct such market failures by altering the incentives faced by economic agents. Evidence has shown that such instruments can influence the behaviour of consumers and manufacturers in more subtle, yet potentially more powerful ways, than conventional regulatory controls. For example establishing property rights in the form of tradable permits for air pollution emissions in the USA was seen to deliver higher emission reductions at a lower cost than conventional regulation.

3.5. This is important in looking at the design of policies for improving air quality, and in the selection of the initial list of options (as outlined in the previous chapter). It is often possible to use economic instruments on existing markets to achieve environmental objectives. It is also possible (where appropriate) to create new markets to tackle environmental problems such as by establishing tradable permits.

Externalities and Economic instruments

3.6. Markets are sometimes subject to imperfections or market failures. This is particularly the case for markets involving the environment. Correcting these market failures helps to make the market deliver more efficient outcomes.

3.7. In the case of the environment, and air quality, market failures exist principally because the costs of environmental damage are not reflected in the prices of goods and services. These are known as environmental externalities as the costs are external to the decision makers directly involved in the transaction. Correcting these externalities can improve overall economic efficiency by delivering better environmental outcomes. It is worth noting that other market failures may also exist, for example information failures may prevent public group action against emitters that could in theory lead to an efficient outcome.

3.8. One way to address market failures is through economic instruments. Economic instruments are broadly defined by the OECD as “instruments that seek to address the market failures either by incorporating the external cost of production or consumption activities or by creating property rights and facilitating the establishment of a proxy market”. In this way they can provide incentives for behaviour that protects or improves the environment, and deter actions that are damaging to the environment.

3.9. For both consumers and business, economic instruments can enable environmental goals to be achieved in the most efficient way and may even set the optimal level of environmental protection. By internalising environmental costs into prices, they help to signal the changes needed to move to a more sustainable economy. They can encourage innovation and the development of new technology. The behavioural changes are then chosen by economic agents to reflect the full costs of their decisions.

3.10. It is also worth noting that environmental taxes can also provide a “double dividend” in that revenues can be used to reduce the level of other taxes.

3.11. A range of economic instruments can be considered. These might include taxes or other economic instruments such as tradable permit schemes, spending programmes, tax incentives, or voluntary agreements. Each of these instruments can be used independently or as part of a package with other measures.

3.12. The Government has implemented a range of economic instruments in the environmental area over the past decade. These include measures such as the climate change levy and the aggregates levy, changes to existing taxes such as the landfill tax, and fuel duty differentials to favour cleaner fuels and graduated vehicle excise duty (VED) to favour less polluting cars. Examples are presented in Figure 3 below.

3.13. Note, however, that in the case of air quality, there may also be instances where economic instruments are not an appropriate option. The HM Treasury Tax and the Environment document identifies such cases particularly where local quantities of emissions are important or where it is essential that emissions do not exceed specified limits in any individual area. Further, that in these cases, the problem will probably need to be addressed through regulation. Regulations may also be more appropriate where there is a large number of small polluters, as the costs of setting up a scheme based on an economic instrument may outweigh the benefits.

3.14. Local authorities have some potential to introduce economic instruments. However, the options for tackling sources of emissions with economic instruments may be more limited for local authorities. In these cases, it is important to consider economic principles in the design of policy, as outlined below.

Figure 3: Examples of Government policies to address market failures.

Market failure	Tax	Trading schemes	Tax credits/ public spending	Voluntary agreements	Publicity campaigns	Regulation
Negative externalities	• Aggregates levy • Climate change levy • Landfill tax • Fuel duty	• Emissions trading scheme • Landfill permits • Acid gas trading (proposed)	• Reduced rate of VAT on grant-funded installation of central heating and heating appliances	• Pesticides • EU CO_2 from cars agreement		• Integrated pollution prevention and control • Water quality legislation
Positive externalities or public good			• Tax relief for cleaning up contaminated land • Public space • Agri-environment schemes			• Habitats and species protection legislation
Information failures	• Differential rates of fuel duty				• 'Are you doing your bit?' • Car labelling scheme • EU eco-label scheme and energy labelling	• Environmental impact assessment directive

Note: Measures such as fuel duty can help to address information failures as well as external environmental effects.

Source: Tax and the Environment. HMT, 2002[2].

The type of regulation and the route of implementation

3.15. Historically many have commented that regulatory proposals have been too quick to move to 'classic' prescriptive regulations that stipulate objectives and how they should be achieved. While this type of 'classic command and control regulation' can work well – a good example being the Euro standards[3] – it can impose unnecessary burdens and costs, and reduce innovation. It should not be the automatic first choice and other approaches should be considered (as alternatives, or in combination), as they may be quicker, more flexible, cheaper and more effective. This is part of the Government's Better Regulation Agenda,

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[2] www.hm-treasury.gov.uk./documents/taxation_work_and_welfare/tax_and_the_environment/tax_environ_index.cfm
[3] See the Defra Air Quality Evaluation, www.defra.gov.uk/environment/airquality/publications/stratevaluation/index.htm

which is about achieving policy objectives in the most in efficient and effective ways.

3.16. If those being regulated can devise their own ways of achieving an objective, they will find the most efficient way to do so. It is in their interest to meet targets while minimising bureaucracy and costs. Flexible, non-prescriptive regulation can also encourage businesses to innovate, as they are not restricted in how they can achieve regulatory targets. Using alternatives instead of classic regulation also has advantages that alternatives are generally quicker to implement, especially where the organisations and businesses likely to be affected are involved.

3.17. Guidance on these alternatives was provided by the Better Regulation Task Force, in its 'Routes to Better Regulation' document[4]. This outlines the factors that will affect the attractiveness of different options. These alternative approaches include:

- the use of market based instruments (otherwise known as economic instruments);
- providing information or guidance;
- co-regulation or self regulation (including) voluntary approaches;
- partner agreements;
- issuing recommendations; and
- new and flexible approaches.

The discussion of market based instruments was included above. The other approaches are briefly described in Box 1.

3.18. The guidance also identifies certain factors that influence whether or not the use of the above alternatives are likely to be successful.

[4] http://archive.cabinetoffice.gov.uk/brc/upload/assets/www.brc.gov.uk/routes.pdf

Box 1. Alternative Approaches for Better Regulation

Market based instruments (MBIs) seek to influence the behaviour of a market by using either positive or negative incentives. They can include trading schemes, competition policy or fiscal measures.

Providing information or guidance can be a relatively inexpensive and effective method of influencing people's behaviour. Information can be provided by the EU itself or it can demand that industry or other bodies provide information to their customers. Such information can include publicity campaigns, training, guidance or rating systems. This option can be used independently to influence behaviour although campaigns are often combined with other legislative and non-legislative options, so that stakeholders know what is expected of them.

Co-regulation involves a mechanism whereby the attainment of the objectives defined by the legislative authority is entrusted to parties which are recognised in the field (such as economic operators, the social partners, non-governmental organisations, or associations).

Self-regulation requires markets to regulate their own activities, without the requirements or agreements being underpinned by legislation. EU involvement is usually limited to encouraging or facilitating the process, perhaps with the threat of legislation should it not be successful.

Partner agreements give partners (stakeholders) an opportunity to try to reach agreement without the need for legislation. If legislation is necessary, the partners can negotiate its content and they are trusted to reach the most practical solution.

Recommendations are (official) instruments produced that do not have legal force but set out suggested courses of action. They can be used to encourage action in a particular sector and can be used as part of self-regulatory schemes.

Source: Better Regulation Unit, (now Better Regulation Executive)
http://archive.cabinetoffice.gov.uk/brc/upload/assets/www.brc.gov.uk/routes.pdf

General economic principles in policy design

3.19. An important economic principle is that options and policies are often best advanced by providing as much flexibility as possibly through technology neutrality, thus policies or measures are based on the desired outcomes, rather than an approach that would look to establish a specific technology. This is important as it allows greater flexibility for those who are affected by the policy, incentivising innovation, reducing the risk of distorting competition and reducing the opportunity for perverse incentives.

3.20. It is also good practice to consider the design of options such that they have most effect in driving behavioural change. One of the important aspects here is to consider a marginal approach to effect marginal decisions, i.e. targeting options that will affect additional marginal (additional) journeys. In economic pricing, this is usually approached by setting taxes or charges so that they reflect the external costs of additional (marginal) journeys. The logic behind this is that higher average costs do not alter driving behaviour in the intended way; in fact the cost per journey can be reduced in this case by increasing the number of journeys made. Instead, the objectives are more likely to be met by incentivising the reduction in marginal trips (i.e. on a marginal cost basis). For example, a marginal cost-based instrument will give a direct incentive for owners to drive less. For example, discounted parking for LEVs at parking meters is a much better instrument than a discount given on annual parking permits. Similarly, in considering options that do not involve charges directly, focusing on the options that are most likely to affect marginal trips is likely to achieve greater levels of compliance and be more effective.

3.2. Economic Appraisal

3.21. The UK government publishes guidance on undertaking economic appraisal in the HM Treasury Green Book[5]. This is the main guidance on how to undertake economic assessment of spending and investment related guidance for the public sector.

3.22. At the centre of this guidance is the recommendation that all new policies, projects and regulation should be subject to comprehensive but proportionate assessment, so as best to promote the public interest. This assessment should answer the two following questions.

- Are there better ways to achieve this objective?
- Are there better uses for these resources?

3.23. By answering the questions, the guidance aims to promote efficient policy development and resource allocation, and emphasises the need to take account of the wider social costs and benefits (including environmental benefits) of proposals. It sets out three key aims.

- To Identify other possible approaches which may achieve similar results.
- Wherever feasible, to attribute monetary values to effects of the proposed policy or project.
- To assess the costs and benefits for relevant options.

3.24. The Green Book presents the techniques and issues that should be considered when carrying out assessments before implementation (known as **appraisal**), as well as the monitoring and assessment of the success of the scheme after implementation (known as **evaluation**). Economic tools can be used to appraise the costs and benefits of actions, and to identify the most efficient methods of government intervention. The Government aims to use these techniques as effectively as possible to ensure that intervention is effective and efficient, and proportionate to the problem being addressed.

[5] www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm
Note there is also guidance on policy impact assessment (regulatory impact assessment)

3.24. The key steps recommended are:

- to set objectives;
- to develop a list of potential options.
- to appraise options;
- to develop and implement a solution;
- to put in place the necessary steps and monitoring for later evaluation.

3.25. For the first of these, to justify action, the Green Book raises two key questions.

- Is the rationale for intervention clear?
- Is it reasonable to assume that intervention will be cost-effective: i.e. that the benefits of intervention will exceed the costs?

3.27. As highlighted in the previous section on economic principles, the rationale for intervention is often linked to efficiency concerns in cases where there are market failures. The previous section outlined the strong general rationale for improving air quality, because of the existing environmental externalities. In the case of air quality where there is an existing exceedence, there is clearly a strong policy justification for action because of a legally binding commitment. However, there is also a strong justification for action when the aim is for improving air quality (without an exceedence) due to the non-market nature of air pollution.

3.28. The technique recommended to assess if the benefits of intervention will exceed the costs is cost-benefit analysis (more details are given in the later sections). In cost-benefit analysis, all relevant costs and benefits to government and society of all options are valued, and the net benefits or costs calculated[6]. Cost-benefit analysis differs from cost-effectiveness analysis, where a goal is set and the most cost-effective way to meet it is determined, or other approaches such as multi-criteria analysis (also below), where benefits are not (solely) expressed in monetary terms. In the case of air quality, especially where there are AQMAs, both are relevant, see chapter 2.

3.29. Note that the Green Book recommends that the economic assessment undertaken should be proportionate. This is important in formulating how much detail you will need to undertake for your scheme. A more extensive (and expensive) scheme will need a greater level of in depth analysis. This is reflected in the staged approach in this guidance. There is no formalised advice on the level of detail and scale and the level of appraisal necessary.

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[6] though note it is usually difficult to value all the costs and benefits of a particular project.

3.3. What are the Benefits of Using this Guidance

3.30. It is important to recognise what the benefits to local authorities and the public will be from applying this guidance.

3.31. Economics lies at the heart of recommended Government appraisal and decision making. It has been applied routinely at national level, and local level, for many decades. It can help in providing a framework to help make decisions, and to ensure that implementation is achieved efficiently.

3.32. Even in cases where a local authority is working towards a pre-defined level of ambition, i.e. towards achievement of an objective, there are still economic principles that can be applied to ensure that target is achieved efficiently. The guidance here presents an approach to achieve the limit value (or progress towards the limit value) in the most efficient or least cost way. This could significantly reduce the costs of your proposals, increasing their acceptability, and also reducing the level of local authority funds needed (allowing more resource for other local authority activities). Using these approaches will also demonstrate that your proposal is following the principle of cost-effectiveness. Such a technique will help the presentation of the business case for your proposals, and also help the discussion within the local authority and to external stakeholders.

3.33. In cases where there is not an existing exceedence, but there is a policy to improve air quality, the guidance here can provide a sound demonstration that the benefits of the proposals outweigh the costs, and ensure that the policy aims are being progressed in an efficient and effective way. This is particularly important in ensuring that public funds are spent on activities that provide the greatest benefits to society, and that they are spent in the most efficient way. It also provides similar justification to above in relation to discussion within the local authority and to external stakeholders.

3.34. In particular this guidance illustrates that this approach can be useful in helping local authorities to assess the costs and impacts of measures they may be considering as part of their LAQM, local transport planning or land-use planning duties. For example, the economic guidance should be helpful in relation to:

- providing justification for Government funding;
- providing evidence for all decision makers, at different levels of local government, to external stakeholders;
- to help provide information for budget planning;
- to provide wider information for discussion with stakeholders;
- to enhance the success of successful Air Quality Grant bids;
- to help inform central government on the progress towards the air quality objectives that is possible from local action.

4. Scoping Phase

4.1. The first key step is to set out the objective(s) of the actions. The objectives are likely to be either: to achieve or progress towards the limit values; or improve air quality (and local public health). The next second step is then to identify a range of options to achieve the objective.

4.2. Guidance on how to identify options is included in general terms in the Green Book (Chapter 5). It is likely to include a range of approaches, including using existing reports, information from practitioners and experts, research, and drawing on other examples (including international examples).

4.3. It is highlighted that in choosing this list of options, you should have regard for the economic instruments and principles and the possible range of approaches that could be used as set out in Box 1 on page 12. The list of options should include a range of policy instruments, and should span different sorts of interventions, for example regulatory and non-regulatory approaches, including economic incentives (see chapter 3).

4.4. The scheme specific guidance released alongside this document provides information on possible options, low emission zones, incentivising low emission vehicles, incentivising retrofitting of existing fleets, that might be appropriate in drawing up your list of options. It is highlighted that the specific measures in the practice guidance documents are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant policy guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries. Where possible this guidance document therefore presents relevant details of this experience in order to highlight good and bad practice in implementing schemes.

4.5. Once a list of potential options has been identified, the next step is to assess and prioritise these. To do this, a series of steps are required, set out in the following sections.

- The estimation of benefits is first outlined. This includes consideration of the potential economic benefits of emissions and air quality improvements.
- The estimation of cost is then explained.
- The methods for appraisal. Cost-effectiveness and cost-benefit analysis are then explained.
- These considerations must then be weighed against other relevant issues such as practicality, including legal, technical and social barriers.

5. Estimating benefits

5.1 Introduction

5.1. This section outlines the approaches for estimating the benefits of potential schemes, both as emissions and ambient concentrations. It then goes onto outline how these can be assessed in monetary terms using easily usable summary information from the Defra web-site on damage costs.

5.2. Consistent with the Government's environmental policies, the guidance has been developed with a consideration of air pollutants range of impacts on human health, climate change and the environment. The guidance here therefore also provides easily usable summary information from the Defra web-site on how to estimate greenhouse gas emissions in monetary terms as well.

5.3. For many other schemes, there may also be wider benefits, particularly for transport schemes. These also need to be considered, and there is guidance from the DfT on these wider effects.

5.2 Health, Environmental and Other Benefits

5.4. Air pollution has a number of important impacts on human health, as well as on the natural and man-made environment. These include impacts of short-term and long-term exposure to air pollution on health, damage to building materials, effects on crops and impacts on natural and semi-natural ecosystems (both terrestrial and aquatic). These impacts also have a number of important economic or social costs, known as external costs or externalities, as they are not included in the price of goods or services.

5.5. Air quality improvements will therefore lead to health and environmental benefits. It is highlighted, however, that the benefits vary with the type of pollutant and the location of emission.

5.6. The analysis of these impacts and external costs has focused on health and environmental impacts. In the UK, this has been taken forward through the Department of Health's Committee on the Medical Effects of Air Pollutants (COMEAP)[7], which advises on health of outdoor and indoor air pollutants on the basis of data currently available, and has published reports on the quantification of health effects of air pollution in the UK, and the Interdepartmental Group on Costs and Benefits (IGCB)[8], which develops understanding of the costs and benefits of reducing air pollution, and appraisal methods used for policies that reduce air pollution and provides economic analysis and advice on the Air Quality Strategy.

[7] www.advisorybodies.doh.gov.uk/comeap/
[8] www.defra.gov.uk/environment/airquality/panels/igcb/index.htm

5.7. In considering the estimation of benefits, a number of key points are highlighted below.

- Different types and levels of health impacts are attributed to different pollutants. Currently the greatest health concerns are associated with particulate matter (PM), followed by sulphur dioxide (SO_2), ozone and nitrogen dioxide (NO_2).
- A number of important issues are highlighted for particulate matter:
  - Health effects are associated with primary particulates (for example from vehicle exhaust) and also from secondary particulates. These secondary particulates are formed from (amongst other things) sulphur oxides (SO_x) and nitrogen oxides (NO_x) emissions. Therefore reducing NO_x (as an example) has both direct (NO_2) and indirect (secondary particulate) benefits. Note, however, that NO_2 effects are local, whilst secondary particulates are more regional.
  - The health effects of primary particulates will vary with the location of the emission, because of the different population exposure. An emission reduction in a major urban area will therefore have a greater relative health benefit (for example per tonne of pollution reduced) than in a rural area. Note for this reason, the later benefits analysis recommends the use of different damage costs for primary PM according to location.
  - Europe is moving strongly towards a focus on $PM_{2.5}$, reflecting much of the health based evidence and also the advice received from the scientific community such as the World Health Organisation[9].
- A number of important issues are highlighted for NO_2 and SO_2, in relation to the current limit values.
  - COMEAP did not quantify direct impacts of NO_2 (as a gas) at ambient UK levels in its quantification analysis. The Air Quality Strategy identifies that at relatively high concentrations, NO_2 causes inflammation of the airways. There is evidence to show that long-term exposure to NO_2 may affect lung functions and that exposure to NO_2 enhances the response to allergens in sensitised individuals. However, COMEAP did not provide functions for quantification of NO_2 in view of the difficulties and doubts about the relationships between exposure to NO_2 and effects on health (i.e. that apparent NO_2 effects on health at ambient levels may be due to particles; or at least, are highly dependent on background particle levels). However, a possible relationship for the effects of the pollutant on respiratory hospital admissions was included for sensitivity analysis. The recent Air Quality Strategy Review (and also the European legislation) reviewed the evidence on NO_2, and decided not to remove the NO_2 objectives, not least because the achievement of the NO_2 objectives should ensure that risk to vulnerable individuals is reduced.
  - Note that as above, NO_x does affect health indirectly through the formation of secondary particulates, which are quantified in COMEAP,

[9] See the Clean Air for Europe (CAFE) documents at http://ec.europa.eu/environment/archives/cafe/general/keydocs.htm

assuming similar impacts as primary particulates. Nitrogen oxides also have complex relationships on ozone formation, which also affects health.

- Sulphur dioxide has some direct effects as a gas, and COMEAP quantified direct impacts of SO_2 (as a gas). Sulphur dioxide also affects health indirectly through the formation of secondary particulates (see above) which are quantified in COMEAP, assuming similar impacts as primary particulates.

5.8. As well as air quality benefits, it is important that you take account of other environmental issues in your appraisal, and also wider effects. Two key issues are.

- The need to consider greenhouse gas emissions. Many local air quality schemes can also affect greenhouse gas emissions, including carbon dioxide (CO_2). These need to be assessed in your appraisal. There is guidance on how to estimate these emissions changes, and now also guidance on how to value these changes provided by Defra.
- For schemes affecting transport movements, there is a need to consider the wider issues of transport in relation to congestion, accidents and noise. Whilst this guidance has an air quality focus, these other effects must be taken into account in any scheme which is likely to have an effect on transport demand or activity. There is already comprehensive guidance available on these benefits (see later).

5.9. As an example, for the additional practice guidance documents which look at specific schemes, there are other important benefits to consider, shown in the table below. It is highlighted that these measures are not the only measures that local authorities should examine when considering how to improve local air quality.

Table 1: Benefits of Low Emission Zones, Low Emission Vehicles and retrofitting

Scheme	**AQ**	**CO_2**	**Noise**	**Congestion**	**Accidents**
Low emission vehicles (LEV)	✓	Variable *			
Low emission zones (LEZ)	✓	Variable *	✓**		
Retrofitting	✓	Variable *			

* The effects on CO_2 depend on the types of vehicles or retrofit technology. Some newer vehicles have lower CO_2 emissions, however, it varies with Euro standard and vehicle type. Some retrofit technologies, whether applied as a policy, or as a response by operators to say a LEZ, can increase CO_2 emissions.

** A LEZ can have noise benefits if it replaces older vehicles. Changes in vehicle noise legislation have not in general been concurrent with those for exhaust emissions, and the noise certification test does not represent urban driving conditions. Nonetheless, Euro II/III vehicles are likely to be quieter than older vehicles. However, traffic noise has two main sources: tyre/road noise, which is determined by vehicle speed and size (but not necessarily age), and engine noise which considers the age and size of the vehicles. An LEZ will only affect the latter, unless changes in vehicles numbers also occur.

5.3 Estimating Emissions and Air Quality Improvements

5.10. The underlying principle for emissions or air quality impact assessment is to firstly define the baseline or business as usual emissions or air quality. This is the case that currently applies and would apply in future years if no additional action is taken, i.e. the business as usual case should include consideration of:

- the impacts of national policies such as Euro standards for vehicle emissions;
- the impacts of local transport policy on traffic growth; and
- all actions to which the local authority is already committed including transport policies and new developments.

5.11. Once the baseline case has been defined the effects on baseline emissions and or air quality from new policies can be assessed. Emissions and air quality assessments are technical tasks. Therefore local authorities are referred to the guidance document Local Air Quality Management Technical Guidance 2009 for additional information.

Emissions

5.12. In simple terms emissions are calculated as the product of activity of relevant emission sources and appropriate emission factors for that activity. For example, heavy goods vehicle (HGV) NO_x emissions can be estimated as the product of the total distance travelled by the vehicles of interest and the most appropriate emission factor (NO_x g/km) for the vehicle weight, speed and age.

5.13. Therefore, emissions reductions may be assessed for a reduction either in source activity (distance travelled) or in the emission factor (for example by replacing a Euro II heavy duty vehicle (HDV) with a Euro III or better vehicle).

5.14. From this description it follows that a key tool to assess the baseline case and impacts of new policies is a sufficiently detailed emission inventory. Such an inventory allows the impacts of a range of potential policies to be assessed.

5.15. A detailed emission inventory allows baseline and with-policy emissions to be calculated that account for the following.

- Road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed.
- The contribution from stationary traffic. This allows policies that reduce congestion to be assessed.
- Fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.
- The effects of policies being implemented in future years. This allows the trend in reducing road transport emission factors to be accounted for.

5.16. By assessing the impacts of measures on the baseline emissions the local authority can then more accurately assess the potential cost-effectiveness and air quality health benefits associated with the measures.

5.17. Potential sources of data from which to develop emission inventories are summarised below.

Source activity: Road transport models can provide average speed and annual average daily flow data disaggregated by road link and usually split between light and heavy-duty vehicles. More detailed surveys have been used to disaggregate HDV types between buses and HGVs. Furthermore, some traffic models also provide link specific data on the daily average time that traffic is stationary at junctions and the average length of these queues. These data are necessary to estimate the potential contribution from congestion.

Vehicle emission factors: The Air Quality Archive local authority emissions toolkit (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) has tools that allow calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. This tool also calculates emission factors in future years.

Local authorities may also consider using the tool Defra has developed to be used by local authorities in calculating emissions of NO_x and PM_{10} under the new performance indicator framework (i.e. NI 194: Air quality – % reduction in NO_x and primary PM_{10} emissions through local authority's estate and operations). This is available at www.defra.gov.uk/environment/airquality/local/indicator.htm. This tool can be used to indicate the potential difference in emissions due to replacement by one vehicle type with another or due to a reduction in annual mileage.

Specific fleet inventories: In the case of specific and relatively small fleets (such as the local authorities own fleet or commercially operating bus fleets) it is recommended that a specific fleet inventory is developed. A key reason for this is that the distribution of vehicle ages within these fleets can typically vary quite significantly from the national average age distribution. For example, the local bus fleet may be significantly older or younger than the national average. For better accuracy it is therefore recommended to list the age and abatement equipment of each vehicle. In these cases local authorities should attempt to work in partnership with commercial and other fleet operators to obtain the relevant data.

5.18. Other key factors in the inventory: To be useful as a policy assessment tool, local authorities are advised to consider including the following additional capabilities in their local inventories.

- Inventory breakdown by geographical area. In cases where controlled zones are being considered as a local measure the local authority may need to calculate the effect on emissions both inside and outside of the zone or zones. This will require road link and vehicle activity data to be disaggregated.

- Compliance rates. Depending on the range of regulatory approaches being considered to enforce a local measure (strong or weak) then a greater or lesser rate of compliance may be expected. If this is a significant factor then local authorities should include the capability within their inventory for assessing the emissions impact of compliance rates less than 100%.
- Compliance year (or year that the measure under consideration would come into force): Natural vehicle replacement rates mean that on average the national fleet unit emission factors decrease over time. If the compliance year is in the future then local authorities are advised to include these effects in their inventory. Otherwise the inventory is likely to overestimate the potential emissions impact of a local measure.

Air Quality Assessment

5.19. Air quality assessments use monitoring, dispersion model and Geographical Information Systems (GIS) data to assess a) where the air quality objectives are exceeded and b) whether there is relevant exposure at these locations. The methods to be used in these assessments are provided in detail in Local Air Quality Management Technical Guidance 2009 and local authorities are recommended to have regard to this guidance.

5.20. For assessing the effects of local measures it is most appropriate to consider the exercise as a formal Further Assessment, i.e. this is the most detailed of review and assessment technical activities and is designed to estimate the contribution of different sources to the local air quality (source apportionment).

5.21. An appropriate further assessment allows air quality arising from baseline and with-policy cases to be calculated that account for the following.

- Road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed.
- The contribution from stationary traffic. This allows policies that reduce congestion to be assessed.
- Fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.
- The effects of policies being implemented in future years. This allows the trend in reducing road transport emission factors to be accounted for.

5.22. By assessing the impacts of measures on the baseline air quality the local authority can then more accurately assess the potential effect on compliance with the air quality objectives associated with the measures.

5.4 Estimating the Economic Benefits of Air Quality Improvements

5.23. As highlighted above, air quality improvements have health and environmental benefits. Some of these improvements can then be valued using economic evidence to produce monetary estimates (such as through health or environmental improvements).

5.24. As an example, improved air quality leads to health benefits, reducing the numbers of cases of respiratory hospital admissions from high pollution episodes, and this has benefits through reducing health care costs, lost time at work, and the pain and suffering of individuals. These benefits can then be valued using economic evidence on resource savings, health valuations, productivity losses etc.

5.25. Detailed methods have been developed to quantify and value the health and environmental benefits of air pollution improvements. As outlined earlier, in the UK, this has been advanced by the Department of Health's COMEAP group and IGCB. The methods were used in the economic analysis to inform the review of the Air Quality Strategy[10]. Similar methods have also been adopted in the European Commission proposals on air quality, as part of the Clean Air For Europe (CAFE) project and the Thematic Strategy on Air Quality.

5.26. The approach taken by the IGCB for the Air Quality Strategy was very detailed, and used modelling with the 'impact pathway approach', following an estimation of emissions, dispersion and pollution modelling, calculation of receptor exposure, quantification of impacts and valuation.

5.27. However, the group also provided summary values that can be used in appraisal. These are known as '**damage costs'** and provide the benefits of marginal air quality improvements, in **benefits (£) per tonne of pollutant reduced**. These damage costs are presented on the Defra web-site (www.defra.gov.uk) and are recommended for use in cost-benefit analysis (see later section). Examples are included in Box 2.

Box 2. Examples of the Damage Costs

Examples of the damage costs are presented below, for a 2005 emission in 2005 prices, for the central high estimate.

- SO_2 has a central high damage cost value of £1,735 per tonne.
- NO_x has a central high damage cost value of £1,061 per tonne.
- PM_{10} (transport average) has a central high damage cost value of £53,391 per tonne.

[10] www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm

It can be seen that there is a different scale of effect between PM and other pollutants. Note also that the PM values vary with the location – such that values in rural areas are much lower - because of the lower population density.

5.28. These damage costs are based on values for a range of health impacts, including mortality and morbidity effects, and non-health impacts, such as damage to buildings and effects on crop yields, and also take account of both primary and secondary air pollution changes. It should be noted that there are important caveats with application [11].

5.29. Inter-Departmental Group on Costs and Benefits damage costs are given for primary PM_{10}, SO_2 and NO_x. Note that multiple values are given for PM, reflecting the sector and location of emission. This reflects the fact that the benefits of primary PM improvements are strongly related to local population weighted exposure[12],[13].

5.30. It is highlighted that not all potential benefits of air quality have been quantified / valued in these damage costs, because quantification is not possible or highly uncertain. Amongst the most important of the effects excluded are impacts on ecosystems. The values also only include the benefits that occur in the UK (i.e. they do not include benefits from reductions in trans-boundary pollution).

5.31. It is important to highlight that the economic benefits of air quality improvements change over time. It is important not use the same value for each year! These effects can be taken account of by directly using the damage cost calculator on the Defra web site.

5.32. An example on the use of the calculator is included in Box 3. The results are presented as a central value, and also a central range (a low and high). The central range reflects the uncertainty in a small number of key parameters, and is not a measure of statistical uncertainty.

[11] The damage cost approach is intended for use across government, such as for project appraisals (project cost-benefit analysis) and Regulatory Impact Assessments (policy cost-benefit analysis). It is not, however, considered a replacement for detailed modelling and analysis. The use of damage costs is therefore only recommended for policies with a pollution reduction over a period of less than 20 years and: as part of a filtering mechanism to narrow down a wide range of policy options into a smaller number that are then taken forward for more comprehensive assessment; or where air quality impacts are expected to be ancillary to the primary objectives or are relatively small.

[12] For some secondary pollutants (secondary particulates from NO_x and SO_2), one uniform value has been derived for the UK in the IGCB damage costs. This reflects the fact that local issues are less important for these pollutants. These secondary pollutants form in the atmosphere over time, and so the immediate local environment is less important in determining damage costs.

[13] At present the IGCB damage costs do not capture the effects of ozone formation. The use of a single value for ozone (i.e. for precursor emissions of NO_x and volatile organic compounds (VOC)) is more uncertain than other pollutants, especially in relation to NO_x, i.e. strongly non-linear due to the titration effects in urban sites. However, ozone damages (when expressed in £) are small compared to secondary PM effects, and so have little effect on the results for NO_x.

Box 3. Valuation of Air Quality Benefits

The damage cost calculator allows estimation of the monetary benefits of air quality improvements. The analysis needs inputs of emissions over time. For the example here, we have a scheme for five years, **starting in 2007** (and for a 2007 base year) which leads to improvements in PM_{10} and NO_x over time as follows.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
PM_{10} reduction (tonnes)	1	0.8	0.6	0.4	0.2	0
NO_x reduction (tonnes)	5	4	3	2	1	0

The time period, start date, and emission values are entered into the spreadsheet, for example for NO_x.

1. What length (in years) is your policy appraisal?	**5**
2. When is the first year of your appraisal?	**2007**
3. What pollutant are you assessing? (click box to select from drop-down menu)	***1***
4. Input the annual changes in emissions below (in tonnes)	

Year	***2007***	***2008***	***2009***	***2010***	***2011***		
Change in emissions (tonnes)	**5**	**4**	**3**	**2**	**1**		

CALCULATED RESULTS		
Central Estimate Present Value	**£ 0.01**	**Million**
	£ 13,513	

Note that the damage cost calculator automatically estimates the value of the damage costs in future years and then discounts the values of the benefits, as **present** values, so there is no need to do this calculation separately.

One important aspect is that when there are PM_{10} improvements, different values are provided according to the sector (for example transport, waste, etc), and for road transport, different values for the specific area.

- Central London (Existing Congestion Charge Scheme (CCS) area)
- Inner London (within North South Circular)
- Outer London (within GLA boundary)
- Inner Conurbation
- Outer Conurbation
- Urban Big
- Urban Large
- Urban Medium
- Urban Small
- Rural

5.33. The damage costs are based on a number of assumptions. These should be noted, along with a number of caveats, in any application of the values. These are as follows.

- External costs of air pollution vary according to a variety of environmental factors, including overall levels of pollution, geographic location of emission sources, height of emission source, local and regional population density, meteorology and so on. The damage cost numbers take these issues into account to a certain degree only.
- The values are based on national level analysis (and national averages). They are therefore potentially more relevant for national policies than specific local analysis.

5.34. It is also stressed that the values exclude a number of important effects.

- The values do not currently take into account ozone formation and effects, from either NO_x and do not have VOC damage costs (another ozone precursor).
- The numbers only include costs that occur in the UK - all transboundary pollution and impacts are excluded.
- The numbers exclude effects on ecosystems (acidification, eutrophication, etc) and effects on cultural or historic buildings from air pollution.
- A number of potential additional morbidity or mortality aspects are not included. For discussion, see the damage cost guidance documents.

5.5 How to estimate carbon dioxide emissions

5.35. Local authorities should have regard to the section above on assessing the effects of measures on NO_x and PM_{10} emissions. They are advised to consider using the tool Defra has developed to be used by local authorities in calculating emissions of CO_2 under the new performance indicator framework (i.e. NI 185) for this purpose. This can be accessed at www.defra.gov.uk/environment/airquality/local/indicator.htm

5.6 How to Estimate the Economic Benefits of carbon dioxide emissions

5.36. As well as Government values on the benefits of air quality improvements, there are also value for benefits from reducing greenhouse gas emissions. These value the wider social benefits of reductions, rather than the costs of measures and policies needed to reduce greenhouse gas emissions[14].

5.37. The values, and guidance on use, can be found on the Defra web-site, under the section on the Shadow Price of Carbon (SPC) www.defra.gov.uk/environment/climatechange/research/carboncost/step1.htm.

[14] Strictly speaking, the value is the marginal global damage cost of climate change from emissions.

5.38. As with the damage costs for air quality above, the SPC is expressed as the economic benefit for a reduction of 1 tonne of CO_2 emission (or carbon dioxide equivalent (CO_2e)). An example is included in Box 4 below.

Box 4. Valuation of carbon dioxide benefits

The SPC guidance presents values for estimation of the monetary benefits of CO_2 in appraisal. The 2007 base year values are below, as the monetary value per tonne of CO_2.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Value	25.5	26.0	26.5	27.0	27.6	28.1	28.7	29.2	29.8	30.4	31.0	31.6

(2007 prices, with 2% pa increase)

It is important to highlight that the economic benefits of carbon benefits change over time, i.e. they increase in each future year. The values are increased at 2% a year, as in the table above. The values are then discounted in appraisal to give present values, as for the analysis of costs (see later sections). Note that for air quality pollutants, the damage cost calculator (Box 3) does these steps automatically.

As an example, we assume the scheme in Box 3 (for air quality improvements) also leads to emission reductions in CO_2. Using the SPC guidance, the benefits of these improvements can also be monetised. The analysis needs inputs of emissions over time. As with the example above, we have a scheme for five years, **starting in 2007** which leads to improvements in CO_2 over time as follows.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
CO_2 reduction (tonnes)	100	80	60	40	20	0

Going to step 2 of the SPC guidance, the monetary values for CO_2 improvements (shown at the top of this box) are multiplied by the quantity of greenhouse gas emissions abated/emitted in each (expressed in CO_2e) (step 3 of the guidance) to give total benefits in each year.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
£ value	2550	2080	1590	1080	552	0

These values must then be **discounted**. Guidance on discounting is given in the later sections. As an example here, we are using 2007 start date and base year, so the values are discounted back to this year.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
£ value	2550	2080	1590	1080	552	0
Discount factor	1.00	0.97	0.93	0.90	0.87	0.84
Discounted value	2550	2010	1484	974	481	0
Present Value (sum)	7499					

Note that if a different base year to 2007 is chosen – adjustments are needed to the set of shadow prices (to above), and the values will need to be discounted in relation to this different base year.

5.7 How to estimate other benefits

5.39. For some schemes, there will be additional effects. For transport schemes, this will potentially include aspects of noise, accidents, and congestion. For other schemes, it will also include additional aspects.

5.40. These additional elements should be captured in the assessment of options. For transport schemes, further guidance on these aspects is provided at the DfT's webTAG website www.webtag.org.uk/. In many cases, guidance and practical experience of applying these transport appraisal techniques will be within Local Authority Transport Departments.

6. Estimating Costs

6.1 Introduction

6.1. This section outlines the approaches for estimating costs. It focuses on the initial scoping of cost estimates.

6.2. The first stage in a cost assessment is to gather the information on costs. There are a number of sources of information that are likely to be useful to local authorities in undertaking this task. While no centralised database exists of the costs of potential measures for improving air quality, a number of reference sources may be of use. These include.

- Information from previous schemes, introduced in the UK or Europe.
- Information from recent national assessments, such as the Air Quality Strategy and supporting economic analysis (IGCB).
- Information from other government organisations, such as the Energy Saving Trust and its vehicle replacement schemes.

6.3. In collecting these costs, you should be mindful of a number of issues related to the analysis of cost information in appraisal. These are set out below.

6.2 Estimating Costs of Options

6.4. A key building block of an economic appraisal is the estimation of costs. In undertaking cost assessments of air quality options and schemes, it is important to recognise that the analysis of costs in economic appraisal differs from financial budgeting and accounting. This means it may be necessary to collect additional data and that the subsequent analysis requires the consideration of costs in a different way (that is often non-intuitive to conventional financial or budgeting procedures). There are two key issues to note.

- First, it is necessary to capture the full costs of a project or proposal (to society), rather than just the costs of setting up or introducing a scheme to the local authority. This may involve, for example, the costs of capturing the costs to vehicle operators from any scheme that is introduced to improve air quality. Related to this, costs have to be considered in terms of the impact to society as a whole and therefore do not take account of transfers between different sectors (for example taxes and subsidies) or accounting costs such as depreciation. This means there are significant differences between a financial analysis and economic analysis, though for major schemes, both are required.
- Second, it is necessary to present all cost information in equivalent terms. This involves some adjustments to costs (historic or future) to ensure they can all be compared directly.

The sections below outline some of the issues.

6.5. In the subsequent guidance that follows, a simplified (rule of thumb) approach is proposed, which simplifies lots of the following information, but this will be important for subsequent detailed analysis.

6.3 Economic vs. Financial Appraisal

6.6. Many practitioners confuse financial and economic appraisal. They are different because they have different objectives.

- An economic appraisal (economic case) focuses on wider value to money for society as a whole, taking into account all costs and benefits, even those that don't normally have monetary values.
- A financial appraisal looks at the affordability of a proposal. This is more likely to be similar to the sorts of local budgetary framework, financial costs and accounts, that many practitioners will be familiar with, i.e. they are similar to an accountancy based perspective.

6.7. For any scheme, **both the economic and financial case for a proposal will be important**, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable.

6.8. At the simplest level, there are two sets of costs that are likely to be relevant in any option or scheme. These are capital costs and operating costs.

- **Capital costs**, also known as 'up front' or 'investment expenditure' costs, are the costs associated with, for example, the costs of purchase of a retrofit technology, or a new vehicle.
- **Operating costs,** also known as 'maintenance costs', are the costs associated with, for example, the running and maintaining the retrofit technology over the lifetime. These will include the costs of regular maintenance, but should also include the costs of any associated effects, for example on fuel economy.

6.9. In considering the economic costs of any option or scheme, it is important to take account of the capital and operating costs that accrue to all affected individuals, i.e. to society as a whole, rather than to the local authority alone. As an example, the costs of any scheme, such as a LEZ, involves costs to the local authority to set-up, run and enforce the scheme. However, it also includes costs to operators who have to comply with the scheme, and take action for example to upgrade their vehicles with retrofit technology to comply with the scheme.

6.10. It is also necessary to consider all costs and benefits, irrespective of boundaries, in economic appraisal. This will include the costs that occur within the local authority area, for example local fleets, but also other operators who maybe affected by the schemes, i.e. those travelling into the area that will have to comply.

6.11. All sets of costs need be assessed for any option. However, it is good practice to keep these cost elements separate, as this separation is likely to be needed for subsequent financial appraisal, for example to look at scheme affordability to the local authority.

6.12. Some of the cost categories for the examples here are summarised in the table below for a retrofit scheme as an example. More specific examples are presented in the worked examples for the practice guidance.

Table 2: Cost categories for a retrofit scheme

Scheme	Capital Costs	Operating Costs
Cost to the local authority	Capital costs associated with infrastructure for the scheme.	Annual operating costs for the scheme, including staff resource.
Retrofit of a vehicle, for example for Diesel particulate filter (DPF)	Additional costs of purchase and operation of the retrofit technology.	Annual maintenance cost of retrofit technology, for example cleaning. Change in fuel efficiency.

6.13. Note that there are additional costs that are also potentially relevant, especially for larger schemes. These are particularly important for measures that affect transport demand (vehicle km) or travel time, rather than just transport technology and emissions, where there are a much wider set of costs that potentially need to be considered. These would include the wider costs (or benefits) of changes in travel time, accidents, etc.

6.14. There are additional levels of detail that are likely to be needed when undertaking a detailed appraisal, especially of a major scheme or a large transport based schemes. These include the following.

- Operating costs maybe comprised of fixed and variable elements. Some costs will remain fixed over time (for example the same cost each year), whilst some costs will be variable, and may vary with the volume of activity (for example related to annual mileage). Some costs may have elements of both, for example maintenance is an example, where there is usually a set planned programme, as well as a responsive regime whose costs vary in proportion to activity, i.e. the number of call-outs). Note that staff resources (such as those associated with setting up and running any scheme) are also a cost and these should be factored into the analysis.
- The assessment of transport-related costs will need to take account of the costs of new technology, the costs due to a change in fuel use. However, it

will also need to take into account the wider welfare effects due to any change in kilometres travelled.

- Traditionally, cost data availability will be at market prices. For example, the costs of equipment as provided by suppliers of low emission abatement equipment. However, when Government undertakes cost assessment, a different accounting concept is used, based on the ‘**technology costs'** of the measures (as in the Air Quality Strategy Review). This is the cost of the technology that the producers have to face when manufacturing equipment (or new vehicles) and is, of course, lower than the market cost. It is the estimated technology costs assuming mass production.
- For some schemes, there are likely to be wider indirect costs from introduction. As an example, in addition to the costs of implementation and the costs to operators, there maybe wider effects in the local economy from the scheme.

Assessing these effects in detail is more challenging, but these potential effects should be highlighted in your detailed considerations.

6.15. In collecting and analysing cost data, it is also important to recognise that the two appraisal approaches (economic and financial) work with different accounting principles, consistent with their objectives. As an example:

- an **economic appraisal will exclude** VAT and capital charges (including depreciation) because these are not relevant in the wider societal costs as they are effectively transfers,
- a **financial appraisal has to include** these because they have a direct bearing on the affordability of the options.

6.16. Similarly, this principle applies to revenues (taxes and charges) which are raised by scheme options, such as parking charges. In economic appraisals, costs are presented in terms of the impact to society as a whole and therefore do not take account of these transfers between different sectors (for example taxes and subsidies). However, in financial terms, they are strongly related to the affordability of the proposals, for example in relation to revenues that are likely to be important for the local authority.

6.17. Equally, in economic appraisal, it is necessary to consider all costs and benefits, whether or not they fall within local authority boundaries. For financial appraisal, it will be important to the costs and benefits that fall within and outside your area.

6.18. The key differences between economic and financial appraisals can be summarised in Table 3.

6.19. Separating out these issues can be complex, and require detailed input. It is not required for the scoping analysis, but it will be important to be mindful of these issues even in earlier rule of thumb analysis.

Table 3: Comparison of Economic Appraisal and Financial Appraisal

	Economic appraisal	**Financial appraisal**
Focus	Value for Money (measured as net present value)	Affordability (cash flow)
Coverage (boundary)	Wider cover – Government and society (‘UK ltd’)	Relevant organisation (for example local authority)
Analysis / Accounting standards	HMT Green Book on government appraisal	Organisation accounting rules
Transfers (for example VAT)	Excludes all transfer payments such as VAT	Includes all transfer payments such as VAT
Depreciation	Excludes depreciation and capital charges	Includes depreciation and capital charges
Inflation	Excludes general future inflation	Includes inflation
Benefits	Includes all benefits, including those that are not expressed in monetary terms, for example environmental benefits, such as health or air pollution benefits	Only considers cash releasing benefits
Costs	Includes all quantifiable costs, including indirect and attributable costs (costs of others), and environmental costs	
Prices	Constant (real) prices	Current (nominal) prices
Other	Includes opportunity cost Applies Government discount rate Excludes sunk costs	

Source: Adapted slightly from HMT, Business Case guidance.

6.4 Assessing costs in equivalent terms

6.20. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. At first, this might seem rather simple, as all costs can be expressed in £ sterling. However, it is important to note that costs are not constant over time.

6.21. To address this, economic appraisal requires some adjustments to historic costs, for example, to account for effects such as inflation. It also requires adjustments for future costs to allow comparison and direct equivalence to cost that occur today. Note that these adjustments are different to the approaches used in financial appraisal (accountancy).

6.22. For the scoping phase, it is likely indicative costs should suffice. Nonetheless, it is important even in the scoping phase to try and ensure that current and future costs are expressed in equivalent terms. This requires all cost estimates to be expressed in current prices using a common base year.

6.23. This base year provides a common point in time. Note that this base year can vary. Sometimes it is the most recent year. Sometimes it is a common starting point (the same year that the scheme is planned for introduction). Sometimes it is a historic base year (as in transport appraisal). The base year chosen does not really matter, as long as all cost estimates are expressed in this year consistently. As an example, older data should be expressed in this base year. For example, a study from the year 2002 may quote the cost of a piece of pollution control equipment for vehicles at £1000, but these costs will not be representative of current prices. Using this value (from an earlier year, without adjusting for inflation) will underestimate costs. There are approaches for expressing such data in current prices.

6.24. Similarly, it is also necessary to adjust costs that occur in the future. For most proposals, costs include operating costs that occur over the time period of the option or scheme. These might include annual maintenance, or scheme running costs that run over a period of five or more years.

6.25. In economic appraisal, it is necessary to adjust these costs in the future. In order to do this, and directly compare economic costs and benefits at different times, a technique called **discounting** is usually used.

6.26. Discounting is different to inflation, and is based on the principle that individuals (and society) prefer to receive goods and services now rather than later (known as time preference), and also that costs and benefits in the future count less because they affect a larger expected future income.

6.27. In economic appraisal, a **discount rate** is used to convert future economic costs to ‘present values’, so that everything can be compared on a common basis. In Government, a standard discount rate (strictly speaking, a social time preference rate (STPR), representing the rate at which society values the present compared to the future. Note this social rate is much lower than the private investment discount rate used in industry, reflecting that in economic appraisal we are assessing social preferences.

6.28. The recommended Government discount rate is 3.5%. A simple example of how this is applied is presented in Box 5, showing how £1000 changes over a period of five years. This can be related to, for example, running operating costs over time for a scheme.

Box 5. Discounting

Based on the recommended discount rate, an equation is applied to estimate the discount factor. This is applied to future costs to express them as 'present values'. The equation is:

$$D_n = \frac{1}{(1 + r)^n}$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the year.

As an example, the discount factor that should be applied to derive the present value of £1000 in five years time can be calculated as Discount Factor = 1/(1 + 0.035)^5 = 1/(1.1876) = 0.842.

This discount factor is applied to the £1000 to estimate the present value, for example £1000 * 0.842 = £842.

The appropriate discount factors are published in the Treasury Green Book, shown below, though these can be calculated directly for each year using the equation above. **They are included in the guidance cost estimation spreadsheet.**

Year	Long Term Discount Factor
0	1.0000
1	0.9662
2	0.9335
3	0.9019
4	0.8714
5	0.8420
6	0.8135
7	0.7860
8	0.7594
9	0.7337
10	0.7089

The schedule over five years is shown below, showing how the value of £1000 falls with time when expressed in present values, i.e. the discounted value.

Year	**0**	**1**	**2**	**3**	**4**	**5**
Value	£1000	£1000	£1000	£1000	£1000	£1000
Discount factor	1.00	0.966	0.934	0.902	0.871	0.842
Present Value	£1000	£966	£934	£902	£871	£842

Note for later analysis (for example in cost-benefit analysis), the total present value of the scheme is obtained by summing these individual present values over time, so rather than a total of £6000 (6 * £1000), the present value is £1000 + £966+£934+£902+£871 + £842 = £5515.

6.29. Importantly, such an analysis, with all costs expressed in equivalent terms, allows the stream of capital and operating costs in different time periods to be expressed in a single value, called the **present value**. This then allows comparison of options, with different costs in different time periods in a directly equivalent way. This is important in, for example, comparing an option that has a large up-front capital costs versus one that has high operating costs that extend over time. An example is given in Box 6 below, showing the present value for two alternative options. The one with the lowest present value has the lowest economic costs. Note that the approach also allows comparison of schemes that have different operating lifetimes. The same principle is applied to the estimation of benefits (to derive present values) see later section, to allow a direct comparison of the costs and benefits to prioritise options.

Box 6. An example of Present Value

Two alternative options, A and B, are being considered for improving air quality.

- Option A involves a high level of initial capital expenditure to set up (£50,000), but has low operating costs (£1,000 per year) for the six years of the option.
- Option B has much lower initial capital expenditure (£10,000) but has high operating costs (£10,000 per year) for the six years of the option.

The costs in each year are added, and the discount factors are applied to estimate the sum of the values, i.e. the present value.

Option A	**0**	**1**	**2**	**3**	**4**	**5**
Capital costs	£50,000					
Operating costs	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000
Total (cap + op)	£51,000	£1,000	£1,000	£1,000	£1,000	£1,000
Discount factor	1.00	0.97	0.93	0.90	0.87	0.84
Present value	£51,000	£966	£934	£902	£871	£842
Total PV (sum)	£55,515					

Option B	**0**	**1**	**2**	**3**	**4**	**5**
Capital costs	£10,000					
Operating costs	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000
Total (cap + op)	£20,000	£10,000	£10,000	£10,000	£10,000	£10,000
Discount factor	1.00	0.97	0.93	0.90	0.87	0.84
Present value	£20,000	£9660	£9340	£9020	£8710	£8420
Total PV (sum)	£65,151					

In this case, even though option A has larger capital costs, the present value of costs is lower than B, because option B has higher operating costs over time.

6.30. Further details and worked examples are given in the later cost-effectiveness analysis and cost-benefit analysis and in the guidance spreadsheet. Both cost-effectiveness analysis and cost-benefit analysis use the same approach in terms of deriving present values as in the box above. However, for cost-effectiveness analysis, an additional calculation is usually carried out to express the present value in an annual metric, to allow direct comparison with annual benefits.

7. Appraisal: Cost-Effectiveness and Cost-Benefit Analysis

7.1 Introduction

7.1. The next stage in the appraisal process is to compare options. This section sets out the main approaches to do this. It is best practice in Government appraisal to use cost-benefit analysis for appraisal. However, in the case of a legally binding target, as for air quality exceedences, there is also a role for cost-effectiveness analysis. Both techniques use the same building blocks on estimating benefits and costs from the previous chapters. They differ in that cost-effectiveness provides a method for looking at the relative attractiveness of options, usually with a particular focus on a single year, i.e. for a legally binding target date, whilst cost-benefit analysis looks at the absolute costs and benefits of options over time and can assess their full societal benefits and value for money.

7.2 Cost-effectiveness analysis

7.2. In any area, there are a potentially large number of different measures that can be implemented to improve air quality. An important component of developing an action plan or air quality strategy is to compare these options against each other to allow selection of the most appropriate measure or combination of measures to achieve the necessary air quality improvements.

7.3. The existing Guidance highlights that one of the key criteria recommended for action planning is to assess measures in terms of their cost-effectiveness. Undertaking a cost-effectiveness analysis will allow a prioritisation of options according to the physical benefits that they achieve (for example emissions or air quality improvement) for the level of investment (costs). When used in an overall action plan, it can ensure that the achievement of the air quality objective is undertaken in the most economically efficient way. This is important in reducing the costs of proposals.

7.4. To assess the cost-effectiveness of a measure, two elements are involved.

- The first assesses the likely reductions in emissions or air quality concentration improvement, as calculated in the earlier benefits section, for example, how many tonnes of emissions an option achieves in a given year.
- The second assesses the economic costs of implementing the measure, i.e. as estimated in the previous section on cost analysis. This includes all cost elements, with costs expressed in directly equivalent terms as a present value. In the case of air pollution improvements with a given target date, it is usual to express these costs in an annual term, to provide an equivalent annual cost that can be compared against the environmental benefit above.

7.5. Cost-effectiveness simply combines these two metrics, so that an option can be assessed in terms of either the:

economic cost (£) to reduce one tonne of emissions, or

economic cost (£) to improve air quality by 1 µg m^{-3}

7.6. The cost-effectiveness of an option represents the air quality benefits it achieves, relative to its costs, i.e. it provides a ranking of the economic effectiveness of different options. Usually this is reported as a £ cost per tonne, i.e. as an equivalent annualised cost per emission reduced/year (though it can also be expressed by swapping the terms around, i.e. expressed as tonnes reduced per £). Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately it is the cost per level of air quality improvement (µg m^{-3}).

7.7. Expressing different measures in this way allows a method for directly comparing options. By undertaking a scoping analysis, and estimating the indicative cost per tonne, the cost-effectiveness of different options can be compared. This allows one element in the prioritisation and selection of options. The individual cost-effectiveness of measures can also be used to draw up an overall action plan, i.e. by implementing the most cost-effective measures first, it is possible to estimate how to reduce an exceedence, or achieve a given level of air quality improvement, in the most cost-effective way. This is outlined in more detail in a later section.

7.8. The starting point for any scoping cost-effectiveness analysis is the emission improvement and cost data. For the latter, as highlighted in Chapter 6, this must be collected in equivalent terms, and should be based on an economic appraisal method in relation to boundaries, taxes and charges, etc. However, the present values (as in Chapter 6) are expressed as annualised costs. The annualised cost is equivalent to the constant annual payment that is required over a fixed number of years to produce the same present value at a given discount rate.

7.9. However, this type of traditional cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. To address this, it is good practice to assess the ‘net cost-effectiveness’ of options. This extends the cost-effectiveness analysis to a net cost metric (annualised costs less annualised benefits) before comparing against the reduction in tonnes of pollutant (or µg m^{-3}). The advantage of this ‘net’ assessment is it builds in other environmental objectives directly to the relative ranking of options, i.e. so that reductions of other air quality pollutants or changes in greenhouse gas emissions are also considered.

7.10. Undertaking a full cost-effectiveness assessment can be a detailed and time-consuming activity. In a scoping phase, precise calculations of cost-effectiveness will not, in all cases, be possible or needed. The aim is to identify which options merit further consideration. In most cases, a simple cost-effectiveness scoping study based around emissions benefits will very quickly identify those options that achieve good emissions improvements at low cost, which should be taken forward to a more detailed assessment, though a check should be made to see how these vary when ‘net’ cost-effectiveness is considered (to bring in other environmental objectives). For detailed studies, especially of major schemes and specifically for transport schemes, it is likely that additional expertise will need to be brought in for detailed appraisal, and a more in-depth analysis of cost and benefits will be needed.

7.11. As highlighted earlier, the application of this scoping cost-effectiveness is not mandatory, but is good practice. It will demonstrate that local authorities have considered a range of options and the cost-effectiveness information provides an extremely valuable input in ranking and prioritising different options. By using the cost-effectiveness analysis, a local authority is able to demonstrate that cost and efficiency considerations have been considered, (important for internal and external stakeholders). Note, however, that cost-effectiveness is not the sole output for prioritising measures for inclusion in an action plan, and other criteria are important and should be assessed alongside costs. These include, but are not confined to, other environmental effects (which can be assessed with a ‘net cost-effectiveness analysis), social impacts, acceptability of options, and secondary economic effects. It is also important that the distributional implications of each option are considered during appraisal. This type of analysis enhances the understanding of the fairness of proposals, their social impacts and their scale.

7.12. A simplistic worked example is shown in Box 7. Specific examples for each of the schemes are included in the additional practice guidance on LEZ, LEV and retrofitting.

Box 7. Estimating the cost-effectiveness of a measure

The present value of the options A and B was presented in Box 6.

- Option A involves a high level of initial capital expenditure to set up (£50,000), but has low operating costs (£1,000 per year) for the six years of the option. The present value of these costs was £55,515 (see Box 6).
- Option B has much lower initial capital expenditure (£10,000) but has high operating costs (£10,000 per year) for the six years of the option. The present value of these costs was £65,151 (see Box 6).

The two options both reduce annual emissions of NO_x, for example,

- Option A reduces emissions by 10 tonnes of NO_x a year in the area.
- Option B reduces emissions by 14 tonnes of NO_x a year in the area.

To estimate the cost-effectiveness, one additional calculation is needed to convert the present value of costs (from above) into an annual term, an annualisation. This is often known as the equivalent annual cost. This uses an equation which is multiplied by the present values as follows. **There is an excel function which can estimate equivalent annualised costs. This is included in the example sheet.**

Equivalent annualised cost = Present value multiplied by $\left[\frac{r(1+r)^n}{(1+r)^n - 1}\right]$

where again r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the length in years.

This is applied to give [0.035*(1+0.035)^year]/[((1+0.035)^year)-1]. In the case of the six years here, [0.035*(1+0.035)^6]/[((1+0.035)^6)-1] = 0.188.

Therefore, the equivalent annual costs for two options are:

- Option A = £55,515* 0.188 = £10,418
- Option B = £65,151* 0.188 = £12,227

The cost-effectiveness is then the annual emission reduction divided by the equivalent annual cost, as follows

- Option A = 10 tonnes/ £10,418 = £1,042 per tonne reduced.
- Option B = 14 tonnes/ £12,227 = £873 per tonne reduced

So option B is the more cost-effective option, as it achieves a reduction in NO_x for a lower cost per tonne. This type of analysis can also be undertaken for air quality improvement, i.e. cost per micro gram.

Note that if the options had different lifetimes, it would be necessary to annualise them over different periods – so for example – if option B had a longer lifetime by two years, we would need to adjust this in the annualisation equation, so that the costs were spread over the appropriate lifetime.

The cost spreadsheet has a function for estimating the equivalent annualised cost.

However, the analysis above only considers one objective (NO_x improvement), and does not consider other Government environmental goals or benefits of the options, for example PM_{10} reduction, or greenhouse gas emission reductions. To address this, it is necessary to assess the 'net cost-effectiveness' of the options. An example for these options is given in Box 9.

7.13. There are additional levels of detail that are likely to be needed when undertaking a detailed appraisal, especially of a major scheme or a large transport based schemes. These include the following.

- If the study is aiming to reduce a specific hot-spot or achieve a target in a given exceedence area, then the cost-effectiveness will need to target the cost-effectiveness to the emissions benefits that will directly affect the air quality in this area, i.e. very localised benefits, rather than say the benefits across the wider area. In more detailed analysis, this can be investigated in more specific detail by assessing cost-effectiveness for improving air quality concentrations, for example (μg m^{-3}) rather than in emissions.
- In many cases, the emissions benefits of a scheme will change over time. For the scoping assessment above, it is enough to estimate the emission savings in the first year, and compare to annualised costs. In more detailed analysis, it will be necessary to consider how the emissions savings change over the lifetime of the scheme. This is important otherwise the benefits of measures that have high initial benefits which fall off over time may be overestimated.
- It should be noted that the cost-effectiveness methodology assigns all costs to abatement of a single pollutant, for example to PM_{10} or NO_x. Some technologies abate both PM_{10} or NO_x, or lead to positive or negative changes in greenhouse gas emissions for example. Care must be taken not to underestimate the benefits of these measures (i.e. by concentrating on one pollutant at a time). It is possible to take these effects into account by undertaking a 'net' cost-effectiveness analysis (see Box 10), rather than using a simple methodology for ranking options in terms of cost-effectiveness for a single pollutant. Note that cost-benefit analysis also addresses these multi-pollutant issues.
- Other factors will be important in determining the overall ranking of measures, including the wider assessment (see 5As in 2.15) and other legal and technical issues, as well as acceptability.

7.14. Existing data on the cost-effectiveness of different options is not provided in the guidance. However, previous studies do indicate some broad general trends, which are summarised below. The case studies provide more specific examples of this. As very broad considerations, the following is highlighted.

- For transport, the introduction of the Euro standards means that there are strong differences in emissions between older and more modern vehicles. It is therefore usually more cost-effective to target the older, higher polluting vehicles.

- Heavier vehicles, such as lorries, buses and coaches, have much higher emissions than cars per vehicle kilometre driven. These vehicles therefore tend to be more cost-effective to target, because it is possible to have a large impact in reducing emissions by tackling a relatively small number of vehicles. However, note the following bullet.
- In cases where the priority is a LAQM area or hot-spot, it is usually much more cost-effective to tackle those vehicles which have highest annual vehicle km in the area, rather than those that only spend a small proportion of annual distance in the actual area. This often means that it is much more cost-effective to tackle local fleets with high area km, such as buses, local authority fleets or the taxi fleet.

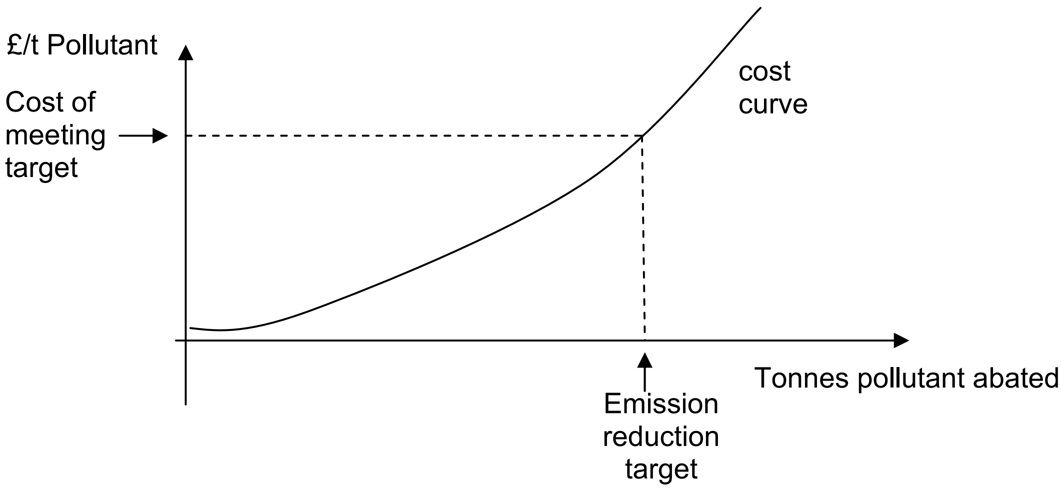
Building up a Cost-Effective Action Plan (Cost Curves)

7.15. The information from a cost-effectiveness analysis above can be used to look at the overall economic costs of hitting an air quality target, and to ensure that the target is achieved in the most cost-effective way.

7.16. In many cases, a combination of options may be needed to achieve, or demonstrate progress towards an air quality target. The cost-effectiveness analysis (previous section) allows prioritisation of a range of different measures and should provide the basis for developing a cost-effective action plan. Those measures that are most cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance.

7.17. Arranging options in order of cost-effectiveness, and building them up to achieve a given target, can be plotted in a figure, known as a cost curve. An illustration is shown in Figure 4. It plots the cumulative emission reduction potential against the costs, and shows the rising costs of options up the vertical axis with increasing emission reductions. The cost curve thus gives the total cumulative emissions reduction, and the total cumulative costs. If there is a target level, for example associated with achieving an air quality level, it is possible to ‘read off’ the curve by drawing a horizontal line, as indicated in the schematic below, to assess the measures needed, and the total costs, of achieving the target.

Figure 4: A Cost Curve for Emission Reductions.



7.18. As outlined above, a traditional cost-effectiveness analysis will only consider one objective in drawing up this cost curve. In order to take account of other environmental objectives, for example multiple air pollutants, and greenhouse gas emissions, the 'net' cost-effectiveness analysis of options should be assessed, and this used to build up the cost curve in order of the ranking of options, so as to provide a more holistic ranking approach.

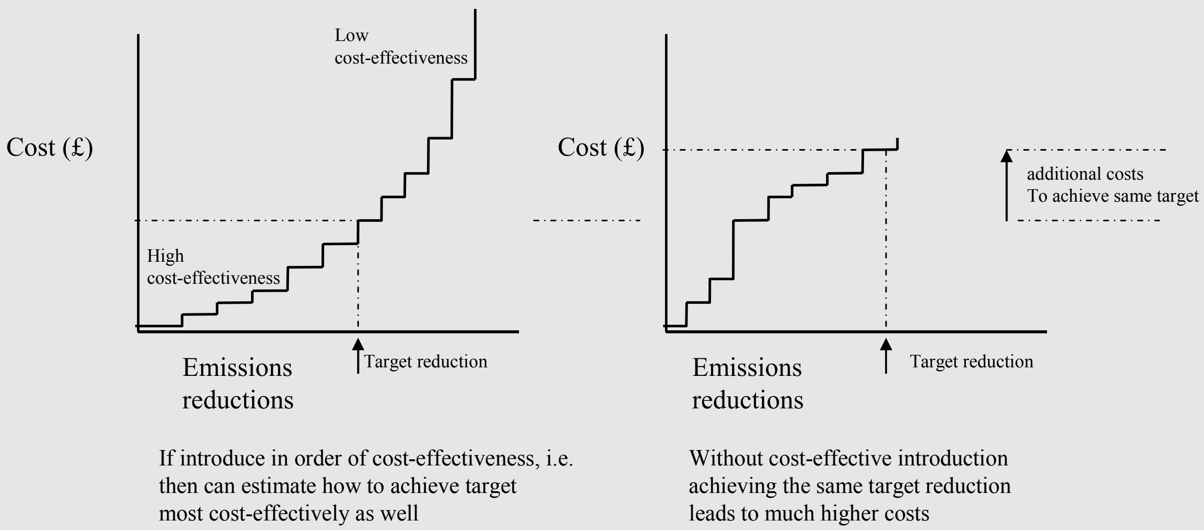
7.19. The advantage of the cost-effectiveness analysis and cost-curve is it demonstrates how to hit a particular target most cost-effectively, as the options are arranged with the most cost-effective ones implemented first (or most cost-effective in 'net' terms). It therefore provides a way to figure out how to achieve a given target at least cost. More description is given in Box 8.

7.20. In some cases, the costs of achieving a target may be considered dis-proportionately high. The cost curve can provide an important demonstration of this, as it will show if there is a disproportionate increase in the relative cost-effectiveness of options at some point, i.e. a step change or discontinuity in the cost curve.

Box 8. Developing a Cost-effective Air Quality Plan

Once a cost-effectiveness analysis has been undertaken, it is possible to rank different options in order of their cost-effectiveness. Under such an analysis (though considering other elements), the most attractive measure is the most cost-effective option, i.e. the one that gives the greatest emissions improvement at least cost. In some cases, however, more than one measure may be needed to meet the necessary air quality target and so the next most cost-effective option must also be added. This process can be continued until the target level is reached (note, checking that measures can be implemented simultaneously). The resulting plan will mean that target levels are achieved at lowest (least) total cost. The approach is shown in the left hand figure below. An approach that does not address cost-effectiveness has the potential to significantly increase the costs of hitting a target. The graph below on the right shows what happens if the cost-effectiveness order is reversed. By reading off to the cost axis, it can be seen that this significantly increases (moves upwards) the costs of achieving the target.

Figure 5: Cost-effective Air Quality Plans



Note that to take account of multiple air quality pollutants, and greenhouse gas emissions, a 'net' cost curve can be produced, which also takes these other environmental objectives into account in the ranking and ordering of different options.

7.21. In practice there are additional complexities in cost curve analysis as part of action plans. Many of these relate to the more detailed issues with cost analysis and cost-effectiveness highlighted in the previous cost section. In addition:

- A key issue is that different measures often affect similar activities, or one option may preclude the introduction of another, and so in practice, it is necessary to check synergies and conflicts between options in drawing up a plan.

- Other factors will be important in determining the overall ranking of measures, including the wider assessment (see 5As in 2.15) and other legal and technical issues, as well as acceptability.

7.3 Cost benefit analysis

7.22. Cost-benefit analysis is an alternative economic appraisal technique. In cost-benefit analysis, all relevant costs and benefits to government and society of all options are valued, and the net benefits or costs calculated. Cost-benefit analysis differs from cost-effectiveness analysis, as it works with monetary values for emissions benefits, and because it does not have to work with a pre-defined goal, i.e. it provides a method for investigation the justification for air quality improvements irrespective of AQMAs. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence, or those that are related to larger transport projects.

7.23. Cost-benefit analysis is the preferred approach for economic appraisal in Government. It is also the main basis of the transport appraisal guidance (NATA and the guidance in webTAG).

7.24. The building blocks for a cost-benefit analysis are the monetary estimation of benefits, described earlier in chapter 5 using the Defra Damage Cost Calculator, downloadable as an excel sheet (www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm), and the estimation of the present value of costs, from chapter 6.

7.25. Note that consistent with Government objectives, it is good practice to include any significant effects on greenhouse gas emissions as part of your estimates (positive or negative) and to include these in your analysis. Chapter 5 set out the approach for estimating the monetary benefits of greenhouse gas emissions improvements, using the Government SPC guidance, downloadable at www.defra.gov.uk/environment/climatechange/research/carboncost/step1.htm.

7.26. A cost-benefit analysis simply compares the present value of all benefits against the present value of all costs. Calculating the differences between the streams of costs and benefits provides the overall **net present value** (NPV) of an option. The NPV is the primary criterion for deciding whether government action can be justified, i.e. if the benefits are higher than the costs.

7.27. Note that unlike cost-effectiveness, cost-benefit analysis looks at the benefits over time, rather than the benefits in a single year. This requires analysis of future benefits. As with future costs, these are discounted using the same Government recommended discount rate.

7.28. Also different to cost-effectiveness, cost-benefit analysis can work with multiple pollutants, so it can estimate the combined benefits of PM and NO_x emission reductions. It can also include wider benefits such as CO_2 emission reductions (and as part of wider appraisal, other elements as well).

7.29. A scheme that has a positive net present value, shows a positive scheme. An example is shown in Box 9 below. Additional examples are given in the worked examples document accompanying this practice guidance case study guidance documents.

Box 9. Example of a Cost-Benefit Analysis

The present value of costs of the options A and B was presented in Box 6.

- Option A involves a high level of initial capital expenditure to set up (£50,000), but has low operating costs (£1,000 per year) for the six years of the option. The present value was £55,515 (see Box 6).
- Option B has much lower initial capital expenditure (£10,000) but has high operating costs (£10,000 per year) for the six years of the option. The present value was £65,151 (see Box 6).

These costs need to be assessed against the economic benefits of the options. As outlined in Box 6, the two options both reduce annual emissions of NO_x. As examples:

- Option A reduces emissions by 10 tonnes of NO_x a year in the area.
- Option B reduces emissions by 14 tonnes of NO_x a year in the area.

In order to estimate the monetary benefits of these emissions, it is necessary to use the Defra damage cost guidance to provide estimates. It is also necessary to increase the value of benefits in future years, and the discount these benefits, to derive a present value of benefits to compare to costs above. Note that the damage cost calculator does these steps automatically. As an example, the value for NO_x for option A are entered into the damage cost calculator spreadsheet, as below.

The present value of NO_x benefits for option A are estimated at £53,318 (see central value above). For option B (not shown) the present value of benefits is £74,407.

1. What length (in years) is your policy appraisal?	6
2. When is the first year of your appraisal?	2007
3. What pollutant are you assessing? (click box to select from drop-down menu)	*1*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Change in emissions (tonnes)	10	10	10	10	10	10	

CALCULATED RESULTS		
Central Estimate Present Value	£ **0.05**	**Million**
	£ ***53,148***	

These benefits can be compared against the present value of costs, to estimate the **net present value** of each option. The findings are:

- Option A has a present value of benefits of £53,148, and present value of costs of £55,515, so it has a negative net present value.
- Option B has a present value of benefits of £74,407, and present value of costs of £65,151, so it has a positive net present value of £9,257.

Therefore Project B is preferable in cost-benefit terms.

Note that if the options above had additional PM emission improvements, **the economic benefits of these other pollutants should be added to the values above** in the cost-benefit analysis (as should CO_2 emissions using the SCP, if these were relevant as well), for example if:

- Option A reduces emissions by 0.1 tonnes of PM_{10} a year in the area.
- Option B reduces emissions by 0.05 tonnes of PM_{10} a year in the area.

In this example, the damage cost calculator is used again. Note that for PM_{10}, it is necessary to specify the sector, and for transport, the location of the emission reductions. In this case, we select inner conurbation. Using the calculator, the present value of PM_{10} benefits for option A are estimated at £65,602, and for option B at £32,801. Therefore:

- Option A has a present value of NO_x benefits of £53,148 and PM_{10} benefits of £65,602, making a total of £118,750 compared to a present value of costs of £55,515, so it now has a positive net present value (compared to the assessment of NO_x alone).
- Option B has a present value of NO_x benefits of £74,407 and PM_{10} benefits of £32,801, making a total of £107,208 compared to a present value of costs of £65,151, so it also has a positive net present value, though the NPV it is now lower than option A.

Option	Present Value Benefits	Present Value Costs	Net Present Value
A	£118,750	£55,515	£63,235
B	£107,208	£65,151	£42,058

With both pollutants considered, option A is now preferable. This highlights the value of cost-benefit analysis in considering the overall benefits.

7.30. The information from a cost-benefit analysis can also be used to consider other environmental objectives in a cost-effectiveness analysis, as part of a ‘net’ cost-effectiveness analysis[15]. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant (or $\mu g\ m^{-3}$). The advantage of this ‘net’ cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas

[15] Note the Defra Greenhouse Gas Policy Evaluation and Appraisal in Government Departments. April 2006, defines cost-effectiveness analysis = NPV costs less NPV benefits divided by carbon saved. In the Defra greenhouse gas programme, cost-effectiveness is similarly defined, as the resource costs, i.e. the costs to society and other ancillary benefits (for example air quality) are also added to the equation. However, the latter document also refers to this being the net cost per tonne saved. This definition of ‘net’ cost-effectiveness is used here, to refer to resource cost-effectiveness analysis.

emissions, in the cost-effectiveness ranking (outlined in earlier sections) and so provides a more holistic overall ranking method. An example is given in Box 10 below.

Box 10. Example of 'Net' Cost-Effectiveness Analysis

The equivalent annual costs of the options A and B were presented in Box 7. When just the cost effectiveness against NO_x improvements were considered, option B was found to be more cost-effective, as shown by the annual emission reduction divided by the equivalent annual cost:

- Option A = 10 tonnes NO_x/ £10,418 = £1,042 per tonne reduced.
- Option B = 14 tonnes NO_x/ £12,227 = £873 per tonne reduced

However, in a 'net' cost-effectiveness analysis, other environmental objectives are considered, using the information from the cost-benefit analysis (Box 9) for NO_x + PM_{10} benefits:

- Option A has a present value for NO_x + PM_{10} benefits of £118,750.
- Option B has a present value for NO_x + PM_{10} benefits of £107,208.

These values must be expressed in an equivalent annual value, to compare to costs. This uses the same equation as in Box 7.

- Option A has an equivalent annual NO_x + PM_{10} benefit of +£22,286.
- Option B has an equivalent annual NO_x + PM_{10} benefit of +£20,120.

A 'net' cost-effectiveness analysis is estimated by (annualised costs less annualised benefits) / reduction in tonnes pollutant – in this case towards a NO_x objective. This gives

- Option A = (£10,418 - +£22,286)/10 tonnes NO_x = -£1,187 per tonne reduced
- Option B = (12,227 - +£20,120)/14 tonnes NO_x = -£564 per tonne reduced

When these other environmental aspects are included, the 'net' cost-effectiveness changes the ranking, and option A is now most favourable. This highlights the importance of considering these other factors. If either option led to changes in greenhouse gases, these would also be considered by estimating the annualised values.

7.31. Note that other factors will be important in determining the overall ranking of measures, including the wider assessment (see 5As in 2.15) and other legal and technical issues, as well as acceptability. Examples of some of these issues are presented in the worked examples document accompanying this practice guidance case study guidance notes.

7.32. In practice there are additional complexities in cost-benefit analysis. Many of these relate to the more detailed issues with cost analysis highlighted in the earlier cost section. There will, however, be other aspects that need to be covered, especially in any more detailed analysis (beyond the scoping stage). Information on detailed cost-benefit analysis is available in the guidance available for major schemes as follows.

- If your options have identified the potential for a major transport scheme, or any scheme that involves transport demand changes, you should consult the DfT’s webTAG available at www.webtag.org.uk/), which follows a cost-benefit approach and provides detailed guidance. This should be seen as a requirement for all projects/studies that require government approval. For projects/studies that do not require government approval the transport analysis guidance should serve as a best practice guide. In many cases, guidance and practical experience of applying these transport appraisal techniques will be within Local Authority Transport Departments.
- If your options have identified a major non-transport scheme, that is likely to require significant public investment, then you should use the Treasury '5 Case Model' which has been in widespread use across the public sector for some years. It complies with both the Green Book guidance on assessment and the OGC Gateway process for project assurance. The Business Case keeps together and summarises the results of all the necessary research and analysis needed to support decision making in a transparent way. It breaks down the case into five different aspects: the strategic, economic, financial, commercial and management aspects (www.hm-treasury.gov.uk/media/C/B/greenbook_businesscase_shortguide.pdf)

Appendix 1: Glossary

AQMA	Air Quality Management Area
CAFE	Clean Air For Europe
CBA	Cost-benefit analysis
CCS	Congestion Charge Scheme
CEA	Cost-effectiveness analysis
CO_2	Carbon dioxide
COMEAP	Department of Health’s Committee on the Medical Effects of Air Pollutants
Defra	Department for Environment Food and Rural Affairs
DfT	Department for Transport
GIS	Geographical Information System
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	Interdepartmental group on costs and benefits
LAQM	Local air quality management
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
NATA	New Approach to Transport Appraisal
NO_x	Oxides of nitrogen or nitrogen oxides
NO_2	Nitrogen dioxide
PM_{10}	Particulate matter smaller than 10 microns
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SPC	Shadow Price for Carbon
VED	Vehicle Excise Duty
VOC	Volatile organic compounds
WebTAG	Web-based Transport Analysis Guidance

ANNEX F

Planning and Environmental Policy Group

Local Air Quality Management

Practice Guidance 2

Practice Guidance to Local Authorities on Low Emissions Zones

December 2009

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887
Website: www.doeni.gov.uk

Information about this publication and further copies are available from:

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887

Email: Stephen.kerr@doeni.gov.uk

This document is available on the Northern Ireland Air Quality website:

www.airqualityni.co.uk

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Executive summary

i. This guidance is principally for local authorities in England to have regard to, if relevant, in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995. This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by providing relevant policy and technical guidance on a specific transport measure – the **Low Emission Zone.** The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

ii. A Low Emission Zone is a geographically defined area where the most polluting of vehicles are restricted, deterred or discouraged from access and use. The aim is to reduce the number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria, with the aim of improving the air quality.

iii. Low Emission Zone schemes are operating in several cities such as London and cities in Sweden and Germany. The most significant existing scheme in the UK is the London Low Emission Zone scheme.

iv. The two main legal options for implementing Low Emission Zones in the UK are Traffic Regulation Orders under the Road Traffic Regulations Act 1984 (commonly introduced to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme) and Section 106 agreements as planning obligations for site usage (see guidance contained in Planning Policy Statement 23: Planning and Pollution Control (2004)).

v. Schemes should be developed via appraisal and the guidance provides information on assessing emissions, air quality and costs assessments. It also provides information on using these data in cost-effectiveness and cost-benefit analyses that are consistent with a generic guidance note on appraising the cost-effectiveness of local air quality action plan measures. Local authorities are strongly encouraged to refer to this guidance note too.

vi. Low Emission Zones tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Previous studies have demonstrated that the most common vehicles to target in a scheme with enforceable restrictions are diesel powered Heavy Duty Vehicles due to their cost-effectiveness relative to schemes that would restrict other vehicle types.

vii. Schemes should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Between now and 2010-2012 a Euro III standard should be considered as the minimum standard for Low Emission Zone schemes. From 2010-2012, higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local source apportionment and analysis should be used to determine which vehicles and which pollutants are the most relevant to target. This should be considered as part of the scheme design, to determine the cost-effectiveness of various options.

viii. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. A significant number of Low Emission Zones are now in place or under development in Europe. Examples of Low Emission Zones from mainland Europe include manual and low-tech enforcement methods as well as camera based systems. Given constraints on revenue budgets, a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

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Appendices

1 Introduction

1.1 Purpose of this Guidance Document

1.1. This guidance is principally for local authorities in England to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995.[1] This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance on a specific transport measure – **Low Emission Zone (LEZ).**

1.2. The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses. It also provides detail on existing or planned examples of these schemes.

1.2 Background to the Guidance

1.3. The guidance has been developed to be consistent with key government guidance on appraising new policy and road transport policies in particular.

1.4. The Government Green Book requires that there should be an economic assessment of the social costs and benefits of all new policies projects and programmes. Within the Green Book and related HM Treasury guidance on assessment of the Business Case (5 Case Model), policies are considered under five components and this guidance is consistent with the Green Book as follows.

- Applicability: LEZs potentially contribute towards strategic objectives in the areas of environment (air quality and climate change) and economy (reduce congestion if linked to a congestion charging scheme).
- Appropriateness: Guidance is given in this document to help develop policies for which costs and benefits are either balanced or overall beneficial in economic terms.
- Attractive: Guidance is given in this document to help authorities to prepare their commercial case for LEZ by considering scheme costs including those falling on vehicle operators.
- Affordable: Guidance is given in this document to help authorities to prepare budgets for LEZ scheme costs.
- Achievable: Guidance is given in this document on existing examples of LEZ schemes and key implementation issues including enforcement powers and other practical considerations.

1.5. As far as possible this guidance is also consistent with the government's New Approach to Transport Appraisal (NATA). In practical terms NATA guidance is delivered via the web-based Transport Analysis Guidance (webTAG). In

[1] Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance covers the whole of the UK.

particular this includes guidance on how to conduct a transport policy or scheme appraisal that meets the Department for Transport (DfT) guidelines. If as guidance changes inconsistencies arise primacy should be given to webTAG guidance except for the evaluation of air pollutants.

1.6. These sources of guidance have been consulted during the development of this guidance document so that a high degree of consistency with overarching governmental guidance on economic appraisal and road transport appraisal in particular have been achieved.

1.3 How should the guidance be used?

1.7. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMAs) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality.

1.8. Local authorities should have regard to this guidance in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are as follows.

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009 including:
  - Practice Guidance on the Economic Principles for the assessment of local measures to improve air quality,
  - Practice Guidance relating to measures to encourage the uptake of Low Emission Vehicles (LEV),
  - Practice Guidance relating to measures to encourage the uptake of retrofit abatement equipment in existing vehicles.

1.9. It is advised that local authorities give regard to all Practice Guidance documents on local air quality measures rather than just this one. Each one contains important information, some of the guidance overlaps between documents and local authorities are also strongly recommended to follow the general guidance on the economic principles of local air quality assessments regardless of the measure being considered.

1.10. It is highlighted that the specific measures in the guidance are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant Policy Guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries.

1.11. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk).

1.4 Definitions of Low Emission Zones

1.12. A LEZ is a geographically defined area where the most polluting of vehicles are restricted, deterred or discouraged from access and use. The aim is to reduce the use and number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria, with the aim of improving the air quality.

1.13. Low Emission Zones have been successfully implemented and run for a number of years in Sweden and the Greater Tokyo Area, and more recently in London and cities in the Netherlands. The impact can be similar to an acceleration of fleet turnover or the fitting of abatement devices, thereby reducing emissions sooner than would otherwise have happened.

1.14. This note will focus on enforceable restrictions of traffic and parking on the public highway and planning conditions to control vehicle use and parking at private development sites, as a basis for setting up a LEZ.

1.15. It should be noted that reducing the number of more polluting vehicles might be achieved by a range of other methods. For example, incentivisation mechanisms, partnerships or regulations that focus on specific sectors of road transport might be used to encourage lower emission vehicles or take-up of emission abatement technologies. Information about these potential approaches to reducing vehicle emissions can be found in the accompanying guidance notes. It would also be possible to combine different schemes as part of an overall emissions reduction strategy.

1.5 Economic rationale for Low Emission Zone Schemes

1.16. The economic rationale for schemes such as these is linked to the external costs of operating polluting vehicles. Those undertaking polluting activity are placing costs on society as a whole through adverse health impacts and damage to ecosystems and the wider environment. The separation of private transport benefits and public impacts means that individuals are likely to consume goods or services in a way that is not socially optimal, unless there is an intervention. To place a limit on this, in relation to air quality for example, there are specific concentration limit values that have been defined and implemented to prevent unacceptable societal damages. Schemes described in this guidance document seek to provide additional incentive in order to make progress towards the limit values by reducing the external costs of transport.

1.17. Low Emission Zone schemes in this guidance are focussed on encouraging the replacement or use of existing vehicles with ones with lower emissions[2]. The main impacts of such schemes are likely to be:

- reduced emissions and improved air quality, hence contributing to UK environmental, health and economic objectives;

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[2] Although LEZ could be defined for industrial or commercial zones such that emissions from stationary sources are regulated, this type of scheme is not addressed in this guidance.

- higher vehicle replacement costs but improved fuel efficiency in many cases.

1.18. The ex ante appraisal of a London LEZ scheme suggested that progress towards air quality objectives would be made cost-effectively. As a result three LEZ policy scenarios were studied during the revision of the UK Air Quality Strategy (Defra, 2007) to appraise the wider application of such schemes. One scenario assumed that LEZ schemes were implemented in seven large urban areas in the UK. The details of the scenario assumed the implementation of a minimum Euro III standard for PM_{10} introduced in 2010 in the central areas of Glasgow, Manchester, Liverpool, Sheffield, Newcastle, Birmingham, and Leeds.

1.19. Benefits were estimated for the period 2010-2017. Emissions saved in 2010 were estimated at 150 tonnes particulate matter (PM_{10}) and 461 tonnes nitrogen oxides (NO_x) diminishing to zero by 2017. This is calculated to produce modest health benefits with a present value of £5-7 million. The calculation did not take account of benefits that may accrue outside of the LEZ zones, i.e. from the activity that vehicles undertake outside of urban centres, which are assumed to be non-negligible. Scheme costs were estimated as a present value of £9 million and costs to operators at £10 million with high uncertainty attached to this estimate. It should be noted that the schemes were assumed to be enforced via fixed and mobile camera techniques. This guidance provides information on lower cost options for implementing LEZ schemes.

1.20. In the Air Quality Strategy analysis the costs outweigh the benefits. However, apart from the scheme cost issue addressed above the analysis only considered a ‘weak’ option for emission standard. A Euro III standard would produce more benefits, say, if it had been implemented in 2008 as in the London scheme. This is an important reason why the London scheme has been appraised as being cost-effective with benefits balancing costs. For schemes implemented from 2010 onwards, local authorities should be thinking of schemes in terms of higher Euro standards. The London scheme does precisely this in a second phase in order to achieve air quality benefits in future years. In such cases the benefits are more likely to match the costs.

2 Options for Low Emission Zone schemes

2.1. The purpose of this chapter is to provide practical guidance on available options for LEZ schemes. Options include the different legal bases under which local authorities are empowered to introduce schemes and the various aspects of scheme design such as boundaries, emissions criteria, management and enforcement. The chapter structures these options and the headings are introduced in the left hand column of the table below. The table also summarises key aspects associated with the headings and options whereas the relevant text following the table expands on this to provide more detail in each case.

Table 1: Structured options and key aspects for introducing Low Emission Zone schemes

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system
Legal basis	Traffic Regulation Order (TRO) under Road Traffic Regulations Act 1984 (RTRA 1984). Enables access by permitted vehicles, which can be based on environmental criteria.	Traffic Regulation Order under RTRA 1984. Enables differential charging, which can be based on environmental criteria.	S106 agreement. Enables obligations based on environmental objectives.
Scheme design			
Vehicle emission standards and type	Can be based on one or more of: • Euro standards; • Vehicle age; • Emission abatement retrofit technology; • Fuel type/engine technology; • Carbon dioxide (CO_2) rating; • Engine size. Vehicle classification should also be specified: • Type(s) of vehicle (for example bus, car, van); • Weight; • Other specifications (are ambulances or specialist vehicles included?)	As per vehicle restrictions. NB most common approach (in UK) is to base on CO_2 ratings/engine size. This would not improve air quality unless combined with a minimum Euro standard requirement.	As per vehicle restrictions.

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system
	Is the scheme to be targeted at specific users, or exclude particular users (emergency vehicles, those with a disability, etc.)?		
Management of permitted vehicles	Scheme rules must be accessible to all vehicle owners, including non-UK owners. Allowing/providing certification routes for compliance by retrofit can be useful.	UK schemes have tended to focus on residents parking or season ticket holders, which provides a management system to build upon.	See Government policy on planning obligations www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations
Enforcement powers and penalties	Outside London the relevant moving vehicle offences are currently enforceable by Police. Powers under Traffic Management Act 2004 (TMA 2004) may provide civil enforcement powers to local authorities. These are necessary to effectively enforce a scheme.	Traffic Management Act 2004 now provides for the civil enforcement of most types of parking contraventions. Local authority appointed Civil Enforcement Officers can issue Penalty Charge Notices (PCN) for parking contraventions.	Following a breach of planning control the Planning Authority (Local Authority or Council) has the option to take enforcement action. This may take the form of enforcement notices, (temporary) stop notices, Breach of Condition Notices, planning contravention notices, or High Court or county court injunctions.
Vehicle detection	Various methods, which can be combined in one scheme: • manual observation; • Automatic Number Plate Recognition (ANPR) cameras (fixed sites or mobile units); • Tag and beacon or swipe-card technology.[3]	Generally done by manual observation, although camera (CCTV) systems have been used.	In principal the same methods as for Traffic Restrictions would be available.

[3] It must be noted that any new on board equipment will need to be consistent with the European Electronic Tolling Service (EETS).

2.1 Scheme design

2.2. The starting point for the design of any LEZ scheme should be the scheme objectives, i.e. targeting pollutants emitted by specific vehicle type(s). Having established the objectives and indications of the potential location(s) for the zone, there are further design considerations local authorities need to take into account. Key issues in the design of a zone where LEV are prioritised over the most polluting vehicles are organised in this section under the headings of:

- legal basis;
- enforcement powers and penalties;
- vehicle emission standards and vehicle type;
- management of permitted vehicles;
- vehicle detection

2.3. Wherever possible, common guidance is given on traffic controls, parking controls and planning obligations. Where it is appropriate, separate guidance is provided.

2.1.1 Legal basis for implementation

2.4. Based on this guidance note’s scope of coverage the following section covers two main routes to setting up an area (or zone) with traffic or parking controls based on vehicle emission criteria:

- Traffic Regulation Orders for enforceable restrictions on the public highway; and
- Section 106 agreements as planning obligations for development sites and private land.

Traffic Regulation Orders - Traffic and parking orders

2.5. There are several types of enforceable restrictions that can be employed by highway authorities under current legislation. The general basis for these is the TRO. Traffic Regulation Orders are commonly introduced to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. For example, TRO can be used to restrict access to a given area or to certain types or weight of vehicle or during specific time periods. Traffic management schemes are typically focused on historic or busy commercial centres, where the effects of traffic on safety, noise and pollution levels can be quite dramatic, and also in sensitive residential neighbourhoods.

2.6. Highway authorities are empowered under the RTRA 1984 to make TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement. Traffic Regulation Orders are required for any enforceable restriction on the highway. They may be made under the terms of the RTRA 1984 or, for “special events”, the Town Police Clauses Act 1847. The RTRA 1984 specifies what restrictions a TRO may impose. The Local

Authorities Traffic Orders (Procedure) (England) Regulations 1996 lay down the legal requirements for making and implementing a TRO.

2.7. The main points relating to the making of Orders that may be used for enforceable restrictions are summarised as follows:

i The Highway Authority may restrict any/all classes of vehicle from using any road or from carrying out certain activities in any road either permanently or on certain days/dates /times, provided that it specifies a valid reason (as defined in the RTRA 1984) in the statement of reasons. They may do this by making restrictions, which prohibit, restrict or regulate the use of any road by vehicular traffic or specified classes of vehicle. Restrictions may require traffic to proceed in a certain direction, restrict waiting or loading or prohibit through traffic.

ii valid reasons for making an Order include:

a) for avoiding danger to persons or other traffic using the road or any other road or for preventing the likelihood of any such danger arising, or
b) for preventing damage to the road or to any building on or near to the road, or
c) for facilitating the passage on the road or any other road of any class of traffic (including pedestrians), or
d) for preventing the use of the road by vehicular traffic of a kind which, or its use by vehicular traffic in a manner which, is unsuitable having regard to the existing character of the road or adjoining property, or
e) (without prejudice to the generality of paragraph (d) above) for preserving the character of a road in a case where it is specially suitable for use by persons on horseback or on foot, or
f) for preserving or improving the amenities of the area through which the road runs, or
g) for any of the purposes specified in paragraphs (a) to (c) of subsection (1) of section 87 of the Environment Act 1995 (EA 1995).

2.8. As noted, under point g), the EA 1995 is relevant. This Act broadened the purposes for which a TRO might be made to include the pursuit of environmental objectives. The relevant parts from the EA 1995 are Section 36 of Schedule 22, which states that TRO can be used “with respect to the assessment or management of the quality of air”. This is relevant to a traffic or parking control scheme designed to maximise environmental benefits.

2.9. Orders can be made that apply to certain classes of vehicle, and to set up a permitting system to exempt certain vehicles from the controls. The criteria for a permission (or permit) is defined by the Authority making the TRO. Therefore, it can be based on an environmental/emission standard linked to local objectives and circumstances. This approach has been used in a priority access scheme in the city of Bath.

2.10. All local authorities need to develop a parking strategy covering on- and off-street parking. Many different types of on-street parking schemes can be created under the powers provided in Part IV of the RTRA 1984. Local authorities use TROs to put parking schemes in place and appropriate traffic signs and road markings so that the public know what the restrictions mean.

2.11. A highway authority has the power to set charges for parking permits pursuant to the RTRA 1984 (as amended) and in doing so may set differential charges for different types of vehicle. In exercising its duties under the 1984 Act, a highway authority is under a duty to secure the expeditious, convenient and safe movement of traffic (including pedestrians) and suitable and adequate parking on and off the road. In meeting these duties, the highway must have regard to;

- the effect on amenities of any locality;
- the strategy prepared under section.80 EA 1995.
- any other matters appearing to the local authority to be relevant.

2.12. These matters provide a legal basis for the differential charging based on CO_2 and other emissions.

2.13. The signing of a vehicle access control scheme should be one of the first elements to consider when designing a scheme, to ensure it can be legally signed. It is important that the design of all sign faces is considered when drawing up the TRO. All signs used for a scheme should be in accordance with the Traffic Signs Regulations and General Directions and used as described in the Traffic Signs Manual. Sometimes the objectives for vehicle access control schemes have led to designs for which no suitable sign is prescribed in Traffic Signs Regulations and General Directions. In such cases it is necessary to seek authorisation for a specific sign from the DfT, before any variation to the prescribed signing takes place. Considering all the available prescribed signing must be a first step.

2.14. Advertising the scheme orders is an essential part of the scheme set-up, and guidance is provided in the relevant regulations about this and the statutory consultees for any TRO. If a major LEZ is to be established then local authorities should seek their own legal advice on the matter of advertising the relevant emission standards to vehicle owners in other Members States. Some European cities have used their membership of the European LEZ Network (www.lowemissionzones.eu) to advertise their information on vehicle emission standards.

Planning conditions

2.15. Local planning authorities can impose conditions on planning permissions only where there is a clear land-use planning justification for doing so. Conditions should be used in a way which is clearly seen to be fair, reasonable and practicable. One key test of whether a particular condition is necessary is if planning permission would have to be refused if the condition were not imposed. Otherwise, such a condition would need special and precise justification. Unless otherwise specified, a planning permission runs with the land. Exceptionally, however, the personal circumstances of an occupier, personal hardship, or the difficulties of businesses which are of value to the welfare of the local community, may be material to the consideration of a planning application. In such circumstances, a permission may be made subject to a condition that it is personal to the applicant. Such arguments will seldom outweigh the more general planning considerations,

however. See The Planning System: General Principles
www.communities.gov.uk/publications/planningandbuilding/planningsystem.

It should be noted that planning conditions cannot be used to require financial contributions. See Circular 11/95: Use of conditions in planning permission
(www.communities.gov.uk/publications/planningandbuilding/circularuse).

2.16. Where it is not possible to include matters that are necessary for a development to proceed in a planning condition, developers may seek to negotiate a planning obligation under section 106 of the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). Planning obligations should meet the Secretary of State's policy tests set out in Circular 05/05
(www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations); i.e. they should be:

- necessary;
- relevant to planning;
- directly related to the proposed development;
- fairly and reasonably related in scale and kind to the proposed development; and
- reasonable in all other respects.

The use of planning obligations must be governed by the fundamental principle that planning permission may not be bought or sold. It is therefore not legitimate for unacceptable development to be permitted because of benefits or inducements offered by a developer which are not necessary to make the development acceptable in planning terms. Planning obligations are only a material consideration to be taken into account when deciding whether to grant planning permission, and it is for local planning authorities to decide what weight should be attached to a particular material consideration.

2.17. In terms of air quality, the impact of a development on air quality should be considered with regard to Planning Policy Statement 23 (often referred to as PPS23), particularly Annex 1
www.communities.gov.uk/publications/planningandbuilding/pps23annex1.

2.18. Both environmental impacts of a development and location of a development (whether it is close to a source of pollution or contributing further to an existing problem) can be taken into account as material planning considerations.

2.19. A useful document on the subject of low emission strategies - using the planning system to reduce transport emissions - has been produced by the Beacons Low Emission Strategies Group (2008). Broader guidance, aimed at ensuring that air quality is properly accounted for in local development control processes, has been produced by the NSCA (now Environmental Protection UK) as ‘Development Control: Planning for Air Quality’ (updated in 2006).

2.2 Enforcement powers and penalties

Traffic and parking orders

Parking enforcement

2.20. Local authorities have long been responsible for managing all on-street and some off-street parking, whether directly or indirectly. The powers to control waiting and loading and to provide and charge for on-street parking are provided by the RTRA 1984, with various amendments since such as by the Road Traffic Regulation (Parking) Act 1986, and most recently the TMA 2004.

2.21. The Road Traffic Act 1991 significantly changed the way that on-street parking restrictions are enforced. Before 1991, the police and traffic wardens were responsible for enforcement and income from fixed penalty notices (FPNs) went to the Exchequer. However, the police service found itself increasingly unable to resource parking enforcement. The 1991 Act made it mandatory for London boroughs and optional for other local authorities to take on the civil enforcement of non-endorsable parking contraventions. When a local authority takes over this power from the police, staff employed directly or indirectly by them issue Penalty Charge Notices (PCNs) and the local authority keeps the income for operation of the scheme.

2.22. Part 6 of the TMA 2004 now provides for the civil enforcement of most types of parking contraventions. It replaces Part II and Schedule 3 of the Road Traffic Act 1991 and some local legislation covering London only. The TMA 2004 and the associated regulations have given to English authorities outside London many powers already available to authorities in London, giving greater consistency across the country while allowing for parking policies to suit local circumstances.

2.23. It is assumed that most Authorities interested in using variable parking charges to incentivise lower emission vehicles will also be interested in taking up the powers available to them under the TMA 2004. Therefore, this guidance note is written with these latest regulations in mind and the environment of Civil Parking Enforcement that they provide.

Traffic enforcement

2.24. The TMA 2004 provides a single framework to make regulations for civil enforcement by local authorities or parking and waiting restrictions, bus lanes and some moving traffic offences. It is therefore a very important piece of legislation for local traffic authorities that wish to better manage their road networks and take on aspects of enforcement that may not be a priority for the Police.

2.25. Regulations under Schedule 7 to the TMA 2004 would allow local traffic authority-appointed Civil Enforcement Officers the powers to monitor and penalise a range of moving traffic offences such as stopping in boxed junctions and making banned turns. This would complement civil enforcement powers already available for parking management. Powers for moving vehicle enforcement may be extended in the future for authorities in

England with regulations provided by DfT. Updates are available via http://www.dft.gov.uk/pgr/roads/tpm/tmaportal/.

2.26. Extending civil enforcements powers would enable Highway Authorities outside London to use camera evidence of traffic contraventions. This would provide such authorities parity with those in London where legislation has enabled the adoption of civil enforcement of moving vehicle contraventions.

2.27. If powers are extended by the Schedule 7 regulations then road traffic signs described by the TMA 2004 for civil enforcement might be used to sign an LEZ. For example 'motor vehicles prohibited' (sign 619) can include the supplementary text 'except for permitted vehicles'. This appears sufficient to sign an access control scheme such as a LEZ, but authorities should seek their own legal advice. This could be more effective if special authorisation was given to add the term 'LEZ' before 'permitted vehicles', or add supplementary plates for which a Highway Authority could apply to DfT.

2.28. Civil penalties for moving vehicle contraventions (under TMA 2004) may be the same as currently applied to bus lane, parking and other similar moving traffic offences. Parking penalty charges are set at different bands and levels, up to £70 outside London, with discount or further charge depending when paid. It would be appropriate for a Highway Authority to consider the level of penalty charge required for effective enforcement. A supplementary local authority circular or relevant guidance is a mechanism that would enable a variation of the PCN charge in certain circumstances.

Planning obligations

2.29. Section 106 of the Town and Country Planning Act 1990 introduced the concept of planning obligations, which comprises both planning agreements and unilateral undertakings. It enables a planning obligation to be entered into by means of a unilateral undertaking by a developer as well as by agreement between a developer and a local planning authority.

2.30. Section 106(1) provides that anyone with an interest in land may enter into a planning obligation enforceable by the local planning authority. Such obligations may restrict development or use of land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically.

2.31. Section 106(5) provides for restrictions or requirements imposed under a planning obligation to be enforced by injunction.

2.32. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides current policy on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).

2.33. In the case of the Greenwich Peninsula and Royal Arsenal developments, the obligation to develop the LEZ scheme in more detail falls on the developer, and the obligation to comply is borne by the developer and the future occupiers.

2.3 Vehicle emission standards and vehicle type

2.34. The approach for defining vehicle standards and vehicle type on which to base enforceable restrictions (on the public highway or at development sites) could be determined in one or a combination of ways.

2.35. The following criteria are relevant to schemes which target toxic pollutants:

- Euro standards (the term for European type approval standards on the emission performance of new vehicles over a defined test cycle);
- age of vehicle/ Year of first registration (because older vehicles tend to be more polluting, largely because Euro standards have progressively raised performance in this area);
- a particular fuel/technology combination (if they are considered to have particular benefits, such as hybrid, gaseous or renewable fuels);
- a retrofit technology (which can be used on older vehicles to clean up exhaust emissions, generally PM or NO_x);
- vehicle type (cars, vans, heavy goods vehicles (HGVs), emergency vehicles etc.) that is to be included or excluded.

2.36. For schemes in which the CO_2 reduction is an objective then the following criteria are a relevant basis for defining permitted vehicles:

- engine size (as a crude proxy for fuel consumption, and hence CO_2 output); and/or
- CO_2 output.

2.37. While the choice between these options in relation to LEZs is a choice for local authorities, Defra and DfT are currently considering how to approach vehicle classification to ensure that there is a level of consistency between schemes. This work will also be relevant for those Authorities considering LEZ schemes as to increase efficiency across scheme types through added consistency.

2.38. Authorities should be aware that setting a carbon reduction objective only may be counter-productive in air quality terms since it may lead to increased uptake of diesel-engined vehicles (being in general more fuel efficient). Authorities should therefore consider whether a Euro-standard objective should be set at the same time.

2.39. Existing LEZ that target toxic pollutants most commonly use Euro standards as the basis for setting emission. In a great number of cases there exist supplementary criteria to allow some exemption (or time-extensions) for retrofitting emission abatement technology. Age as a proxy for Euro standard is also a common accompanying basis.

2.40. For UK based parking schemes CO_2 emissions are the most common focus, and some mainland European schemes include discounts for alternative fuels, and Austria (Graz) for a combination of low CO_2 and high Euro standard (for toxic pollutants).

2.41. Whatever the criteria used, it is essential is that they are open to and operable by any normal user. This would rule out region or country specific standards that might not be available to vehicle owners across Europe.

2.42. Euro standards describe the emissions criteria that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU. Euro I vehicles began to be produced for a EC-specific type approval standard that came into force in 1993, with pre-Euro vehicles generally being those registered before this date.

2.43. The dates at which these standards came into force for various vehicle types are shown in Table 2.

2.44. It should be noted that there can be a time lag between when a vehicle is manufactured (to a particular Euro standard) in order to be Type Approved and when the vehicle is finally sold to the initial purchaser as new, and registered (with DVLA). However, it is also the case that some manufacturers can produce vehicles to a specification that will meet the next Euro standard (on emissions) before the mandatory deadline, so it is possible to purchase buses that considerably exceed Euro 4 standards before the standards for Euro 5 are fully in place.

Table 2: Introduction dates for European emission standards

Vehicle class	Euro 1/I	Euro 2/II	Euro 3 /III	Euro 4/IV	Euro 5/V	Euro 6/VI
Passenger cars (for example private hire taxi)	31/12/92 – 01/01/97	01/01/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class I – up to 1.3 tonnes unladen weight	01/10/94 – 01/10/97	01/10/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class II/III between 1.3 tonnes unladen and 3.5 tonnes maximum laden weight	01/10/94 – 01/10/97	01/10/98 – 01/01/02	01/01/02 – 01/01/07	01/01/07 - 01/01/12	01/01/12 - 01/09/16	01/09/16 -
Heavy duty - over 3.5 tonnes maximum laden weight (inc. N2 & N3 and PSV M2 & M3)	10/10/93 –01/10/96	01/10/96 – 01/10/01	01/10/01 – 01/10/06	01/10/06 - 01/10/09	01/10/09 -	01/01/14

2.45. The benefits of using Euro standards for a scheme design are that they describe the emission performance in a well defined way, based on an approved testing procedure that defines the manufacturing process. It is a criteria against which any vehicle in Europe can be judged, therefore it is interoperable across countries. One drawback is that information about an individual vehicle's Euro standard is not always easy to access by its owner or the scheme operator, particularly for older vehicles.

2.46. The benefits of using age-based standards are simplicity and smooth progression (on an annual basis) of vehicles that will not comply with the scheme rules. The latter may be advantageous for forward investment and planning. The drawback is a potentially arbitrary cut-off point for vehicle moving from compliant to non-compliant status. A vehicle could be the wrong side of the age-criteria but have been manufactured to the same Euro standard as a slightly younger vehicle.

2.47. In practice, if a Euro standard basis is chosen for the scheme, it is useful to provide for some age-based proxies for vehicles when necessary in order to simplify the registration/certification process for vehicles where Euro standard information is hard to find. The experience from London LEZ is that information on Euro standards is not always readily available. Therefore, while the London LEZ expresses its emission criteria in terms of emissions standard in many cases vehicles are assessed using an age-as-proxy-for Euro standard. For any large-scale LEZ it is suggested that similar systems would be applicable in England, based on lessons learned and processes developed by Government agencies from the London implementation.

2.48. The benefit of retrofit technologies is that they can provide a 'safety net' for those vehicle owners who do not want, or cannot afford, to buy a newer vehicle to comply with a scheme. Emission abatement technology can be retrofitted to a vehicle to make it meet more stringent emissions limits than those to which it was originally type approved. For vehicles with long lifetimes and high usage, such as buses, this can be more cost-effective than replacing the vehicle.

2.49. The drawback, from a scheme design and administration viewpoint, is that while PM abatement technology can be approved in the UK (via the VOSA Reduced Pollution Certificate (RPC) process) the only equivalent scheme for NO_x reduction equipment is Transport for London's (TfL) London Taxi Emissions Abatement scheme, the scope of which is limited to black cabs. While NO_x abatement equipment is available for retrofitting the lack of an approval and certification route makes it more difficult to design a UK scheme which has the option of NO_x abatement to reach a required emission standard, compared to PM abatement via the VOSA RPC scheme. Further discussion of retrofitting can be found in the Practice Guidance on measures to encourage the uptake of retrofitting abatement equipment on vehicles.

2.50. The level of a vehicle's local pollutant emissions are primarily influenced by the vehicle technology rather than the properties of the fuel. Alternative fuels do not necessarily offer air quality benefits. However, gaseous fuels generally emit less CO_2 than petrol and biofuels can offer lifecycle CO_2 emissions reductions. As a result there may be local and specific arguments for including alternative fuels and technologies in the list of compliant vehicles, perhaps if carbon reduction is a stated focus of the scheme.

2.51. For CO_2 focussed schemes the most common criteria are engine size and CO_2 emissions, and can be found from vehicle registration records for passenger car models from the VCA website (http://www.vcacarfueldata.org.uk/index.asp). Carbon dioxide figures for specific vehicles from registration records is available from the Direct Gov website at www.taxdisc.direct.gov.uk/EvlPortalApp/index.jsp. From 1 March 2001, practically all new car registrations have a published CO_2 emission level in g/km recorded on the registration documents and DVLA database. Therefore all carbon-focussed scheme, even one that only includes passenger cars, will need to include two methods for participation to ensure the scheme is open and fair.

2.52. It should be noted that there is no reliable approach for basing a scheme on emissions performance ‘in service’ (for example via the annual testing regime) since annual emissions testing merely checks for major faults on vehicles and is not capable of distinguishing between correctly functioning vehicles of different emissions performance. However, this has not proved a barrier to the introduction of a LEZ in the UK (London) or other European countries, as they use age and/or Euro standards as a basis.

2.3.1 Management of permitted vehicles

2.53. The scheme operator maintains the definition of what is a permitted vehicle. Processes are required to verify the emission standard of a particular vehicle. Certification processes may be necessary, or useful to include in a scheme if they already exist, if there is likely to be a lack of information about potential users of the scheme or if the scheme design means retrofit emission abatement equipment is allowed.

2.54. Management of the permission to enter the zone requires information and identification of individual vehicles with administration systems to cross-check permissions. In a large scheme covering a number of types of vehicle this would probably require the creation of a database with links to the DVLA, as for the London LEZ.

2.55. If a scheme is small-scale, affecting relatively few vehicles or one focussed on local fleets, then a basic permit management and verification system might be sufficient. Access control schemes in Cambridge and Bath are examples of where transponders are provided to a relatively small number of exempted vehicles (taxis and buses).

2.56. Carbon dioxide based UK parking schemes are based on resident parking permits or season ticket holders, which provides an administrative basis for managing new users. Schemes such as Winchester discount on parking for A and B-band CO_2 rated cars was limited at launch to Season ticket holders at long stay car parks. At the end of the trial period, the concept was extended to residents parking schemes in and around the city centre. The discounts are not available for short-stay Pay and Display, Park and Ride, Pay on Foot or Pay on Exit car parks. Including these types of parking within a scheme would involve more complex management systems, and therefore higher running costs.

2.57. Management of permitted vehicles in a scheme focussed on a development site should be more straightforward compared to the public highway. Through-traffic is not normal and all vehicles are destined for privately controlled parking. The costs of administering any scheme would be expected to be borne by the developer, or ongoing management company set up by the developer or development occupiers.

2.58. Once a vehicle owner has checked with the scheme rules whether their vehicle complies or not they must be able to prove the status of their vehicle against the scheme rules. The vehicle registration mark (VRM) shown on the number plate can be used if this information is linked with the data used to verify the emissions criteria. Alternatively, or as a supplement, a specific sticker or plate may be issued by the scheme operator following verification of a qualifying emission standard.

2.4 Vehicle detection

2.59. This section identifies the likely approaches for detecting vehicles and determining which do not comply with the criteria set for a traffic, parking or development control scheme aimed at reducing vehicle emissions. This section assumes powers under the TMA 2004 for civil enforcement of both parking and moving vehicle contraventions on the public highway are available and have been taken up. It does not aim to repeat operational guidance available on specific matters of parking enforcement.

2.60. Identification of a vehicle that complies with scheme criteria could be via a paper permit, windscreen sticker, by the VRM on the number plate. A scheme design could instead require the vehicle to self-identify itself, by use of a transponder or a proximity smart card.

2.61. Detection of a vehicle for subsequent identification of emission status could be carried out by a variety of methods, sometimes in combination.

- Manual methods, whereby enforcement personnel visually check vehicles travelling within or parked within the scheme area for identification marks (VRM and/or a permit/sticker). In the mainland Europe examples of LEZ the checks would tend to focus on older looking vehicles and might use a mixture of manual recording and possibly photography. Some post-checking against a database of compliant vehicles would then be necessary.
- Digital cameras and ANPR – all passing number plates are recorded and using Optical Character Recognition (OCR) for matching against a database of vehicle data. A network of cameras would be installed on the key routes into/out of the boundary of the scheme and possibly at key junctions within the zone if it is very large. As a supplementary, or alternative approach, mobile ANPR cameras could be used to monitor key junctions and/or ‘hot-spots’ of possible non-compliance.
- Dedicated Short Range Communication (DSRC) – tags and beacons, more suitable for schemes with relatively few and pre-determined users

which comply with the scheme criteria. Tags or proximity smartcards are commonly issued to vehicle owners for accessing private car parks, or can be scanned through a wind-screen, and can also be used to trigger bollards which control access on the public highway.

2.62. The benefits of manual detection methods are lower capital costs, and some flexibility over future operating costs if enforcement levels can be reduced. Manual enforcement is suitable for parking schemes, whether on-street parking on development sites. A drawback of manual enforcement is the limit on the number and speed of vehicles that can be checked by a person. However, existing schemes show this approach should not be ruled out.

2.63. The London Lorry Control Scheme (commonly referred to as 'The London Lorry Ban') is an example of a successful manually enforced scheme. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month. Officers position themselves at junctions known to be attractive, but controlled, routes for HGV. In addition, they will respond to complaints from residents of vehicles 'off-route'. The main objective is deterrence and to assist HGV drivers with better route planning in order to raise compliance rates. This scheme, and those LEZ enforced manually in other European countries, indicate that manual detection could be a basis for enforcement. Detection of Heavy Duty Vehicles (HDVs) is likely to be more successful than Light Duty Vehicles (LDVs), as HDVs are larger and less numerous.

2.64. The TMA 2004 regulations currently give the power to authorities throughout England to issue PCNs for parking contraventions detected with a camera and associated recording equipment (approved device). Regulations from the Act may also be prepared for moving vehicle contraventions. Cameras can only be used by Highway Authorities in a civil enforcement environment. There is current experience of using camera enforcement within London for moving traffic enforcement, and outside London for bus lane enforcement. The Secretary of State must certify any type of device used solely to detect contraventions and once certified they may be called an 'approved device'.

2.65. The benefits of such automated enforcement systems are that high speed and volume flows of vehicles can be detected and recorded, and that every vehicle can be checked. Drawbacks can include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs.

2.66. Automatic Number Plate Recognition cameras can provide one part of such an automated system. They are able to capture 90%+ of passing number plates. Automatic Number Plate Recognition cameras are used in the London Congestion Charge Scheme (CCS) and for the London LEZ. In the London CCS, images are kept for checking of vehicles whose details are not in a database of vehicles for which a charge has been paid (or registered as exempt). In order to cover 'hotspots' of non-permitted vehicles within the LEZ, mobile (van-based) enforcement units could be suitable.

2.67. There will be additional options for identification and detection of vehicles entering development sites, depending on the layout and approach for managing traffic and parking. Development sites generally have a limited number of entry and exit points, and are able to use manual or automatic barriers at these and at entrances to car parks. The road network tends to discourage through-movement, and access by non-residents or visitors. These factors enable greater opportunity for checks on vehicles. Parking permit and management systems provide opportunities for further identification and detection, to verify against a permitted vehicle database.

2.68. It should be noted that it is not strictly necessary to achieve a 100% detection level for a scheme to be effective. The level of compliance, and impact non-compliance has on emission impacts, will impact on the value for money of any scheme. However, the aim should be to achieve a balance with sufficient enforcement to provide an effective deterrent, in order to achieve the scheme objectives.

3 Developing a Low Emission Zone

3.1. Schemes may be designed using the options introduced in the previous chapter. Local authorities will need to appraise these options to make decisions on the most appropriate and cost-effective for a scheme in their area. This chapter provides guidance on the most important aspects of appraisal in particular regarding appraising the cost-effectiveness and benefits of schemes in terms of air quality objectives.

3.2. The chapter is structured as follows.

- The overall or generic effects of schemes are defined.
- A staged approach to appraising emissions and air quality effects of scheme designs is introduced. Staging the appraisal may allow a number of designs to be scoped out of the appraisal at an early stage on grounds of negligible benefits.
- The important types of capital and operating costs are introduced to allow a realistic appraisal of scheme design costs and costs to operators to be drawn up during appraisal.
- Guidance on using emissions and costs data to complete cost-effectiveness and cost-benefit appraisals is then provided.

3.1 Generic Effects

3.3. It is likely that LEZ schemes will have significant impacts on environmental objectives. Indeed improving the environment is a key objective of such schemes. The nature of the impacts will be scheme specific and depend on the scheme location and the scheme's impact on traffic levels by location, time of day and the composition of traffic. The environmental impacts of a scheme will also depend on the extent to which the LEZ is combined with other measures.

3.4. Table 3 describes qualitatively the potential impacts of these schemes.

Table 3: Qualitative assessment of the potential impacts of a Low Emission Zone scheme

Impact	**Qualitative assessment**	**Notes/assumptions**
Inside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	True for Euro-standard based schemes. Schemes may address NOx and PM_{10} either individually or not.
CO_2 emissions	✓	Assuming Vehicle Excise Duty (VED)-based schemes
	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	✓	Newer vehicles are typically quieter
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Regulatory costs	X	Wide range of potential costs. Could be partly offset by revenue raised by the scheme
Operator costs	X	Additional operating costs or vehicle replacement costs before end of commercially useful life.
Outside scheme zone		
Pollutant emissions (NO_x, PM_{10})	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
CO_2 emissions	-	
	-	Assuming a Euro-standard based scheme
Noise	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Regulatory costs	-	Potentially no regulatory costs outside of zone
Operator costs	-	Potentially neutral operator costs if travel time impacts are neutral

Notes:
1. Qualitative assessment: ✓ symbolises a beneficial impact, x symbolises a negative impact, - symbolises a neutral impact.
2. Low Emission Zone schemes may have potentially significant non-air quality impacts. Therefore local authorities are advised to have regard to the generic guidance on the economic principles that apply when assessing these schemes. This guidance provides more detail on actions to take to assess significant non-air quality impacts.

3.2 Emissions/Air Quality Impact Assessment

3.5. Local authorities are advised to proceed through a staged process to assess the potential emissions and air quality impacts. These stages are:

- a screening stage (to identify the potential of such schemes);
- intermediate stage (consistent with LAQM methods and duties such as action planning and progress reporting);
- detailed stage (using the webTAG from DfT on appraising road transport schemes).

3.2.1 Screening assessment

3.6. The purpose of a screening assessment is to quickly assess the potential benefits of a scheme. It is intended to be simple and to use a minimum of information that is available.

3.7. At a basic level LEZ schemes are intended to reduce the use of more polluting vehicles with ones with more stringent emissions standards, for example, a shift from Euro II or older vehicles to Euro IV vehicles. In these basic terms the potential benefit from a LEZ scheme is therefore associated with the reduction in unit emissions (or emission factors).

3.8. A broad assessment could proceed as follows:

1. Define a zone inside which a LEZ scheme might operate and identify those vehicle types that the scheme would seek to regulate.
2. Assemble from transport models or otherwise estimate the annual activity (veh km) of those vehicle types within the zone. One way of estimating activity is to multiply traffic volumes by link length and then to sum over all links in the zone.
3. Define a year in which the scheme may start.
4. Use the emissions factor toolkit for vehicle emissions (http://www.airquality.co.uk/archive/laqm/tools.php?tool=emission) to obtain the year and vehicle type specific emission factors for NO_x and PM_{10} (g/veh km).
5. Multiply activity by emission factor to estimate the basecase emissions.

3.9. The effect of scheme depends on the emission standard set. For example, the London LEZ scheme requires HDVs to achieve at least a Euro III standard for PM_{10} by 7 July 2008.

1. The effect is to change the weighted emission factors for HDV types (see worked example in later section).
2. Recalculate the product of the activity and the emission factors to estimate the annual emissions with the scheme in operation.
3. The difference from the basecase is the potential emissions benefit of the scheme.
4. In combination with screening assessments of other schemes the relative attractiveness of each scheme in emissions terms can be compared.

3.10. Note that this simple approach to assessing LEZ schemes does not address potentially important effects such as the re-distribution of traffic and the contribution to emissions from congested conditions. Intermediate or detailed assessments are advised to address these issues more fully.

3.2.2 Intermediate assessment guidance

3.11. For an intermediate assessment Local authorities are advised to have regard to the related guidance documents on generic economic principles for assessment local air quality schemes provided alongside this guidance. This guidance document provides background information on emissions and air quality impact assessments. In particular it sets out recommendations on:

- developing a detailed baseline emission inventory;
- potential sources of data for the inventory;
- available tools for estimating the emission impacts of transport measures;
- having regard to the technical guidance on further assessment of local air quality for assessing compliance against the air quality objectives.

Specific guidance on assessing Low Emission Zone schemes

3.12. These schemes aim to change the emission factors of vehicles that circulate in a zone. Therefore the emissions and air quality assessments should be designed to include the following parameters or indicators:

- annual average daily road transport activity (veh.km) disaggregated by vehicle type and road links;
- implementation year (so that future underlying changes in emission factors are accounted for);
- fleet inventories (number of vehicles, their breakdown by euro standard and retrofit abatement equipment if relevant) for vehicle types affected by the measure.

3.13. During the design phase of a LEZ scheme local authorities should assess the effect (or range of effects) of the scheme on these indicators. In particular the effects of requiring a minimum Euro standard by an implementation date for specific vehicle types will be the key impact. Applying these changes to the baseline emission inventory and air quality dispersion model will estimate the potential emissions and air quality benefits of the measure.

3.2.3 Detailed assessment guidance

3.14. If assessment of the scheme proceeds to the need for a formal road scheme appraisal consistent with the NATA then local authorities should have full regard for the detailed guidance on completing these appraisals.

3.15. The full Transport Analysis Guidance can be found online at http://www.webtag.org.uk/. Unit 3.3.3 contains the specific guidance on local air quality assessment.

3.3 Cost Assessment

3.16. For any scheme, in order to demonstrate value for money local authorities will need to analyse both set up costs and operational costs.

3.17. Traffic enforcement, parking enforcement and development control schemes will all deal with users (customers) and collect and store information about specific vehicles. Traffic and parking schemes will certainly involve some administration of financial matters, be it via a charge for permits and/or income from penalties.

3.18. The back office operation that underpins the operation of the scheme should be based on a sound business model. The choice and design of business model will be a key determinant in whole-life costs of a scheme. There is a strong argument to determine the business model immediately after choosing the scheme format, in order to understand the basis on which the various sub-systems that will deliver a working scheme will operate and be linked. Consideration also needs to be given to the procurement strategy.

3.19. The objective of the procurement process is to ensure that competition is used to obtain the lowest whole life costing while providing the most robust and technically proven. Some of the lessons from commercial sector organisations are that developing an effective procurement strategy at the outset is essential to getting value for money.

3.20. If a scheme uses any hardware or software components it is valuable to specify industry standards (not just sector or function specific) packages rather than bespoke software solutions. This will provide benefit by ensuring that ongoing support and maintenance as well as future upgrades can be carried out at a competitive rate.

3.21. A scheme may incorporate more than one solution in order to meet the needs and constraints of different users. Indeed, it is desirable that all but the smallest schemes do incorporate more than one solution in order to maximise cost-effectiveness and meet a range of user needs. An example would be a CO_2-based resident parking schemes where vehicles registered prior to 2001 have permits allocated against their engine size, because CO_2 emission ratings are not readily available.

3.22. If schemes are required to be interoperable, then this will need building into the design phase and both set-up and operational aspects could involve some aspect of additional cost.

3.23. Additional factors that will affect a consideration of cost and timescale for setting up and operating a traffic enforcement schemes are bound up in the scheme characteristics. This includes the basis of scheme (numbers and sub-types of vehicles that are to be included within the scope), the physical size of the scheme and the level of technology used for detection and enforcement. Together these factors contribute much to the level of complexity of a scheme design.

3.24. The greater the number of vehicle types within the scope of the scheme the greater the overall number of vehicles, and therefore costs. In broad terms, the size of the UK fleet rises in number from Bus/coach, HGV, Light Goods Vehicles (LGV) (vans) to passenger cars. Therefore, a scheme which includes only HDV will tend to cost the scheme operator less than one which only includes passenger cars, all other things being equal. This does not yet take into account operator costs.

3.25. A physically larger scheme will tend to cost more to set up and operate, if all other factors remain equal. Hence, a single strategic access point that effectively controls most of the cross-city traffic in a historic urban area could be very effective, but will not be an option for a modern city centre with urban dual carriageway through-routes. The size of a scheme design will be individual to the location and opportunities of the road network, as well as the extent of air quality problems.

3.26. A major factor is the level of technology used. Schemes that use technology in the vehicle identification, detect or enforcement functions (tags, smart cards or ANPR) will tend to have greater set-up costs than paper or sticker-based schemes, and operating design should be considered in the cost-benefit/effectiveness assessment. Considerable attention should be paid to what are the predicted minimum and maximum compliance rates. Compliance rates will markedly change the overall cost-effectiveness of different scheme options. However, if a windscreen sticker-based system works effectively in the UK context, it will tend to be more cost-effective than one closely monitored by camera systems.

3.27. With powers that may be available under the TMA 2004 PCN can be applied by local authority Civil Enforcement Officers. Penalty Charge Notice revenues may be retained and used to support the operation of a scheme. If a traffic enforcement scheme is running effectively the levels of PCN revenue should be low. However, scheme running costs will still continue, albeit ideally at lower levels. This means there are strong arguments for designing low-cost traffic enforcement schemes, particularly for the operation phase.

3.28. For parking schemes, then the revenue earned is dependant on the amount and demand for parking places. Authorities should never use parking charges just to raise revenue or as a local tax. However, where the demand for parking is high, the delivery of transport objectives with realistic demand management prices for parking may result in surplus income. In such cases local authorities must ensure that any on-street revenue not used for enforcement is used for legitimate purposes only and that its main use is to improve, by whatever means, transport provision in the area so that road users benefit. Carbon dioxide related parking schemes have generally been designed so that overall the scheme costs remain in line with the situation prior to the scheme, even if charges may now fall differentially across the users.

3.29. The costs of setting up and operating a scheme based on planning conditions would be expected to be borne by the developer. There would, however, be time and effort required from the Planning Authority in agreeing the scheme rules. A development based scheme aimed at reducing emissions from traffic should take into account the types of costs and design impacts noted in this guidance.

3.30. Considering the various cost elements that might be relevant to a scheme, we can divide these into capital costs (i.e. set-up or investment costs) and operating costs. A list of generic cost categories is set out in Table 4 below.

Table 4: Cost items for Low Emission Zone scheme set-up and operation

Capital costs	Operating costs

• Scheme design and planning
• Legal support
• TRO review and update
• Consultation process
• Marketing and information campaign
• Traffic management / safety
• Roadside equipment (signing, detection, enforcement)
• Central administration and IT systems (back-office functions: vehicle record, certification, enquiry handling)
  o project management
  o systems design and configuration control
  o systems integration and implementation
  o systems testing and acceptance
	• Accommodation
	• Staff costs
	• Training
	• Registration and validation of vehicles
	• Any new vehicle identification method (for example windscreen stickers) and the issuing process for this
	• Equipment / software replacement and maintenance costs
	• Vehicle immobilisation and removals
	• PCN processing
	• Adjudication and appeal costs
	• Supplies, services and transport
	  o contingency plans for business continuity and disaster recovery;
	  o data retention and archiving;
	• Monitoring and evaluating the scheme impacts
	• Certification of retrofit devices, suppliers and vehicles fitted with retrofit devices

3.4 Cost-effectiveness and Cost-benefit Assessment

3.31. Cost-effectiveness analysis and Cost-Benefit Analysis are both methods for economic appraisal. Practice Guidance on Economic Principles provides more detailed information on these techniques and how to use them. This section summarises the key points.

3.32. Cost-effectiveness compares different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. However, such a cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently.

3.33. Cost-benefit analysis assesses whether the total benefits of a project or policy exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence. The results of a cost-benefit analysis can then be used to update the cost-effectiveness analysis to consider all environmental goals, by working with 'net' cost-effectiveness, where the capital and scheme costs are expressed net of all environmental costs or benefits, before the cost-effectiveness ranking.

3.34. Note that these two techniques can be complementary. Cost-effectiveness is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals.

3.35. In order to undertake either cost-effectiveness analysis or cost-benefit analysis, it is necessary to collate and assess information on costs for use in an economic framework. It is highlighted that practitioners often confuse financial and economic appraisal. An economic appraisal considers the costs in terms of society as a whole and the overall value for money. A financial appraisal looks at the affordability of a proposal, and is more likely to be more familiar as it will be similar to local budgetary framework, financial costs and accounts (an accountancy based perspective). For any scheme, both the economic and financial case for a proposal will be important, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable. However, for cost-effectiveness analysis and cost-benefit analysis, the economic assessment should be used. The Practice Guidance on Economic Principles provides more details.

3.36. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. The Practice Guidance on Economic Principles provides details of how to analyse cost information so it can be used in cost-effectiveness and cost-benefit analysis. This is likely to require some analysis of cost data (including future costs). It is also necessary to work within an economic framework in the assessment of costs, which requires analysis of all costs (not just those that occur to the local authority in the local authority area), and has to exclude all transfers, such as VAT, taxes or charges. The Practice Guidance on Economic Principles provides more details.

3.37. To undertake a scoping cost-effectiveness analysis, the annual emissions benefits of a measure, as estimated using the approach set out in the previous section, are combined with the cost data, where costs are expressed as an equivalent annual costs. The annual emission benefits are divided by the equivalent annual cost to give the cost (£) to reduce one tonne of emissions (cost per tonne). This gives the cost-effectiveness of a measure – and this allows different options to be compared – those with the lowest cost per tonne abated (the lower cost per tonne) are the most cost-effective.

Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately, it is the cost per level of air quality improvement (μg m^{-3}). However, such an analysis only considers one environmental goal, and it is also necessary to consider other environmental objectives in a 'net' cost-effectiveness analysis to correctly prioritise measures (see below).

3.38. It is also possible to use the cost-effectiveness ranking to build up an action plan towards the reduction of an exceedence. Those measures that are most cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance. Note, however, that cost-effectiveness works only with a single pollutant. To address this, it is possible to work with the 'net cost-effectiveness' to consider other environmental objectives. Moreover, the cost-effectiveness of a measure is only one element of the options, and other factors will be important in determining the overall ranking of measures, including the wider assessment, legal and technical issues, practicality and acceptability.

3.39. To undertake a cost-benefit analysis, the same information on emissions and costs is used, though there are important differences. First, the emissions benefits are expressed in monetary terms. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at (http://www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants, such as NO_x and PM_{10}) are estimated, along with the monetary values for other environmental effects such as greenhouse gas emissions, using the Government damage cost (the Shadow Price for Carbon, SPC). This is used to generate the total present value of benefits, which can be compared against the total present value of costs of the options (note cost-benefit analysis works with the total stream of costs, i.e. the present value, not the annualised costs used in cost-effectiveness analysis above).

3.40. The cost-benefit analysis simply compares the present value of the stream of benefits divided by the present value of the stream of costs, to generate a net present value (NPV). The NPV is the primary criterion for deciding whether government action can be justified, i.e. whether a scheme has a positive net present value. A higher NPV indicates an option is preferable. However, other factors will be important in determining the overall ranking of measures, including any other benefits or costs, legal and technical issues, practicality and acceptability.

3.41. The cost-benefit analysis results can be used to provide a 'net' cost-effectiveness analysis. The 'net' cost effectiveness is equal to the present value of costs less present value of benefits / by reduction in tonnes pollutant, or in the above case where the cost-effectiveness analysis is concerned with air quality targets in a given year, is equal to annualised costs less annualised benefits / by reduction in tonnes pollutant (or µg m^{-3}). The advantage of this ‘net’ cost-effectiveness assessment is it allows consideration of other environmental objectives, i.e. reductions of other air quality pollutants or changes in greenhouse gas emissions, and so provides a more holistic overall ranking method for planning.

3.42. Previous studies have looked at the cost-effectiveness and cost-benefit analysis of retrofit schemes. These include for example, the Interdepartmental Group on Costs and Benefits (IGCB) Economic Analysis to Inform the Review of the Air Quality Strategy (http://www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm), the London LEZ (http://www.tfl.gov.uk/roadusers/lez/default.aspx). A worked example is included in the following section.

4 Worked example

4.1 Introduction

4.1. To illustrate how the guidance in chapter 3 may work in practice the following worked example provides guidance on assessing emissions effects, costs and cost-effectiveness and cost benefit assessment.

4.2. This worked example assumes a LEZ is implemented to regulate HGV emissions via replacement of existing vehicles with new vehicles. The example illustrates the effect of:

- varying the emission standard with which the HGVs must comply;
- varying the year by which HGVs must comply (ie the implementation year).

4.2 Emissions assessment

Do minimum or baseline case

4.3. This policy would affect HGVs only. If possible collate information on:

- number of vehicles potentially affected;
- their age (i.e. when first registered) and whether they already have abatement equipment fitted;
- planned replacement rates (ie, how long each is expected to remain in service).

4.4. However, HGVs and their activity are mainly unregulated by local authorities. Unlike bus operators there are potentially very many operators and many vehicles involved so that it is unlikely that accurate data of these types will be readily available. In these circumstances it is necessary to rely on the national predictions from the Air Quality Archive. Use the emissions factor toolkit for vehicle emissions (http://www.airquality.co.uk/archive/laqm/tools.php?tool=emission) or National Atmospheric Emissions Inventory (NAEI) webpages to obtain the year and vehicle type specific emission factors for NO_x and PM_{10} (g/veh km). These emission factors take account of the weighted contribution of different Euro standard vehicles to the average emission factor based on national data regarding vehicle replacement rates. Tables 5 and 6 illustrate this approach.

Table 5: Proportionate breakdown of national Heavy Goods Vehicle fleet by Euro standard

Vehicle	Standard	2007	2008	2009	2010	2011	2012	2013	2014	2015
Rigid HGV	Pre-Euro I	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rigid HGV	Euro I	0.054	0.033	0.015	0.006	0.000	0.000	0.000	0.000	0.000
Rigid HGV	Euro II	0.294	0.237	0.187	0.138	0.098	0.066	0.035	0.016	0.006
Rigid HGV	Euro III	0.510	0.474	0.428	0.392	0.332	0.274	0.219	0.170	0.123
Rigid HGV	Euro IV	0.137	0.230	0.232	0.207	0.195	0.189	0.170	0.146	0.119
Rigid HGV	Euro V	0.000	0.027	0.137	0.257	0.375	0.471	0.575	0.667	0.751
Total		**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**
Artic HGV	Pre-Euro I	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Artic HGV	Euro I	0.027	0.018	0.009	0.003	0.000	0.000	0.000	0.000	0.000
Artic HGV	Euro II	0.210	0.149	0.101	0.069	0.051	0.035	0.021	0.010	0.003
Artic HGV	Euro III	0.587	0.518	0.441	0.360	0.274	0.201	0.143	0.098	0.067
Artic HGV	Euro IV	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.093
Artic HGV	Euro V	0.000	0.035	0.175	0.316	0.449	0.569	0.675	0.765	0.837
Total		**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**

Table 6: Baseline Heavy Goods Vehicle emission factors (g/km) at 30 kph based on national fleet trends

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x - Rigid HGV	5.388	5.000	4.527	4.097	3.702	3.386	3.073	2.821	2.612
NO_x - Artic HGV	11.77	10.79	9.55	8.47	7.57	6.80	6.16	5.62	5.23
PM_{10} - Rigid HGV	0.142	0.121	0.105	0.091	0.078	0.068	0.058	0.050	0.044
PM_{10} - Artic HGV	0.38	0.32	0.27	0.22	0.19	0.16	0.13	0.11	0.10

4.5. Note that this example takes a simple view that an average speed of 30 kph is representative of urban HGV activity. Detailed analysis should include consideration of emissions associated with congestion too if these are relevant to the case.

4.6. It is also necessary to collate estimates of the total annual vehicle kilometres travelled by these vehicles. These data are most likely to be held in local datasets such as local authority traffic models. Note that if the policy will only be enforced in a specific zone that the total annual vehicle kilometres travelled by these vehicles in that zone should be estimated. This can be estimated by multiplying the total link length on the implicated routes by the annual traffic flow.

Table 7: Baseline Heavy Goods Vehicle activity data (million veh.km)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Rigid HGV	44.13	43.69	43.25	42.81	43.01	43.20	43.40	43.60	43.79
Artic HGV	22.29	22.88	23.48	24.08	24.45	24.83	25.20	25.58	25.95

4.7. Emission rates and activity data are multiplied to estimate the baseline HGV emissions shown in Table 8.

Table 8: Estimated baseline Heavy Goods Vehicle emissions (tonnes) in the Low Emission Zone

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x - Rigid HGV	255.2	233.6	209.0	186.7	168.1	153.4	138.6	126.7	116.9
NO_x - Artic HGV	262.33	246.84	224.29	203.92	185.03	168.92	155.15	143.85	135.69
NOx total	517.49	480.44	433.32	390.64	353.17	322.29	293.73	270.54	252.55
PM_{10} - Rigid HGV	7.1	6.0	5.1	4.4	3.7	3.2	2.7	2.3	2.0
PM_{10} - Artic HGV	8.43	7.34	6.29	5.37	4.56	3.89	3.34	2.91	2.62
PM_{10} total	15.55	13.35	11.40	9.76	8.29	7.09	6.05	5.23	4.63

4.8. Note that the estimates illustrate a decline in emissions over time due to vehicle replacement rates and more stringent Euro standards in new vehicles.

Estimated effect of varying the emission standard to be achieved

4.9. The baseline HGV fleet can be analysed for realistic options for setting future emission standards. Between 2008-11 the majority of vehicles are of Euro III standard or better. Therefore the objective of an LEZ during this period may be for all vehicles to achieve a Euro III standard or better. From 2011 onwards the contribution of Euro III standard vehicles is also in decline hence during that period a LEZ scheme may require a Euro IV standard or better vehicle.

4.10. From 2008 onwards Euro V standard vehicles are increasingly available. Theoretically it would be possible for a fleet operator to buy vehicles second-hand if they are compliant with whatever euro standard is selected as the criteria for a scheme but this example assumes that replacement is always to a brand-new vehicle.

4.11. The tables below illustrate the changes to the baseline HGV fleet and emissions that would occur if the fleet had by 2010 to achieve:

- a Euro III standard (requires all pre-Euro III vehicles to be replaced)’

- a Euro IV standard (requires all pre-Euro IV vehicles to be replaced)’
- a Euro V standard (requires all pre-Euro V vehicles to be replaced).

4.12. The tables include a calculation of the difference in annual emissions relative to the base case.

Criteria	Euro III standard									Euro IV standard									Euro V standard								
Rigid HGVs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0.05	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Euro II	0.29	0.24	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.24	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.24	0.19	0.00	0.00	0.00	0.00	0.00	0.00
Euro III	0.51	0.47	0.43	0.39	0.33	0.27	0.22	0.17	0.12	0.51	0.47	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.47	0.43	0.00	0.00	0.00	0.00	0.00	0.00
Euro IV	0.14	0.23	0.23	0.21	0.19	0.19	0.17	0.15	0.12	0.14	0.23	0.23	0.21	0.19	0.19	0.17	0.15	0.12	0.14	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Euro V	0.00	0.03	0.14	0.40	0.47	0.54	0.61	0.68	0.76	0.00	0.03	0.14	0.79	0.81	0.81	0.83	0.85	0.88	0.00	0.03	0.14	1.00	1.00	1.00	1.00	1.00	1.00
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Emission rate																											
NO_X (g/km)	5.78	5.35	4.83	3.59	3.39	3.20	3.00	2.82	2.63	5.78	5.35	4.83	2.40	2.38	2.37	2.34	2.30	2.26	5.78	5.35	4.83	2.07	2.07	2.07	2.07	2.07	2.07
PM (mg/km)	0.16	0.14	0.12	0.08	0.07	0.06	0.06	0.05	0.04	0.16	0.14	0.12	0.03	0.03	0.03	0.03	0.03	0.03	0.16	0.14	0.12	0.03	0.03	0.03	0.03	0.03	0.03
Emissions (tonnes)																											
NO_X	255.16	233.60	209.04	153.56	145.60	138.22	130.38	122.91	115.36	255.16	233.60	209.04	102.58	102.22	102.30	101.50	100.34	98.96	255.16	233.60	209.04	88.79	89.20	89.59	90.01	90.42	90.82
PM_{10}	7.12	6.02	5.12	3.27	2.98	2.70	2.43	2.20	1.96	7.12	6.02	5.12	1.30	1.30	1.31	1.32	1.32	1.33	7.12	6.02	5.12	1.30	1.30	1.31	1.32	1.32	1.33
Artic HGVs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0.027	0.018	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.018	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.018	0.009	0.000	0.000	0.000	0.000	0.000	0.000
Euro II	0.210	0.149	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.210	0.149	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.210	0.149	0.101	0.000	0.000	0.000	0.000	0.000	0.000
Euro III	0.587	0.518	0.441	0.360	0.274	0.201	0.143	0.098	0.067	0.587	0.518	0.441	0.000	0.000	0.000	0.000	0.000	0.000	0.587	0.518	0.441	0.000	0.000	0.000	0.000	0.000	0.000
Euro IV	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.093	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.093	0.175	0.280	0.274	0.000	0.000	0.000	0.000	0.000	0.000
Euro V	0.000	0.035	0.175	0.39	0.50	0.60	0.70	0.78	0.84	0.000	0.035	0.175	0.75	0.77	0.80	0.84	0.87	0.91	0.000	0.035	0.175	1.00	1.00	1.00	1.00	1.00	1.00
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Emission rate																											
NO_X (g/km)	11.77	10.79	9.55	7.63	6.98	6.41	5.91	5.51	5.19	11.77	10.79	9.55	5.29	5.20	5.10	4.98	4.87	4.76	11.77	10.79	9.55	4.45	4.45	4.45	4.45	4.45	4.45
PM (mg/km)	0.38	0.32	0.27	0.19	0.16	0.14	0.12	0.11	0.10	0.38	0.32	0.27	0.08	0.08	0.08	0.08	0.08	0.08	0.38	0.32	0.27	0.08	0.08	0.08	0.08	0.08	0.08
Emissions (tonnes)																											
NO_X	262.33	246.84	224.29	183.73	170.72	159.12	149.04	140.87	134.74	262.33	246.84	224.29	127.36	127.09	126.57	125.50	124.49	123.45	262.33	246.84	224.29	107.06	108.70	110.39	112.03	113.72	115.37
PM_{10}	8.43	7.34	6.29	4.55	3.98	3.49	3.10	2.79	2.58	8.43	7.34	6.29	1.90	1.93	1.96	1.99	2.02	2.05	8.43	7.34	6.29	1.90	1.93	1.96	1.99	2.02	2.05
Emissions (tonnes)																											
Total NO_X	517.49	480.44	433.32	337.29	316.32	297.34	279.41	263.78	250.10	517.49	480.44	433.32	229.93	229.31	228.87	227.00	224.83	222.41	517.49	480.44	433.32	195.84	197.90	199.98	202.04	204.15	206.19
Total PM_{10}	15.55	13.35	11.40	7.82	6.97	6.19	5.53	4.99	4.55	15.55	13.35	11.40	3.20	3.24	3.27	3.31	3.35	3.38	15.55	13.35	11.40	3.20	3.24	3.27	3.31	3.35	3.38
Difference from																											
Baseline (tonnes)																											
Total NO_X	0.00	0.00	0.00	53.35	36.85	24.95	14.32	6.76	2.44	0.00	0.00	0.00	160.70	123.87	93.43	66.73	45.71	30.14	0.00	0.00	0.00	194.80	155.27	122.31	91.69	66.39	46.36
Total PM_{10}	0.00	0.00	0.00	1.93	1.32	0.89	0.52	0.24	0.09	0.00	0.00	0.00	6.56	5.05	3.81	2.74	1.89	1.25	0.00	0.00	0.00	6.56	5.05	3.81	2.74	1.89	1.25

Estimated effect of varying the implementation year

4.13. The baseline HGV data can be analysed for realistic options for setting the year by which standards should be achieved.

4.14. In this example it is assumed that the emission standard to be achieved is Euro III (ie all pre-Euro III vehicles are replaced.) The effects of requiring this change by 2010, 2012 and 2015 are examined.

4.15. Examining the baseline data table it can be seen that the 2010 compliance date will affect around 15% of rigid HGV and 7% of articulated vehicles, the 2012 date would affect 7% of rigid HGV and 3.5% of articulated vehicles whereas the 2015 date will affect only <1% of rigid HGV and <1% of articulated vehicles due to the predicted natural replacement rate of vehicles over this period. From this it follows that compliance with the 2012 and 2015 dates would cost operators less but would also have a lesser effect.

4.16. This discussion illustrates the important point that setting an early compliance date will achieve more local air quality and emission benefits but usually at higher costs.

4.17. The tables below illustrate the changes to the baseline HGV fleet and emissions that would occur for the examples that if the fleet complies with the Euro III standard by 2010, 2012 and 2015 respectively.

4.18. Key points to note are that the 2010 implementation date would deliver several years of benefits relative to the base case, whereas the 2012 case would deliver fewer benefits and for a shorter period. As time passes the gap between the base case and the Euro III standard decreases due to natural replacement of older vehicles. By 2015 the benefits due to the Euro III standard is very small. The policy of requiring the Euro III standard by 2015 would only deliver a small benefit – this policy delivers too little too late.

Criteria	2010 compliance date									2012 compliance date									2015 compliance date								
Rigid HGVs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0.05	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.054	0.033	0.015	0.006	0.000	0.000	0.000	0.000	0.000	0.054	0.033	0.015	0.006	0.000	0.000	0.000	0.000	0.000
Euro II	0.29	0.24	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.294	0.237	0.187	0.138	0.098	0.000	0.000	0.000	0.000	0.294	0.237	0.187	0.138	0.098	0.066	0.035	0.016	0.000
Euro III	0.51	0.47	0.43	0.39	0.33	0.27	0.22	0.17	0.12	0.510	0.474	0.428	0.392	0.332	0.274	0.219	0.170	0.123	0.510	0.474	0.428	0.392	0.332	0.274	0.219	0.170	0.123
Euro IV	0.14	0.23	0.23	0.21	0.19	0.19	0.17	0.15	0.12	0.137	0.230	0.232	0.207	0.195	0.189	0.170	0.146	0.119	0.137	0.230	0.232	0.207	0.195	0.189	0.170	0.146	0.119
Euro V	0.00	0.03	0.14	0.40	0.47	0.54	0.61	0.68	0.76	0.000	0.027	0.137	0.257	0.375	0.537	0.611	0.683	0.757	0.000	0.027	0.137	0.257	0.375	0.471	0.575	0.667	0.757
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Emission rate																											
NO_X (g/km)	5.78	5.35	4.83	3.59	3.39	3.20	3.00	2.82	2.63	5.78	5.35	4.83	4.36	3.91	3.20	3.00	2.82	2.63	5.78	5.35	4.83	4.36	3.91	3.55	3.19	2.91	2.63
PM (mg/km)	0.16	0.14	0.12	0.08	0.07	0.06	0.06	0.05	0.04	0.16	0.14	0.12	0.10	0.09	0.06	0.06	0.05	0.04	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.04
Emissions (tonnes)																											
NO_X	255.16	233.60	209.04	153.56	145.60	138.22	130.38	122.91	115.36	255.16	233.60	209.04	186.72	168.14	138.22	130.38	122.91	115.36	255.16	233.60	209.04	186.72	168.14	153.37	138.58	126.69	115.36
PM_{10}	7.12	6.02	5.12	3.27	2.98	2.70	2.43	2.20	1.96	7.12	6.02	5.12	4.39	3.73	2.70	2.43	2.20	1.96	7.12	6.02	5.12	4.39	3.73	3.20	2.70	2.32	1.96
Artic HGVs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0.027	0.018	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.018	0.009	0.003	0.000	0.000	0.000	0.000	0.000	0.027	0.018	0.009	0.003	0.000	0.000	0.000	0.000	0.000
Euro II	0.210	0.149	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.210	0.149	0.101	0.069	0.051	0.000	0.000	0.000	0.000	0.210	0.149	0.101	0.069	0.051	0.035	0.021	0.010	0.000
Euro III	0.587	0.518	0.441	0.360	0.274	0.201	0.143	0.098	0.067	0.587	0.518	0.441	0.360	0.274	0.201	0.143	0.098	0.067	0.587	0.518	0.441	0.360	0.274	0.201	0.143	0.098	0.000
Euro IV	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.093	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.093	0.175	0.280	0.274	0.253	0.226	0.195	0.160	0.126	0.000
Euro V	0.000	0.035	0.175	0.39	0.50	0.60	0.70	0.78	0.84	0.000	0.035	0.175	0.316	0.449	0.603	0.696	0.775	0.840	0.000	0.035	0.175	0.316	0.449	0.569	0.675	0.765	1.00
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Emission rate																											
NO_X (g/km)	11.77	10.79	9.55	7.63	6.98	6.41	5.91	5.51	5.19	11.77	10.79	9.55	8.47	7.57	6.41	5.91	5.51	5.19	11.77	10.79	9.55	8.47	7.57	6.80	6.16	5.62	4.45
PM (mg/km)	0.38	0.32	0.27	0.19	0.16	0.14	0.12	0.11	0.10	0.38	0.32	0.27	0.22	0.19	0.14	0.12	0.11	0.10	0.38	0.32	0.27	0.22	0.19	0.16	0.13	0.11	0.08
Emissions (tonnes)																											
NO_X	262.33	246.84	224.29	183.73	170.72	159.12	149.04	140.87	134.74	262.33	246.84	224.29	203.92	185.03	159.12	149.04	140.87	134.74	262.33	246.84	224.29	203.92	185.03	168.92	155.15	143.85	115.37
PM_{10}	8.43	7.34	6.29	4.55	3.98	3.49	3.10	2.79	2.58	8.43	7.34	6.29	5.37	4.56	3.49	3.10	2.79	2.58	8.43	7.34	6.29	5.37	4.56	3.89	3.34	2.91	2.05
Emissions (tonnes)																											
Total NO_X	517.49	480.44	433.32	337.29	316.32	297.34	279.41	263.78	250.10	517.49	480.44	433.32	390.64	353.17	297.34	279.41	263.78	250.10	517.49	480.44	433.32	390.64	353.17	322.29	293.73	270.54	250.10
Total PM_{10}	15.55	13.35	11.40	7.82	6.97	6.19	5.53	4.99	4.55	15.55	13.35	11.40	9.76	8.29	6.19	5.53	4.99	4.55	15.55	13.35	11.40	9.76	8.29	7.09	6.05	5.23	4.55
Difference from																											
Baseline (tonnes)																											
Total NO_X	0.00	0.00	0.00	53.35	36.85	24.95	14.32	6.76	2.44	0.00	0.00	0.00	0.00	0.00	24.95	14.32	6.76	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44
Total PM_{10}	0.00	0.00	0.00	1.93	1.32	0.89	0.52	0.24	0.09	0.00	0.00	0.00	0.00	0.00	0.89	0.52	0.24	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09

Conclusions

4.19. In terms of emissions and air quality benefits the main points to be considered for any vehicle replacement policy are as follows.

1. To set an appropriate emission standard (bearing in mind the cost to those operators affected) to achieve an outcome where there are local emissions reductions relative to the base case. The higher the Euro standard the bigger the potential reductions.
2. To set an appropriate implementation year to achieve an outcome where there are local emissions reductions relative to the base case. Earlier is better.
3. To consider setting further Euro standards and implementation years (ie subsequent phases of emission reduction) otherwise the benefits of the policies will be eroded over time by natural vehicle replacement rates.
4. That the emission standards and implementation years have to be balanced up against issues of costs but also the level of action required to achieve the air quality objectives in the AQMA.

4.3 Cost assessment, cost-effectiveness and Cost-Benefit Analysis

4.20. An example of the cost analysis for a LEZ is shown below, comparing alternative options. The Base scheme in this illustrative example refers to an access control scheme giving priority to public transport in a small city centre area, enforced using ANPR. Schemes A to C are potential developments of this Base scheme into a LEZ, with progressively greater numbers of permitted vehicles meeting specified emissions criteria. Schemes A to C require additional ANPR camera sites, plus accompanying back-office systems and operating staff.

4.21. First the cost estimates are presented, showing the cost elements for capital and operating costs for a base scenario, and then three alternative schemes comparing different vehicle types.

Table 9: Cost estimates for Low Emission Zone scheme

	Base scheme	**Scheme A. Bus**	**Scheme B. HDV, Coach, Bus**	**Scheme C. HDV, Coach, Bus, LGV, Car, Taxi**
Start-up (capital) £				
Equipment	150,000	250,000	250,000	350,000
Central system	50,000	100,000	150,000	200,000
Other	70,000	100,000	200,000	250,000
Total start-up	**270,000**	**450,000**	**600,000**	**800,000**
Operating costs (end of year 1) £				
Maintenance	10,000	20,000	20,000	30,000
Central system, premises, supplies	65,000	75,000	80,000	150,000

Staff costs	120,000	170,000	230,000	330,000
Total operating	**195,000**	**265,000**	**330,000**	**510,000**

4.22. The costs of the scheme over the lifetime then has to be calculated, and expressed in equivalent terms, as a present value of costs. For the analysis here, we assume that the scheme starts the following year (year 1). In each case, the costs in each year are multiplied by the discount factors, to allow the discounted costs to be estimated. The sum of these discounted costs gives the present value of costs. These are then converted to an equivalent annual cost for the cost-effectiveness analysis (using either the Equivalent Annualised Cost equation[4] , or the excel formula, see worksheet example). As an example, the values for scheme A are shown below. The calculation is provided in the worksheet example.

Table 10: Estimation of Present Value of Costs, and Equivalent Annual Cost – Scheme A

Scheme A	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Capital costs £	450,000							
Ongoing costs £	265,000	265,000	265,000	265,000	265,000	265,000	265,000	265,000
Total £	715,000	265,000	265,000	265,000	265,000	265,000	265,000	265,000
Discount factor	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940
Discounted cost £	690,833	247,378	239,004	230,921	223,130	215,578	208,290	201,241
Present value £	2,256,374							
Equivalent annualised cost £	328,250							

4.23. The values for all three schemes are summarised below.

Option	Base	A	B	C
Present value (sum)	1,601,285	2,256,374	2,848,107	4,278,649
Equivalent annualised cost	232,949	328,250	414,333	622,444

4.24. This provides an estimate of the equivalent annualised costs of each scheme, which can be compared with the annual tonnes abated from each option [not calculated here], to derive estimates of cost-effectiveness (costs per tonne abated). However, to accurately capture the full costs of each

[4] Equivalent annualised cost = NPV multiplied by

$$\left[\frac{r(1+r)^n}{(1+r)^n-1}\right]$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years.

scheme, and undertake this cost-effectiveness analysis, it is also necessary to estimate the costs to operators for each scheme as well as the scheme costs. This will include the costs to non-compliant vehicles that will be affected. The section on benefits gave the information on estimating the number of vehicles affected by the scheme, consistent with the analysis of emission benefits. These estimates can be used to estimate the costs to operators. This will involve the estimates of retrofitting or vehicle replacement.

4.25. Note that, however, a LEZ will reduce both PM and NO_x emissions (and may also have effects on other pollutants on greenhouse gas emissions). A cost-effectiveness analysis can only take one pollutant into account at a time (this is one of the problems with cost-effectiveness). It is possible to address this by estimating 'net' cost-effectiveness of options to correctly prioritise measures taking other objectives into account (see below).

4.26. Guidance on the estimation of the costs to operators is given in the other guidance notes on vehicle retrofit and low emission vehicles. The Practice Guidance on retrofitting vehicles provided an example with retrofitting Diesel Particulate Filters (DPFs) showing the estimation of costs and cost-effectiveness. Note that in this analysis, it is the resource costs of technology that are used in the economic appraisal, rather than the market prices. The Practice Guidance on LEVs provided an example for the costs of new vehicles, based on the additional marginal technology costs of these vehicles over a standard new vehicle.

4.27. Note that there are some different issues when considering vehicle replacement, rather than just the consideration of retrofits or alternative new vehicles, for a LEZ. In the case where vehicles are replaced by operators as a result of LEZ, it is important to consider what happens to the replaced vehicles. This can be very complex, and depends on operator behaviour, market values – see the London LEZ considerations as an example. In a case where an older vehicle is retired prematurely, it is necessary to consider the useful resources of that vehicle that are being lost. This is usually estimated by calculating the market value of the vehicles in the year that they are being retired[5]. There may also be other effects in such a case with changes in fuel efficiency (as above). In other cases, vehicles may be moved to other routes (fleet switching) without retirement, or vehicle may be sold on.

4.28. One additional problem with cost-effectiveness analysis for LEZs is the issue of declining benefits above the baseline, i.e. the fact that emissions benefits are not constant over time. Whilst it is possible to estimate the benefits in the first year as a proxy for the benefits of different schemes, this approach effectively over-estimates the benefits in future years. Some consideration of these issues is important in comparing schemes, and ensuring that schemes are adjusted over time to maximise benefits (see earlier sections).

[5] This approach was used in the IGCB analysis, and reflects an estimate of the value of the service the vehicle would have provided fro the rest of its lifetime, had it not been retired early.

4.29. It is also possible to address the overall benefits and costs of the schemes, taking any such effects over time into account, through the use of cost-benefit analysis.

4.30. The first stage in a cost-benefit analysis is to estimate the monetary value of the benefits. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at (http://www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants) are estimated. So, for example, the emission benefits of the schemes can be input into the calculator and the benefits identified. Examples of the use of the damage cost calculator are given in the Practice Guidance on

.

4.31. The estimated present value of benefits can then be compared against the present value of costs. Note that for the latter, this should include the costs associated with scheme start-up and operation (see above), but also the costs to vehicle operators to comply with the scheme (see the examples in Practice Guidance Measures to Encourage the Uptake of Low Emission Vehicles and Practice Guidance Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles). The total present value of benefits can be compared with present value of cost to estimate the overall NPV for each scheme.

4.32. The information from a cost-benefit analysis can also be used to consider other environmental objectives as part of a 'net' cost-effectiveness analysis. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant. The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas emissions, in the cost-effectiveness ranking and so provides a more holistic overall ranking method. More details are given in the Practice Guidance on Econmic Principles, Practice Guidance Measures to Encourage the Uptake of Low Emission Vehicles and Practice Guidance Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles. The advantage of this approach is it allows multiple pollutants (for example NO_x and PM_{10} benefits) to be taken into account when undertaking the cost-effectiveness ranking between options.

5 Examples of Low Emission Zone schemes

5.1. The purpose of this chapter is to provide key information on existing or planned LEZ schemes. This includes a brief description of how key implementation and enforcement issues are addressed in these schemes.

5.2. Traffic control schemes are common in UK towns and cities. Linking a variety of access control schemes on sections of the public highway builds up the overall traffic management approach in many city and town centres. A small number of such traffic control schemes in the UK have either been designed to include emission criteria or have been examined for such a modification, and therefore can be considered small-scale examples of LEZ.

5.3. Larger LEZs, with enforceable restrictions on vehicle access, from across Europe include:

- Swedish environmental zones, where HGV over a certain age are banned from entry;
- Netherlands LEZ, where minimum Euro standards and/or retrofit technologies are required for HGV;
- the German LEZ regulations, which a city can apply to all vehicles except motorbikes based on a range of environmental standards and with a strong focus on diesel-fuelled vehicles;
- Japanese LEZ in the Greater Tokyo area, where emissions standards have applied to both light and heavy diesel vehicles since 2003;
- Austrian A12 motorway, with Euro standard limit on HGV that also vary by time of day.

5.4. A number of schemes achieve their emission objectives by applying charges to more polluting vehicles:

- London LEZ;
- Milan Ecopass; and
- Bologna Limited Traffic Zone (LTZ).

5.5. Information on a wide number of current and planned LEZs across Europe can be found via the EU-wide LEZ Network (www.lowemissionzones.eu). The web site provides information about network members' schemes and is a mechanism for members to publicise access restrictions on a pan-Europe basis.

5.6. Low emission zones from a range of countries are included in this section. Where possible these are presented by country as there are often similarities in the scheme design and operating rules within the same country.

5.7. Key summary information on the schemes is provided in Table 11 whereas more detailed information is found in the following text sections.

Table 11: Summary of key information on example schemes in this guidance

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Mgt of permitted vehicles	Comments (Strengths/weaknesses)
Sweden - Environmental Zone	Traffic restriction	City centres or key districts	HDV (HGV and bus)	HGV: age limit of six years. Allowance for trucks between six and eight years old if retrofitted for PM.	Manual enforcement by Police. Scheme applies to foreign vehicles.	Sticker permits denote compliant vehicles. Retrofit for PM possible for narrow age band.	Age based system is relatively simple.
Greenwich Peninsula	Planning obligation	190 acres of development site.	All vehicles.	Various, depending on land-use and vehicle type. Based on Euro standards.	Non compliance will be a breach the agreement.	To be confirmed. Retrofitting of HDV possible for PM.	Management and operation is responsibility of developer.
Bath - PAS	Traffic restriction	One key route through centre	Priority/access for bus and taxi, plus a few permitted Goods Vehicles.	Free access to bus and taxi. Supermarket delivery vehicles must be of latest Euro standard.	Manual, by Police. Vehicles without transponders cannot trigger green light to pass through access point.	Bus, taxi, permitted Goods Vehicle apply for transponders.	Simple addition of environmental criteria to ensure high standards from non-public transport vehicles. Enforcement depends on Police support.
Milan - EcoPass	Charge	City centre	All vehicles.	Charge related to level of PM emissions. Cleanest diesel and petrol vehicles gain free entry.	43 entrance points with CCTV and ANPR cameras. Penalty is 75€ to 275€ depending vehicle size.	Daily and multi-day/annual passes can be purchased. Cost based on Euro standards. Alternative fuels and retrofit for PM possible.	Reduces congestion as well as emissions (due to charge). Revenue can be used to improved transport. Complex scheme rules with variety of passes.
London - LEZ	Charge	Greater London	HDV (HGV, Coach etc), with heavy vans to be added later.	From 4th Feb. 2008, a standard of Euro 3 for PM for lorries over 12 tonnes Gross Vehicle Weight (GVW), and buses and coaches over 5 tonnes GVW. From July 2008, a standard of Euro 3 for PM for lorries between 3.5 and 12 tonnes,	Large network of ANPR cameras. Penalty for non-compliance and non-payment is £500/£1000 depending vehicle size.	Compliant vehicles self-registered via number plate and DVLA records. Non-standard cases and retrofit vehicles required to register vehicle, and retrofit vehicles inspected annually by VOSA. Daily charge (£200 or	Phased approach to ensure tightening emission standards.

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Mgt of permitted vehicles	Comments (Strengths/weaknesses)
				buses and coaches. From Oct. 2010, a standard of Euro 3 for PM for larger vans and minibuses. From Jan. 2012, a standard of Euro 4 for PM for lorries over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.		£100, depending on the size/type of vehicle) for vehicles who do not comply. Retrofit for PM possible.	
Netherlands - LEZ (Milieuzone)	Traffic restriction	Central city areas	HGV	Min standard of Euro 2 and 3 plus particulate filter or Euro 4 will be in force up until 1 Jan. 2010. Between 1 Jan. 2010 and 1 July 2013 the minimum standard will be less than eight years or Euro 3 plus PM filter. After 1 July 2013 the minimum standard is Euro 4.	Manual, plus some (increasing number of) ANPR camera. Penalty is 150€.	Retrofit for PM possible.	Phased approach to ensure tightening emission standards.
German LEZ (Umweltzone)	Traffic restriction	Central city areas	All vehicles	Vehicle owners required to purchase stickers (20 €) stating environmental standard. Each LEZ signs which is minimum sticker/standard required for access. Standards tougher for diesel vehicles.	Manual enforcement. 40 € fine plus 1 point in national traffic penalty register for German vehicles	Stickers denote emission level of all relevant vehicles. Sticker must be shown if vehicle to be driven in any LEZ. Certification system for retrofit vehicles. Retrofit for PM (cars and HGV) possible.	Flexible framework for cities to choose from emission standards. Includes cars and encourages PM retrofitting.

Sweden – environmental zones

5.8. Swedish environmental zones have the longest history of LEZ, since the law passed in 1996 by Parliament, and operate in the four largest cities including Stockholm. The LEZ apply to HGVs with an age limit of six years, with some allowance for trucks between six and eight years old if they had retrofitted exhaust treatment.

5.9. The initial environmental zones covered relatively small areas of the cities of Stockholm (5x7km), Gothenburg (3x5km) and Malmo (3x3km). In some cases a strategic route through the zone is left for crossing the zone and due to lack of city jurisdiction over such roads. Extension of the zones has been considered/planned in some cases. Enforcement is carried out by Police, based on manual spotting of vehicles.

Netherlands – low emission zones

5.10. In the Netherlands seven LEZ were in operation by the end of 2007 (including Maastricht, Rotterdam and Utrecht) with several more being prepared. There is a national framework that cities may opt to join which means all LEZ have the same emissions requirements. Currently LEZ apply only to HGVs, over 3.5 tonnes.

5.11. The vehicle emission rules are a combination of age and Euro standards depending on the year in question:

- a minimum standard of Euro 2 and 3 plus particulate filter or Euro 4 will be in force up until 1 January 2010;
- between 1 January 2010 and 1 July 2013 the minimum standard will be a mixture of both an age-based standard (less than eight years) or Euro 3 plus filter;
- after 1 July 2013 the minimum standard is Euro 4.

5.12. Manual enforcement is planned until networks of automatic cameras are in place. Fines are set at 150 €.

Germany – low emission zones

5.13. As of 1 January 2008 three major cities in Germany (Berlin, Hanover and Koln) had LEZ in operation. However, up to fourteen cities in total have confirmed their planned introduction of LEZ (Umweltzone) in the remainder of 2008, with another seven by 2010.

5.14. A national framework sets out vehicle emissions standards, and the cities choose whether to introduce, what vehicles to cover, which year and what area will be covered by their LEZ. German LEZ affects all vehicle types except motorcycles.

Table 12: German Low Emission Zone standards

Emission class	**1**	**2**	**3**	**4**
Sticker type	No sticker available			
Diesel vehicles	Euro I or older	Euro 1 or Euro 2 plus particulate filter	Euro 2 or Euro 3 plus particulate filter	Euro 3 or Euro 4 plus particulate filer
Petrol vehicles	Without catalytic converter (i.e. Pre-Euro 1)			Euro1 with a catalytic converter or better.

5.15. Vehicle owners are required to purchase stickers (at a cost of around 20 €) which denote the environmental standard of their vehicle if they are to drive on any local roads passing through the LEZ participating cities. These must be displayed inside the windscreen and are then valid for all German LEZ. Emission standards can vary city by city, within the same national framework. There are four levels of emission class and the boundary signing for each LEZ denotes the emission standard required for entry. The penalty for not displaying a sticker or driving a vehicle with the wrong sticker is a 40 € fine, and one point in the national traffic penalty register for German vehicles.

Figure 1: German Low Emission Zone sign

5.16. Primarily, the German scheme targets diesel vehicles, as any Euro 1 petrol vehicle (i.e. post 1993) will gain the highest standard 'green' sticker. In contrast, Euro 1 and older diesel car owners cannot buy any type of sticker. Older vehicles can receive stickers after emission system upgrades, which must be issued directly from a certified local emission repair garage after passing the emission standards test. The scheme has the effect of incentivising owners of diesel vehicles, including cars, to retrofit particulate filters. Encouraging diesel car retrofit has been done in Germany through various initiatives for a number of years.

Japan – Nitrogen oxides and particulate matter law

5.17. The Japanese NO_x and PM Law was designed to try to ensure that the Ambient Environmental Quality Standards for nitrogen dioxide (NO_2) and suspended particulate matter (SPM) were met by the end of 2010, through special regulation and other measures for vehicles. The area covered is large, including 276 municipalities in the Tokyo Metropolis and the Prefectures of Saitama, Chiba, Kanagawa, Aichi, Mie, Osaka, and Hyogo.

5.18. Vehicles covered by the law are HGV, vans, buses, and diesel passenger cars. Therefore, diesel-fuelled vehicles are the main focus. In the prefectures affected, programmes for total emission control have been set up according to a basic plan established by the national government to ensure systematic promotion of different measures. This includes traffic management to improve traffic flows and support for businesses with 30+ vehicles to implement fleet improvement plans.

5.19. The scheme was introduced in 2002 and, for the time, very tough emission standards were set for all new registered vehicles. For these, PM emissions equivalent to the planned emission standard for diesel vehicles in 2005 were required, which had the impact of incentivising low PM fuels such as CNG and LPG.

London – Low Emission Zone

5.20. The London LEZ started operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered vehicles, thereby prioritising PM reduction.

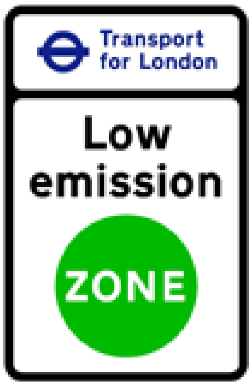
5.21. The LEZ commenced on 4 February 2008 for lorries over 12 tonnes, with different vehicles affected over time and tougher emissions standards due to be introduced in January 2012.

5.22. The London LEZ emission standards describe the minimum Euro standard which vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using a vehicle whose engine was type approved to this standard (or better) or by retrofitting exhaust after-treatment technology to raise the emission standard. Further information on LEVs can be found in the Practice Guidance Measures to Encourage the Uptake of Low Emission Vehicles. Further information on retrofitting can be found in the Practice Guidance Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles. The standards by vehicle/weight and timescale are:

- from 4 February 2008, a standard of Euro III for PM for lorries over 12 tonnes,

- from 7 July 2008, a standard of Euro III for PM for lorries between 3.5 and 12 tonnes and buses and coaches over 5 tonnes ,
- from 4 October 2010, a standard of Euro III for PM for larger vans and minibuses,
- from 3 January 2012, a standard of Euro IV for PM for lorries over 3.5 tonnes and buses and coaches over 5 tonnes.

Figure 2: Entrance sign to London LEZ



5.23. While the London LEZ has the same objectives as the environmentally-focussed schemes in Sweden and Germany, it actually operates as a road charging scheme. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not pay. It was set up using a Scheme Order, which is the same legal basis as the London CCS. However, it is not a congestion charge as the objective is not to reduce traffic levels.

5.24. The London LEZ began operation in 2008. Transport for London has planned a work programme that will undertake an analysis and it is expected that results will be made public in due course. The scheme has been scrutinised closely during its development and a recent TfL analysis of the potential impacts of the scheme (TfL, 2007) found the following. The LEZ is anticipated to produce significant air quality benefits both within and beyond the LEZ boundary. In 2008 the scheme is expected to reduce the area of Greater London that exceeds the daily PM_{10} limit by 7% and by 15% by 2012. By 2010 the scheme is expected to reduce the area of Greater London that exceeds the annual mean NO_2 limit by 4% and by 16% by 2012. Health benefits associated with these changes are estimated to be £170-250 million due to predicted reduction in illness and in extended life expectancy (years of life gained).

Milan Eco Pass

5.25. The City of Milan has introduced a charge, known as Eco Pass, for all vehicles entering the main city centre of the Cerchia dei Bastoni area. Eco Pass came into effect on 2 January 2008 and aims to reduce PM emissions, relieve congestion (and therefore speed public transport journeys) and raise revenue for public transport. It can be considered to combine the objectives of both the London LEZ and the London CCS.

5.26. Eco Pass consists of a charge applied to vehicles circulating within the city centre area during week the from 7.30 am to 7.30 pm (changing to 7.00 am to 7.00 pm from 15th of April 2008). Drivers pay a charge (from 2 € to 10 € for daily entrance) corresponding to the levels of PM emissions from their vehicle, with the cleanest petrol and diesel vehicles paying no charge. There is also zero charge for alternative fuels and hybrid vehicles.

5.27. In addition, a simple LEZ approach is applied in Milan at night-time in winter months (15 October to 15 April). During these months pre-Euro and Euro 1 petrol and diesel cars, as well as mopeds and motorcycles, are forbidden to enter the central area from 7.30 am to 7.30 pm.

UK access control schemes

5.28. Access control schemes in various areas of England have tended to prioritise types of vehicle rather than particular emission standards. These include schemes such as bus priority schemes, bus gates and access control schemes in residential areas.

5.29. The main objective of the Bath Priority Access Scheme (PAS) is to reduce congestion from through-traffic and prioritise space for pedestrians and public transport. Buses and taxis are permitted to use a traffic signal controlled ‘gate’ that regulates cross-city traffic, and can call for a green signal using an in-vehicle transponder. In addition, the scheme design permits a small number of supermarket delivery vehicles which must meet the latest emission standards. The use of new vehicles is a condition under which they receive permits (and traffic light transponders). This scheme has only a limited application of specific environmental criteria, via the permitted vehicle approach, but is a demonstration of the legal principals in a UK setting.

UK and mainland Europe - parking controls

5.30. Historically, parking controls have been used to manage demand for scarce road space and to support the safe and efficient flow of traffic. PPG 13 notes that the availability of car parking has a major influence on the means of transport people choose for their journeys. It goes on to summarise that some studies suggest that levels of parking can be more significant than levels of public transport provision in determining means of travel (particularly for the journey to work) even for locations very well served by public transport.

5.31. A number of local traffic authorities have adjusted the operation of their parking management schemes with more specific environmental objectives that aim to discourage use of the most polluting vehicles and simultaneously incentivise LEVs. Further information on LEVs can be found in Practice Guidance on Measures to Encourage the Uptake of Low Emission Vehicle .

5.32. A range of approaches to parking controls can be seen in these examples, which include discouragement and/or incentives for one or both of toxic pollutants and greenhouse gas emissions:

- City of Westminster and London Borough of Croydon parking charge discounts for electric vehicles;
- City of Stockholm parking discounts for electric vehicles, biomethane vehicles and hybrid vehicles;
- London Borough of Richmond parking permit scheme with charges based on CO_2 ratings or engine sizes;
- City of Winchester parking permit scheme discounts for vehicles in the two lowest CO_2 emission bands;
- City of Graz (Austria), discount on parking charges for vehicles with a combination of latest Euro pollutant emission standards and low CO_2 rating.

UK - planning obligations

5.33. The transportation aspect of development control is usually only one of a number of factors that relate to a development proposal. However, the development control process provides an opportunity to influence future use and access to a site in the medium to long term.

5.34. The Greenwich Peninsula Low Emission Strategy places restrictions on the use of more polluting vehicles, with compliance being a legal obligation of the sale of land for development, and will also be passed directly on to dwelling purchasers.

5.35. Low Emission Zone controls are applicable to the Greenwich Peninsula development (Dome/MDL) and which form part of the Section 106 legal agreement, signed on the 23 February 2004. The Greenwich Peninsula LEZ will apply to the 190 acres of land approved for development on the 17th April 2003. The LEZ will apply until the completion of the development, anticipated in 2021. A range of controls are initially outlined for different aspects of the development where an impact on air quality is envisaged.

5.36. Residential parking permits will be given to vehicles that comply with:

- affordable Housing – Euro 3 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner; and
- private Residential – Euro 4 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner.

5.37. The annual parking service charge will be free/less for compliant vehicles, with an incentive for vehicles to exceed the compliance standard. Non-compliant vehicles will be surcharged a public transport levy that will go towards initiatives aimed at encouraging residents not to own a car, for example Car Club, transport voucher, cycle voucher.

5.38. Other areas of the development are covered as follows:

- O2 Arena Suite and Arena Premium Parking will set a standard of Euro 4IV;
- reasonable endeavours will be used to ensure that coaches accessing the site will be of the same, or better, than the emission standard of TfL buses;
- Limited office parking space permits will be issued to vehicles complying with Euro 4;
- the hotel will operate with a minimum of Euro 2 from the outset, with a target of achieving Euro 4 by 1 January 2009.
- management company vehicles should be of the highest Euro standard and a minimum of Euro 4 by 1 January 2009.
- For HGVs/ Construction Vehicles over 7.5 tonnes when 80% of HGVs will achieve a minimum of Euro 2 plus Reduced Pollution Certificate up to 1 January 2007, with a view to achieving Euro 4 by 1 January 2010. Initial HGV controls have some flexibility, to take account of reasonable financial limits.

5.39. The Greenwich Post Office scheme was an earlier (2000) instance of this London Borough using planning conditions to specify vehicle emission standards. To minimise NO_x and SO_x emissions the Post Office agreed to:

- use low sulphur diesel in vehicles at the sorting office development;
- fit PM abatement technology to vehicles when it becomes reasonably practicable; and
- use vehicles that comply with Euro 3 standard by 2004.

5.40. A major 76 acre site, the Royal Arsenal, Woolwich (LB of Greenwich) is a mixed urban development regenerating a riverside location in London. The agreement requires the developer to submit to the council for approval details of a LEZ, and LEZ controls. The agreement goes on to outline more detailed provisions to be included for both the construction and operational phases of the development.

6 Conclusions

6.1. A range of schemes can be developed by local authorities to directly influence the emission standards of vehicles downward in sensitive areas on the public highway or private land. Traffic and parking restrictions can be developed into such schemes by the Highway Authority, and development control schemes by Planning Authorities.

6.2. Schemes based on traffic restrictions on public highway are closest in nature to the concept of a LEZ, and may have the greatest scope for application in towns and cities working towards improved air quality. Powers are available for Highway Authorities to use a traffic restriction for the improvement of air quality.

6.3. The London LEZ (and Milan Eco Pass) are based on charging for access with exemptions for the cleanest vehicles and as such are charge-based schemes. Many of the functions and processes required for setting up and operating the scheme are the same, whether the basis is a restriction on a vehicle or a charge. The London LEZ has provided considerable experience within TfL and Government Agencies, and elements of the scheme design could be replicated elsewhere.

6.4. A range of current LEZ based on traffic restrictions show that key variables in scheme characteristics to be:

- scheme size and land-use type;
- vehicle types;
- emission standards and pollutant types;
- management of permitted vehicles; and
- vehicle detection and enforcement methods.

6.5. Such LEZ tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Source apportionment should be used to determine which vehicles and which pollutants are the most relevant to target. This should be considered as part of the scheme design, to determine the cost-effectiveness of various options.

6.6. From existing examples, the most common vehicles to target in a scheme with enforceable restrictions are HDVs (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. The most common toxic pollutant to target is PM. It is likely this is due to a number of factors:

- HDV produce higher levels of emissions than lighter, smaller engined vehicles;
- the options for retro-fitting HDV are better developed and more cost-effective given the cost of PM abatement equipment compared to NO_x abatement, cost of retrofitting as a proportion of HDV value, and the potential reduction in overall level of emissions (compared to a LDV);

- a scheme that encompasses more vehicles will generally be more costly to set-up and administer, therefore in value for money terms it is more cost effective to target those vehicles with the highest overall emission contribution first (for example bus fleets with large urban centre activity), which is also where any grants or subsidies for retrofitting should be aimed;
- diesel vehicles tend to produce higher levels of PM emissions than the equivalent petrol vehicle, and reduction in PM emission generates significant levels of health benefits.

6.7. The worked example in this guidance illustrated the key points that the scheme should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Between now and 2010-2012 a Euro III standard should be considered as the minimum standard for LEZ schemes. From 2010-2012, higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local authorities will need to consider their own case, costs and benefits when setting emission standards and compliance dates.

6.8. Similar standards within a country are useful, but not essential to setting up and operating a LEZ. A common framework, with cities free to choose the level of standard within it, forms a possible model (seen in Germany). A common set of standards across all vehicles, with authorities choosing which vehicles from the framework to include in their scheme and how to enforce it, might provide another model. When choosing standards, co-operation between neighbouring authorities can be useful, to harmonise standards and reduce competition between those with LEZ and those without.

6.9. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Unfortunately, existing systems will probably not provide a complete solution and the example LEZ show that new systems and processes were required. Taking a practicable approach to completing gaps in information, and making the scheme as straightforward as possible for the user is recommended. There may need to be some trade-off between the optimum operation of a scheme (for emission reduction and cost) against ease of use and acceptance.

6.10. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

6.11. Small areas, road networks with limited access points, and areas with existing traffic restrictions (for example pedestrian zones) provide scope for adding LEZ components at relatively low cost , and if air quality assessments justify it these can be the most cost-effective areas to tackle first.

6.12. A significant number of LEZ are now in place or under development in Europe. Examples of LEZ from mainland Europe include manual and low-tech enforcement methods as well more complex and capital intensive camera based systems. The London Lorry Control Scheme is an example of a manually enforced vehicle restriction scheme. These indicate the importance of UK local authorities investigating lower-cost vehicle detection and enforcement methods when scoping possible scheme designs for overall value for money.

6.13. Relevant parking schemes have tended to focus on passenger cars and CO_2 reduction in the UK to date. Examples from mainland Europe show a broader application, and include criteria for toxic pollutant emissions.

6.14. Relevant UK parking incentives for LEVS have been based on, or adapted from, more traditional residential parking or season ticket holder schemes. This provides the local authority with a proven and existing administration system in many cases, that for only a small additional cost can be tailored to local environmental objectives. An existing scheme on which to base a parking incentive scheme appears to be a factor in successful operation to date. On-street pay and display parking with discounts for cleaner vehicles will require additional systems and processes, which are likely to be more costly than adapting an existing season ticket holder scheme for a off-street car park.

6.15. The use of planning conditions and obligations can have significant potential for specific locations. To date there are two major examples of setting emission standards through the development control process in Greenwich. A smaller scheme was also successfully implemented for a new Post Office sorting office in the same area. The cost of designing and operating a planning obligation scheme can be borne by the developer. A scheme can apply to both construction and operational phases of a development, with obligations passed onto future occupiers. Such an approach provides a useful method of incorporating vehicle specific environmental criteria into planning decisions.

Appendices

Appendix 1: Glossary

Appendix 2: References

Appendix 1. Glossary

ANPR	automatic number plate recognition
AQMA	Air Quality Management Area
CCS	Congestion Charge Scheme
CO_2	carbon dioxide
Defra	Department for Environment Food and Rural Affairs
DfT	Department for Transport
DSRC	Dedicated Short Range Communication
EA 1995	Environment Act 1995
EETS	European Electronic Tolling Service
FPN	Fixed Penalty Notice
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	interdepartmental group on costs and benefits
LAQM	local air quality management
LDV	Light Duty Vehicle
LGV	Light Goods Vehicle
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
LTZ	Limited Traffic Zone
NATA	New Approach to Transport Appraisal
NO_x	oxides of nitrogen or nitrogen oxides
NO_2	nitrogen dioxide
OCR	Optical Character Recognition
PAS	Priority Access Scheme
PCN	Penalty Charge Notice
PM_{10}	particulate matter smaller than 10 microns
RPC	Reduced Pollution Certificate
RTRA 1984	Road Traffic Regulations Act 1984
SPC	Shadow Price for Carbon
SPM	Suspended Particulate Matter
TMA 2004	Traffic Management Act 2004
TfL	Transport for London
TRO	Traffic Regulation Order

VED	Vehicle Excise Duty
VRM	Vehicle Registration Mark
WebTAG	web-based Transport Analysis Guidance

Appendix 2: References

Beacons Low Emission Strategies Group (2008). Low emission strategies - using the planning system to reduce transport emissions.

Defra (2007). An Economic Analysis to inform the Air Quality Strategy, volume 3, Updated Third Report of the Interdepartmental Group on Costs and Benefits.

Department of Transport (1987) Local Transport Note 1/87: Guidance on vehicle restriction in Pedestrian Zones.

Department of Transport (1996) Traffic Advisory Leaflet 04/96: Traffic Management and Emissions.

Department of Transport (1997) Traffic Advisory Leaflet 04/97: Rising Bollards.

DfT (2008) Statutory guidance to local authorities on the civil enforcement of parking contraventions: Traffic Management Act 2004

DfT (2008) Operational Guidance to Local Authorities: Parking Policy and Enforcement, Traffic Management Act 2004
NSCA (2006). Development Control: Planning for Air Quality.

NSCA (1999) Reducing the environmental impact of vehicles in urban areas - low emission zone concepts.

TfL (2007). LEZ Supplementary Information.

TfL (2007). Report to the Mayor following consultation with stakeholders, businesses, other organisations and the public on the Scheme Order 2006.

Planning and Environmental Policy Group

Local Air Quality Management

Practice Guidance 3

Practice Guidance to Local Authorities on measures to Encourage the Uptake of Low Emission Vehicles

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Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887
Website: www.doeni.gov.uk

Information about this publication and further copies are available from:

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887

Email: Stephen.kerr@doeni.gov.uk

This document is available on the Northern Ireland Air Quality website:

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Executive summary

i. This guidance is principally for local authorities in England to have regard to, if relevant, in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995. This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of Low Emission Vehicles.** The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

ii. Low Emission Vehicle schemes are defined areas or locations where the most polluting of vehicles are restricted, deterred or discouraged from access and use. The aim is to improve air quality in a particular area by reducing the number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria. A supplementary benefit of Low Emission Vehicle schemes may be to reduce carbon dioxide emissions in addition to emissions of local air pollutants. For example one useful definition of an Low Emission Vehicle is a vehicle with emissions better than the Euro 4/IV standard and with carbon dioxide emissions better than 140g/km.

iii. Low Emission Vehicle schemes are operating in several UK and overseas towns and cities. Significant existing schemes in the UK include:

- the London Low Emission Zone scheme which from July 2008 requires that all heavy duty vehicles achieve at least a Euro III emission standard for particulate matter smaller than 10 μm;
- Quality Bus Partnership Agreements in South Yorkshire requiring Euro III buses on designated routes;
- discounted car parking charges of up to 100% for vehicles with zero local emissions in Westminster and lesser discounts for Low Emission Vehicles in other locations;
- voluntary schemes with economic incentives such as Car Clubs that have successfully cut operators costs and emissions.

iv. Voluntary options should not be discarded prematurely but in situations where more formal enforcement is required the options for implementing Low Emission Vehicle schemes in the UK are:

- Traffic Regulation Orders under the Road Traffic Regulations Act 1984 (commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme) and Section 106 agreements as planning conditions for site usage under guidance contained in Planning Policy Statement 23: Planning and Pollution Control (2004);

- For local bus services, contract conditions of tendered services, Quality Partnership Schemes and Bus Quality Contracts.

v. Schemes should be developed via appraisal and this guidance provides information on assessing emissions, air quality and costs assessments. It also provides information on using this data in cost-effectiveness and cost-benefit analyses that are consistent with a generic guidance provided alongside this guidance. Local authorities are strongly encouraged to refer to this guidance note too.

vi. Low Emission Vehicle schemes are frequently focussed on city and town centres, where land-use is dense, traffic is heavy, population exposure is high and where Air Quality Management Areas may have been declared. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles owing to the high population density and therefore high potential health benefits. Previous studies have suggested that the most efficient vehicles to target in a scheme with enforceable restrictions are diesel powered Heavy Duty Vehicles due to their cost-effectiveness relative to schemes that would restrict other vehicle types.

vii. The most cost-effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will typically be to use existing systems and sources of information as far as possible. A significant number of Low Emission Vehicle schemes are now in place or under development in Europe. Examples range from manual enforcement methods to high tech camera based systems. Selection between such schemes will depend on the relevant constraints for example a scheme which has low operating costs will tend to be more attractive if there are strong budgetary constraints. However, such considerations needs to be carefully balanced against other impacts such as the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme may be undermined.

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Appendices

1 Introduction

1.1 Purpose of this Guidance Document

1.1. This guidance is principally for local authorities in England to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995.[1] This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of Low Emission Vehicles (LEV).**

1.2. The guidance provides information on identifying options to realise the potential benefits from this type of scheme, practical issues that have arisen in previous implementations, and evaluating costs and benefits of options in either cost-effectiveness or cost-benefit analyses. It also provides detail on existing or planned examples of these schemes.

1.2 Background to the Guidance

1.3. The guidance has been developed to be consistent with key government guidance on appraising new policy and road transport policies in particular.

1.4. The Government Green Book requires that there should be an economic assessment of the social costs and benefits of all new policies projects and programmes. Within the Green Book and related HM Treasury guidance on assessment of the Business Case (5 Case Model), policies are considered under the following five components.

- Applicability: LEV schemes potentially contributes towards strategic objectives in the areas of environment (air quality and climate change).
- Appropriateness: Guidance is given to help develop policies for which costs and benefits are either balanced or overall beneficial in economic terms.
- Attractive: Guidance is given in this document to help authorities to prepare their commercial case for LEV schemes by considering scheme costs including those falling on vehicle operators.
- Affordable: Guidance is given in this document to help authorities to prepare budgets for LEV scheme costs.
- Achievable: Guidance is given in this document on existing examples of LEV schemes and key implementation issues including enforcement powers and other practical considerations.

1.5. As far as possible this guidance is also consistent with the government's New Approach to Transport Appraisal (NATA). In practical terms NATA guidance is delivered via the web-based Transport Analysis Guidance (webTAG). In particular this includes guidance on how to conduct a transport policy or scheme appraisal that meets the Department for Transport (DfT) guidelines.

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[1] Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance covers the whole of the UK.

Although every care has been taken to ensure consistency if contradictions do occur, for example as guidance changes, then primacy should be given to this guidance in the consideration of air quality impacts (air quality and climate change effects) and webTAG guidance for wider transport impacts.

1.6. These sources of guidance have been consulted during the development of this guidance document so that a high degree of consistency with overarching governmental guidance on economic appraisal and road transport appraisal in particular have been achieved.

1.3 How should the guidance be used?

1.7. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMAs) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality.

1.8. Local authorities should have regard to this guidance in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are:

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009 including
  - Practice Guidance on the Economic Principles for the assessment of local measures to improve air quality,
  - Practice Guidance relating to Low Emission Zones (LEZ),
  - Practice Guidance relating to measures to encourage the uptake of retrofit abatement equipment in existing vehicles.

1.9. It is advised that local authorities give regard to all guidance documents on local air quality measures rather than just this one. Each one contains important information, some of the guidance overlaps between documents and local authorities are also strongly recommended to follow the general guidance on the economic principles of local air quality assessments regardless of the measure being considered.

1.10. It is highlighted that the specific measures in the guidance are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant policy guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries. Where possible this guidance document therefore presents relevant details of this experience in order to highlight current practice in implementing LEV schemes.

1.11. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk)

1.4 Definitions of Low Emission Vehicle Schemes

Local Incentive Schemes for the Uptake of Low Emission Vehicles

1.12. These are schemes that promote the use of LEVs above other vehicle types. There are already a number of national schemes of this type such differentiating vehicle excise duty (VED) according to carbon dioxide (CO_2) emissions. This guidance therefore focuses on actions local authorities could take to incentivise the uptake of LEVs.

1.13. A scheme may be implemented in a geographically defined area where the most polluting vehicles are restricted, deterred or discouraged from access and use. The aim is to reduce the number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria, with the aim of improving the air quality.

Low Emission Vehicles

1.14. There is currently no universal definition of a LEV. All current definitions are expressed in relative terms; i.e. replacement by a LEV could mean replacing any existing vehicle with any vehicle that has lower emissions.

1.15. For any given scheme it is important to define the LEV in terms of the desired outcome in emission and/or air quality terms. This means that the LEV must be defined in terms of an emission standard or standards. The standard could include one or more of the following possibilities.

- So-called Euro standards that regulate emissions of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC) and particulate matter (PM) from conventional petrol and diesel powered road vehicles.
- Vehicle Excise Duty banding A-M which defines vehicles in terms of their CO_2 emissions.
- It may also be possible to set less formal emission standards associated with non-conventional powered road vehicles such as hydrogen or electric powered vehicles. However, such an approach may promote one technology above others whereas Euro standard and VED-based emission standards are technology neutral. Local authorities are recommended to adopt technology neutral approaches to allow vehicle operators to comply with standards by the most cost-effective route for them.

1.16. It should be noted that Defra and DfT are considering how local authorities should approach vehicle classification to ensure that there is a level of consistency between schemes. This work may also be relevant to LEV standards as a consistent standard may increase the effectiveness of specific schemes by allowing the realisation of economies of scope across different schemes.

1.17. For example, a local authority may decide to provide an incentive for light duty vehicles (LDVs) that comply with a given Euro standard and/or achieve a given VED banding or better. It is important that local authorities define both these standards and the year in which they must be achieved in order to qualify. Clearly there will be co-benefits from setting standards that address both local pollutant and CO_2 emissions and local authorities are recommended to follow this dual approach when considering LEV schemes.

1.18. The analysis within the revision of the UK Air Quality Strategy found a significant net benefit (£63-£112 million annually for the UK, a benefit to cost ratio of around two) may accrue from a policy to incentivise the uptake of diesel and petrol cars with emissions better than the Euro 4 standard and with CO_2 emissions better than the then current voluntary threshold within the manufacture industry (140g/km). Local authorities are encouraged to consider LEV schemes around this level of ambition. This approach is expanded upon in section 1.5 below.

Incentives and enforcement

1.19. In the context of these schemes, ‘incentives’ could mean there being one of the following:

- penalties for the use of non-LEVs;
- discounts for the use of LEVs;
- a mixed situation where high emitters are penalised and low emitters are given discounts. Such a scheme could potentially be fiscally neutral.

1.20. This guidance will focus on enforceable restrictions of traffic and parking on the public highway and planning obligations to control vehicle use and parking at private development sites via penalties or discounts, as a basis for setting up a LEV scheme.

Overlap with other guidance

1.21. From the definitions above it is seen that there is an overlap with the Practice Guidance on LEZ; i.e. these types of scheme promote the use of LEVs via access or parking controls. This guidance includes summary information from the practice guidance on LEZ where appropriate. However, it is recommended that the other practice guidance on LEZ be considered for a more complete set of recommendations concerning encouraging the uptake of LEZs.

1.5 Economic rationale for Low Emission Vehicle uptake schemes

1.22. The economic rationale for LEV schemes is linked to the external costs of operating a high polluting vehicle. Those undertaking polluting activity are placing costs on society as a whole through adverse health impacts and damage to ecosystems and the wider environment. The separation of private transport benefits and public impacts means that individuals are likely to undertake transport beyond the socially-optimal level, unless there is an intervention. To address this, in relation to air quality for example, there are specific concentration limit values that have been defined and implemented to prevent unacceptable societal damages. Schemes described in this guidance document seek to provide additional incentive in order to make progress towards the limit values by reducing the external costs of transport.

1.23. Low Emission Vehicle incentive schemes are focussed on replacing the use of high emitting vehicles with ones with lower air pollutant emissions. The main impacts of such behavioural changes are likely to be:

- reduced emissions and improved air quality, hence contributing to UK environmental, health and economic objectives;
- reduced consumer transport costs from using more efficient modes of transport;
- higher vehicle replacement costs but overall improved fuel efficiency.

1.24. A LEV policy scenario was studied during the revision of the UK Air Quality Strategy (Defra, 2007). The scenario assumed that from 2006 onwards diesel and petrol cars when replaced are replaced by new cars with emissions that are better than Euro 4 standard for NO_x and PM_{10} and better than the current industry voluntary agreement for carbon. Relative to a Euro 4 car (diesel all road types) this would be equivalent to an 80% reduction in NO_x, 92% reduction in PM_{10} and 29% reduction in CO_2 emissions. The equivalent values for petrol cars are 38% NO_x reduction, 0% PM_{10} reduction and 34% CO_2 reduction. These values clearly demonstrate the significant potential for emissions reductions under this definition of a LEV.

1.25. Assuming a 20% take-up rate in diesel LEVs by 2020 and a 25% take-up rate in petrol LEVs by the same date, modest improvements in NO_2 and PM_{10} concentrations were estimated. It should be noted that the national modelling approach cannot address all locally identified concentration hot-spots so that the localised impact of the LEV scenario may have been underestimated in the national analysis. Significant health benefits were estimated to accrue from the LEV scenario.

1.26. The additional cost of the engine technology within LEVs was estimated at between £600 and £1,200 per vehicle. Note that to some extent this additional cost would be offset to a large extent by improved fuel efficiency meaning cheaper unit travel costs. Both cost impacts were included in the Air Quality strategy analysis.

1.27. Comparison of the costs and health benefits found overall annual net benefits in the range £60-£110 million. The conclusion of the national level analysis is that an LEV incentive scheme could deliver substantial net benefits. The substantial emissions reductions relative to Euro 4 vehicles is likely to also have a significant beneficial effect on air quality in concentration hot-spots (AQMAs). Under this rationale, local authorities are therefore encouraged to consider LEV schemes consistent with the Air Quality Strategy definition: diesel and petrol cars when replaced are replaced by new cars with emissions that are better than Euro 4 standard for NO_x and PM_{10} and better than the current industry voluntary agreement for carbon. From 2008 onwards even more stringent Euro standards such as Euro 5 requiring reductions in NO_x emissions will come onto the market. Therefore, in future years the definition of an LEV should focus on achieving Euro 5 standards and better.

1.28. The guidance document on LEZ concludes that vehicles commonly targeted in a scheme with enforceable emissions-based restrictions are Heavy Duty

Vehicles (HDVs) (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. Information in the guidance illustrated the key points that schemes should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Therefore, between now and 2010-2012 a Euro III standard should be considered as the minimum standard for LEZ schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing with time.

2 Options for Low Emission Vehicle uptake schemes

2.1. The purpose of this chapter is to provide practical guidance on available options for LEV schemes. Options include the different legal bases under which local authorities are empowered to introduce schemes and the various aspects of scheme design such as boundaries, emissions criteria, management and enforcement. The chapter structures these options and the headings are introduced in the left hand column of the table below. The table also summarises key aspects associated with the headings and options whereas the relevant text following the table expands on this to provide more detail in each case.

Table 1: Structured options and key aspects for introducing Low Emission Vehicle uptake schemes

Scheme options	**Vehicle restrictions**	**Parking restrictions**	**Using the planning system**	**Bus fleet conditions**
Legal basis	Traffic Regulation Order (TRO) under Road Traffic Regulations Act 1984 (RTRA 1984). Enables access by permitted vehicles, which can be based on environmental criteria.	Traffic Regulation Order under RTRA 1984. Enables differential charging, which can be based on environmental criteria.	S106 agreement. Enables obligations based on environmental objectives.	Contract conditions for contracted services. Quality Bus Partnership Agreements (QBPA), Quality Partnership Schemes (QPS) or bus quality contracts (QC) for local commercial services. Enables conditions based on environmental objectives.
Scheme design				
Location of boundaries	May determine scheme capital and operating costs. Should take account of any source apportionment results and extent of activity in AQMAs by vehicle type.			
Vehicle emission standards	Recommended to be based on both: • Euro standards or vehicle age as a proxy; • CO_2 rating or engine size depending on vehicle age. Technology neutral standards allow operators flexibility in how they comply. Basing standards on in-service emissions is not practicable. Phased approach to tightening standards in future years ensures benefits continue over time.			
Management of permitted vehicles	Scheme rules must be accessible to all vehicle owners.	UK schemes have tended to focus on residents parking or season ticket holders, which provides a management	See Government policy on planning obligations – www.communities.gov.uk/publications/planningandbuilding/circularplanningo	Management of permitted vehicles is responsibility of contracting authority, local traffic authority or traffic

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system	Bus fleet conditions
		system to build upon.	bligations	commissioner depending on the approach taken.
Enforcement powers and penalties	Outside London the relevant moving vehicle offences are currently enforceable by Police. Powers under Traffic Management Act 2004 (TMA 2004) may provide civil enforcement powers to local authorities. These are necessary to effectively enforce a scheme.	Traffic Management Act 2004 now provides for the civil enforcement of most types of parking contraventions. Local authority appointed Civil Enforcement Officers can issue Penalty Charge Notices (PCN) for parking contraventions.	Guidance on enforcement of planning conditions is available at www.communities.gov.uk/documents/planningandbuilding/pdf/324923.pdf. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides guidance on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).	Responsibility for enforcement will also vary as above depending on the approach taken. Levels of penalties would range from no penalty for partnership agreements through to termination of contract or removal of licence to operate on routes covered by quality partnership or contract schemes
Vehicle detection	Various methods, which can be combined in one scheme: • manual observation; • Automatic Number Plate Recognition (ANPR) cameras (fixed sites or mobile units); • Tag and beacon or swipe-card technology[2].	Generally done by manual observation, although camera (CCTV) systems have been used.	In principal the same methods as for Traffic Restrictions would be available	In principal the same methods as for Traffic Restrictions would be available although simple manual methods will have significant advantages.

[2] It must be noted that any new on board equipment will need to be consistent with the European Electronic Tolling Service (EETS)

2.1 Legal basis for implementation

2.2. Based on this guidance note's scope of coverage the following section covers two main routes to setting up an area (or zones) with traffic or parking controls based on vehicle emission criteria:

- Traffic Regulation Orders for enforceable restrictions on the public highway; and
- Section 106 agreements as planning obligations for development sites and private land.

2.3. Apart from these authorities can also consider setting up schemes for buses or coaches using:

- quality bus partnership agreements,
- contract conditions of tendered services,
- quality partnership scheme,
- bus quality contracts.

Traffic Regulation Order - Traffic and parking orders

2.4. There are several types of enforceable restrictions that can be employed by highway authorities under current legislation. The general basis for these is the TRO. Traffic Regulation Orders are commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. For example, TRO can be used to restrict access to a given area or to certain types or weight of vehicle or during specific time periods. Traffic management schemes are typically focused on historic or busy commercial centres, where the effects of traffic on safety, noise and pollution levels can be quite dramatic, and also in sensitive residential neighbourhoods.

2.5. Highway authorities are empowered under the RTRA 1984 to make TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement. Traffic Regulation Orders are required for any enforceable restriction on the highway. They may be made under the terms of the RTRA 1984 or, for "special events", the Town Police Clauses Act 1847. The RTRA 1984 specifies what restrictions a TRO may impose. The Local Authorities Traffic Orders (Procedure) (England) Regulations 1996 lay down the legal requirements for making and implementing a TRO.

2.6. The main points relating to the making of Orders that may be used for enforceable restrictions are summarised as follows:

i The Highway Authority may restrict any/all classes of vehicle from using any road or from carrying out certain activities in any road either permanently or on certain days/dates /times, provided that it specifies a valid reason (as defined in the RTRA 1984) in the statement of reasons. They may do this by making restrictions, which prohibit, restrict or regulate the use of any road by vehicular traffic or specified classes of vehicle. Restrictions may require traffic to proceed in a certain direction, restrict waiting or loading or prohibit through traffic.

ii valid reasons for making an Order include:

a) for avoiding danger to persons or other traffic using the road or any other road or for preventing the likelihood of any such danger arising, or
b) for preventing damage to the road or to any building on or near to the road, or
c) for facilitating the passage on the road or any other road of any class of traffic (including pedestrians), or
d) for preventing the use of the road by vehicular traffic of a kind which, or its use by vehicular traffic in a manner which, is unsuitable having regard to the existing character of the road or adjoining property, or
e) (without prejudice to the generality of paragraph (d) above) for preserving the character of a road in a case where it is specially suitable for use by persons on horseback or on foot, or
f) for preserving or improving the amenities of the area through which the road runs, or
g) for any of the purposes specified in paragraphs (a) to (c) of subsection (1) of section 87 of the Environment Act 1995 (EA 1995).

2.7. As noted, under point g), the EA 1995 broadened the purposes for which a TRO might be made to include the pursuit of environmental objectives. The relevant parts from the EA 1995 are Section 36 of Schedule 22, which states that TRO can be used “with respect to the assessment or management of the quality of air”. This is relevant to a traffic or parking control scheme designed to maximise environmental benefits.

2.8. Orders can be made that apply to certain classes of vehicle, or to set up a permitting system to exempt certain vehicles from the controls. The criteria for permission (or permit) is defined by the Authority making the TRO. Therefore, it can be based on an environmental/emission standard linked to local objectives and circumstances. This approach has been used in a priority access scheme in the city of Bath.

2.9. All local authorities need to develop a parking strategy covering on- and off-street parking. Many different types of on-street parking schemes can be created under the powers provided in Part IV of the RTRA 1984. Local authorities use TROs to put parking schemes in place and appropriate traffic signs and road markings so that the public know what the restrictions mean.

2.10. A highway authority has the power to set charges for parking permits pursuant to the Road Traffic Regulation Act 1984 (as amended) and in doing so may set differential charges for different types of vehicle. In exercising its duties under the 1984 Act, a highway authority is under a duty to secure the expeditious, convenient and safe movement of traffic (including pedestrians) and suitable and adequate parking on and off the road. In meeting these duties, the highway must have regard to:

- the effect on amenities of any locality;
- the strategy prepared under s.80 EA 1995;
- any other matters appearing to the local authority to be relevant.

2.11. These matters provide a legal basis for the differential charging based on CO_2 and other emissions.

2.12. The signing of a vehicle access control scheme should be one of the first elements to consider when designing a scheme, to ensure it can be legally signed. It is important that the design of all sign faces is considered when drawing up the TRO. All signs used for a scheme should be in accordance with the Traffic Signs Regulations and General Directions and used as described in the Traffic Signs Manual. Sometimes the objectives for vehicle access control schemes have led to designs for which no suitable sign is prescribed in Traffic Signs Regulations and General Directions. In such cases it is necessary to seek authorisation for a specific sign from the DfT, before any variation to the prescribed signing takes place. Considering all the available prescribed signing must be a first step.

Planning conditions

2.13. Local planning authorities can impose conditions on planning permissions only where there is a clear land-use planning justification for doing so. Conditions should be used in a way which is clearly seen to be fair, reasonable and practicable. One key test of whether a particular condition is necessary is if planning permission would have to be refused if the condition were not imposed. Otherwise, such a condition would need special and precise justification. Unless otherwise specified, a planning permission runs with the land. Exceptionally, however, the personal circumstances of an occupier, personal hardship, or the difficulties of businesses which are of value to the welfare of the local community, may be material to the consideration of a planning application. In such circumstances, a permission may be made subject to a condition that it is personal to the applicant. Such arguments will seldom outweigh the more general planning considerations, however. See The Planning System: General Principles - www.communities.gov.uk/publications/planningandbuilding/planningsystem - for more information, including on enforcement. It should be noted that planning conditions cannot be used to require financial contributions. See Circular 11/95: Use of conditions in planning permission (www.communities.gov.uk/publications/planningandbuilding/circularuse).

2.14. Where it is not possible to include matters that are necessary for a development to proceed in a planning condition, developers may seek to negotiate a planning obligation under section 106 of the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). Planning obligations should meet the Secretary of State's policy tests set out in Circular 05/05 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations); i.e. they should be:

- necessary;
- relevant to planning;
- directly related to the proposed development;
- fairly and reasonably related in scale and kind to the proposed development; and

- reasonable in all other respects.

2.15 The use of planning obligations must be governed by the fundamental principle that planning permission may not be bought or sold. It is therefore not legitimate for unacceptable development to be permitted because of benefits or inducements offered by a developer which are not necessary to make the development acceptable in planning terms. Planning obligations are only a material consideration to be taken into account when deciding whether to grant planning permission, and it is for local planning authorities to decide what weight should be attached to a particular material consideration.

2.16. In terms of air quality, the impact of a development on air quality should be considered with regard to Planning Policy Statement 23 (often referred to as PPS23), particularly Annex 1 www.communities.gov.uk/publications/planningandbuilding/pps23annex1.

2.17. Both environmental impacts of a development and location of a development (whether it is close to a source of pollution or contributing further to an existing problem) can be taken into account as material planning considerations.

2.18. A useful document on the subject of low emission strategies - using the planning system to reduce transport emissions - has been produced by the Beacons Low Emission Strategies Group (2008). Broader guidance, aimed at ensuring that air quality is properly accounted for in local development control processes, has been produced by the NSCA (now Environmental Protection UK) as ‘Development Control: Planning for Air Quality’ (updated in 2006).

Approaches for Buses

2.19. The approaches discussed here will ultimately be affected by the progress and outcome of the Local Transport Bill, which is still being debated. Once this Bill is enacted work will begin to produce final regulations and guidance before the provisions of the Bill can commence. Local Traffic Authorities are therefore advised to monitor the progress of the Bill, regulations and guidance when considering using these approaches to regulate bus emissions.

2.20. It is also noted that local passenger transport is a function of the Passenger Transport Authorities or Executives in metropolitan areas, and county councils elsewhere whereas LAQM is a function of district authorities. This is therefore a clear case where, in two-tier authorities there will need to be close liaison between the two tiers to implement such schemes.

Quality Bus Partnership Agreement

2.21. To set up a QBPA the local authority provides and maintains facilities to improve local bus services, which helps make bus travel more reliable and attractive. In return the main bus operators using the infrastructure agree to make improvements to their fleet or service levels.

2.22. A voluntary or partnership approach to the scheme could in theory be low cost to the authority. However, QBPA generally work by both parties investing in the improvement to services, voluntary agreement on an ambitious emissions reduction programme could be easier to achieve if complementary measures are also introduced that significantly improve the commercial environment for bus operations.

2.23. It is a voluntary agreement, entered into freely on both sides, with generally a non-binding document setting out the terms. Note that agreements are constrained by general legislation such as the Competition Act 1998 but that the Local Transport Bill would, however, introduce a new competition test that could make it easier for local authorities to enter into agreements with several bus operators, rather than separate agreements with each. Examples of schemes given listed earlier in this section illustrate the actions that several authorities are undertaking to include emissions based criteria within their Agreements.

2.24. An authority could decide at any time whether they wish to try to use a QBPA approach to setting up a scheme. Taking forward a bus emission reduction strategy based on a QBPA can be divided into the following two stages.

Preparation

- Authority prepares evidence base, scenario(s) and preferred outcome for future bus fleet profiles for all local commercial service providers, tourist coach, express coach and city tour services, including:
  - Target emission reduction;
  - A possible target for carbon reduction.
- Authority prepares negotiation framework with outline of process, actions and timescales based both on a voluntary approach and using mandatory options (if they prove necessary) taking into account:
  - Target implementation dates;
  - Target emission standards (plus phasing, proportions etc);
  - Preferred timescale for achieving emission reductions (via process);
  - Key milestones en route (such as those below);
  - Any decision points related to the accompanying political processes.

Negotiation

- Authority enters negotiations with bus operators for raising emissions standards through voluntary means, within a timetable for achieving the preferred (or next-best) outcome and commitment to move to more enforceable approaches such a Quality Contract Schemes described later.
- Evaluate the proposals of the bus operators if they fall short of the Authorities preferred scenario, quantify shortfall, and make a decision if the bus operator proposals are acceptable. Assessment should include evaluation of emissions and any requests for additional expenditure on highways or roadside infrastructure.

2.25. If the negotiation route with one or more operators does not produce the result the Authority wishes for, then there are more enforceable options described later.

2.26. Quality Bus Partnership Agreement is an approach that authorities could use with smaller bus operators and authorities may wish to avoid scenarios where smaller operators are forced to be uncompetitive relative to bigger operators offering increasingly high-quality services that capture a greater market share. However, choosing the QBPA approach may mean the Council accepting that they cannot include smaller operators in any meaningful way in the scheme. The impact of smaller operators on overall emissions should be assessed in preparation for this outcome, and taken into account when decisions about which approach will be used to set up the scheme. A key issue may be whether the main bus operators will still participate in a voluntary scheme of higher emission standards even if smaller operators refuse to join.

2.27. Within the QBPA approach there could be some scope for reaching agreement with coach and city tour service providers. They are users of roadside infrastructure in the city and a business that operates from the city, and therefore may wish to benefit from infrastructure improvements.

Contract conditions of tendered services

2.28. Tendered services are time-limited contracts to provide a service for:

- subsidised public services;
- education department (i.e. school buses); and
- other contracts (for example, Park and Ride buses).

2.29. Local authorities have the power to regulate the emissions performance of tendered services including subsidised services, educational contracts and other specialised contracts. Many councils do not currently specify emissions criteria in their contracts. However pricing preference schemes (whereby commitments to operate new vehicles on the contracted routes get a preferred weighting during procurement assessments) have the effect of encouraging the use of brand new vehicles on subsidised bus routes when their contracts are renewed. It is considered possible that authorities could vary such pricing preference schemes to encourage the uptake of abatement equipment as well as the use of new vehicles where appropriate. Subsidised public services are regulated by Bus Service management function within local authorities.

2.30. To fully understand the timeline and decision points for influencing the tendered service bus fleet, it will be necessary to catalogue each of the tendered service contracts, noting the number of vehicles, anticipated vehicle mileage, duration of contract and contract end date. This will show the scope and future opportunities for influencing the take-up of newer vehicles. It is suggested that this work could be done in parallel with any preparation work for negotiation on commercially operated services, though the QBPA.

Quality Partnership Schemes

2.31. Statutory QPS apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). From this it follows that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, are within the definition of local service and could be regulate by this route.

2.32. It is suggested that the use of a QPS be considered in parallel to the BQPA route, as it would provide a contractual framework for the scheme should the authority decide they will provide additional infrastructure and investment for bus services in the city in exchange for faster than currently planned fleet turnover.

2.33. Under a statutory QPS, the local authority - for these purposes, county councils, unitary authorities and Passenger Transport Authorities - draws up a scheme, aimed at implementing the policies in its local bus strategy. The bus strategy forms part of the local transport policies required under section 108 of the Transport Act 2000. A QPS in effect represents a commitment on the part of the authority to provide certain facilities to improve local bus services, and to maintain them throughout the life of the scheme; and an obligation on the part of participating bus operators to meet the quality standards prescribed in the scheme when using the facilities in question.

2.34. The cost of the scheme to the authority will largely be comprised of any investment in roadside infrastructure, bus priority etc. This is probably what bus operators would prefer to see in any QBPA so the cost to the authority may not be any greater than that of the voluntary approach.

2.35. Such schemes have statutory force and would be registered with the Traffic Commissioner, who can prevent non-compliant operations from using corridor facilities. In this respect, a QPS varies from a QBPA, the latter being entirely voluntary.

2.36. The essence of a QPS is that:

- the Authority and where appropriate District Councils provide facilities to improve bus operation – including bus lanes and other priority measures and facilities like stops and shelters;
- the Authority also specifies a quality level for buses that must be met by bus operators as a condition of using the facilities provided.

2.37 Department for Transport guidance notes that the specified standard of services should be one which can be reasonably met by any operator, unless the standard is higher but the benefits derived from its application outweigh the costs of compliance. For instance, a requirement to operate buses with facilities to give a high standard of accessibility for disabled people will probably be considered reasonable, as the benefit to the travelling public would justify any operator investment. However a requirement to operate vehicles built by a particular manufacturer or to a particular design is likely to be unreasonable.

2.38. A key question is therefore what is the standard of service the main bus operators and smaller bus operators would find reasonable to offer in return for incentives by the Authority? The QPS is still a partnership between the

Authority and one or more operators, so the key question is finding out what grounds there are for reaching an agreement. As per the QBPA process, the Council(s) should determine what their minimum or target emission standard is, based on air quality impacts, in order to assess the position of any given bus operator.

2.39. The participating bus operators are then obliged to meet the quality standards prescribed in the scheme when using these facilities, and must give a written undertaking to the traffic commissioners to provide the service to the specified standard. Quality standards can relate to the vehicles to be used, and this can include the percentage of vehicles that meet a given Euro standard either due to vehicle replacement or due to retrofitting abatement equipment.

2.40. Quality Partnership Schemes address the potential problem found in voluntary approaches that operators who do not agree to raise their standards cannot be excluded from using the new facilities. Bus operators might be reluctant to enter partnerships and spend money if they can be undercut by low cost, low quality rivals. Therefore the number of vehicles provided by smaller operators and their ability to increase investment in vehicles will need to be considered by authorities. If sufficient services can be provided by those operators willing and able to meet the QPS standards, provision of bus services would not suffer as a result of some operators being excluded from using the routes/areas covered by a QPS.

2.41. Operators that choose to continue to operate along a route subject to a QPS but which are not participating in the Scheme, will need to give thought to what, if any, stopping points they observe. They will need to satisfy the Traffic Commissioner that they are neither using the facilities included in the Scheme, nor are they planning to stop in places that will create adverse traffic congestion or safety impacts.

2.42. The Act in its current form specifically excludes the Authority from specifying timetables and fares as part of the scheme. In this respect, a QPS scheme differs from the provisions of a Quality Contract (discussed later in this guidance), and QPS represents something of a half-way house between a voluntary BQPA and a QC Scheme.

2.43. The Local Transport Bill currently before Parliament would make significant changes to QPS while retaining its essential nature. In particular, it would allow Authorities to specify frequencies, timings and maximum fares in a scheme, subject to safeguards to give existing operators in the area the opportunity to object to such a proposal, and to ensure that all relevant operators are involved in subsequent fare reviews. (However, operators would not have a similar right to object to provisions about vehicle standards). The Bill also contains provisions to restrict the registration of new services, or the variation or cancellation of existing ones, in the area of the scheme if these would be detrimental to the operation of the scheme. These would not necessarily apply in every scheme, this being for the Authority to determine. The Local Transport Bill provisions would not prevent an Authority from making a scheme of the kind permitted under the existing legislation, they simply add further options. The Bill would be supplemented by regulations and guidance, drafts of which are available at www.dft.gov.uk/pgr/regional/localtransportbill/ltbdraftguidance.pdf and may be subject to consultation and further amendment

2.44. From DfT Guidance on QPS in England, the following milestones and decision points can be picked out.

- Preliminary discussions with bus operators can be anticipated to take a number of months. Local transport authorities are advised to make informal contact with bus operators at an early stage of planning a QPS, and with the Highways Agency where there is potential for impact on the trunk road network. This will ensure that the published proposals come as no surprise and that operators have a chance to comment on the feasibility and acceptability of the proposals.
- Having drafted a QPS, the local transport authority making it is obliged to publish it and undertake a formal consultation exercise in accordance with section 115 of the Transport Act 2000. The local transport authority (or authorities) would publish a notice of the proposed QPS in one or more newspapers circulating in the area it would cover. Either the notice itself must give full details of the facilities covered by the Scheme and the standard of service required, or it must state where such details may be inspected. Formal consultation does not have to last a specified length of time, so around three months could be considered sufficient.
- After giving notice, the local transport authority must formally consult the stakeholders. It is obligatory to consult:
    - all operators of local bus services that they think would be affected by the QPS;
    - organisations representing the users of local bus services (in the absence of a known local group, the local transport authority should consult the national organisation, Bus Users UK, which can be found at www.bususers.org);
    - other relevant local authorities that they think would be affected by the QPS - these include other local transport authorities, metropolitan district councils, and also, where appropriate, adjoining local transport authorities in London, Wales or Scotland;
    - the Traffic Commissioner for each traffic area affected by the QPS;
    - the chief officer of police for each police area affected by the QPS.
- The local transport authority should also consult any other persons they think fit. This could well include non-metropolitan district councils whose policies (for example on planning or on [off-street] parking) could be affected by the Scheme, and those affected by the proposed works (i.e. development of the facilities) required prior to the Scheme's commencement.
- There is no fixed time limit for consultation but sufficient time should be allowed to ensure that those who are likely to have views have a reasonable opportunity to make a considered response. Central Government's practice is to allow a minimum of 12 weeks for consultation except in cases of urgency.
- Following consultation, the local transport authority may make the QPS, either as originally proposed or with modifications. The date of coming into operation must not, in any event, be less than three months after the

date on which the QPS is made. But if one or more traffic regulation orders are needed to give effect to the Scheme then the date must also be at least three months after the date on which the order (or the latest of those orders) is made. However, these are only minimum times, and the important issue is that sufficient time is allowed for the local transport authority to provide all the necessary facilities and for operators to provide services to the specified standard.

- Once the QPS has been made, within 14 days, a further notice must be published in one or more newspapers circulating in the area to which the Scheme relates.
- Although the QPS must specify a date of coming into operation, there may be instances where, due to unforeseen circumstances, it becomes impossible to make all the necessary arrangements by that date. There is therefore a provision for postponing the date for up to (but no more than) 12 months from the original proposed implementation date.
- The Transport Act 2000 provides that a QPS must remain in operation for at least five years. There is no upper limit, but local transport authorities should bear in mind that policies and service requirements are likely to change over time and that Schemes should therefore be reviewed at reasonable intervals.

2.45. The Local Transport Bill, if enacted, will make certain changes to the provisions for QPS, and regulations and statutory guidance made under these provisions will also be relevant. However, the changes will not fundamentally affect issues concerning vehicle emissions standards.

2.46. Current progress of the Local Transport Bill can be found here, showing the latest round of reading in the Commons/Lords: http://services.parliament.uk/bills/2007-08/localtransporthl.html

Bus Quality Contract Schemes

2.47. As with QPS, statutory QC Schemes apply only to "local services" (bus services where passengers may travel at "separate fares" for distances less than 15 miles). Therefore it is reiterated that contracted schools services (i.e. not charging "separate fares") and many inter-urban long distance ("coach") services, chartered coach, etc would be excluded. However, typical "city sightseeing tours" that can be joined at a bus stop without being a pre-formed party, is within the definition of local service and so could be regulate by this route.

2.48. Smaller operators are not particularly excluded from such a scheme, but they may find it difficult to offer the level of service or investment required in competition with larger operating groups for a QC, in cases where they run an older than average fleet.

2.49. The powers of the Transport Act 2000 enable local authorities to bring forward schemes in which they can determine what local bus services should be provided in their area, and to what standards, and can let contracts with bus operators giving them exclusive rights to provide services to the authority's specification. The Authority may determine the routes, timetables, fares and ticketing arrangements for the bus services, and any other matters relating to their standards including the emissions standards of the vehicles used. The local authority, not the traffic commissioner, carries out enforcement and operation of QC contracts.

2.50. Under the existing legislation a QC scheme must relate to the implementation of a bus strategy, and the making of a scheme must be 'the only practicable way' of implementing the bus strategy. Schemes require Ministerial approval.

2.51. No schemes are currently in operation. However, the Local Transport Bill includes a number of changes to the legislation aimed at making this a more realistic option for Authorities with a good case for using it. In particular, the Bill would replace the “only practicable way” criterion with new, more objective criteria based on increasing bus use and improving service quality. In England, an Approvals Board, chaired by a traffic commissioner, would approve schemes, rather than the Secretary of State, with a right of appeal to the Transport Tribunal.

2.52. Given the lack of experience of introducing these schemes it is difficult to make sound estimates over timescales. However, DfT has estimated that a “small uncontroversial scheme” could go through the statutory processes from statutory notice prior to consultation in 15 months. “For complicated schemes we may need to add up to ten months for the tendering process and for appeal (by any operator) to the Transport Tribunal perhaps a further three months.” In addition, an approvals board that requires any scheme modifications will mean further consultation.

2.53. There are details about guidance and obligations for consultation for QC schemes set out in DfT guidance on the subject in ‘Quality Contract schemes for bus services: Guidance to English local authorities’ found via this link: www.dft.gov.uk/pgr/regional/buses/quality/. This will be revised by the Local Transport Bill in due course.

2.2 Scheme design

2.54. The starting point for the design of any LEV scheme should be the scheme objectives, i.e. the targeted replacement of older vehicles with newer lower emitting ones. Having established the objectives and indications of the potential location(s) for the zone in which the vehicles are to be regulated, there are further design considerations local authorities need to take into account. Key issues in the design of a zone where LEV are prioritised over the most polluting vehicles are organised in this section under the following headings:

- location of boundaries;
- vehicle emission standards;
- management of permitted vehicles;
- enforcement powers and penalties;
- vehicle detection.

2.3 Location of boundaries

2.55. The location of boundaries is an important component of scheme design either in cordon or area-wide schemes. An early indication of the options for boundaries may be important since significant infrastructural and operating costs (if relevant) will largely be determined by the location. The geographical extent of schemes would necessarily take into account of the conclusions of LAQM Review and Assessments that have identified which vehicle types are contributing to the level of exceedence observed in the AQMA and how much of their activity is focussed in these areas.

2.4 Vehicle emission standards

2.56. The approach for defining LEV standards on which to base enforceable restrictions (on the public highway or at development sites) could be determined in one or a combination of ways. The following criteria are relevant to schemes which target local pollutants:

- Euro standards (the term for European type approval standards for new vehicles, which includes the emission performance against a defined test cycle);
- age of vehicle/ year of first registration. Note that in practice this criteria is almost identical to the Euro standard one i.e. year of first registration can be taken as a proxy for Euro standard in almost all cases;
- a particular fuel/technology combination (if they are considered to have particular benefits, such as hybrid, gaseous or renewable fuels).

2.57. For schemes in which the CO_2 reduction is an objective then the following criteria are a relevant basis for defining permitted vehicles:

- engine size (as a proxy for fuel consumption, and hence CO_2 output); and/or
- CO_2 output.

2.58. Authorities should be aware that setting a carbon reduction objective only may be counter-productive in air quality terms since it may lead to increased uptake of diesel-engined vehicles (being in general more fuel efficient). Authorities should therefore consider whether a Euro-standard objective should be set at the same time.

2.59. Existing LEV that target local pollutants most commonly use Euro standards as the basis for setting emission criteria. In a number of cases there exist supplementary criteria to allow some exemption (or time-extensions) for retrofitting emission abatement technology. Age as a proxy for Euro standard is also a common accompanying basis.

2.60. For UK based parking schemes CO_2 emissions and engine size as a proxy of emissions are the most common focus, and some mainland European schemes include discounts for alternative fuels, and Austria (Graz) for a combination of low CO_2 and high Euro standard (for toxic pollutants).

2.61. A feature of schemes that promote the uptake of LEVs is that their local environmental benefits will reduce over time unless the defined emissions standards and incentives are reviewed and revised periodically. For example, a scheme that provides incentives for compliance with Euro IV emissions limits or better will no longer provide local benefits once all vehicles in the fleet are compliant with that standard. Therefore, local authorities should consider a phased approach whereby tighter emission standards are required in future years to qualify for the incentive. The London LEZ is an example of this approach.

2.62. Whatever the criteria used, it is essential that they are open to and operable by any normal user. This would rule out region or country specific standards that might not be available to vehicle owners across Europe.

Local Pollutant Criteria

2.63. Euro standards describe the emissions criteria that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU. Euro I vehicles began to be produced for a EC-specific type approval standard that came into force in 1993, with pre-Euro vehicles generally being those registered before this date. Note that Euro standards actually include more criteria than simply emissions and form the standards that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU.

2.64. The dates at which these standards came into force for various vehicle types are shown in Table 2 below.

Table 2: Introduction dates for European emission standards

Vehicle class	Euro 1/I	Euro 2/II	Euro 3 /III	Euro 4/IV	Euro 5/V	Euro 6/VI
Passenger cars (for example private hire taxi)	31/12/92 – 01/01/97	01/01/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class I – up to 1.3 tonnes	01/10/94 – 01/10/97	01/10/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class II/III - between 1.3 and 3.5 tonnes	01/10/94 – 01/10/97	01/10/98 – 01/01/02	01/01/02 – 01/01/07	01/01/07 - 01/01/12	01/01/12 - 01/09/16	01/09/16 -
Heavy duty - over 3.5 tonnes (inc. N2 & N3 and PSV M2 & M3)	10/10/93 – 01/10/96	01/10/96 – 01/10/01	01/10/01 – 01/10/06	01/10/06 - 01/10/09	01/10/09 -	na

2.65. It should be noted that there can be a time lag between when a vehicle is manufactured (to a particular Euro standard) in order to be Type Approved and when the vehicle is finally sold to the initial purchaser as new, and registered (with DVLA). However, it is also the case that some manufacturers can produce vehicles to a specification that will meet the next Euro standard (on emissions) before the mandatory deadline, so it is possible to purchase buses that considerably exceed Euro 4 standards before the standards for Euro 5 are fully in place.

2.66. The benefits of using Euro standards for a scheme design are that they describe the emission performance in a well defined way, based on an approved testing procedure that defines the manufacturing process. They are criteria against which any vehicle in Europe can be judged; therefore it is interoperable across countries. One drawback is that information about an individual vehicle's Euro standard is not always easy to access by its owner or the scheme operator, particularly for heavier or older vehicles.

2.67. The benefits of using age-based standards are simplicity and smooth progression (on an annual basis) of vehicles that will not comply with the scheme rules. The latter may be advantageous for forward investment and planning. The drawback is a potentially arbitrary cut-off point for vehicle moving from compliant to non-compliant status. A vehicle could be the wrong side of the age-criteria but have been manufactured to the same Euro standard as a slightly younger vehicle.

2.68. In practice, if a Euro standard basis is chosen for the scheme, it is useful to provide for some age-based proxies for vehicles when necessary in order to simplify the registration/certification process for vehicles where Euro standard information is hard to find. For example the experience from the London LEZ is that information on HDV Euro standards is not always readily available. In the UK this information is recorded for cars and vans, but not Heavy Goods Vehicles (HGV). Therefore, while the London LEZ expresses its emission criteria in terms of emissions standard in many cases vehicles are assessed using an age-as-proxy-for Euro standard. For any large-scale LEV scheme it is suggested that similar systems would be applicable in England, based on lessons learned and processes developed by Government agencies from the London implementation.

2.69. The level of a vehicle's local pollutant emissions are primarily influenced by the vehicle technology rather than the properties of the fuel. Alternative fuels do not necessarily offer air quality benefits. However, gaseous fuels generally emit less CO_2 than petrol and biofuels can offer lifecycle CO_2 emissions reductions. As a result there may be local and specific arguments for including alternative fuels and technologies in the list of compliant vehicles, perhaps if carbon reduction is a stated focus of the scheme.

2.70. It should be noted that there is no reliable approach for basing a scheme on emissions performance 'in service'. However, this has not proved a barrier to the introduction of a LEZ in the UK (London) or other European countries, as they use age and/or Euro standards as a basis.

Carbon dioxide Emission Criteria

2.71. For CO_2 focussed schemes the most common criteria engine size and CO_2 emissions can be found from vehicle registration records and for passenger cars from the VCA website (www.vcacarfueldata.org.uk/index.asp). From 1

March 2001 all new petrol and diesel cars had a published CO_2 emission level in grams per kilometre and the VED payable on these vehicles is related to their CO_2 emissions. The banding system is shown in Table 3.

Table 3: Current definition of Vehicle Excise Duty banding with carbon dioxide emissions

CO_2 Emission Value	Vehicle Band
Less than or equal to 100g/km	Band A
More than or equal to 101g/km but less than or equal to 120g/km	Band B
More than or equal to 121g/km but less than or equal to 150g/km	Band C
More than or equal to 151g/km but less than or equal to 165g/km	Band D
More than or equal to 166g/km but less than or equal to 185g/km	Band E
More than or equal to 186g/km but less than or equal to 225 g/km	Band F
More than or equal to 226g/km	Band G

2.72. Cars first registered prior to this date pay a VED rate related to their engine size. Note that this is not necessarily an accurate approximation of their unit (g/km) CO_2 emissions.

2.73. From 2009 VED will be restructured to incorporate six new bands (hence bands A-M), which will increase the financial difference between the most and least polluting cars. Further VED changes include:

- reducing the standard rate of VED in 2009-10 for all new and existing cars that emit 150g/km of CO_2 or less and increasing the standard rate of VED on the most polluting cars;
- from 2010-11, extending the zero rate of VED to all new cars that emit 130g/km of CO_2 during the first year of ownership;
- introducing a new first-year rate of £950 for new, high CO_2-emitting cars;
- aligning the alternative fuel and standard rates of VED in 2011.

2.74. Therefore all carbon-focussed schemes, even one that only includes passenger cars, should take account of the variety of ways that vehicles in the existing fleet are defined via the VED system to ensure the schemes are open and fair. The benefits of using VED bands for scheme design are that they describe the CO_2 emission performance in a well-defined way (for cars registered after 2001), based on their registration documents. The drawbacks include the difficulties including pre-2001 registered vehicles in schemes.

2.75. It is not relevant to use an age-based standard for regulating CO_2 emissions since vehicles will be defined according to their VED-banding regardless of their age – i.e. it is not possible to account for changes in fuel economy with increasing vehicle age via a simple VED-band based system.

2.5 Management of permitted vehicles

2.76. The scheme operator maintains the definition of what is a permitted vehicle. Processes are required to verify the emission standard of a particular vehicle. Certification processes may be necessary, or useful to include in a scheme if they already exist, if there is likely to be a lack of information about potential users of the scheme.

2.77. Management of the permission to enter the zone requires information and identification of individual vehicles with administration systems to cross-check permissions.

- In a large scheme covering a number of types of vehicle this would probably require the creation of a database with links to the DVLA records, as for the London LEZ.
- If a scheme is small-scale, affecting relatively few vehicles or one focussed on local fleets, then a basic permit management and verification system might be sufficient using vehicle registration documents. This might be the case for schemes focussing on bus and coach fleets or residential parking.

2.78. UK parking schemes are based on resident parking permits or season ticket holders, which provides an administrative basis for managing new users. Schemes such as Winchester discount on parking for A and B-band CO_2 rated car was limited at launch to Season ticket holders at long stay car parks. At the end of the trial period, the concept was extended to residents parking schemes in and around the city centre. The discounts are not available for short-stay Pay and Display, Park and Ride, Pay on Foot or Pay on Exit car parks. Including more open types of parking within a scheme would involve more complex management systems, and higher running costs.

2.79. Management of permitted vehicles in a scheme focussed on a development site should be more straightforward compared to the public highway. Through-traffic is not normal and all vehicles are destined for privately controlled parking. The costs of administering any scheme would be expected to be borne by the developer, or ongoing management company set up by the developer or development occupiers.

2.80. In the case of bus fleets the management and cost of maintaining information on permitted vehicles would be borne by the authority concerned with the approach adopted as follows:

- Quality Bus Partnership Agreement – the Local Traffic Authority;
- Contract conditions – the contracting Authority;
- Quality Partnership Schemes – the Traffic Commissioner;
- Quality Contract Schemes - the county council, unitary or Passenger Transport Authority.

2.81. Once a vehicle owner has checked with the scheme rules whether their vehicle complies or not they must be able to prove the status of their vehicle against the scheme rules. The vehicle registration mark (VRM) shown on the number plate can be used if this information is linked with the data used to verify the emissions criteria. Alternatively, or as a supplement, a specific sticker or plate may be issued by the scheme operator following verification of a qualifying emission standard. Relevant emission data on different vehicle types and models can be obtained from www.vcacarfueldata.org.uk/ (note that information on some vehicles is not available on this site).

2.6 Enforcement powers and penalties

Traffic and parking orders

Parking enforcement

2.82. Local authorities have long been responsible for managing all on-street and some off-street parking, whether directly or indirectly. The powers to control waiting and loading and to provide and charge for on-street parking are provided by the RTRA 1984, with various amendments since such as by the Road Traffic Regulation (Parking) Act 1986, and most recently the TMA 2004.

2.83. The Road Traffic Act 1991 significantly changed the way that on-street parking restrictions are enforced. Before 1991, the police and traffic wardens were responsible for enforcement and income from fixed penalty notices (FPNs) went to the Exchequer. However, the police service found itself increasingly unable to resource parking enforcement. The 1991 Act made it optional for local authorities (not London boroughs) to take on the civil enforcement of non-endorsable parking contraventions. When a local authority takes over this power from the police, staff employed directly or indirectly by them issue PCNs and the local authority keeps the income for operation of the scheme.

2.84. Part 6 of the TMA 2004 now provides for the civil enforcement of most types of parking contraventions. It replaces Part II and Schedule 3 of the Road Traffic Act 1991 and some local legislation covering London only. The TMA 2004 and the associated regulations have given to English authorities outside London many powers already available to authorities in London, giving greater consistency across the country while allowing for parking policies to suit local circumstances.

2.85. It is assumed that most Authorities interested in using variable parking charges to incentivise lower emission vehicles will also be those interested in taking up the powers available to them under the TMA 2004. Therefore, this guidance note is written with these latest regulations in mind and the environment of Civil Parking Enforcement that they provide.

Traffic enforcement

2.86. The TMA 2004 provides a single framework to make regulations for civil enforcement by local authorities or parking and waiting restrictions, bus lanes and some moving traffic offences. It is therefore a very important piece of legislation for local traffic authorities that wish to better manage their road networks and take on aspects of enforcement that may not be a priority for the Police.

2.87. Regulations under Schedule 7 to the Traffic Management Act 2004 would allow local traffic authority appointed Civil Enforcement Officers the powers to monitor and penalise a range of moving traffic offences such as stopping in boxed junctions and making banned turns. This would complement civil enforcement powers already available for parking management. Powers for moving vehicle enforcement may be extended in the future for authorities in England with regulations provided by DfT. Updates are available via www.dft.gov.uk/pgr/roads/tpm/tmaportal/.

2.88. Extending civil enforcements powers would enable Highway Authorities outside London to use camera evidence of traffic contraventions. This would provide such authorities parity with those in London where legislation has enabled the adoption of civil enforcement of moving vehicle contraventions.

2.89. If powers are extended by the Schedule 7 regulations then road traffic signs described by the TMA 2004 for civil enforcement might be used to sign a zone where LEVs are incentivised. For example 'motor vehicles prohibited' (sign 619) can include the supplementary text 'except for permitted vehicles'. This appears sufficient to legally sign an access control scheme.

2.90. Civil penalties for moving vehicle contraventions (under TMA 2004) may be the same as currently applied to bus lane, parking and other similar moving traffic offences. Parking penalty charges are set at different bands and levels, up to £70 outside London, with discount or further charge depending when paid. It would be appropriate for a Highway Authority to consider the level of penalty charge required for effective enforcement. A supplementary local authority circular or relevant guidance is a mechanism that would enable a variation of the PCN charge in certain circumstances.

Planning obligations

2.91. Section 106 of the Town and Country Planning Act 1990 introduced the concept of planning obligations, which comprises both planning agreements and unilateral undertakings. It enables a planning obligation to be entered into by means of a unilateral undertaking by a developer as well as by agreement between a developer and a local planning authority.

2.92. Section 106(1) provides that anyone with an interest in land may enter into a planning obligation enforceable by the local planning authority. Such obligations may restrict development or use of land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically.

2.93. Section 106(5) provides for restrictions or requirements imposed under a planning obligation to be enforced by injunction.

2.94. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides existing policy on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).

2.95. In the case of the Greenwich Peninsula development, the obligation to develop the low emission zone aspects of the development in more detail falls on the developer, and the obligation to comply is borne by the developer and the future occupiers.

Bus-based schemes

2.96. The previously discussed legal bases for bus focussed schemes included detail on which authority would have responsibility for enforcing the scheme. In summary the responsibility for enforcement will vary.

- Quality Bus Partnership Agreements are generally non-binding documents so that the ability to force non-compliant operators to comply is weak.
- Criteria for tendered services can clearly be enforced via the contracting authority via the conditions of contract.
- The Traffic Commissioner who can prevent non-compliant operations from using the facilities provided by the authority can enforce Quality Partnership Schemes.
- Bus Quality Contract Schemes would be enforced and operated by the local traffic authority and not the Traffic Commissioner.

2.97. Note that apart from QPS the local traffic authority would be responsible for enforcement; unless the district authority also lets tendered services so that they too may have responsibility. These authorities would therefore need there to be adequate systems and resources to check the compliance of vehicles. The potential penalties involved are the withdrawal of contract and any incentives associated with this.

2.7 Vehicle detection

2.98. This section identifies the likely approaches for detecting vehicles and determining which do not comply with the criteria. For traffic, parking or development control schemes it is assumed that powers under the TMA 2004 for civil enforcement of both parking and moving vehicle contraventions on the public highway are available and have been taken up.

2.99. Identification of a vehicle that complies with scheme criteria could be via a paper permit, windscreen sticker, or by the VRM on the number plate. A scheme design could require the vehicle to self-identify itself, by use of a transponder or a proximity smart card.

2.100. Detection of a vehicle for subsequent identification of emission status could be carried out by a variety of methods, sometimes in combination:

- Manual methods, whereby enforcement personnel visually check vehicles travelling within or parked within the scheme area for identification marks (VRM and/or a permit/sticker). In the mainland Europe examples of LEZ the checks would tend to focus on older looking vehicles and might use a mixture of manual recording and possibly photography. Some post-checking against a database of compliant vehicles would then be necessary.

- Digital cameras and ANPR – all passing number plates are recorded and recognised using Optical Character Recognition (OCR) for matching against a database of vehicles. A network of cameras could be installed on the key routes into/out of the boundary of the scheme and possibly at key junctions within the zone if it is very large. As a supplementary, or alternative approach, mobile ANPR cameras could be used to monitor key junctions and/or 'hot-spots' of possible non-compliance.
- Dedicated Short Range Communication (DSRC) – tags and beacons, more suitable for schemes with relatively few and pre-determined users which comply with the scheme criteria. Tags or proximity smartcards are commonly issued to vehicle owners for accessing private car parks, or can be scanned through a wind-screen, and have also been used to trigger bollards which control access on the public highway.

Manual Detection

2.101. The benefits of manual detection methods are lower capital costs, and some flexibility over future operating costs if enforcement levels can be reduced. Manual enforcement is suitable for parking schemes, whether on-street parking on development sites. A drawback of manual enforcement is the limit on the number and speed of vehicles that can be checked by a person. However, existing schemes show this approach should not be ruled out.

2.102. The London Lorry Control Scheme (commonly referred to as 'The London Lorry Ban') is an example of a successful manually enforced scheme. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month. Officers position themselves at junctions known to be attractive, but controlled, routes for HGV. In addition, they will respond to complaints from residents of vehicles 'off-route'. The main objective is deterrence and to assist HGV drivers with better route planning in order to raise compliance rates. This scheme, and those LEZ enforced manually in other European countries, indicate that manual detection could be a basis for enforcement. Detection of HDV is likely to be more successful than LDV, as HDV are larger and less numerous.

2.103. In most urban areas of the UK it might also be anticipated that compliance by bus fleets could be detected manually due to the smaller number of operators, vehicles and layover locations.

Automated Detection

2.104. The TMA 2004 regulations currently give the power to authorities throughout England to issue PCNs for parking contraventions detected with a camera and associated recording equipment (approved device). Regulations from the Act may also be prepared for moving vehicle contraventions. Cameras can only be used by Highway Authorities in a civil enforcement environment. There is current experience of using camera enforcement within London for moving traffic enforcement, and outside London for bus lane enforcement. The Secretary of State must certify any type of device used solely to detect contraventions and once certified they may be called an 'approved device'.

2.105. The benefits of such automated enforcement systems are that high speed and volume flows of vehicles can be detected and recorded, and that every vehicle can be checked. Drawbacks can include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs.

2.106. Automatic Number Plate Recognition cameras can provide one part of such an automated system. They are able to capture 90%+ of passing number plates. Automatic Number Plate Recognition cameras are used in the London Congestion Charge Scheme (CCS) and for the London LEZ. In the London CCS, images are kept for checking of vehicles whose details are not in a database of vehicles for which a charge has been paid (or registered as exempt). In order to cover 'hotspots' of non-permitted vehicles within the LEZ, mobile (van-based) enforcement units could be suitable.

2.107. There will be additional options for identification and detection of vehicles entering development sites, depending on the layout and approach for managing traffic and parking. Development sites generally have a limited number of entry and exit points, and are able to use manual or automatic barriers at these and at entrances to car parks. The road network tends to discourage through-movement, and access by non-residents or visitors. These factors enable greater opportunity for checks on vehicles. Parking permit and management systems provide opportunities for further identification and detection, to verify against a permitted vehicle database.

2.108. It should be noted that it is not strictly necessary to achieve a 100% detection level for a scheme to be effective. The level of compliance, and impact non-compliance has on emission impacts, will impact on the value for money of any scheme. However, the aim should be to achieve a balance with sufficient enforcement to provide an effective deterrent, in order to achieve the scheme objectives.

3 Developing and appraising Low Emission Vehicle schemes

3.1. Schemes may be designed using the options introduced in the previous chapter. Local authorities will need to appraise these options to make decisions on the most appropriate and cost-effective for a scheme in their area. This chapter provides guidance on the most important aspects of appraisal in particular regarding appraising the cost-effectiveness and benefits of schemes in terms of air quality objectives.

3.2. The chapter is structured as follows.

- The overall or generic effects of schemes are defined.
- A staged approach to appraising emissions and air quality effects of scheme designs introduced. Staging the appraisal may allow a number of designs to be scoped out of the appraisal at an early stage on grounds of negligible benefits.
- The important types of capital and operating costs are introduced to allow a realistic appraisal of scheme design costs and costs to operators to be drawn up during appraisal.
- Guidance on using emissions and costs data to complete cost-effectiveness and cost-benefit appraisals is then provided.

3.1 Generic Effects of the Scheme

3.3. It is likely that LEV schemes will have significant impacts on environmental objectives. Indeed improving the environment is a key objective of such schemes. The nature of the impacts will be scheme specific and depend on the scheme location and the scheme's impact on vehicle emissions by location and the composition of traffic. The environmental impacts of a scheme will also depend on the extent to which the LEV is combined with other measures. Table 4 describes qualitatively the potential impacts of these schemes.

Table 4: Qualitative assessment of the potential impacts of a Low Emission Vehicle scheme

Impact	Qualitative assessment	Notes/assumptions
Inside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	True for Euro-standard based schemes. Schemes may address NO_x and PM_{10} either individually or not.
CO_2 emissions	✓	Assuming VED-based schemes
	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	✓	Newer vehicles are typically quieter
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	X	Most schemes have low costs. Could be partly offset by revenue raised by the scheme from non-compliant vehicles
Costs to operators	X	Potential vehicle replacement costs before end of commercially useful life. Potential operating cost savings or increases
Outside scheme zone		
Pollutant emissions (NO_x, PM_{10})	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
CO_2 emissions	-	
	-	Assuming a Euro-standard based scheme
Noise	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	-	Potentially no regulatory costs outside of zone
Costs to operators	-	Potentially neutral operator costs if travel time impacts are neutral

Notes:
1. Qualitative assessment: ✓ symbolises a beneficial impact, x symbolises a negative impact, - symbolises a neutral impact.
2. Low Emission Vehicle incentive schemes are potentially unlikely to have significant non-air quality impacts. Therefore local authorities are advised to have regard to the generic guidance on the economic principles that apply when assessing these schemes. This guidance provides more detail on actions to take to assess significant non-air quality impacts.

3.2 Emissions/Air Quality Impact Assessment

3.4. Local authorities are advised to proceed through a staged process to assess the potential emissions and air quality impacts. These stages are:

- a screening stage (to identify the potential of such schemes);
- intermediate stage (consistent with LAQM methods and duties such as action planning and progress reporting);and
- detailed stage (using the webTAG from DfT on appraising road transport schemes).

3.2.1 Screening assessment

3.5. The purpose of a screening assessment is to quickly assess the potential benefits of a scheme. It is intended to be simple and to use a minimum of information that is available.

3.6. At a basic level LEV schemes are intended to replace older or more polluting vehicles with ones with more stringent emissions standards, for example, a shift from Euro II or older vehicles to Euro IV vehicles, or better. In these basic terms the potential benefit from a LEV scheme is therefore associated with the reduction in unit emissions (or emission factors).

3.7. A broad assessment could proceed as follows.

1. Define a zone inside which a LEV scheme might operate and identify those vehicle types that the scheme would seek to regulate.
2. Assemble from transport models or otherwise estimate the annual activity (veh km) of those vehicle types within the zone. One way of estimating activity is to multiply traffic volumes by link length and then to sum over all links in the zone.
3. Define a year in which the scheme may start.
4. Use the emissions factor toolkit for vehicle emissions (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) to obtain the year and vehicle type specific emission factors for NO_x and PM_{10} (g/veh km).
5. Multiply activity by emission factor to estimate the basecase emissions.

3.8. The effect of scheme depends on the emission standard set. For example, the London LEZ scheme requires HDVs to achieve at least a Euro III standard for PM_{10} by 7 July 2008.

1. The effect is to change the weighted emission factors for HDV types (see worked example in later section).
2. Recalculate the product of the activity and the emission factors to estimate the annual emissions with the scheme in operation.
3. The difference from the base-case is the potential emissions benefit of the scheme.
4. In combination with screening assessments of other schemes the relative attractiveness of each scheme in emissions terms can be compared.

3.9. Note that this simple approach to assessing LEV schemes does not address potentially important effects such as the re-distribution of traffic and the contribution to emissions from congested conditions. Intermediate or detailed assessments are advised to address these issues more fully.

3.2.2 Intermediate assessment guidance

3.10. For an intermediate assessment Local authorities are advised to have regard to the related guidance documents on generic economic principles for assessment local air quality schemes. This guidance document provides background information on emissions and air quality impact assessments. In particular it sets out recommendations on:

- developing a detailed baseline emission inventory;
- potential sources of data for the inventory;
- available tools for estimating the emission impacts of transport measures;
- having regard to the technical guidance on further assessment of local air quality for assessing compliance against the air quality objectives.

3.11. The underlying principle for emissions or air quality impact assessment is to firstly define the baseline or business as usual emissions or air quality. This is the case that currently applies and would apply in future years if no additional action were taken. Once the baseline case has been defined the effects on baseline emissions and or air quality from new policies can be assessed. Emissions and air quality assessments are technical tasks. Therefore local authorities are referred to the guidance document Local Air Quality Management Technical Guidance 2008 for additional information.

3.12. Inventory should be sufficiently detailed to allow the impacts of a range of potential policies to be assessed. A detailed emission inventory allows baseline and with-policy emissions to be calculated that account for:

- the impacts of national policies such as Euro standards for vehicle emissions;
- the impacts of local transport policy on traffic growth and other actions to which the local authority is already committed including transport policies and new developments;
- road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed;
- the contribution from stationary traffic. This allows policies that reduce congestion to be assessed;
- fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.

3.13. By assessing the impacts of measures on the baseline emissions the local authority can then more accurately assess the potential cost-effectiveness and air quality health benefits associated with the measures.

3.14. Potential sources of data from which to develop emission inventories are summarised below:

- **Source activity**: Road transport models can provide average speed and annual average daily flow data disaggregated by road link and usually split between light and heavy-duty vehicles. More detailed surveys have been used to disaggregate HDV types between buses and HGVs. Furthermore, some traffic models also provide link specific data on the daily average time that traffic is stationary at junctions and the average length of these queues. These data are necessary to estimate the potential contribution from congestion.
- **Vehicle emission factors**:
  - The Air Quality Archive local authority emissions toolkit (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) has tools that allow calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. This tool also calculates emission factors in future years.
  - Local authorities may also consider using the tool Defra has developed to be used by local authorities in calculating emissions of NO_x and PM_{10} under the new performance indicator framework (i.e. NI 194: Air quality – percentage reduction in NO_x and primary PM_{10} emissions through local authority's estate and operations) www.defra.gov.uk/environment/airquality/local/indicator.htm. This tool can be used to indicate the potential difference in emissions due to replacement by one vehicle type with another or due to a reduction in annual mileage.

Specific fleet inventories:

3.15. In the case of specific and relatively small fleets (such as the local authorities own fleet or commercially operating bus fleets) it is recommended that a specific fleet inventory is developed. A key reason for this is that the distribution of vehicle ages within these fleets can typically vary quite significantly from the national average age distribution. For example, the local bus fleet may be significantly older or younger than the national average. For better accuracy it is therefore recommended to list the age and abatement equipment of each vehicle. In these cases local authorities should attempt to work in partnership with commercial and other fleet operators to obtain the relevant data.

3.16. Other key factors in the inventory: To be useful as a policy assessment tool, local authorities are advised to consider including the following additional capabilities in their local inventories.

- Compliance rates. Depending on the range of regulatory approaches being considered to enforce a local measure (strong or weak) then a greater or lesser rate of compliance may be expected. If this is a significant factor then local authorities should include the capability within their inventory for assessing the emissions impact of compliance rates less than 100%.
- Compliance year (or year that the measure under consideration would come into force). Natural vehicle replacement rates mean that on average the national fleet unit emission factors decrease over time. If the compliance year is in the future then local authorities are advised to

include this effect in their inventory. Otherwise the inventory is likely to overestimate the potential emissions impact of a local measure.

Air Quality Assessment

3.17. Air quality assessments use monitoring, dispersion model and Geographical Information Systems (GIS) data to assess a) where the air quality objectives are exceeded and b) whether there is relevant exposure at these locations. The methods to be used in these assessments are provided in detail in Local Air Quality Management Technical Guidance 2008 and local authorities are recommended to have regard to this guidance.

3.18. For assessing the effects of local measures it is most appropriate to consider the exercise as a formal Further Assessment i.e. this is the most detailed of review and assessment technical activities and is designed to estimate the contribution of different sources to the local air quality (source apportionment).

3.19. An appropriate further assessment allows air quality arising from baseline and with-policy cases to be calculated that account for the same criteria as those described for detailed emission inventories. By assessing the impacts of measures on the baseline air quality the local authority can then more accurately assess the potential effect on compliance with the air quality objectives associated with the measures.

Specific guidance on assessing low emission vehicle incentive schemes

3.20. These schemes aim to change the emission factors of vehicles that circulate in an authority by promoting the uptake of newer vehicles. Therefore the emissions and air quality assessments should be designed to include the following parameters or indicators:

- annual average daily road transport activity (veh.km) disaggregated by vehicle type and road links;
- implementation year (so that future underlying changes in emission factors are accounted for);
- fleet inventories (number of vehicles, their breakdown by euro standard or vehicle excise duty band) for vehicle types affected by the measure.

3.21. During the design phase of a LEV scheme local authorities should assess the effect (or range of effects) of the scheme on these indicators. In particular the effects of requiring a minimum Euro and/or VED standard by an implementation date for specific vehicle types will be a key impact. Local authorities should include an assessment of the likely rate of compliance with the scheme, which may vary according to the ‘strength’ of the approach used to regulate the scheme. Applying these changes to the baseline emission inventory and air quality dispersion model will estimate the potential emissions and air quality benefits of the measure.

3.2.3 Detailed assessment guidance

3.22. If assessment of the scheme proceeds to the need for a formal road scheme appraisal consistent with the NATA then local authorities should have full regard for the detailed guidance on completing these appraisals.

3.23. The full Transport Analysis Guidance can be found online at www.webtag.org.uk/. Unit 3.3.3 contains the specific guidance on local air quality assessment.

3.3 Costs Assessment

3.24. The main factors that will affect a consideration of cost and timescale for setting up and operating a LEV scheme are the types or sub-categories of vehicles that are to be included (and any differences in standards), the size of the scheme and the level of technology used for detection and enforcement. Together these factors contribute much to the level of complexity of a scheme's design.

3.25. Typically, the greater the number of vehicle types within the scheme, the greater the number of vehicles, so set-up and running costs associated with a scheme will tend to rise. In broad terms, the size of the UK fleet rises proportionately from bus/coach to HGV to Light Goods Vehicles (LGV) (vans) to passenger cars. Therefore, a scheme which includes only HDV will tend to cost the scheme operator less than one which only includes passenger cars, all other things being equal. This does not yet take into account operator costs. This relationship fits well with the known contribution to emissions (per vehicle) that tends to show that, due to engine size and power output, each HDV produces more pollutant emission than each passenger car.

3.26. A larger scheme will tend to cost more to set up and operate, if all other factors remain equal. Hence, a small number of strategic access points that effectively controls most of the cross-city traffic or parking in a historic urban area is considerably cheaper than a large city centre scheme with urban dual carriageway through-routes.

3.27. The third major factor is the level of technology used. High technology schemes, based on ANPR cameras, will tend to have greater set-up and running costs than paper or sticker-based schemes. However, the relationships is not as simple as that because issues around detection/compliance rate mean that a scheme's more costly operating basis (i.e. technology) may be more *effective* to the extent it is actually more cost-effective. So, for example, there may be concerns about a windscreen sticker-based system working in the UK context. However, if a windscreen sticker-based system works effectively in the UK context, it will tend to be more cost-effective than one closely monitored by camera systems.

3.28. These three factors (vehicle type, scheme size and technology basis) will tend to interact with one another to produce variations in complexity, and hence cost.

3.29. Considering the various cost elements that might be relevant to any scheme, we can divide these into capital costs (i.e. set-up or investment costs) and operating costs. A list of generic cost categories is set out in Table 5.

Table 5: Potential cost items for Low Emission Vehicle set-up and operation

Capital costs	Operating costs
• Scheme design and planning • Legal/ set-up costs • Consultation process • Marketing and information campaign • Traffic management / safety • Roadside equipment (signing, detection, enforcement) • Central administration and IT systems (vehicle record, certification, enquiry handling)	• Accommodation • Staff costs • Any new vehicle identification method (for example windscreen stickers) and the issuing process for this • Equipment / software replacement and maintenance costs • Supplies, services and transport

3.4 Cost-effectiveness and cost-benefit Assessment

3.30. Cost-effectiveness analysis and Cost-Benefit Analysis are both methods for economic appraisal. The Practice Guidance on Economic Principles provides more detailed information on these techniques and how to use them. This section summarises the key points.

3.31. Cost-effectiveness compares different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. However, such a cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently.

3.32. Cost-benefit analysis assesses whether the total benefits of a project or policy exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence. The results of a cost-benefit analysis can then be used to update the cost-effectiveness analysis to consider all environmental goals, by working with ‘net’ cost-effectiveness, where the capital and scheme costs are expressed net of all environmental costs or benefits, before the cost-effectiveness ranking.

3.33. Note that these two techniques can be complementary. Cost-effectiveness is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals.

3.34. In order to undertake either cost-effectiveness analysis or cost-benefit analysis, it is necessary to collate and assess information on costs for use in an economic framework. It is highlighted that practitioners often confuse financial and economic appraisal. An economic appraisal considers the costs in terms of society as a whole and the overall value for money. A financial appraisal looks at the affordability of a proposal, and is more likely to be more familiar as it will be similar to local budgetary framework, financial costs and accounts (an accountancy based perspective). For any scheme, both the economic and financial case for a proposal will be important, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable. However, for cost-effectiveness analysis and cost-benefit analysis, the economic assessment should be used. The Practice Guidance on Economic Principles provides more details.

3.35. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. The Practice Guidance on Economic Principles provides details of how to analyse cost information so it can be used in cost-effectiveness and cost-benefit analysis. This is likely to require some analysis of cost data (including future costs). It is also necessary to work within an economic framework in the assessment of costs, which requires analysis of all costs (not just those that occur to the local authority in the local authority area), and has to exclude all transfers, such as VAT, taxes or charges. The Practice Guidance on Economic Principles provides more details.

3.36. To undertake a scoping cost-effectiveness analysis, the annual emissions benefits of a measure, as estimated using the approach set out in the previous section, are combined with the cost data, where costs are expressed as an equivalent annual costs. The annual emission benefits are divided by the equivalent annual cost to give the cost (£) to reduce one tonne of emissions (cost per tonne). This gives the cost-effectiveness of a measure – and this allows different options to be compared – those with the lowest cost per tonne abated (the lower cost per tonne) are the most cost-effective. Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately, it is the cost per level of air quality improvement ($\mu g\ m^{-3}$). However, such an analysis only considers one environmental goal, and it is also necessary to consider other environmental objectives in a ‘net’ cost-effectiveness analysis to correctly prioritise measures (see below).

3.37. It is also possible to use the cost-effectiveness ranking to build up an action plan towards the reduction of an exceedence. Those measures that are most cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance.

Note, however, that cost-effectiveness works only with a single pollutant. To address this, it is possible to work with the 'net cost-effectiveness' to consider other environmental objectives. Moreover, the cost-effectiveness of a measure is only one element of the options, and other factors will be important in determining the overall ranking of measures, including the wider assessment, legal and technical issues, practicality and acceptability.

3.38. To undertake a cost-benefit analysis, the same information on emissions and costs is used, though there are important differences. First, the emissions benefits are expressed in monetary terms. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at (www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants, such as NO_x and PM_{10}) are estimated, along with the monetary values for other environmental effects such as greenhouse gas emissions, using the Government damage cost (the Shadow Price for Carbon). This is used to generate the total present value of benefits, which can be compared against the total present value of costs of the options (note cost-benefit analysis works with the total stream of costs, i.e. the present value, not the annualised costs used in cost-effectiveness analysis above).

3.39. The cost-benefit analysis simply compares the present value of the stream of benefits divided by the present value of the stream of costs, to generate a net present value (NPV). The NPV is the primary criterion for deciding whether government action can be justified, i.e. whether a scheme has a positive net present value. A higher NPV indicates an option is preferable. However, other factors will be important in determining the overall ranking of measures, including any other benefits or costs, legal and technical issues, practicality and acceptability.

3.40. The cost-benefit analysis results can be used to provide a 'net' cost-effectiveness analysis. The 'net' cost effectiveness is equal to the present value of costs less present value of benefits / by reduction in tonnes pollutant, or in the above case where the cost-effectiveness analysis is concerned with air quality targets in a given year, is equal to annualised costs less annualised benefits / by reduction in tonnes pollutant (or $\mu g\ m^{-3}$). The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other environmental objectives, i.e. reductions of other air quality pollutants or changes in greenhouse gas emissions, and so provides a more holistic overall ranking method for planning.

3.41. Previous studies have looked at the cost-effectiveness and cost-benefit analysis of retrofit schemes. These include for example, the Interdepartmental Group on Costs and Benefits (IGCB) Economic Analysis to Inform the Review of the Air Quality Strategy (www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm), the London LEZ (www.tfl.gov.uk/roadusers/lez/default.aspx). A worked example is included in the following section.

3.42. A number of studies have examined the balance of costs, benefits and the effectiveness of these schemes. A consistent set of conclusions has emerged from these studies that local authorities should consider when examining these schemes for their region.

- Cost-effective schemes and enforcement are possible for small specific parts of the fleet (such as buses and taxis) but that are typically significant emitters in AQMAs. However, they are still significant in terms of operator cost.
- Regulating emissions from larger, less regulated parts of the fleet is increasingly costly, much less cost-effective and potentially provide very few local air quality benefits.
- Overall it is judged that there may be significant air quality benefits (in terms of compliance with the air quality objectives at least) in introducing schemes to replace older diesel-fuelled HDV particularly where they undertake a significant share of the road transport activity within an AQMA or urban centre.
- This means that authorities may currently prioritise their efforts to regulate emissions via LEV incentive schemes in the following order of decreasing priority: buses and coaches>taxis>HGVs>private cars.

4 Worked example

4.1 Introduction

4.1. To illustrate how the guidance in chapter 3 may work in practice the following worked example provides guidance on assessing emissions effects, costs and cost-effectiveness and cost benefit assessment.

4.2. This worked example assumes a policy is implemented to replace existing buses with new vehicles. The example illustrates the effect of:

- varying the emission standard with which the buses must comply.
- varying the year by which buses must comply (i.e. the implementation year).

4.2 Emissions assessment

4.2.1 Do minimum or baseline case

4.3. This policy would affect buses only. The first step would be to collate information on:

- number of vehicles potentially affected;
- their age (i.e. when first registered) and whether they already have abatement equipment fitted;
- planned replacement rates (i.e. how long each is expected to remain in service).

4.4. This information is best obtained from the vehicle operators and this provides an opportunity to engage with these key stakeholders at an early stage of policy development.

4.5. It is also necessary to collate estimates of the total annual vehicle kilometres travelled by these vehicles. The total can again be calculated from data supplied by operators. Note that if the policy to retrofit abatement equipment will only be enforced in a specific zone that the total annual vehicle kilometres travelled by these vehicles in that zone should be estimated. This can be estimated by multiplying the total link length on bus routes by their annual service frequency.

4.6. Note that this example will deal with a single fleet representative of all buses operating in an area but it is possible to disaggregate this fleet according to type of bus operation (commercial, contracted, etc) and/or operator. This level of dis-aggregation may be important depending on the enforcement approach being considered and also if there are significant differences between the fleets of different operators. An example of the collated data is shown in Table 6.

Table 6: Baseline bus data

Number of buses	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8
Euro III	72	78	53	53	53	53	49	46	46
Euro III + CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total number of buses	151	150	149	149	149	149	149	149	149
Total veh.km (millions) in central zone	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Total veh.km (millions)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

CRT is Continuously Regenerating Particle Trap

4.7. Note that these data illustrate:

- the ongoing effects of existing vehicle replacement policies;
- that some Euro II and Euro III vehicles already have particulate traps fitted to abate their PM emissions. Manufacturers should be consulted for information on the abatement efficiency of their equipment. In this example the abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions. The NO_x abatement efficiency for this system is assumed to be 60%.

4.8. The next step is to calculate the trend in emission rates for the baseline case. Emission rate/speed data disaggregated by vehicle type and Euro standard are available from the National Atmospheric Emissions Inventory (NAEI) web pages. Using these rates and the data illustrated above the baseline trend in emission rates (average weighted by vehicle age and abatement equipment if relevant) can be calculated. These are presented in Table 7.

Table 7: Age and abatement-weighted emission rates at 30 kph

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83
PM (mg/km)	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63

4.9. Note that this example takes a simple view that an average speed of 30 kph is representative of bus activity. Detailed analysis should include consideration of emissions associated with bus stops, layovers and journey delays due to congestion if these are relevant to the case.

4.10. Emission rates and activity data from the first table are multiplied to estimate the baseline bus emissions in Table 8.

Table 8: estimated baseline bus emissions

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x emissions (tonnes) in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78
Total NO_x emissions (tonnes)	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74
PM_{10} emissions (tonnes) in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10} emissions (tonnes)	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23

4.11. Note that the estimates illustrate a decline in emissions over time due to vehicle replacement plans and more stringent Euro standards in new vehicles. In particular there is a large relative decrease in PM_{10} emissions between 2007 and 2008 due to the introduction of particulate filter equipment to the majority of the Euro II vehicles.

4.2.2 Estimated effect of varying the emission standard to be achieved

4.12. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting future emission standards.

4.13. From 2009 onwards there would normally be only Euro II vehicles remaining that have PM abatement fitted. This however would have no influence on NO_x emissions so that the vehicles would not be fully compliant with the Euro III standards. Also between 2009 and 2013 the fleet is almost fixed in terms of its age profile, i.e. planned investments in Continuously Regenerating particle Traps (CRT) systems and new vehicles during 2007/08 are the only major investments during the period. From 2014 onwards planned replacement of existing Euro II and III vehicles starts.

4.14. From 2008 onwards Euro V standard vehicles are increasingly available. Theoretically it would be possible for a fleet operator to buy vehicles second-hand if they are compliant with whatever euro standard is selected as the criteria for a scheme but this example assumes that replacement is always to a brand-new vehicle.

4.15. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur if the fleet had by 2010 to achieve:

a) a Euro III standard (requires all pre-Euro III vehicles to be replaced)
b) a Euro IV standard (requires all pre-Euro IV vehicles to be replaced)
c) a Euro V standard (requires all pre-Euro V vehicles to be replaced)

4.16. The tables include a calculation of the difference in annual emissions relative to the base case.

Criteria	Euro III standard								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0
Euro III	72	78	53	53	53	53	49	46	46
Euro III+CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	84	84	84	88	96	98
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	3.92	2.77	2.77	2.77	2.70	2.61	2.59
PM (mg/km)	123.53	72.52	54.30	56.34	56.34	56.34	53.89	52.06	52.06
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	12.16	8.59	8.59	8.59	8.38	8.08	8.03
Total NO_x	23.34	20.99	17.65	12.47	12.47	12.47	12.16	11.73	11.65
PM_{10} in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16
Total PM_{10}	0.56	0.33	0.24	0.25	0.25	0.25	0.24	0.23	0.23
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	0.00	3.38	3.38	3.38	3.38	1.13	0.75
Total NO_x	0.00	0.00	0.00	4.90	4.90	4.90	4.90	1.63	1.09
PM_{10} in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PM_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Criteria	Euro IV standard								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0
Euro III	72	78	53	0	0	0	0	0	0
Euro III+CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	137	137	137	137	142	144
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	3.92	1.86	1.86	1.86	1.86	1.81	1.80
PM (mg/km)	123.53	72.52	54.30	23.96	23.96	23.96	23.96	23.96	23.96
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	12.16	5.76	5.76	5.76	5.76	5.63	5.57
Total NO_x	23.34	20.99	17.65	8.36	8.36	8.36	8.36	8.17	8.09
PM_{10} in central zone	0.38	0.22	0.17	0.07	0.07	0.07	0.07	0.07	0.07
Total PM_{10}	0.56	0.33	0.24	0.11	0.11	0.11	0.11	0.11	0.11
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	0.00	6.21	6.21	6.21	5.99	3.58	3.21
Total NO_x	0.00	0.00	0.00	9.01	9.01	9.01	8.70	5.20	4.65
PM_{10} in central zone	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.09	0.09
Total PM_{10}	0.00	0.00	0.00	0.14	0.14	0.14	0.13	0.12	0.12

Criteria	Euro V standard								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0
Euro III	72	78	53	0	0	0	0	0	0
Euro III+CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	0	0	0	0	0	0
Euro V	0	11	46	149	149	149	149	149	149
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	3.92	1.75	1.75	1.75	1.75	1.75	1.75
PM (mg/km)	123.53	72.52	54.30	23.96	23.96	23.96	23.96	23.96	23.96
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	12.16	5.43	5.43	5.43	5.43	5.43	5.43
Total NO_x	23.34	20.99	17.65	7.89	7.89	7.89	7.89	7.89	7.89
PM_{10} in central zone	0.38	0.22	0.17	0.07	0.07	0.07	0.07	0.07	0.07
Total PM_{10}	0.56	0.33	0.24	0.11	0.11	0.11	0.11	0.11	0.11
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	0.00	6.53	6.53	6.53	6.32	3.77	3.34
Total NO_x	0.00	0.00	0.00	9.49	9.49	9.49	9.18	5.48	4.85
PM_{10} in central zone	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.09	0.09
Total PM_{10}	0.00	0.00	0.00	0.14	0.14	0.14	0.13	0.12	0.12

4.2.3 Estimated effect of varying the implementation year

4.17. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting the year by which standards should be achieved.

4.18. In this example it is assumed that the emission standard to be achieved is Euro III (i.e. all pre-Euro III vehicles are replaced.) The effects of requiring this change by 2010, 2012 and 2015 are examined.

4.19. Examining the baseline bus data table it can be seen that the 2010 compliance date will affect 36 vehicles, the 2012 date would also affect these 36 vehicles whereas the 2015 date will affect only eight due to the natural replacement rate of vehicles over this period. The 2012 compliance date would require similar costs to the 2010 date but since it comes two years later would have an overall lesser benefit associated with it. The 2015 compliance date is likely to require lower costs but would also have a lesser effect.

4.20. This discussion illustrates the important point that setting an early compliance date will achieve more local air quality and emission benefits but usually at higher costs.

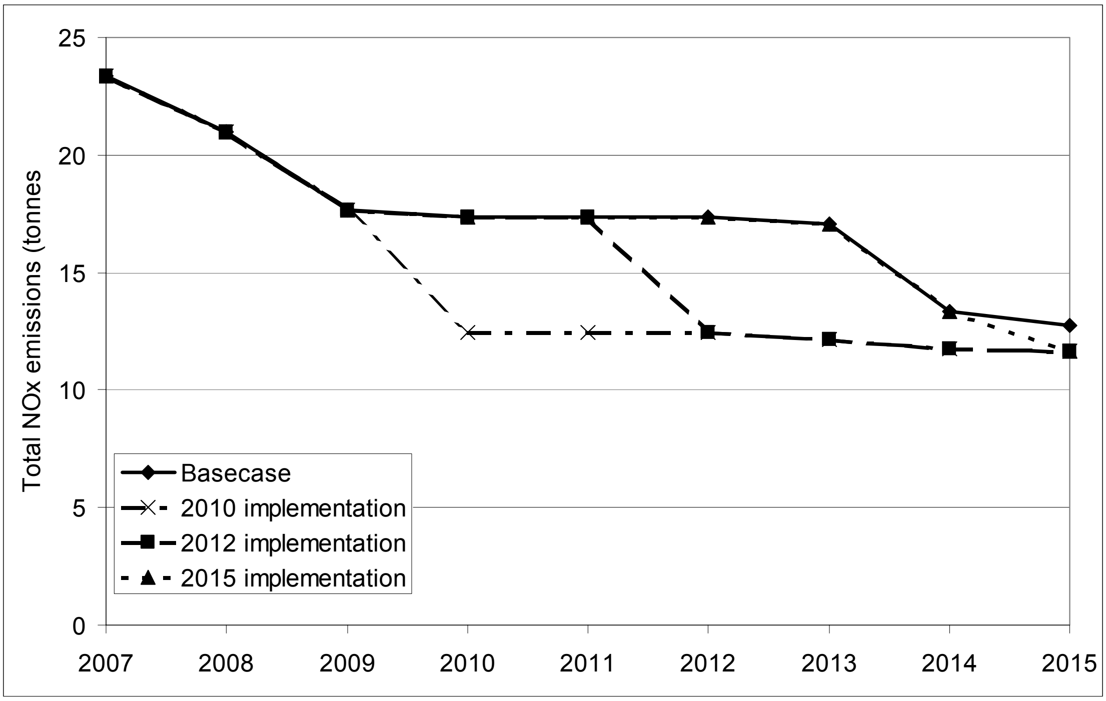
4.21. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur for the examples that if the fleet complies with the Euro III standard by:

a) 2010 (replacement of 36 Euro II vehicles)
b) 2012 (replacement of 36 Euro II vehicles)
c) 2015 (replacement of eight Euro II vehicles)

4.22. Figure 1 illustrates the trends in emissions due to the different implementation dates.

4.23. Key points to note in the graph are that the 2010 implementation date would deliver several years of benefits relative to the base case, whereas the 2012 case would deliver an identical benefit but for a shorter period. However, as time passes the gap between the base case and the Euro III standard decreases due to natural replacement of older vehicles. By 2015 the benefits due to the Euro III standard is very small. The policy of requiring the Euro III standard by 2015 would only deliver a small benefit – this policy delivers too little too late.

Figure 1: Graph of annual nitrogen oxides emissions for the base case, 2010, 2012 and 2015 implementation dates for a Euro III standard.



Criteria	2010 compliance date									2012 compliance date									2015 compliance date								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0	9	45	38	36	36	0	0	0	0	9	45	38	36	36	36	36	12	0
Euro III	72	78	53	53	53	53	49	46	46	72	78	53	53	53	53	49	46	46	72	78	53	53	53	53	49	46	46
Euro III+CRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	84	84	84	88	96	98	0	11	46	48	48	84	88	96	98	0	11	46	48	48	48	52	84	98
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																											
NO_x (g/km)	5.19	4.67	3.92	2.77	2.77	2.77	2.70	2.61	2.59	5.19	4.67	3.92	3.86	3.86	2.77	2.70	2.61	2.59	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.59
PM (mg/km)	123.53	72.52	54.30	56.34	56.34	56.34	53.89	52.06	52.06	123.53	72.52	54.30	54.41	54.41	56.34	53.89	52.06	52.06	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	52.06
Emissions (tonnes)																											
NO_x in central zone	16.08	14.46	12.16	8.59	8.59	8.59	8.38	8.08	8.03	16.08	14.46	12.16	11.97	11.97	8.59	8.38	8.08	8.03	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.03
Total NO_x	23.34	20.99	17.65	12.47	12.47	12.47	12.16	11.73	11.65	23.34	20.99	17.65	17.37	17.37	12.47	12.16	11.73	11.65	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	11.65
PM_{10} in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10}	0.56	0.33	0.24	0.25	0.25	0.25	0.24	0.23	0.23	0.56	0.33	0.24	0.24	0.24	0.25	0.24	0.23	0.23	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23
Difference from Baseline (tonnes)																											
NO_x in central zone	0.00	0.00	0.00	3.38	3.38	3.38	3.38	1.13	0.75	0.00	0.00	0.00	0.00	0.00	3.38	3.38	1.13	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
Total NO_x	0.00	0.00	0.00	4.90	4.90	4.90	4.90	1.63	1.09	0.00	0.00	0.00	0.00	0.00	4.90	4.90	1.63	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09
PM_{10} in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PM_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.2.4 Conclusions

4.24. In terms of emissions and air quality benefits the main points to be considered for any vehicle replacement policy are as follows.

1. To set an appropriate emission standard to achieve an outcome where there are local emissions reductions relative to the base case. The higher the Euro standard the bigger the potential reductions.
2. To set an appropriate implementation year to achieve an outcome where there are local emissions reductions relative to the base case. Earlier is better.
3. To consider setting further Euro standards and implementation years (i.e. subsequent phases of emission reduction) otherwise the benefits of the policies will be eroded over time by natural vehicle replacement rates.
4. That the emission standards and implementation years have to be balanced up against issues of costs but also the level of action required to achieve the air quality objectives in the AQMA.

4.3 Cost-effectiveness and cost-benefit assessment

4.25. A simple example is given below on cost-effectiveness analysis and cost-benefit assessment for low emission vehicles. Note that this example does not follow-on from the detailed emissions example above, it is a separate example to illustrate the concepts.

4.3.1 Cost-effectiveness analysis

4.26. The first example is to generate some simple cost-effectiveness values for different LEVs. The estimated capital and running costs of abatement equipment is summarised below, along with the lifetime. Note that for the economic analysis, it is the resource costs (technology costs) that are used, rather than the market prices. For the financial analysis, the market prices are relevant. The example is based on the examples given in the IGCB analysis of the Air Quality Strategy Review. They assume Exhaust Gas Recirculation (EGR) technology to LDVs and Selective Catalytic Reduction (SCR) to HDVs. In this case, the analysis considers the additional marginal cost of these technologies in new vehicles, not the absolute cost of the vehicles. The input data is shown in the example below, though note there are additional variations on these specific technologies in the full IGCB analysis.

Table 9: Cost input data

Equipment – heavy vehicle	Resource Costs (£)	Annual additive cost	Change in fuel efficiency	Lifetime
SCR (new rigid HGV)*	430 - 800	219	-6%	10 years
EGR (new LGV) *	288	12	-2%	6 years

* source: IGCB Economic Analysis to Inform the Review of the Air Quality Strategy, based on value for articulated HGVs.

4.27. In this example here, only the direct costs of the fuel penalty are included. In more in depth analysis, for example as in the case of the IGCB analysis, the additional negative impact on fuel economy is considered, as the higher costs causes less vehicle kilometres to be driven (rebound effects). These might in turn affect the emissions of pollutants (reducing them) but has other welfare effects.

4.28. The costs of these individual options over their lifetime has to be calculated, and expressed in equivalent terms, as a present value of costs. In each case, the costs in each year are multiplied by the discount factors, to allow the discounted costs to be estimated. The sum of these discounted costs gives the present value of costs. These are then converted to an equivalent annual cost for the cost-effectiveness analysis (using either the Equivalent Annualised Cost equation[3] , or the excel formula, see worksheet example). As an example, the values for the SCR estimation (low resource cost) are shown below.

4.29. As well as operating and capital costs, there are also the changes in fuel efficiency in this case. If there is a positive impact of fuel economy, the vehicle will have greater mileage per litre of fuel compared to the situation without the new technology. If there is a negative impact on fuel economy, the reverse is true. These changes lead to direct costs for the operator. Note there are also wider effects on fuel economy, because when fuel economy increases (for example), all other things being equal, the marginal cost of driving falls, this causes demand in the more fuel efficient vehicles to rise. These additional effects (the rebound effect) are not taken into account here, and require more detailed economic analysis. There are also associated welfare effects due to rebound effects, though again these are not considered here and require more detailed analysis.

4.30. In the case of the two technologies here, there is a negative impact on fuel economy, so the new vehicles will use more fuel per km compared to the comparative Euro standard. The additional fuel consumption cost is calculated based on the increased fuel use, and the resource costs of fuel, i.e. no tax is included. Data on average fuel consumption of rigid vehicles, and data on fuel prices (without tax) are available from the DfT statistics, www.dft.gov.uk/pgr/statistics/datatablespublications/tsgb/2007edition/section3energyenvironment.pdf Table 3.3 and annual mileage from Table 3.4 for rigid vehicles. Data on vehicle mileage is available from DfT road freight statistics, it is assumed that for a larger rigid vehicle , annual mileage of 50,000km www.dft.gov.uk/162259/162469/221412/221522/222944/285840/01_Road_Freight_Stats_2006_1.pdf

[3] Equivalent annualised cost = NPV multiplied by

$$\left[\frac{r(1+r)^n}{(1+r)^n - 1}\right]$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years.

Table 10: Estimation of Present Value of Costs, and Equivalent Annual Cost – Rigid Selective Catalytic Reduction

SCR	**Year (relative to base year)**									
Equipment (£)	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**
Resource cost	430									
Maintenance	219	219	219	219	219	219	219	219	219	219
Fuel penalty	1029	1029	1029	1029	1029	1029	1029	1029	1029	1029
Total	1,678	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248
Discount factor	1.000	0.966	0.933	0.902	0.871	0.842	0.814	0.786	0.759	0.734
Discounted cost	1,678	1,206	1,165	1,125	1,087	1,051	1,015	981	948	916
Present value	11,172									
Equivalent annual cost	1,343									

Source: fuel prices (no tax) from Department for Transport, Transport Statistics Great Britain (TSGB), 2007, Table 3.3 and annual mileage from Table 3.4 for rigid vehicles.
www.dft.gov.uk/pgr/statistics/datatablespublications/tsgb/2007edition/section3energyenvironment.pdf
Data on freight annual mileage is available from DfT freight statistics, for example
www.dft.gov.uk/162259/162469/221412/221522/222944/285840/01_Road_Freight_Stats_2006_1.pdf

4.31. The values for all technologies are summarised below.

Option	**SCR for rigid**	**EGR for LDV**
Present value (sum)	11,172 to 11,542	600
Equivalent annualised cost	1,343 to 1,388	113

4.32. This provides an estimate of the annualised costs of the equipment, which can be compared with the annual tonnes abated from each option, to estimate the cost-effectiveness. Again, in this case it is the marginal improvement above the alternative (associated with the technology of the LEV) that is important.

- For the SCR, abatement efficiency is assumed to lead to a 50% reduction in new NO_x emissions.
- For the EGR, abatement efficiency is assumed to lead to a 20% reduction in new NO_x emissions and a 90% reduction in PM emissions.

4.33. The annual emissions benefits of each scheme are based on the vehicles driving in urban conditions, 30 kph, are shown below from the NAEI web pages. We assume each vehicle drives 20,000 km a year in the central zone. If it is assumed that there is a constant abatement efficiency across all vehicle types and Euro standards, then the cost-effectiveness is determined by the equivalent annual cost above, divided by the annual emissions reduction. The values are shown for the SCR in Table 11.

Table 11: Cost-effectiveness Analysis Selective Catalytic Reduction

	Emissions gNO_x /km	NO_x Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne
Euro IV	3.629	0.07259		
LEV	1.815	0.03629		
Difference	1.815	0.036	1,343 to 1,388	£37,011 to £38,237

4.34. The same approach is applied to EGR for a LDV. The results, in Table 12 below, shows that for NO_x the EGR technology for LGVs is less cost-effective than SCR for rigids shown in Table 11 above. However (see above) the EGR technology tackles both pollutants. This highlights one of the problems with cost-effectiveness, as the approach can only assess one pollutant at a time. The cost-effectiveness analysis also does not take other environmental considerations into account, notably greenhouse gas emissions. It is possible to address other pollutants and greenhouse gases by estimating ‘net’ cost-effectiveness of options to correctly prioritise measures taking other objectives into account (see later discussion).

Table 12: Cost-effectiveness Analysis Exhaust Gas Recirculation

	Emissions gNO_x/km	NO_x Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne of NO_x
Euro IV	0.051	0.00102		
LEV	0.005	0.00010		
Difference	0.046	0.0017	113	£66,302

	Emissions gPM_{10}/km	PM_{10} Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne of PM_{10}
Euro IV	0.425	0.00849		
LEV	0.340	0.00679		
Difference	0.085	0.002	113	£122,764

4.35. The overall benefits of options can be assessed using assessed with cost-benefit analysis, and this highlights the complementary role for using the two together.

4.3.2 Cost-benefit analysis

4.36. The first stage in a cost-benefit analysis is to estimate the monetary value of the benefits.

4.37. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants) are estimated.

4.38. As an example, the values for annual NO_x emissions reductions from a SCR on a rigid HGV was shown above. However, in this case, it is necessary to look at the full benefits of the scheme (the full value to society) rather than the benefits that only occur in the central zone. For this, it is assumed that the vehicle also has an annual mileage of 20,000 km in the outer zone of the city. The total benefits are therefore twice as big as the table above (0.036*2 tonnes per year)

4.39. The values are then entered in the damage cost calculator. In this case, we assume a 2008 start date, a ten year lifetime, and one pollutant, NO_x.

4.40. The spreadsheet output is shown below (note benefits extend out to 2017).

1. What length (in years) is your policy appraisal?	10
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*1*
4. Input the annual changes in emissions below (in tonnes)	

15. PM T
16. PM T
17. PM T
18. PM T
19. CO_2

Year	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Change in emissions (tonnes)	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259

CALCULATED RESULTS

Central Estimate Present Value	**£ 0.00**	**Million**
	£ 640	

4.41. The central estimate is of £640 present value of benefits. These can be compared against the present value of costs in the earlier table, which were much higher. This shows that in this case, the NPV is negative (so costs are higher than benefits). However, consideration of this technology with additional particulate control would be likely to improve the NPV.

4.42. A similar analysis is undertaken with EGR abatement equipment. Note for this analysis it is necessary to include both NO_x and PM_{10} emissions benefits. Note for PM_{10} the location of the emissions has to be estimated, i.e. the split by location. The monetary benefits of NO_x and PM_{10} are added together to give the total present value of benefits, and these are compared against costs.

Table 13: Cost-Benefit Analysis Results (Air Quality only)

Equipment - bus	Present Value Benefits	Present Value Costs	Net Present Value
EGR LGV	724	600	124
SCR rigid	640	11,172 to 11,542	-10,532 to -10,902

4.43. The results show the EGR new vehicle has a positive NPV.

4.44. However, with LEVs, it is also necessary to take account of any effects on fuel consumption and greenhouse gas emissions in the cost-benefit analysis. As outlined earlier, the LEV options here lead to increases in fuel consumption compared to the baseline technology. They will therefore lead to higher CO_2 emission per km.

4.45. As well as Government values on the benefits of air quality improvements (the damage costs), there are also estimates for valuing greenhouse gas emissions. These value the wider social benefits of reductions, rather than the costs of measures and policies needed to reduce greenhouse gas emissions. The values, and guidance on use, can be found on the Defra web-site[4], under the section on the Shadow Price of Carbon (SPC), see also the Practice Guidance of Economic Principles. This guidance allows the changes in greenhouse gas emissions (and likewise if there were CO_2 benefits) to be valued in economic terms, and added to the overall cost-benefit analysis. As with the damage costs for air quality above, the shadow price of carbon is expressed as the economic benefit for a reduction of 1 tonne of CO_2 emission (or carbon dioxide equivalent (CO_2e)). In this example, the additional greenhouse gas effects are not included, but they would reduce the NPV of the options above. Similarly, for LEVs that reduced greenhouse gas emissions, this would increase the NPV.

4.46. The same approach can be used to build up the analysis of cost-effectiveness analysis and cost-benefit analysis for entire schemes, as with the emissions benefit example above.

4.47. The information from a cost-benefit analysis can also be used to consider other environmental objectives as part of a 'net' cost-effectiveness analysis. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant. The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas emissions, in the cost-effectiveness ranking and so provides a more holistic overall ranking method. In the example above, it would allow a consideration of both NO_x and PM_{10} benefits in the cost-effectiveness analysis of EGR (compared to SCR). The estimation of net cost-effectiveness analysis would take the information above from the cost-benefit analysis, but convert the present value of benefits into an equivalent annual term. This is then subtracted from the equivalent annual costs, and divided by emissions improvements, to

[4] www.defra.gov.uk/environment/climatechange/research/carboncost/step1.htm

estimate the net cost-effectiveness. This allows both pollutants (for example NO_x and PM_{10} benefits) to be taken into account when undertaking ranking options. An example of a net cost-effectiveness analysis is given in the Practice Guidance on retrofitting vehicles. Note that the net cost-effectiveness analysis should also take greenhouse gas emissions changes, and the economic benefits (from the Shadow Price for Carbon valuation) into account.

4.48. Note that there are some different issues when considering vehicle replacement, rather than just the consideration of alternative new vehicles as above. In the case where vehicles are replaced, it is important to consider what happens to the replaced vehicles. This can be very complex, and depends on operator behaviour, market values, etc. As an example, in a case where an older vehicle is retired prematurely, it is necessary to consider the useful resources that are being lost. This is usually estimated by calculating the market value of the vehicles in the year that they are being retired[5] – and the additional costs added to the calculation - though in this case the emission benefits are greater as an older vehicle with higher emissions is being retired early. There may also be other effects in such a case with changes in fuel efficiency (as above). In other cases, vehicles maybe moved to other routes (fleet switching) without retirement, or vehicle maybe sold on.

[5] This approach was used in the IGCB analysis, and reflects an estimate of the value of the service the vehicle would have provided for the rest of its lifetime, had it not been retired early.

5 Examples of Low Emission Vehicle uptake schemes

5.1. The purpose of this chapter is to provide key information on existing or planned LEV schemes. This includes a brief description of how key implementation and enforcement issues are addressed in these schemes.

5.2. Traffic control schemes are common in UK towns and cities. Linking a variety of access control schemes on sections of the public highway builds up the overall traffic management approach in many city and town centres. A small number of such traffic control schemes in the UK have either been designed to include emission criteria or have been examined for such a modification, and are therefore can be considered small-scale examples of LEV uptake schemes.

5.3. A selection of relevant schemes includes:

- buses and coaches: Quality Bus Partnerships and Quality Bus Corridors in South Yorkshire among others;
- Heavy Goods Vehicles: the London LEZ among others;
- cars: car clubs, parking charges electric and vehicle charging schemes in London and other locations.

5.4. These schemes achieve their emission objectives via a variety of routes; either by applying regulatory or access controls or charges to more polluting vehicles and discounts to less polluting vehicles, or by simply providing economic incentives to cause voluntary behaviour change.

5.5. Key summary information on the schemes is provided in Table 14 whereas more detailed information is found in the following text sections.

Table 14: Summary of key information on example schemes in this guidance

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Management of vehicle	Comments (Strengths/weaknesses)
South Yorks A6135 and quality bus corridor	QPS	Specific bus service routes	Bus fleet	Minimum number of Euro IV vehicles and review of complete fleet	Traffic Commissioner	Vehicle registration documents	Relatively simple enforcement
London bus emission strategy	Transport for London specifications	Greater London	London Bus fleets	Minimum of Euro II plus particulate filter and moving to diesel-electric hybrid vehicles in the future	Transport for London		QPS or quality contract schemes are needed outside London to exert a similar level of control over commercial services
Oxfordshire	QBPA	Oxford City	Bus fleets	Under review	Under review		A range of approaches may be necessary to regulate emissions from all relevant bus fleets
Shrewsbury	QBPA	Specific bus service routes	Commercial bus fleets	Euro II minimum with target for introducing Euro IV within five years	Agreement means no legal enforcement	Vehicle registration documents	Weak enforcement and care needed to ensure emission standards are strong enough to achieve objectives.
London - LEZ	Charge	Greater London	HDV (HGV, Coach etc), with heavy vans to be added later.	From 4th Feb. 2008, a standard of Euro 3 for PM for lorries over 12 tonnes Gross Vehicle Weight (GVW), and buses and coaches over 5 tonnes GVW. From July 2008, a standard of Euro 3 for PM for lorries between 3.5 and 12 tonnes, buses and coaches. From Oct. 2010, a standard of Euro 3 for PM for larger vans and minibuses. From Jan. 2012, a standard of Euro 4 for PM for lorries	Large network of ANPR cameras. Penalty for non-compliance and non-payment is £500/£1000 depending vehicle size.	Compliant vehicles self-registered via number plate and DVLA records. Non-standard cases and retrofit vehicles required to register vehicle, and retrofit vehicles inspected annually by VOSA. Daily charge (£200 or £100, depending on the size/type of	Phased approach to ensure tightening emission standards.

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Management of vehicle	Comments (Strengths/weaknesses)
				over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.		vehicle) for vehicles who do not comply. Retrofit for PM possible.	
Edinburgh and other car clubs	Commercial	No designated area within the authority	Private cars	Switch from individual to joint 'ownership' of cars.	None. Financial incentives	Owners registered on club database	Good financial incentives for many users. Not all urban areas economically attractive to commercial car club operators
LB Croydon and Westminster	Parking discounts	Designated parking bays in the boroughs	Private cars	Switch from conventional to zero local emission vehicles	None. Financial incentives	Register of permits	Good financial incentives for users.
LB Richmond, Winchester, Stockholm and Graz	Discounted car parking fees	Whole borough or urban centres	Private cars	Incentives to operate low carbon emitting and/or latest Euro-standard vehicles	Financial incentives	Register of permits	Good financial incentives for users.
Greenwich Peninsula	Planning obligation	190 acres of development site.	All vehicles.	Various, depending on land-use and vehicle type. Based on Euro standards.	Non compliance will be a breach of the agreement	Retrofitting of HDV possible for PM.	Management and operation is responsibility of developer.

Bus and coach schemes

South Yorkshire Public Transport Executive

5.6. A route in North Sheffield, following the A6135 between Spital Hill and Chapeltown, including Firth Park centre is part of the Sheffield QPS. As is usual in QPS new facilities have been provided for this route including new bus lane, raised kerbs for accessible boarding, new shelters and real time bus frequency and traffic management information. At the same time the QPS specifies minimum standards for the buses using these services. These standards include accessibility and safety considerations but of particular relevance is the result that 105 buses that are at least Euro III standard are operating in the scheme.

5.7. Elsewhere in Doncaster, a Quality Bus Corridor scheme operates. The conditions of the scheme require at least 18 Euro 4 standard vehicles to operate on the routes and for there to be a review of the whole fleet during 2008.

London

5.8. The London Bus Emission Strategy is a long-term programme of bus upgrading in part to improve the fleet's emissions performance. As at March 2007 there were 8181 vehicles in the fleet. In advance of the London LEZ going operational the fleet was improved via vehicle replacement and emissions abatement retrofits (further information on the London LEZ can be found in Chapter 5 of the Practice Guidance on LEZ). As a result the fleet contained 36% Euro II vehicles plus particulate filters, 61% Euro III vehicles plus particulate filters and 3% Euro IV vehicles with in-built SCR or EGR NO_x abatement (further information on retrofitting can be found in the Practice Guidance on retrofitting abatement equipment).

5.9. In addition to local pollutant emission reductions the London bus fleet priority is also to reduce carbon emissions. As a result there is now a short-medium term strategy to replace conventional diesel powered vehicles with diesel-electric hybrid vehicles and a long-term strategy to replace vehicles with hydrogen fuel-cell technology. These technologies are already under trial in London and are predicted to result in further reductions of local pollutant emissions and NO_x emissions in particular.

5.10. Current plans are to introduce 800 hybrid vehicles by the end of financial year 2011/12 and for all vehicle replacements post April 2012 to be a hybrid vehicle. Relative to a Euro IV vehicle these will be specified to achieve 80% reduction in hydrocarbons, 95% less CO, 30% drop in CO_2, 15% reduction in NO_x and be equivalent to Transport for London's (TfL) PM standard for Euro IV.

Oxfordshire

5.11. The County and City Councils has an ongoing review of the costs and effects of introducing an emissions protocol into a QBPA (and other approaches to regulating emissions from commercial bus fleets). Currently contracted bus services are let with 'price preference' conditions whereby tenders that include commitment to operate new vehicles are given additional credit when assessed. This has the effect of promoting the use of new vehicles when contracts are renewed.

Shrewsbury

5.12. A QBPA includes commitment by operators starting from 2005 to operate Euro II buses as a minimum and to renew or refurbish buses on specified routes within five years with existing buses likely to be replaced with Euro IV vehicles.

Heavy Goods Vehicles

London – Low Emission Zone

5.13. The London LEZ started operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine HDVs including lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered vehicles, thereby prioritising PM reduction. The largest number of vehicles that will potentially be affected in the first phase of the scheme are HGVs.

5.14. The LEZ commenced on 4 February 2008 for lorries over 12 tonnes, with different vehicles affected over time and tougher emissions standards due to be introduced in January 2012.

5.15. The London LEZ emission standards describe the minimum Euro standard which vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using a vehicle whose engine was type approved to this standard (or better) or by retrofitting exhaust after-treatment technology to raise the emission standard (further information on retrofitting can be found in the Practice Guidance on retrofitting abatement equipment). The standards by vehicle/weight and timescale are:

- from 4 February 2008, a standard of Euro III for PM for lorries over 12 tonnes;
- from 7 July 2008, a standard of Euro III for PM for lorries between 3.5 and 12 tonnes and buses and coaches over 5 tonnes;
- from 4 October 2010, a standard of Euro III for PM for larger vans and minibuses;
- from 3 January 2012, a standard of Euro IV for PM for lorries over 3.5 tonnes and buses and coaches over 5 tonnes.

5.16. The London LEZ actually operates as a road charging scheme. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not pay. It was set up using a Scheme Order, which is the same legal basis as the London CCS. However, it is not a congestion charge as the objective is not to reduce traffic levels.

5.17. The London LEZ began operation in 2008. Transport for London has planned a work programme that will undertake an analysis of the schemes impact and it is expected that results will be made public in due course. The scheme has been scrutinised closely during its development and a recent TfL analysis of the potential impacts of the scheme (TfL, 2007) found the following. The LEZ is anticipated to produce significant air quality benefits both within and beyond the LEZ boundary. In 2008 the scheme is expected to reduce the area of Greater London that exceeds the daily PM_{10} limit by 7% and by 15% by 2012. By 2010 the scheme is expected to reduce the area of Greater London that exceeds the annual mean NO_2 limit by 4% and by 16% by 2012. Health benefits associated with these changes are estimated to be £170-250 million due to predicted reduction in illness and extended life expectancy (years of life gained).

5.18. Further information on LEZs can be found in the Practice Guidance on LEZ. Information on a wide number of other current and planned low emission zones across Europe can be found via the EU-wide LEZ Network (www.lowemissionzones.eu). The web site provides information about network members' schemes and is a mechanism for members to publicise access restrictions on a pan-Europe basis.

Safe and Fuel Efficient Driving

5.19. The Safe and Fuel Efficient Driving (SAFED) Scheme for HGV and vans is a national scheme for training drivers in safe and fuel efficient practices. Information on the scheme can be found at www.safed.org.uk/. Although the scheme does not attempt to regulate the uptake of LEVs it does provide incentives for operators to change behaviour change that results in fuel savings. These translate into cost savings and emissions reductions so that the scheme does have a beneficial environmental impact.

5.20. The SAFED scheme provides high quality driver development training with proven, significant fuel saving benefits. Training Guides exist for both the HGV driver and van driver trainers. These are available from the Freight Best Practice programme and can be downloaded from www.freightbestpractice.org.uk or ordered from the Hotline on 0845 877 0877. In addition case studies of HGV fleets using SAFED have been published and case studies of van fleets are soon to be published.

5.21. To illustrate the potential benefits of SAFED training Leeds City Council had its van drivers trained and evaluated its annual fuel cost savings as a result of the training at £253,000 and CO_2 emission savings of 707 tonnes. In another case Salisbury District Council trained 80 van drivers and evaluated its annual fuel cost savings at £28,000 and CO_2 emission savings of 80 tonnes.

Cars

Car Clubs

5.22. Commercially run car clubs offer a cost-effective alternative to car ownership in urban areas. Club members pay a subscription fee and pro rata hourly or distance based charge to drive a club car rather than pay maintenance, tax, insurance and MOT costs associated with car ownership. Car club cars are usually recently registered vehicles and hence have among the lowest emissions of on-road vehicles in their class.

Edinburgh City Car Club

5.23. The aim of the scheme is to tackle congestion, pollution and parking pressures in the city, while recognising the importance of the car. It was originally designed as a pilot project, and received funding of £250,000 from the City of Edinburgh and the (then) Department for the Environment, Transport and the Regions (DETR) and the Scottish Office. This covered project set up costs, in-car telematics, provision of designated on street parking bays and monitoring and evaluation of the project. Further funding of £40,000 for promotion and marketing were used in a re-launch in November 2001. As of June 2005, the club was supporting 28 cars and 522 members.

5.24. Access to the cars is by Smartcard, which only allows entry to a member during a pre-booked period. A computer terminal in the car interfaces with the booking software, allowing members to make or extend bookings, as well as enabling automation of invoicing. Bookings, which can also be made by phone or internet, are by the hour, day or weekend. Members can make longer bookings at a preferential rate. Members now also have reciprocal membership of other CityCarClubs around the UK, giving them the option of using public transport for longer journeys while still having access to a car at their destination.

5.25. Membership costs £15 per month and usage rates are either around £3 per hour or 18p per mile. These rates include full comprehensive insurance and VAT costs.

5.26. Schemes also operate in Sheffield, Leeds, Bristol, Swansea, Liverpool, Manchester, Birmingham, Newcastle and other locations. Essentially the schemes are similar in providing an online booking system and flexible hire model. Costs are broadly similar across the UK. More information and case studies of UK car clubs can be obtained from http://www.carplus.org.uk/.

5.27. Carplus, the national charity promoting responsible car use, has estimated that a typical owner that drives less than 6,000 miles per year may save between £1,000 to £1500 per year at 2005 prices relative to operating their own vehicle. Increased fuel costs may translate to larger savings in 2008. Club members typically give up their car or second car on joining. On average, in the UK each car club vehicle replaces six privately owned cars. Car club members also generally reduce their annual travel. Car club vehicles are usually one to two years old and hence have lower emissions than the fleet average.

5.28. Carplus has estimated that the overall reduction in mileage and shift to newer vehicles produces savings of 0.7 tonnes of CO_2 per member per year in the UK. Savings in emissions of NO_x and PM_{10} have not been quantified or estimated. However, reduced mileage and a shift to newer vehicles would in principle deliver emissions savings in local pollutants.

Parking Controls

5.29. Historically, parking controls have been used to manage demand for scarce road space and to support the safe and efficient flow of traffic. PPG 13 notes that the availability of car parking has a major influence on the means of transport people choose for their journeys. It goes on to summarise that some studies suggest that levels of parking can be more significant than levels of public transport provision in determining means of travel (particularly for the journey to work) even for locations very well served by public transport.

5.30. A number of local traffic authorities have adjusted the operation of their parking management schemes with more specific environmental objectives that aim to discourage use of the most polluting vehicles and simultaneously incentivise lower emission vehicles.

5.31. A range of approaches to parking controls can be seen in these examples, which include discouragement and/or incentives for one or both of toxic pollutants and greenhouse gas emissions.

- City of Westminster and London Borough of Croydon parking charge discounts for electric vehicles.
  - In Westminster electric vehicles may park in a nominated car park for no cost other than an annual administration fee of £205 and a refundable £75 fee for the access key and cable equipment to allow charging. This is a saving of over £6,000 annually compared to a normal vehicle parking permit. There are 50 charging bays in car parks across the Borough and 12 on-street charging bays for this purpose.
  - Croydon offers electric vehicle operators a 50% discount on season ticket costs in council owned car parks.
  - Information on all London-based electric vehicle uptake schemes can be found at www.electricparking.com/lists.html.
- London Borough of Richmond parking permit scheme with charges based on CO_2 ratings or engine sizes.
  - From April 2007 Richmond supplies most parking permits in the Borough according to CO_2 emissions or engine capacity. For vehicles first registered before March 2001 charges are based on engine size and annual residential permits vary from £75 for engines less than 1L up to £450 for engines greater than 3L. For vehicles first registered after March 2001 charges are based on CO_2 emissions detailed on the vehicle registration and annual residential permits vary from £0 for emissions up to 100g/km and £450 for emissions greater than 225g/km. Details can be obtained from www.richmond.gov.uk/home/transport_and_streets/motor_vehicles_roads_and_parking/parking/car_parking_permits.htm.
- City of Winchester parking permit scheme discounts for vehicles in the two lowest CO_2 emission bands:
  - Annual resident parking permits are usually £22. However, if the vehicles was registered since March 2001 and is in VED band A (up to 100 g/km CO_2 emission rate) a 75% discount applies. If the vehicle is

in band B (101-120 g/km CO_2) a 50% discount applies. There is no discount for vehicles registered before March 2001 regardless of engine size.

- City of Stockholm parking discounts.
  - Annual residential parking permits normally cost around £450 in Stockholm. However, owners of electric vehicles, biomethane vehicles and hybrid vehicles do not have to pay. Over 400 vehicles have so far taken advantage of this scheme. In addition commercial enterprises can also apply for free permits if they use the city centre extensively and operate these cleaner vehicle types; an annual saving of around £700.
- City of Graz (Austria), discount on parking charges for vehicles with a combination of latest Euro pollutant emission standards and low CO_2 rating.
  - Vehicles are eligible for a 30% reduction in on-street and car park parking fees if they are of Euro IV standard and have CO_2 emissions less than 140g/km (130g/km for diesel vehicles).

Parking controls via planning obligations

5.32. The transportation aspect of development control is usually only one of a number of factors that relate to a development proposal. However, the development control process provides an opportunity to influence future use and access to a site in the medium to long term.

5.33. The Greenwich Peninsula Low Emission Strategy places restrictions on the use of more polluting vehicles, with compliance being an agreed obligation of the sale of land for development, and will also be passed directly on to dwelling purchasers.

5.34. Low Emission Zone controls are applicable to the Greenwich Peninsula development (Dome/MDL) and form part of the Section 106 legal agreement, signed on the 23 February 2004. The Greenwich Peninsula LEZ will apply to the 190 acres of land approved for development on the 17th April 2003. The LEZ will apply until the completion of the development, anticipated in 2021. A range of controls are initially outlined for different aspects of the development where an impact on air quality is envisaged.

5.35. Residential parking permits will be given to vehicles that comply with:

- affordable Housing – Euro 3 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner; and
- private Residential – Euro 4 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner.

5.36. The annual parking service charge will be free/less for compliant vehicles, with an incentive for vehicles to exceed the compliance standard. Non-compliant vehicles will be surcharged a public transport levy that will go towards initiatives aimed at encouraging residents not to own a car, for example Car Club, transport voucher, cycle voucher.

6 Conclusion

6.1. A range of schemes have been and could be developed by local authorities to directly influence the emission standards of vehicles downward in sensitive areas on the public highway or private land. Although a standard definition for LEVs has not been adopted throughout the UK or the EU the examples illustrate that incentives are potentially very high for vehicles with zero local emissions (for example, Westminster scheme). At the UK national level analysis has suggested that significant local pollutant and CO_2 emissions reduction might accrue from a significant shift towards Euro IV cars with CO_2 emissions below 140g/km in the short to medium term and that this would achieve a net benefit. For HDVs there will be significant benefits from accelerating the shift to Euro V vehicles in the medium term.

6.2. A key conclusion is that schemes that aim to reduce either air quality strategy pollutants or carbon emissions may be counterproductive in having no effect or a negative effect on the emissions not regulated by the scheme criteria. There is a greater strategic benefit in setting emissions criteria for both carbon and pollutant emissions.

6.3. Existing schemes have been implemented by a wide variety of approaches illustrating the large number of options available to local traffic authorities to introduce an element of emissions control into their policies regardless of vehicle type.

6.4. At the voluntary level authorities can encourage the uptake of LEVs via Quality Bus Partnership Schemes or Car Clubs. In both cases the authority can do much to facilitate uptake for example by seed funding Car Clubs or providing adequate facilities for Car Clubs and Bus services. The success of such approaches will necessarily rest on the efforts to engage with the vehicle operators in a detailed and constant manner.

6.5. If voluntary approaches are not realistic then there is a range of methods to encourage or compel the uptake of LEVs.

6.6. Cars emissions could be managed via discounted parking charges or residential permits or by discounts and penalties for circulating in a defined zone. These traffic and parking restrictions can be developed into such schemes by the Highway Authority, and development control schemes (supplementary planning documents) by Planning Authorities. The schemes in Westminster and Greenwich are good examples of parking and development control schemes. So far the revised London CCS and LEZ Schemes are the most developed instance of controlling emissions via traffic access restrictions but smaller schemes of these types are being considered or implemented in other area of the UK.

6.7. Traffic access restrictions may be the only practical approach to manage emissions from HGV (and could be used to manage all vehicle types) unless significant traffic could be regulated via development control schemes. Again the Greenwich Peninsula scheme is a good example of attempting to manage emissions from these vehicles as far as possible. These schemes tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Small areas, road networks with limited access points, and areas with existing traffic restrictions (for example pedestrian zones) provide the scope for adding LEV components at lower cost than areas without, and if air quality assessments justify it can be the most cost-effective areas to tackle first.

6.8. For buses there are a number of approaches are these are necessary since bus and coach services are supplied under a variety of commercial, contracted and ad hoc models. The options for regulating emissions of commercial services are changing with the advent of the Local Transport Bill. Once regulations under this are produced there should be an improved route to including emissions based criteria within QPS and QC Schemes. Emissions based contract conditions could and are being included now for contracted services in some local authorities.

6.9. Since many buses undertake a large proportion of their activity in urban centres (and by extension within many AQMAs) and since there are still many Euro III or older vehicles in fleets – local authorities are strongly encouraged to fully explore all of the available voluntary and regulatory options to manage emissions from these vehicles.

6.10. Cars are the most numerous vehicle types on the road hence large potential benefits are possible from reducing their unit emissions. They do not necessary contribute significantly in urban centres but since their use is so widespread approaches to reduce their emissions will be useful in reducing emissions and improving air quality area-wide. The approaches of Richmond and Westminster demonstrate that emissions management can be simply added to the existing parking permit schemes and could be used in a phased way to continue to reduce emissions.

6.11. Within scheme design and appraisal the environmental objectives of the scheme are a key consideration. Source apportionment should be used to determine which vehicles and which pollutants are the most relevant to target and to determine the cost-effectiveness of various options.

6.12. From existing examples, common vehicles that are targeted in a scheme with enforceable restrictions are HDV (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. The worked example in this guidance illustrated the key points that the scheme should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. However, local authorities will need to consider their own case, costs and benefits when setting emission standards and compliance dates.

6.13. Similar standards within a country are useful, but not essential to setting up and operating a LEV scheme. The Euro standards and VED CO_2 emissions banding designations are successfully used as definitions of compliant vehicles in many cases. When choosing standards, co-operation between neighbouring authorities can be useful, to harmonise standards and reduce competition between those with schemes and those without.

6.14. In traffic access control schemes the most common toxic pollutant to target is PM but this is by no means the case for all schemes particularly parking control schemes where reduced NO_x and CO_2 emissions are encouraged too. Local authorities are encouraged to consider all emissions holistically in the context of their local air quality and climate change policies and objectives.

6.15. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Unfortunately, existing systems will probably not provide a complete solution and the example LEZ showed that new systems and processes were required (see Practice Guidance on LEZs). Taking a practicable approach to completing gaps in information, and making the scheme as straightforward as possible for the user is recommended. There may need to be some trade-off between the optimum operation of a scheme (for emission reduction and cost) against ease of use and acceptance. The examples of parking permit based schemes or QBPAs illustrate that management solutions need not be complex.

6.16. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

6.17. Relevant UK parking incentives for lower emission vehicles have been based on, or adapted from, more traditional residential parking or season ticket holder schemes. This provided the local authority with a proven and existing administration system in many cases, which for only a small additional cost can be tailored to local environmental objectives. Having an existing scheme on which to base a parking incentive scheme appears to date to be a factor in successful operation. On-street pay and display parking with discounts for cleaner vehicles will require additional systems and processes, which are likely to be more costly than adapting an existing season ticket holder scheme for major off-street car parks.

6.18. Planning condition and obligation schemes can have significant potential for specific locations. The cost of designing and operating a planning condition and obligation scheme can be borne by the developer. A scheme can apply to both construction and operational phases of a development, with obligations passed on to future occupiers. Such an approach provides a useful method of incorporating vehicle specific environmental criteria into planning decisions.

6.19. The assessment of emissions, air quality, cost-effectiveness and cost-benefits of such schemes may be a necessary task in order to develop the evidence to allow decisions on such schemes to be determined. This is particularly true of schemes with either significant costs or ones that affect many vehicle operators. The guidance makes it clear that existing capacity and tools to assess emissions and air quality may have to be supplemented with specific local data to improve the accuracy of assessments. Local authorities that wish to consider LEV schemes are therefore encouraged to plan their data and assessment needs in advance of any stage where the costs and benefits of different scheme options are to be assessed.

Appendices

Appendix 1: Glossary

Appendix 2: References

Appendix 1: Glossary

ANPR	Automatic number plate recognition
AQMA	Air Quality Management Area
CCS	Congestion Charge Scheme
CO	Carbon monoxide
CO_2	Carbon dioxide
Defra	Department for Environment Food and Rural Affairs
DfT	Department for Transport
DSRC	Dedicated Short Range Communication
EA 1995	Environment Act 1995
EGR	Exhaust Gas Recirculation
FPN	Fixed Penalty Notice
GIS	Geographical Information Systems
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	Interdepartmental group on costs and benefits
LAQM	Local air quality management
LDV	Light Duty Vehicle
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
LGV	Light Goods Vehicles
NAEI	National Atmospheric Emissions Inventory
NATA	New Approach to Transport Appraisal
NO_x	Oxides of nitrogen or nitrogen oxides
NO_2	Nitrogen dioxide
OCR	Optical Character Recognition
NPV	Net Present Value
PCN	Penalty Charge Notice
PM_{10}	Particulate matter smaller than 10 microns
QBPA	Quality Bus Partnership Agreement
QPS	Quality Partnership Schemes
QC	quality contracts
RTRA 1984	Road Traffice Regulation Act 1984
SAFED	Safe and Fuel Efficient Driving

SCR	Selective Catalytic Reduction
SPC	Shadow Price for Carbon
TfL	Transport for London
TMA 2004	Traffic Management Act 2004
TRO	Traffic Regulation Order
VED	Vehicle Excise Duty
VOC	Volatile organic compounds
VRM	Vehicle Registration Mark
WebTAG	Web-based Transport Analysis Guidance

Appendix 2: References

Defra (2007). An Economic Analysis to inform the Air Quality Strategy volume 3, Updated Third Report of the Interdepartmental Group on Costs and Benefits

NSCA (2006). Development Control: Planning for Air Quality.

TfL (2007). Report to the Mayor following consultation with stakeholders, businesses, other organisations and the public on the Scheme Order 2006

ANNEX H

Planning and Environmental Policy Group

Local Air Quality Management

Practice Guidance 4

Practice Guidance to Local Authorities on Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles

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Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887
Website: www.doeni.gov.uk

Information about this publication and further copies are available from:

Department of the Environment
Calvert House
23 Castle Place
Belfast BT1 1FY
Telephone 028 90254887

Email: Stephen.kerr@doeni.gov.uk

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Executive summary

i. This guidance is principally for local authorities in England to have regard to, if relevant, in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995. This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of retrofit abatement equipment.** The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

ii. Retrofit schemes are defined area(s) or locations where the most polluting of vehicles are encouraged to retrospectively install technologies to reduce its emissions. The aim is to reduce the emissions of more polluting vehicles being used in a particular area by setting particular emission standards or criteria encouraging them to retrofit abatement equipment, with the aim of improving local air quality. A range of systems exist for vehicles that could abate particulate matter (PM_{10}) and nitrogen oxides (NO_x) emissions. Where emission criteria are expressed in technology-neutral terms (i.e. a given Euro-standard must be achieved) then retrofit as opposed to vehicle replacement can become a viable route to compliance.

iii. Schemes are operating in several UK and overseas cities. The most significant existing scheme in the UK is the London Low Emission Zone scheme which from July 2008 requires that all heavy duty vehicles achieve at least a Euro III emission standard for PM_{10}. Many operators are expected to comply with the scheme restrictions via retrofitting particulate filters.

iv. The legal approach for implementing a traffic control measure in the UK is usually by Traffic Regulation Orders under the Road Traffic Regulations Act 1984 (commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme). Local authorities can also consider voluntary approaches such as Quality Bus Partnership Schemes, contract/licence conditions to manage emissions from contracted bus services and taxi fleets or more formal regulation of local bus services via Quality Partnership Schemes or Quality Contract Schemes.

v. Schemes should be developed via appraisal and this guidance provides information on assessing emissions, air quality and costs assessments. It also provides information on using these data in cost-effectiveness and cost-benefit analyses that are consistent with a generic guidance note on appraising the cost-effectiveness of local air quality action plan measures. Local authorities are strongly encouraged to refer to this guidance note too.

vi. Schemes tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles owing to the high potential health benefits. Previous studies have demonstrated that the most cost-effective vehicles to target in a scheme with enforceable restrictions are diesel powered Heavy Duty Vehicles.

vii. Between now and 2010-2012 an equivalent Euro III standard should be considered as the minimum standard for retrofit schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local source apportionment and analysis should be used to determine which vehicles and which pollutants are the most relevant to target. This should be considered as part of the scheme design, to determine the cost-effectiveness of various options.

viii. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Examples of Low Emission Zones from mainland Europe include manual and low-tech enforcement methods as well as camera-based systems. A particular feature of retrofit schemes is the need for a robust system of certifying and identifying those vehicles that have had abatement equipment retrofitted so that they can enjoy the incentives of the given scheme. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

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1 Introduction

1.1 Purpose of this Guidance Document

1.1. This guidance is principally for local authorities in England to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995.[1] This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance on a specific transport measure – **encouraging the uptake of retrofit abatement equipment.**

1.2. The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

1.2 Background to the Guidance

1.3. The guidance has been developed to be consistent with key government guidance on appraising new policy and road transport policies in particular.

1.4. The Government Green Book requires that there should be an economic assessment of the social costs and benefits of all new policies projects and programmes. Within the Green Book and related HM Treasury guidance on assessment of the Business Case (5 Case Model), policies are considered under five components and this guidance is consistent with the Green Book as follows.

- Applicability: Retrofitting of vehicles potentially contributes towards strategic objectives in the areas of environment (air quality and climate change).
- Appropriateness: Guidance is given in this document to help develop policies for which costs and benefits are either balanced or overall beneficial in economic terms.
- Attractive: Guidance is given in this document to help authorities to prepare their commercial case for retrofitting schemes by considering scheme costs including those falling on vehicle operators.
- Affordable: Guidance is given in this document to help authorities to prepare budgets for retrofitting scheme costs.
- Achievable: Guidance is given in this document on existing examples of retrofitting schemes and key implementation issues including enforcement powers and other practical considerations.

1.5. As far as possible this guidance is also consistent with the government's New Approach to Transport Appraisal (NATA). In practical terms NATA guidance is delivered via the web-based Transport Analysis Guidance (webTAG). In

[1] Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance covers the whole of the UK.

particular this includes guidance on how to conduct a transport policy or scheme appraisal that meets the Department for Transport (DfT) guidelines. Although every care has been taken to ensure consistency if contradictions do occur, for example as guidance changes, then primacy should be given to this guidance in the consideration of air quality impacts (air quality and climate change effects) and webTAG guidance for wider transport impacts.

1.6. These sources of guidance have been consulted during the development of this guidance document so that a high degree of consistency with overarching governmental guidance on economic appraisal and road transport appraisal in particular have been achieved.

1.3 How should the guidance be used?

1.7. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMAs) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality.

1.8. Local authorities should have regard to this guidance in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are:

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009 including
    - Practice Guidance on the Economic Principles for the assessment of local measures to improve air quality,
    - Practice Guidance relating to Low Emission Zones (LEZ),
    - Practice Guidance relating to measures to encourage the uptake of Low Emission Vehicles (LEV).

1.9. It is advised that local authorities give regard to all guidance documents on local air quality measures rather than just this one. Each one contains important information, some of the guidance overlaps between documents and local authorities are also strongly recommended to follow the general guidance on the economic principles of local air quality assessments regardless of the measure being considered.

1.10. It is highlighted that the specific schemes in the guidance are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant policy guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries. Where possible this guidance document therefore presents relevant details of this experience in order to highlight current practice in implementing Incentives for the uptake of Incentives for the uptake of retrofit abatement equipment schemes.

1.11. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality

Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk).

1.4 Definitions of Retrofit Schemes

Local Incentive Schemes for the Retrofitment of Abatement Equipment

1.12. These are schemes that promote the retrofitment of emissions abatement equipment via **local** incentives. There have been a number of national schemes of this type such as the TransportEnergy CleanUp scheme (2000-2004. This guidance focuses on actions local authorities could take to incentivise the uptake of LEVs.

1.13. A scheme may be implemented in a geographically defined area where the most polluting of vehicles are encouraged to install technologies to reduce emissions of air pollutants. The aim is to improving the air quality by reducing emissions from the highest polluting vehicles.

Retrofit Emissions Abatement Equipment

1.14. Retrofit emissions abatement equipment are systems that can be applied to existing vehicles typically to reduce their particulate matter (PM) and nitrogen oxides (NO_x) emissions.

1.15. A range of systems exist and these are briefly summarised below:

Cleaner Vehicle Retrofit Options
Diesel particulate filters (DPFs) (particulate traps). These are usually fine ceramic filters that collect carbon particles. These devices are generally only acceptable with some means of self-regeneration. This may be a fuel borne catalyst or embedded catalyst within the filter. There were earlier issues with DPFs for urban driving as a certain exhaust gas temperature is required for regeneration (to burn off collected particulate material), though these have been largely resolved through lagging pipes, good oil control and catalyst size. Full flow filter traps (rather than partial traps) reduce particulate levels by around 90 to 95% based on conventional PM measurement methods. A large number of heavy vehicles were fitted with DPFs under EST's CleanUp programme. The estimated cost of such systems was considered in the Air Quality Strategy Review. It is known that particulate control technologies using oxidation catalysts lead to an increase in the proportion of NO_x emitted as nitrogen dioxide (NO_2). In order to regenerate the particulate trap (i.e. burn off the particulate matter collected), these filters convert a proportion of the nitric oxide (NO) emissions in the exhaust stream to NO_2, which is then used for trap regeneration. For diesel vehicles equipped with these filters, the proportion of NO_x emitted directly as NO_2 can be as high as 50% (compared to approximately 10% for diesel vehicles not equipped with this technology). The implication is that PM_{10} concentrations could be reduced but at the cost of increased NO_2 concentrations. **Selective catalytic reduction (SCR)**. This involves reduction of NO_x to nitrogen (N_2) using ammonia (NH_3). Reductions of 50-90% in NO_x can be achieved; some studies quote central values of 65%. Carbon monoxide (CO) and hydrocarbon emissions are also reduced. It is best suited to larger vehicles, as it is a bulky system. A number of Euro IV and V Heavy Goods Vehicles (HGVs) now have SCR fitted to meet NO_x emission limits and there is a

Cleaner Vehicle Retrofit Options
network of urea re-filling locations to support the technology. There is less experience with retrofit SCR is on a commercial basis, although trials have taken place and some London taxis have been retrofitted. A DPF could be fitted alongside SCR, but there may be space limitations in some vehicles, which could make this difficult, if not impossible. However, there is at least one commercially available system which combines DPF and SCR into a single unit. While the size of this unit may still be an issue for some vehicles, it may be worthwhile to undertake an assessment of the proportion of relevant fleets that could retrofit both a DPF and SCR unit if a strategy to reduce both PM_{10} and NO_x/NO_2 emissions is desired. . **Exhaust Gas Recirculation (EGR).** This uses a valve to recirculate the exhaust gas back into the engine. This inhibits formation of NO_x as the exhaust gas is depleted in oxygen. Exhaust Gas Recirculation is often used in conjunction with an oxidation catalyst or a particulate trap because on its own it generally leads to an increase in particulate emissions. Exhaust Gas recirculation has been fitted to all new light duty diesel (LDV) vehicles for several years but has not been fitted to HGVs (and may now be superseded by SCR for Euro 5 vehicles). Retrofitting EGR may involve upgrading the cooling system of the vehicle, and attention has so far focused on inner city buses. The addition of EGR technology can lead to up to an estimated 45% reduction in NO_x emissions. As with DPFs with embedded catalysts any EGR system using an oxidation catalyst may increase the proportion of NO_x emitted as NO_2. **Re-engining.** One strategy is to re-engine older vehicles, i.e. to replace the engine with a newer unit with lower emissions. However, the substitution of an older engine with a later engine may be complicated by necessary changes to exhaust, cooling system, transmission interface and electronic engine management. In theory the emissions reduction from re-engining is equivalent to the difference between the emissions limits of the Euro standard being replaced and the standard of its replacement. Re-engining costs vary widely with vehicle type.

1.16. There are important limitations associated with some of these systems. Firstly, abatement systems featuring oxidation catalysts have been observed to increase the proportion of NO_x that is emitted as NO_2. This means that the system may reduce PM_{10} emissions but may worsen the local air quality with respect to NO_2. Secondly, the size and costs of some of these systems are such that they may only be a cost-effective and feasible option for specific vehicles.

1.17. Local authorities and operators considering these systems should examine the impact of the limitations described and consult both manufacturers and vehicle operators before making final decisions on schemes.

1.18. The extent by which emissions may be reduced by these systems can vary significantly to achieve any given standard. To simplify the setting of targets, schemes that typically promote the uptake of retrofit equipment define either:

- the type of equipment that must be fitted and certified; or
- the Euro standard emissions limits that should be met by vehicles once they have fitted the equipment.

1.19. Local authorities may prefer the second of these definitions since operators are free to choose whichever abatement system is most suitable and cost-effective for their vehicles. A key feature of such schemes is that local authorities define both the standard and the year in which it must be achieved in order for vehicles to benefit from an incentive.

Incentives and enforcement

1.20. In the context of these schemes, 'incentives' could mean there being one of the following:

- penalties for the use of vehicles not complying with emissions standards (via abatement equipment);
- discounts for the use of vehicles complying with emissions standards (via abatement equipment); or
- a mixed situation where high emitters are penalised and low emitters are given discounts. Such a scheme could potentially be fiscally neutral.

1.21. This guidance will focus on enforceable restrictions of traffic and parking on the public highway and planning obligations to control vehicle use and parking at private development sites via penalties or discounts, as a basis for setting up a scheme.

Overlap with other guidance

1.22. There is some overlap between this document and the practice guidance documents on LEZs and LEVs; . This guidance includes information from those guidance documents where appropriate. However, it is recommended that the other guidance documents be considered for a more complete set of recommendations concerning incentivising LEZs or LEVs .

1.5 Economic rationale for retrofit incentive schemes

1.23. The economic rationale for schemes such as these is linked to the external costs of operating polluting vehicles. Those undertaking polluting activity are placing costs on society as a whole through adverse health impacts and damage to ecosystems and the wider environment. The separation of private transport benefits and public impacts means that individuals are likely to consume transport in a way that is not socially optimal, unless there is an intervention. To place a limit on this, in relation to air quality for example, there are specific concentration limit values that have been defined and implemented to prevent unacceptable societal damages. Schemes described in this guidance document seek to provide additional incentive in order to make progress towards the limit values by reducing the external costs of transport.

1.24. Retrofit incentive schemes are focussed on the addition of abatement equipment to existing vehicles thereby lowering their local pollutant emissions. The main impacts of such replacement are likely to be:

- reduced emissions and improved air quality, hence contributing to UK environmental, health and economic objectives; and
- an additional capital cost (for the abatement equipment).

1.25. Three retrofit policy scenarios were studied during the development of the UK Air Quality Strategy[2]. The scenarios assumed different uptake rates of DPFs in the UK bus, coach and HGV fleets with emissions standard Euro IV or worse from 2006 onwards. Considering scenario H3 it was assumed that the uptake would increase from 3% in 2006 up to 35% by 2012.

1.26. The emissions benefits of this uptake rate were estimated at 1005 tonnes PM_{10} nationally in 2010 and diminishing in subsequent years due to underlying vehicle turnover rates. Retrofit equipment has been considered to reduce fuel efficiency but more recent consultation with industry concluded that the effect on fuel efficiency and hence carbon emissions is neutral.

1.27. Health benefits of the order of 13-14,000 life years saved were estimated to accrue from the retrofit uptake scenario. In monetised terms this is equivalent to an annual present value of £18-26million. This result clearly demonstrates the potential for emissions reductions in the Heavy Duty Vehicle (HDV) fleet from retrofits and the benefits that may accrue.

1.28. The additional cost of the retrofit technology for HDVs was estimated at between £1350-1750 per vehicle with an additional £160-240 annual cleaning costs. Nationally these are estimated to give rise to costs of around £25million in present value terms. The best assessment comparison of the costs and health benefits found overall benefits and costs to be balanced.

1.29. The conclusion of the national level analysis is that retrofit incentive schemes could deliver substantial benefits nationally. The emissions reductions due to abatement equipment are likely to also have a beneficial effect on air quality in concentration hot-spots (AQMAs). On this basis, local authorities are therefore encouraged to consider local retrofit schemes.

1.30. Other analyses have considered retrofit strategies for complying with LEZ restrictions. They have concluded that schemes focussed on HDV emissions in urban centres offer the best outcomes in terms of cost-effectiveness. Such schemes should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Therefore, between now and 2010-2012 a Euro III standard should be considered as the minimum standard for retrofit schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing with time.

[2] Defra (2007). An Economic Analysis to inform the Air Quality Strategy volume 3, Updated Third Report of the Interdepartmental Group on Costs and Benefits.

2 Options for retrofit schemes

2.1. The purpose of this chapter is to provide practical guidance on available options for retrofit schemes. Options include the different legal bases under which local authorities are empowered to introduce schemes and the various aspects of scheme design such as boundaries, emissions criteria, management and enforcement. The chapter structures these options and the headings are introduced in the left hand column of the table below. The table also summarises key aspects associated with the headings and options whereas the relevant text following the table expands on this to provide more detail in each case.

Table 1: Structured options and key aspects for introducing retrofit uptake schemes

Scheme options	**Vehicle restrictions**	**Parking restrictions**	**Using the planning system**	**Bus fleet conditions**
Legal basis	Traffic Regulation Order (TRO) under Road Traffic Regulations Act 1984 (RTRA 1984). Enables access by permitted vehicles, which can be based on environmental criteria.	Traffic Regulation Order under RTRA 1984. Enables differential charging, which can be based on environmental criteria.	S106 agreement. Enables obligations based on environmental objectives.	Contract conditions for contracted services. Quality bus partnership agreements (QBPA), quality partnership schemes (QPS) or bus quality contracts (QC) for local commercial services. Enables conditions based on environmental objectives.
Scheme design				
Location of boundaries	May determine scheme capital and operating costs. Should take account of any source apportionment results and extent of activity in AQMAs by vehicle type.			
Vehicle emission standards	Recommended to be based on: • Equivalent euro standards • Emission abatement retrofit technology • Specific certification that vehicles comply with the standard Objective Euro-standards allow operators flexibility in how they comply since they are technology neutral. Basing standards on in-service emissions is not practicable. Phased approach to tightening standards in future years ensures benefits continue over time.			
Management of permitted vehicles	Scheme rules must be accessible to all vehicle owners. Large schemes may require	Schemes could be introduced via residents parking or season ticket holders, which provides a	See Government policy on planning obligations – www.communities.gov.uk/publications/planningandbuilding/c	Management of permitted vehicles is responsibility of contracting authority, local traffic authority or

Scheme options	**Vehicle restrictions**	**Parking restrictions**	**Using the planning system**	**Bus fleet conditions**
	database of permitted vehicles	management system to build upon.	ircularplanningobligations	traffic commissioner depending on the approach taken.
Enforcement powers and penalties	Outside London the relevant moving vehicle offences are currently enforceable by Police. Powers under Traffic Management Act 2004 (TMA 2004) may provide civil enforcement powers to local authorities. These are necessary to effectively enforce a scheme.	Traffic Management Act 2004 now provides for the civil enforcement of most types of parking contraventions. Local authority appointed Civil Enforcement Officers can issue Penalty Charge Notices (PCN) for parking contraventions.	Guidance on enforcement of planning conditions is available at www.communities.gov.uk/documents/planningandbuilding/pdf/324923.pdf. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides guidance on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).	Responsibility for enforcement will also vary as above depending on the approach taken. Levels of penalties would range from no penalty for partnership agreements through to termination of contract or removal of licence to operate on routes covered by quality partnership or contract schemes
Vehicle detection	Various methods, which can be combined in one scheme: • manual observation; • Automatic Number Plate Recognition (ANPR) cameras (fixed sites or mobile units); • Tag and beacon or swipe-card technology[3].	Generally done by manual observation, although camera (CCTV) systems have been used.	In principal the same methods as for Traffic Restrictions would be available	In principal the same methods as for Traffic Restrictions would be available although simple manual methods will have significant advantages.

[3] It must be noted that any new on board equipment will need to be consistent with the European Electronic Tolling Service (EETS)

2.1 Legal basis for implementation

2.3. Based on this guidance note's scope of coverage the following section covers two main routes to setting up an area with traffic or parking controls based on vehicle emission criteria:

- Traffic Regulation Orders for enforceable restrictions on the public highway; and
- Section 106 agreements as planning obligations for development sites and private land.

2.4. Apart from these authorities can also consider setting up schemes for buses or coaches using:

- quality bus partnership agreements;
- contract conditions of tendered services;
- quality partnership scheme;
- bus quality contract schemes.

Traffic Regulation Order - Traffic and parking orders

2.5. There are several types of enforceable restrictions that can be employed by highway authorities under current legislation. The general basis for these is the TRO. Traffic Regulation Orders are commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. For example, TROs can be used to restrict access to a given area or to certain types or weight of vehicle or during specific time periods. Traffic management schemes are typically focused on historic or busy commercial centres, where the effects of traffic on safety, noise and pollution levels can be quite dramatic, and also in sensitive residential neighbourhoods.

2.6. Highway authorities are empowered under the RTRA 1984 to make TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement. Traffic Regulation Orders are required for any enforceable restriction on the highway. They may be made under the terms of the RTRA 1984 or, for "special events", the Town Police Clauses Act 1847. The RTRA 1984 specifies what restrictions a TRO may impose. The Local Authorities Traffic Orders (Procedure) (England) Regulations 1996 lay down the legal requirements for making and implementing a TRO.

2.7. The main points relating to the making of Orders that may be used for enforceable restrictions are summarised as follows:

i) The Highway Authority may restrict any/all classes of vehicle from using any road or from carrying out certain activities in any road either permanently or on certain days/dates /times, provided that it specifies a valid reason (as defined in the RTRA 1984) in the statement of reasons. They may do this by making restrictions, which prohibit, restrict or regulate the use of any road by vehicular traffic or specified classes of vehicle. Restrictions may require traffic to proceed in a certain direction, restrict waiting or loading or prohibit through traffic.

ii) valid reasons for making an Order include:

a) for avoiding danger to persons or other traffic using the road or any other road or for preventing the likelihood of any such danger arising, or
b) for preventing damage to the road or to any building on or near to the road, or
c) for facilitating the passage on the road or any other road of any class of traffic (including pedestrians), or
d) for preventing the use of the road by vehicular traffic of a kind which, or its use by vehicular traffic in a manner which, is unsuitable having regard to the existing character of the road or adjoining property, or
e) (without prejudice to the generality of paragraph (d) above) for preserving the character of a road in a case where it is specially suitable for use by persons on horseback or on foot, or
f) for preserving or improving the amenities of the area through which the road runs, or
g) for any of the purposes specified in paragraphs (a) to (c) of subsection (1) of section 87 of the Environment Act 1995 (EA 1995).

2.8. As noted, under point g), the EA 1995 broadened the purposes for which a TRO might be made to include the pursuit of environmental objectives. The relevant parts from the EA 1995 are Section 36 of Schedule 22, which states that TRO can be used “with respect to the assessment or management of the quality of air”. This is relevant to a traffic or parking control scheme designed to maximise environmental benefits.

2.9. Orders can be made that apply to certain classes of vehicle, or to set up a permitting system to exempt certain vehicles from the controls. The criteria for a permission (or permit) is defined by the Authority making the TRO. Therefore, it can be based on an environmental/emission standard linked to local objectives and circumstances. This approach has been used in a priority access scheme in the city of Bath.

2.10. All local authorities need to develop a parking strategy covering on- and off-street parking. Many different types of on-street parking schemes can be created under the powers provided in Part IV of the RTRA 1984. Local authorities use TROs to put parking schemes in place and appropriate traffic signs and road markings so that the public know what the restrictions mean.

2.11. A highway authority has the power to set charges for parking permits pursuant to the RTRA 1984 (as amended) and in doing so may set differential charges for different types of vehicle. In exercising its duties under the 1984 Act, a highway authority is under a duty to secure the expeditious, convenient and safe movement of traffic (including pedestrians) and suitable and adequate parking on and off the road. In meeting these duties, the highway must have regard to:

- the effect on amenities of any locality;
- the strategy prepared under s.80 EA 1995.
- any other matters appearing to the local authority to be relevant.

2.12. These matters provide a legal basis for the differential charging based on CO_2 and other emissions.

2.13. The signing of a vehicle access control scheme should be one of the first elements to consider when designing a scheme, to ensure it can be legally signed. It is important that the design of all sign faces is considered when drawing up the TRO. All signs used for a scheme should be in accordance with the Traffic Signs Regulations and General Directions and used as described in the Traffic Signs Manual. Sometimes the objectives for vehicle access control schemes have led to designs for which no suitable sign is prescribed in Traffic Signs Regulations and General Directions. In such cases it is necessary to seek authorisation for a specific sign from the Department for Transport, before any variation to the prescribed signing takes place. Considering all the available prescribed signing must be a first step.

Planning conditions

2.14. Local planning authorities can impose conditions on planning permissions only where there is a clear land-use planning justification for doing so. Conditions should be used in a way which is clearly seen to be fair, reasonable and practicable. One key test of whether a particular condition is necessary is if planning permission would have to be refused if the condition were not imposed. Otherwise, such a condition would need special and precise justification. Unless otherwise specified, a planning permission runs with the land. Exceptionally, however, the personal circumstances of an occupier, personal hardship, or the difficulties of businesses which are of value to the welfare of the local community, may be material to the consideration of a planning application. In such circumstances, a permission may be made subject to a condition that it is personal to the applicant. Such arguments will seldom outweigh the more general planning considerations, however. See The Planning System: General Principles - www.communities.gov.uk/publications/planningandbuilding/planningsystem - for more information, including on enforcement.

It should be noted that planning conditions cannot be used to require financial contributions. See Circular 11/95: Use of conditions in planning permission (www.communities.gov.uk/publications/planningandbuilding/circularuse).

2.15. Where it is not possible to include matters that are necessary for a development to proceed in a planning condition, developers may seek to negotiate a planning obligation under section 106 of the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). Planning obligations should meet the Secretary of State's policy tests set out in Circular 05/05 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations); i.e. they should be:

- necessary;
- relevant to planning;
- directly related to the proposed development;

- fairly and reasonably related in scale and kind to the proposed development; and
- reasonable in all other respects.

The use of planning obligations must be governed by the fundamental principle that planning permission may not be bought or sold. It is therefore not legitimate for unacceptable development to be permitted because of benefits or inducements offered by a developer which are not necessary to make the development acceptable in planning terms. Planning obligations are only a material consideration to be taken into account when deciding whether to grant planning permission, and it is for local planning authorities to decide what weight should be attached to a particular material consideration.

2.16. In terms of air quality, the impact of a development on air quality should be considered with regard to Planning Policy Statement 23 (often referred to as PPS23), particularly Annex 1 www.communities.gov.uk/publications/planningandbuilding/pps23annex1.

2.17. Both environmental impacts of a development and location of a development (whether it is close to a source of pollution or contributing further to an existing problem) can be taken into account as material planning considerations.

2.18. A useful document on the subject of low emission strategies - using the planning system to reduce transport emissions - has been produced by the Beacons Low Emission Strategies Group[4]. Broader guidance, aimed at ensuring that air quality is properly accounted for in local development control processes, has been produced by the NSCA (now Environmental Protection UK) as 'Development Control: Planning for Air Quality' (updated in 2006)[5].

Approaches for Buses

2.19. The approaches discussed here will ultimately be affected by the progress and outcome of the Local Transport Bill, which is still being debated. Once this Bill is enacted work will begin to produce final regulations and guidance before the provisions of the Bill can commence. Local Traffic Authorities are therefore advised to monitor the progress of the Bill, regulations and guidance when considering using these approaches to regulate bus emissions.

2.20. It is also noted that local passenger transport is a function of the Passenger Transport Authorities and Executives in metropolitan areas, and county councils elsewhere whereas LAQM is a function of district authorities. This is therefore a clear case where, in two-tier authorities there will need to be close liaison between the two tiers to implement such schemes.

[4] Beacons Low Emission Strategies Group (2008). Low emission strategies - using the planning system to reduce transport emissions.
[5] NSCA (2006). Development Control: Planning for Air Quality

Quality Bus Partnership Agreement

2.21. To set up a QBPA the local authority provides and maintains facilities to improve local bus services, which helps make bus travel more reliable and attractive. In return the main bus operators using the infrastructure agree to make improvements to their fleet or service levels.

2.22. A voluntary or partnership approach to the scheme could in theory be low cost to the authority. However, QBPA generally work by both parties investing in the improvement to services, voluntary agreement on an ambitious emissions reduction programme could be easier to achieve if complementary measures are also introduced that significantly improve the commercial environment for bus operations.

2.23. It is a voluntary agreement, entered into freely on both sides, with generally a non-binding document setting out the terms. Note that agreements are constrained by general legislation such as the Competition Act 1998 but that The Local Transport Bill would, however, introduce a new competition test that could make it easier for local authorities to enter into agreements with several bus operators, rather than separate agreements with each. Examples of schemes given listed earlier in this section illustrate the actions that several authorities are undertaking to include emissions based criteria within their Agreements.

2.24. An authority could decide at any time whether they wish to try to use a QBPA approach to setting up a scheme. Taking forward a bus emission reduction strategy based on a QBPA can be divided into the following two stages:

Preparation

- Authority prepares evidence base, scenario(s) and preferred outcome for future bus fleet profiles for all local commercial service providers, tourist coach, express coach and city tour services, including:
  - Target emission reduction;
  - A possible target for carbon reduction.
- Authority prepares negotiation framework with outline of process, actions and timescales based both on a voluntary approach and using mandatory options (if they prove necessary) taking into account:
  - Target implementation dates;
  - Target emission standards (plus phasing, proportions etc);
  - Preferred timescale for achieving emission reductions (via process);
  - Key milestones en route (such as those below);
  - Any decision points related to the accompanying political processes.

Negotiation

- Authority enters negotiations with bus operators for raising emissions standards through voluntary means, within a timetable for achieving the preferred (or next-best) outcome and commitment to move to more enforceable approaches such as QC Schemes described later;
- Evaluate the proposals of the bus operators if they fall short of the Authorities preferred scenario, quantify shortfall, and make a decision if the bus operator proposals are acceptable. Assessment should include

evaluation of emissions and any requests for additional expenditure on highways or roadside infrastructure.

2.25. If the negotiation route with one or more operators does not produce the result the Authority wishes for, then there are more enforceable options described later.

2.26. Quality Bus Partnership Agreement is an approach that authorities could use with smaller bus operators and authorities may wish to avoid scenarios where smaller operators are forced to be uncompetitive relative to bigger operators offering increasingly high-quality services that capture a greater market share. However, choosing the QBPA approach may mean the Council accepting that they cannot include smaller operators in any meaningful way in the scheme. The impact of smaller operators on overall emissions should be assessed in preparation for this outcome, and taken into account when decisions about which approach will be used to set up the scheme. A key issue may be whether the main bus operators will still participate in a voluntary scheme of higher emission standards even if smaller operators refuse to join.

2.27. Within the QBPA approach there could be some scope for reaching agreement with coach and city tour service providers. They are users of roadside infrastructure in the city and a business that operates from the city, and therefore may wish to benefit from infrastructure improvements.

Contract conditions of tendered services

2.28. Tendered services are time-limited contracts to provide a service for:

- subsidised public services;
- education department (i.e. school buses); and
- other contracts (for example, Park and Ride buses).

2.29. Local authorities have the power to regulate the emissions performance of tendered services including subsidised services, educational contracts and other specialised contracts. Many councils do not currently specify emissions criteria in their contracts. However pricing preference schemes (whereby commitments to operate new vehicles on the contracted routes get a preferred weighting during procurement assessments) have the effect of encouraging the use of brand new vehicles on subsidised bus routes when their contracts are renewed. Subsidised public services are regulated by Bus Service management function within local authorities.

2.30. To fully understand the timeline and decision points for influencing the tendered service bus fleet, it will be necessary to catalogue each of the tendered service contracts, noting the number of vehicles, anticipated vehicle mileage, duration of contract and contract end date. This will show the scope and future opportunities for influencing the retrofitment of abatement equipment. It is suggested that this work could be done in parallel with any preparation work for negotiation on commercially operated services, though the QBPA.

Quality Partnership Schemes

2.31. Statutory QPS apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). From this it follows that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, is within the definition of local service and so could be regulate by this route.

2.32. It is suggested that the use of a QPS be considered in parallel to the BQPA route, as it would provide a contractual framework for the scheme should the authority decide they will provide additional infrastructure and investment for bus services in the city in exchange for faster than currently planned fleet turnover.

2.33. Under a statutory QPS, the local authority - for these purposes, county councils, unitary authorities and Passenger Transport Authorities - draws up a scheme, aimed at implementing the policies in its local bus strategy. The bus strategy forms part of the local transport policies required under section 108 of the Transport Act 2000. A QPS in effect represents a commitment on the part of the authority to provide certain facilities to improve local bus services, and to maintain them throughout the life of the scheme; and an obligation on the part of participating bus operators to meet the quality standards prescribed in the scheme when using the facilities in question.

2.34. The cost of the scheme to the authority will largely be comprised of any investment in roadside infrastructure, bus priority etc. This is probably what bus operators would prefer to see in any QBPA so the cost to the authority may not be any greater than that of the voluntary approach.

2.35. Such schemes have statutory force and would be registered with the Traffic Commissioner, who can prevent non-compliant operations from using corridor facilities. In this respect, a QPS varies from a QBPA, the latter being entirely voluntary.

2.36. The essence of a QPS is that:

- the Authority and where appropriate District Councils provide facilities to improve bus operation – including bus lanes and other priority measures and facilities like stops and shelters;
- the Authority also specifies a quality level for buses that must be met by bus operators as a condition of using the facilities provided.

2.37. Department for Transport guidance notes that the specified standard of services should be one which can be reasonably met by any operator, unless the standard is higher but the benefits derived from its application outweigh the costs of compliance. For instance, a requirement to operate buses with facilities to give a high standard of accessibility for disabled people will probably be considered reasonable, as the benefit to the travelling public would justify any operator investment. However a requirement to operate vehicles built by a particular manufacturer or to a particular design is likely to be unreasonable.

2.38. A key question is therefore what is the standard of service the main bus operators and smaller bus operators would find reasonable to offer in return for incentives by the Authority? The QPS is still a partnership between the Authority and one or more operators, so the key question is finding out what grounds there are for reaching an agreement. As per the QBPA process, the Council(s) should determine what their minimum or target emission standard is, based on air quality impacts, in order to assess the position of any given bus operator.

2.39. The participating bus operators are then obliged to meet the quality standards prescribed in the scheme when using these facilities, and must give a written undertaking to the traffic commissioners to provide the service to the specified standard. Quality standards can relate to the vehicles to be used, and this can include the percentage of vehicles that meet a given Euro standard either due to vehicle replacement or due to retrofitting abatement equipment.

2.40. Quality Partnership Schemes address the potential problem found in voluntary approaches that operators who do not agree to raise their standards cannot be excluded from using the new facilities. Bus operators might be reluctant to enter partnerships and spend money if they can be undercut by low cost, low quality rivals. Therefore the number of vehicles provided by smaller operators and their ability to increase investment in vehicles will need to be considered by authorities. If sufficient services can be provided by those operators willing and able to meet the QPS standards, provision of bus services would not suffer as a result of some operators being excluded from using the routes/areas covered by a QPS.

2.41. Operators that choose to continue to operate along a route subject to a QPS but which are not participating in the Scheme, will need to give thought to what, if any, stopping points they observe. They will need to satisfy the Traffic Commissioner that they are neither using the facilities included in the Scheme, nor are they planning to stop in places that will create adverse traffic congestion or safety impacts.

2.42. The Act in its current form specifically excludes the Authority from specifying timetables and fares as part of the scheme. In this respect, a QPS scheme differs from the provisions of a QC (discussed later in this guidance), and QPS represent something of a half-way house between a voluntary QBPA and a QC Scheme.

2.43. The Local Transport Bill currently before Parliament would make significant changes to QPS while retaining its essential nature. In particular, it would allow Authorities to specify frequencies, timings and maximum fares in a scheme, subject to safeguards to give existing operators in the area the opportunity to object to such a proposal, and to ensure that all relevant operators are involved in subsequent fare reviews. (However, operators would not have a similar right to object to provisions about vehicle standards). The Bill also contains provisions to restrict the registration of new services, or the variation or cancellation of existing ones, in the area of the scheme if these would be detrimental to the operation of the scheme. These would not necessarily apply in every scheme, this being for the Authority to determine. The Local Transport Bill provisions would not prevent an Authority from making a scheme of the kind permitted under the existing legislation, they simply add further options. The Bill would be supplemented by regulations and guidance, drafts of which are available at www.dft.gov.uk/pgr/regional/localtransportbill/ltbdraftguidance.pdf and may be subject to consultation and further amendment.

2.44. From DfT Guidance on QPS in England, the following milestones and decision points can be picked out.

- Preliminary discussions with bus operators can be anticipated to take a number of months. Local transport authorities are advised to make informal contact with bus operators at an early stage of planning a QPS, and with the Highways Agency where there is potential for impact on the trunk road network. This will ensure that the published proposals come as no surprise and that operators have a chance to comment on the feasibility and acceptability of the proposals
- Having drafted a QPS, the local transport authority making it is obliged to publish it and undertake a formal consultation exercise in accordance with section 115 of the Transport Act 2000. The local transport authority (or authorities) would publish a notice of the proposed QPS in one or more newspapers circulating in the area it would cover. Either the notice itself must give full details of the facilities covered by the Scheme and the standard of service required, or it must state where such details may be inspected. Formal consultation does not have to last a specified length of time, so around three months could be considered sufficient.
- After giving notice, the local transport authority must formally consult the stakeholders. It is obligatory to consult:
    - all operators of local bus services that they think would be affected by the QPS;
    - organisations representing the users of local bus services (in the absence of a known local group, the local transport authority should consult the national organisation, Bus Users UK, which can be found at www.bususers.org);
    - other relevant local authorities that they think would be affected by the QPS - these include other local transport authorities, metropolitan district councils, and also, where appropriate, adjoining local transport authorities in London, Wales or Scotland;
    - the Traffic Commissioner for each traffic area affected by the QPS;
    - the chief officer of police for each police area affected by the QPS.
- The local transport authority should also consult any other persons they think fit. This could well include non-metropolitan district councils whose policies (for example on planning or on [off-street] parking) could be affected by the Scheme, and those affected by the proposed works (i.e. development of the facilities) required prior to the Scheme's commencement.
- There is no fixed time limit for consultation but sufficient time should be allowed to ensure that those who are likely to have views have a

reasonable opportunity to make a considered response. Central Government's practice is to allow a minimum of 12 weeks for consultation except in cases of urgency.

- Following consultation, the local transport authority may make the QPS, either as originally proposed or with modifications. The date of coming into operation must not, in any event, be less than three months after the date on which the QPS is made. But if one or more traffic regulation orders are needed to give effect to the Scheme then the date must also be at least three months after the date on which the order (or the latest of those orders) is made. However, these are only minimum times, and the important issue is that sufficient time is allowed for the local transport authority to provide all the necessary facilities and for operators to provide services to the specified standard.
- Once the QPS has been made, within 14 days, a further notice must be published in one or more newspapers circulating in the area to which the Scheme relates.
- Although the QPS must specify a date of coming into operation, there may be instances where, due to unforeseen circumstances, it becomes impossible to make all the necessary arrangements by that date. There is therefore a provision for postponing the date for up to (but no more than) 12 months from the original proposed implementation date.
- The Transport Act 2000 provides that a QPS must remain in operation for at least five years. There is no upper limit, but local transport authorities should bear in mind that policies and service requirements are likely to change over time and that Schemes should therefore be reviewed at reasonable intervals.

2.45. The Local Transport Bill, if enacted, will make certain changes to the provisions for QPS, and regulations and statutory guidance made under these provisions will also be relevant. However, the changes will not fundamentally affect issues concerning vehicle emissions standards

2.48. Current progress of the Local Transport Bill can be found here, showing the latest round of reading in the Commons/Lords: http://services.parliament.uk/bills/2007-08/localtransporthl.html

Bus Quality Contract Schemes

2.46. As with QPS, statutory QC Schemes apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). Therefore it is reiterated that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, are within the definition of local service and so could be regulate by this route.

2.47. Smaller operators are not particularly excluded from such a scheme, but they may find it difficult to offer the level of service or investment required in competition with larger operating groups for a QC, in cases where they run an older than average fleet.

2.48. The powers of the Transport Act 2000 enable local authorities to bring forward schemes in which they can determine what local bus services should be provided in their area, and to what standards, and can let contracts with bus operators giving them exclusive rights to provide services to the authority's specification. The Authority may determine the routes, timetables, fares and ticketing arrangements for the bus services, and any other matters relating to their standards including the emissions standards of the vehicles used. The local authority, not the traffic commissioner, carries out enforcement and operation of QC contracts.

2.49. Under the existing legislation a QC scheme must relate to the implementation of a bus strategy, and the making of a scheme must be 'the only practicable way' of implementing the bus strategy. Schemes require Ministerial approval.

2.50. No schemes are currently in operation. However, the Local Transport Bill includes a number of changes to the legislation aimed at making this a more realistic option for Authorities with a good case for using it. In particular, the Bill would replace the “only practicable way” criterion with new, more objective criteria based on increasing bus use and improving service quality. In England, an Approvals Board, chaired by a traffic commissioner, would approve schemes, rather than the Secretary of State, with a right of appeal to the Transport Tribunal.

2.51. Given the lack of experience of introducing these schemes it is difficult to make sound estimates over timescales. However, DfT has estimated that a “small uncontroversial scheme” could go through the statutory processes from statutory notice prior to consultation in 15 months. “For complicated schemes we may need to add up to ten months for the tendering process and for appeal (by any operator) to the Transport Tribunal perhaps a further three months.” In addition, an approvals board that requires any scheme modifications will mean further consultation.

2.52. There are details about guidance and obligations for consultation for QC schemes set out in DfT guidance on the subject in ‘Quality Contract schemes for bus services: Guidance to English local authorities’ found via this link: www.dft.gov.uk/pgr/regional/buses/quality/. This will be revised by the Local Transport Bill in due course.

2.2 Scheme design

2.53. The starting point for the design of any retrofit scheme should be the scheme objectives, i.e. the targeted improvement of the emissions performance of older vehicles by retrofitting abatement equipment. Having established the objectives for the zone in which the vehicles are to be regulated, there are further design considerations local authorities need to take into account. Key issues in the design of a zone where retrofitting is incentivised for the most polluting vehicles are organised in this section under the following headings:

- location of boundaries;
- vehicle emission standards;
- management of permitted vehicles;
- enforcement powers and penalties; and

- vehicle detection.

2.3 Location of boundaries

2.54. The location of boundaries is an important component of scheme design either in cordon or area-wide schemes. An early indication of the options for boundaries may be important since significant infrastructural and operating costs (if relevant) will largely be determined by the location. The geographical extent of schemes would necessarily take into account of the conclusions of LAQM Review and Assessments that have identified which vehicle types are contributing to the level of exceedence observed in the AQMA and how much of their activity is focussed in these areas.

2.4 Vehicle emission standards

2.55. The approach for defining retrofit standards on which to base enforceable restrictions (on the public highway or at development sites) could be determined in one or a combination of ways. The following criteria are relevant to schemes which target local pollutants:

- a list of approved proprietary retrofit or fuel conversion technologies (which can be used on older vehicles to clean up exhaust emissions, generally PM or NO_x);
- an emission attainment standard usually expressed in terms of an equivalent to emissions limits in a particular Euro standard for one or more pollutants.
    - Euro standards (the term for European type approval standards for new vehicles, which includes the emission performance against a defined test cycle).

2.56. Several existing LEV schemes such as the London LEZ (see chapter 5 for examples of retrofit schemes) use equivalent Euro standards as the basis for setting emission criteria. Such an approach allows compliance either via vehicle replacement or retrofit approaches. In a number of cases there exist supplementary criteria to allow some exemption (or time-extensions) for retrofitting emission abatement technology to vehicles that previously complied with the zone emission criteria.

2.57. The benefit of the retrofit approach being allowed for within these schemes is that they can provide a ‘safety net’ for those vehicle owners who do not want, or cannot afford, to buy a new vehicle to comply with a given Euro standard. Emission abatement technology can be retrofitted to a vehicle to make it meet more stringent emissions limits than those to which it was originally type approved. For vehicles with long lifetimes and high usage, such as buses, this can be more cost-effective than replacing the vehicle.

2.58. A feature of schemes that promote the uptake of retrofit equipment is that their local environmental benefits will reduce over time unless the defined emissions standards and incentives are reviewed and revised periodically. For example, a scheme that provides incentives for compliance with Euro III emissions limits for HDVs will no longer provide local benefits once all HDVs in the fleet are compliant with that standard. Therefore, local authorities should consider a phased approach whereby tighter emission standards are required in future years to qualify for the incentive. The London LEZ is an example of this approach.

2.59. Whatever the criteria used, it is essential is that they are open to and operable by any normal user. This would rule out region or country specific standards that might not be available to vehicle owners across Europe.

Local Pollutant Criteria

2.60. Euro standards describe the emissions criteria that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU. Euro I vehicles began to be produced for a EC-specific type approval standard that came into force in 1993, with pre-Euro vehicles generally being those registered before this date. Note that Euro standards actually include more criteria than simply emissions and form the standards that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU.

2.61. The benefits of using Euro standards for a scheme design are that they describe the emission performance in a well-defined way, based on an approved testing procedure that defines the manufacturing process. They are criteria against which any vehicle in Europe can be judged; therefore it is interoperable across countries.

2.62. However, the complicating factor within schemes that allow retrofit approaches is how to set and certify equivalent Euro standard criteria for vehicles that retrofit abatement equipment. To adequately certify or permit a vehicle for a retrofit scheme more relevant information in the UK context than can be found from one or a combination of the vehicle registration documents and the DVLA record are required i.e. an additional identifier that a vehicle has retrofitted abatement equipment is required. The most developed system of this kind in the UK is found for the London LEZ. The following box provides the relevant details.

2.63. One current drawback, from scheme objective and administration viewpoints, is that while retrofit PM abatement technology can be approved in the UK (via the VOSA Reduced Pollution Certificate (RPC) process) there is not an equivalent national incentive for retrofitting NO_x abatement equipment. While the RPC scheme has been extended until 1 October 2009 to include Euro V and Envrionmentally Enhanced Vehicles (EEVs), in practice only new vehicles rather than those with retrofits can realistically achieve the RPC criteria. While NO_x abatement equipment is available for retrofitting to HDVs the lack of an approval and certification route makes it impossible to design schemes with NO_x abatement objectives via a nationally recognised certificate. However, this does not preclude the possibility of creating a local certification scheme along similar lines to the London Low Emissions Certificate (LEC).

Setting and Certifying Equivalent Euro Standard Criteria – The London Experience

Equipment and Testing: Vehicle operators must ensure that they purchase an abatement system that is on the approved list. For HDVs this list is found at www.tfl.gov.uk/roadusers/lez/comply/5074.aspx).

Heavy duty vehicle operators must submit their vehicles for acceleration and smoke testing by an approved examiner being either VOSA or a VOSA-authorised Approved Examiner (who may also have fitted the abatement device).

The authorised examiner will complete a Declaration of Conformity and Declaration application form which will be sent to VOSA and if the test is successful, VOSA will issue a LEC or RPC and send this directly to the applicant within ten days of the test.

Reduced Pollution Certificate
Some Euro I and II vehicles will already have a RPC certificate. If they have had an RPC issued before 1st January 2001 and it has lapsed, they can be eligible for a RPC test. However, vehicles which have not previously had an RPC cannot be issued with an RPC even if they have an eligible engine, since the DfT's Reduced Pollution Certificate Regulations changed in January 2001.

Specific types of vehicles registered in the UK prior to October 2006 are able to obtain a RPC. Vehicles with a valid RPC can be registered for a reduced level of VED. Vehicles that are eligible to obtain a RPC are:

- vehicles over 3500kg revenue weight in tax class HGV, used in connection with a trade or business, including vehicles used for exceptional loads and haulage vehicles (not showman's);
- coaches i.e. Public Service Vehicles in tax class Bus that have been demonstrated:
    - to comply to an enhanced environmental standard as approved by VCA, or
    - to a higher environmental standard, or
    - to run on petrol or gas.

In practice this requires that all compliant pre-Euro IV diesel HDVs must have been constructed or adapted (via addition of particulate trap equipment for example) to achieve a considerably higher standard of particulate emission than that required by the EU emissions directive in force at the time of manufacture. The higher standards required are set out in Schedule 2 to the Road Vehicles (Registration and Licensing) Regulations 2002 (SI 2002 no 2742) as amended.

Additionally vehicles in the tax classes above fitted with Euro 5 or EEV engines and NO_x control can now be accepted for RPC provided they are registered in the UK prior to 1 October 2009.

More information on certification via RPC can be found at www.transportoffice.gov.uk/crt/lorryandvanoperators/londonlowemissionzone/reducedpollutioncertificatesandlowemissionscertificates.htm#P1_61.

Low Emissions Certificate
This is a certificate offered by Transport for London (TfL) to allow vehicles to provide proof they comply with the emissions requirements of the scheme. It is issued to vehicles or engines which are not eligible for the RPC, but which comply with the LEZ emissions standards. After a LEC or RPC test has been conducted, the test results are transferred from VOSA to TfL automatically and the data is updated on TfL's database within ten days.

Vehicles that are eligible to obtain a LEC are:

- vehicles and passenger vehicles over eight seats plus driver used in connection with a trade or business, including vehicles used for exceptional loads and haulage vehicles;
- where no RPC compliant solutions are available, for example some vehicles between 3500kg and 5000kg revenue weight;
- in tax classes not eligible for RPC (for example, private HGVs, private light goods (PLG)LG including private minibuses and motorhomes);
- which were not UK registered prior to 1 October 2006 or first RPC tested prior to 5 January 2001.

Which are:

- identified on the TfL Eligible Engines List;
- known to comply with an enhanced environmental standard as approved by VCA that would have (except for date of test or registration) been eligible for an RPC and will meet the London LEZ emissions standards.
- modified to an enhanced PM standard as approved by VCA or Energy Savings Trust EST, including filter or other abatement technology that doesn't meet the RPC eligibility criteria. The LEC approved device list can also be found on the TfL website;
- re-engined to a higher environmental standard, or
- fitted/converted to run solely on petrol or gas.

2.64. The key elements of the approach adopted in London and which are relevant for new schemes are:

- a clear definition of vehicle types affected and their required emissions performance;
- a clear definition of the requirements that abatement devices and suppliers have to meet to prove the equipment is able to meet this standard;
- a defined list of approved suppliers/fitters and abatement devices which are certified as meeting the emission standard on specific engines;
- a defined list of approved testers and test conditions to certify compliance;
- a central database able to identify those vehicles that have been certified as compliant.

2.65. It should be noted that there is no reliable approach for basing a scheme on emissions performance 'in service'. However, this has not proved a barrier to the introduction of a LEZ in the UK (London) or other European countries, as they use age and/or equivalent Euro standards as a basis.

2.5 Management of permitted vehicles

2.66. The scheme operator maintains the definition of what is a permitted vehicle. Processes are required to verify the emission standard of a particular vehicle. Certification processes may be necessary, or useful to include in a scheme if they already exist, if there is likely to be a lack of information about potential users of the scheme such as the case where scheme design means retrofit emission abatement equipment is allowed.

2.67. Management of the permission to enter the zone requires information and identification of individual vehicles with administration systems to cross-check permissions.

- In a large scheme covering a number of types of vehicle this would probably require the creation of a database with links to the DVLA records as well as reduced pollution certification records, as for the London LEZ (see later chapter on example schemes).
- If a scheme is small-scale, affecting relatively few vehicles or one focussed on local fleets, then a basic permit management and verification system might be sufficient using vehicle registration documents and local reduced pollution certification records. This might be the case for schemes focussing on bus and coach fleets or on development sites.

2.68. Management of permitted vehicles in a scheme focussed on a development site should be more straightforward compared to the public highway. Through-traffic is not normal and all vehicles are destined for privately controlled parking. The costs of administering any scheme would be expected to be borne by the developer, or ongoing management company set up by the developer or development occupiers.

2.69. In the case of bus fleets the management and cost of maintaining information on permitted vehicles would be borne by the authority concerned with the approach adopted as follows.

- Quality Bus Partnership Agreement – the Local Traffic Authority.
- Contract conditions – the contracting Authority.
- Quality Partnership Schemes – the Traffic Commissioner.
- Quality Contract Schemes - the county council, unitary or Passenger Transport Authority.

2.70. Once a vehicle owner has checked with the scheme rules whether their vehicle complies or not they must be able to prove the status of their vehicle against the scheme rules. The vehicle registration mark (VRM) shown on the number plate can be used if this information is linked with the data used to verify the emissions criteria. As a supplement, a specific sticker or plate may be issued by the scheme operator following verification of a qualifying emission standard, for example certifying that an approved abatement system has been retrofitted.

2.6 Enforcement powers and penalties

Traffic and parking orders

Parking enforcement

2.71. Local authorities have long been responsible for managing all on-street and some off-street parking, whether directly or indirectly. The powers to control waiting and loading and to provide and charge for on-street parking are provided by the RTRA 1984, with various amendments since such as by the Road Traffic Regulation (Parking) Act 1986, and most recently the TMA 2004.

2.72. The Road Traffic Act 1991 significantly changed the way that on-street parking restrictions are enforced. Before 1991, the police and traffic wardens were responsible for enforcement and income from fixed penalty notices (FPNs) went to the Exchequer. However, the police service found itself increasingly unable to resource parking enforcement. The 1991 Act made it optional for local authorities (not London boroughs) to take on the civil enforcement of non-endorsable parking contraventions. When a local authority takes over this power from the police, staff employed directly or indirectly by them issue PCNs and the local authority keeps the income for operation of the scheme.

2.73. Part 6 of the TMA 2004 now provides for the civil enforcement of most types of parking contraventions. It replaces Part II and Schedule 3 of the Road Traffic Act 1991 and some local legislation covering London only. The TMA 2004 and the associated regulations have given to English authorities outside London many powers already available to authorities in London, giving greater consistency across the country while allowing for parking policies to suit local circumstances.

2.74. It is assumed that most Authorities interested in using variable parking charges to incentivise lower emission vehicles will also be those interested in taking up the powers available to them under the TMA 2004. Therefore, this guidance note is written with these latest regulations in mind and the environment of Civil Parking Enforcement that they provide.

Traffic enforcement

2.75. The TMA 2004 provides a single framework to make regulations for civil enforcement by local authorities or parking and waiting restrictions, bus lanes and some moving traffic offences. It is therefore a very important piece of legislation for Local Traffic authorities that wish to better manage their road networks and take on aspects of enforcement that may not be a priority for the Police.

2.76. Regulations under Schedule 7 to the Traffic Management Act 2004 would allow Local Traffic Authority appointed Civil Enforcement Officers the powers to monitor and penalise a range of moving traffic offences such as stopping in boxed junctions and making banned turns. This would complement civil enforcement powers already available for parking management. Powers for moving vehicle enforcement may be extended in the future for authorities in England with regulations provided by DfT. Updates are available via www.dft.gov.uk/pgr/roads/tpm/tmaportal/.

2.77. Extending civil enforcements powers would enable Highway Authorities outside London to use camera evidence of traffic contraventions. This would provide such authorities parity with those in London where legislation has enabled the adoption of civil enforcement of moving vehicle contraventions.

2.78. If powers are extended by the Schedule 7 regulations then road traffic signs described by the TMA 2004 for civil enforcement might be used to sign a zone where LEVs are incentivised. For example ‘motor vehicles prohibited’ (sign 619) can include the supplementary text 'except for permitted vehicles'. This appears sufficient to legally sign an access control scheme.

2.79. Civil penalties for moving vehicle contraventions (under TMA 2004) may be the same as currently applied to bus lane, parking and other similar moving traffic offences. Parking penalty charges are set at different bands and levels, up to £70 outside London, with discount or further charge depending when paid. It would be appropriate for a Highway Authority to consider the level of penalty charge required for effective enforcement. A supplementary local authority circular or relevant guidance is a mechanism that would enable a variation of the PCN charge in certain circumstances.

Planning obligations

2.80. Section 106 of the Town and Country Planning Act 1990 introduced the concept of planning obligations, which comprises both planning agreements and unilateral undertakings. It enables a planning obligation to be entered into by means of a unilateral undertaking by a developer as well as by agreement between a developer and a local planning authority.

2.81. Section 106(1) provides that anyone with an interest in land may enter into a planning obligation enforceable by the local planning authority. Such obligations may restrict development or use of land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically.

2.82. Section 106(5) provides for restrictions or requirements imposed under a planning obligation to be enforced by injunction,

2.83. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides existing policy on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).

2.84. In the case of the Greenwich Peninsula development, the obligation to develop the LEZ aspects of the development in more detail falls on the developer, and the obligation to comply is borne by the developer and the future occupiers.

Bus-based schemes

2.85. The previously discussed legal bases for bus focussed schemes included detail on which authority would have responsibility for enforcing the scheme. In summary the responsibility for enforcement will vary.

- Quality Bus Partnership Agreements are generally non-binding documents so that the ability to force non-compliant operators to comply is weak.
- Criteria for tendered services can clearly be enforced via the contracting authority via the conditions of contract.

- The Traffic Commissioner who can prevent non-compliant operations from using the facilities provided by the authority can enforce Quality Partnership Schemes.
- Bus Quality Contract Schemes would be enforced and operated by the local traffic authority and not the Traffic Commissioner.

2.86. Note that apart from QPS the local traffic authority would be responsible for enforcement; unless the district authority also lets tendered services so that they too may have responsibility. These authorities would therefore need there to be adequate systems and resources to check the compliance of vehicles. The potential penalties involved are the withdrawal of contract and any incentives associated with this.

2.7 Vehicle detection

2.87. This section identifies the likely approaches for detecting vehicles and determining which do not comply with the criteria. For traffic or parking it is assumed that powers under the TMA 2004 for civil enforcement of both parking and moving vehicle contraventions on the public highway are available and have been taken up.

2.88. Identification of a vehicle that complies with scheme criteria could be via a paper permit, windscreen sticker, or by the VRM on the number plate. A scheme design could require the vehicle to self-identify itself, by use of a transponder or a proximity smart card.

2.89. Detection of a vehicle for subsequent identification of emission status could be carried out by a variety of methods, sometimes in combination:

- Manual methods, whereby enforcement personnel visually check vehicles travelling within or parked within the scheme area for identification marks (VRM and/or a permit/sticker). In the mainland Europe examples of LEZ the checks would tend to focus on older looking vehicles and might use a mixture of manual recording and possibly photography (see later chapter on example schemes). Some post-checking against a database of compliant vehicles would then be necessary. External identifiers of these kinds would be particularly useful to aid detection and enforcement in retrofit based schemes.
- Digital cameras and ANPR – all passing number plates are recorded and recognised using Optical Character Recognition (OCR) for matching against a database of vehicles (and their certification of an approved retrofit is necessary). A network of cameras could be installed on the key routes into/out of the boundary of the scheme and possibly at key junctions within the zone if it is very large. As a supplementary, or alternative approach, mobile ANPR cameras could be used to monitor key junctions and/or 'hot-spots' of possible non-compliance.
- Dedicated Short Range Communication (DSRC) – tags and beacons, more suitable for schemes with relatively few and pre-determined users, which comply with the scheme criteria. Tags or proximity smartcards are commonly issued to vehicle owners for accessing private car parks, or

can be scanned through a windscreen, and have also been used to trigger bollards which control access on the public highway.

Manual Detection

2.90. The benefits of manual detection methods are lower capital costs, and some flexibility over future operating costs if enforcement levels can be reduced. Manual enforcement is suitable for parking schemes, whether on-street parking on development sites. A drawback of manual enforcement is the limit on the number and speed of vehicles that can be checked by a person. However, existing schemes show this approach should not be ruled out.

2.91. The London Lorry Control Scheme (commonly referred to as 'The London Lorry Ban') is an example of a successful manually enforced scheme. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month. Officers position themselves at junctions known to be attractive, but controlled, routes for HGV. In addition, they will respond to complaints from residents of vehicles 'off-route'. The main objective is deterrence and to assist HGV drivers with better route planning in order to raise compliance rates. This scheme, and those LEZ enforced manually in other European countries, indicate that manual detection could be a basis for enforcement. Detection of HDVs is likely to be more successful than LDV, as HDV are larger and less numerous.

2.92. In most urban areas of the UK it might also be anticipated that compliance by bus fleets could be detected manually due to the smaller number of operators, vehicles and layover locations.

Automated Detection

2.93. Traffic Management Act 2004 regulations currently give the power to authorities throughout England to issue PCNs for parking contraventions detected with a camera and associated recording equipment (approved device). Regulations from the Act may also be prepared for moving vehicle contraventions. Cameras can only be used by Highway Authorities in a civil enforcement environment. There is current experience of using camera enforcement within London for moving traffic enforcement, and outside London for bus lane enforcement. The Secretary of State must certify any type of device used solely to detect contraventions and once certified they may be called an 'approved device'.

2.94. The benefits of such automated enforcement systems are that high speed and volume flows of vehicles can be detected and recorded, and that every vehicle can be checked. Drawbacks can include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs.

2.95. Automatic number plate recognition cameras can provide one part of such an automated system. They are able to capture 90%+ of passing number plates. Automatic number plate recognition cameras are used in the London Congestion Charge Scheme (CCS) and for the London LEZ. In the London CCS, images are kept for checking of vehicles whose details are not in a database of vehicles for which a charge has been paid (or registered as exempt). In order to cover 'hotspots' of non-permitted vehicles within the LEZ, mobile (van-based) enforcement units could be suitable.

2.96. There will be additional options for identification and detection of vehicles entering development sites, depending on the layout and approach for managing traffic and parking. Development sites generally have a limited number of entry and exit points, and are able to use manual or automatic barriers at these and at entrances to car parks. The road network tends to discourage through-movement, and access by non-residents or visitors. These factors enable greater opportunity for checks on vehicles. Parking permit and management systems provide opportunities for further identification and detection, to verify against a permitted vehicle database.

2.97. It should be noted that it is not strictly necessary to achieve a 100% detection level for a scheme to be effective. The level of compliance, and impact non-compliance has on emission impacts, will impact on the value for money of any scheme. However, the aim should be to achieve a balance with sufficient enforcement to provide an effective deterrent, in order to achieve the scheme objectives.

3 Developing and appraising retrofit schemes

3.1. Schemes may be designed using the options introduced in the previous chapter. Local authorities will need to appraise these options to make decisions on the most appropriate and cost-effective for a scheme in their area. This chapter provides guidance on the most important aspects of appraisal in particular regarding appraising the cost-effectiveness and benefits of schemes in terms of air quality objectives.

3.2. The chapter is structured as follows.

- The overall or generic effects of schemes are defined.
- A staged approach to appraising emissions and air quality effects of scheme designs introduced. Staging the appraisal may allow a number of designs to be scoped out of the appraisal at an early stage on grounds of negligible benefits.
- The important types of capital and operating costs are introduced to allow a realistic appraisal of scheme design costs and costs to operators to be drawn up during appraisal.
- Guidance on using emissions and costs data to complete cost-effectiveness and cost-benefit appraisals is then provided.

3.1 Generic Effects of the Scheme

3.3. It is likely that retrofit schemes will have significant impacts on environmental objectives. Indeed improving the environment is a key objective of such schemes. The nature of the impacts will be scheme specific and depend on the scheme location and the scheme's impact on vehicle emissions by location and the composition of traffic. The environmental impacts of a scheme will also depend on the extent to which the scheme is combined with other measures. Table 2 describes qualitatively the potential impacts of these schemes.

Table 2: Qualitative assessment of the potential impacts of a retrofit incentive scheme

Impact	Qualitative assessment	Notes/assumptions
Inside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	True for Euro-standard based schemes. Schemes may address NO_x and PM_{10} either individually or not.
CO_2 emissions	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	-	
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	X	Costs of certification of equipment and vehicles to be considered.
Costs to operators	X	Additional operating costs or abatement equipment costs. Could be partially offset by increased passenger fares for some vehicle types
Outside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	Compliant vehicles that use the zone are also active outside of the zone
CO_2 emissions	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	-	
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	-	Potentially no regulatory costs outside of zone
Costs to operators	-	Potentially neutral operator costs if travel time impacts are neutral

Notes:

1. Qualitative assessment: ✓ symbolises a beneficial impact, x symbolises a negative impact, - symbolises a neutral impact.
2. Abatement equipment incentive schemes are potentially unlikely to have significant non-air quality impacts other than economic impacts. However, local authorities are advised to have regard to the generic guidance on the economic principles that apply when assessing these schemes. This guidance provides more detail on actions to take to assess significant non-air quality impacts.

3.2 Emissions/Air Quality Impact Assessment

3.4. Local authorities are advised to proceed through a staged process to assess the potential emissions and air quality impacts. These stages are:

- a screening stage (to identify the potential of such schemes);
- intermediate stage (consistent with LAQM methods and duties such as action planning and progress reporting);
- detailed stage (using the webTAG from DfT on appraising road transport schemes).

3.2.1 Screening assessment

3.5. The purpose of a screening assessment is to quickly assess the potential benefits of a scheme. It is intended to be simple and to use a minimum of information that is available.

3.6. At a basic level retrofit schemes are intended to upgrade older vehicles to ones with more stringent emissions standards, for example, fitting a particulate filter to a Euro II or older would convert it to being a vehicle with an equivalent Euro III emission standard or better. In these basic terms the potential benefit from a retrofit scheme is therefore associated with the reduction in unit emissions (or emission factors).

3.7. A broad assessment could proceed as follows:

1. Define a zone inside which a retrofit scheme might operate and identify those vehicle types that the scheme would seek to regulate.
2. Assemble from transport models or otherwise estimate the annual activity (veh km) of those vehicle types within the zone. One way of estimating activity is to multiply traffic volumes by link length and then to sum over all links in the zone.
3. Define a year in which the scheme may start.
4. Use the emissions factor toolkit for vehicle emissions (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) to obtain the year and vehicle type specific emission factors for NO_x and PM_{10} (g/veh km).
5. Multiply activity by emission factor to estimate the base-case emissions.

3.8. The effect of scheme depends on the emission standard set. For example, fitting particulate filters may reduce unit PM_{10} emission factors by up to 95% and SCR may reduce unit NO_x emissions by up to 65%.

1. The effect is to change the weighted emission factors for HDV types (see worked example in later section).
2. Recalculate the product of the activity and the emission factors to estimate the annual emissions with the scheme in operation.
3. The difference from the base-case is the potential emissions benefit of the scheme.
4. In combination with screening assessments of other schemes the relative attractiveness of each scheme in emissions terms can be compared.

3.9. Note that this simple approach to assessing retrofit schemes does not address potentially important effects such as the re-distribution of traffic and the contribution to emissions from congested conditions. Intermediate or detailed assessments are advised to address these issues more fully.

3.2.2 Intermediate assessment guidance

3.10. For an intermediate assessment Local authorities are advised to have regard to the related guidance documents on generic economic principles for assessment local air quality schemes. This guidance document provides background information on emissions and air quality impact assessments. In particular it sets out recommendations on:

- developing a detailed baseline emission inventory;
- potential sources of data for the inventory;
- available tools for estimating the emission impacts of transport measures;
- having regard to the technical guidance on further assessment of local air quality for assessing compliance against the air quality objectives.

3.11. The underlying principle for emissions or air quality impact assessment is to firstly define the baseline or business as usual emissions or air quality. This is the case that currently applies and would apply in future years if no additional action were taken. Once the baseline case has been defined the effects on baseline emissions and or air quality from new policies can be assessed. Emissions and air quality assessments are technical tasks. Therefore local authorities are referred to the guidance document Local Air Quality Management Technical Guidance 2008 for additional information.

3.12. Inventory should be sufficiently detailed to allow the impacts of a range of potential policies to be assessed. A detailed emission inventory allows baseline and with-policy emissions to be calculated that account for:

- the impacts of national policies such as Euro standards for vehicle emissions;
- the impacts of local transport policy on traffic growth and other actions to which the local authority is already committed including transport policies and new developments;
- road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed;
- the contribution from stationary traffic. This allows policies that reduce congestion to be assessed;
- fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.

3.13. By assessing the impacts of measures on the baseline emissions the local authority can then more accurately assess the potential cost-effectiveness and air quality health benefits associated with the measures.

3.14. Potential sources of data from which to develop emission inventories are summarised below:

- **Source activity**: Road transport models can provide average speed and annual average daily flow data disaggregated by road link and usually split between light and heavy duty vehicles. More detailed surveys have been used to disaggregate HDV types between buses and heavy goods vehicles. Furthermore, some traffic models also provide link specific data on the daily average time that traffic is stationary at junctions and the average length of these queues. These data are necessary to estimate the potential contribution from congestion.
- **Vehicle emission factors**:
  - The Air Quality Archive local authority emissions toolkit (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) has tools that allow calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. This tool also calculates emission factors in future years.
  - Local authorities may also consider using the tool Defra has developed to be used by local authorities in calculating emissions of NO_x and PM_{10} under the new performance indicator framework (i.e. NI 194: Air quality – % reduction in NO_x and primary PM_{10} emissions through local authority's estate and operations). www.defra.gov.uk/environment/airquality/local/indicator.htm. This tool can be used to indicate the potential difference in emissions due to replacement by one vehicle type with another or due to a reduction in annual mileage.

Specific fleet inventories:

3.15. In the case of specific and relatively small fleets (such as the local authorities own fleet or commercially operating bus fleets) it is recommended that a specific fleet inventory is developed. A key reason for this is that the distribution of vehicle ages within these fleets can typically vary quite significantly from the national average age distribution. For example, the local bus fleet may be significantly older or younger than the national average. For better accuracy it is therefore recommended to list the age and abatement equipment of each vehicle. In these cases local authorities should attempt to work in partnership with commercial and other fleet operators to obtain the relevant data.

3.16. Other key factors in the inventory: To be useful as a policy assessment tool, local authorities are advised to consider including the following additional capabilities in their local inventories.

- Compliance rates. Depending on the range of regulatory approaches being considered to enforce a local measure (strong or weak) then a greater or lesser rate of compliance may be expected. If this is a significant factor then local authorities should include the capability within their inventory for assessing the emissions impact of compliance rates less than 100%.

- Compliance year (or year that the measure under consideration would come into force): Natural vehicle replacement rates mean that on average the national fleet unit emission factors decrease over time. If the compliance year is in the future then local authorities are advised to include this effects in their inventory. Otherwise the inventory is likely to overestimate the potential emissions impact of a local measure.

Air Quality Assessment

3.17. Air quality assessments use monitoring, dispersion model and Geographical Information Systems (GIS) data to assess a) where the air quality objectives are exceeded and b) whether there is relevant exposure at these locations. The methods to be used in these assessments are provided in detail in Local Air Quality Management Technical Guidance 2008 and local authorities are recommended to have regard to this guidance.

3.18. For assessing the effects of local measures it is most appropriate to consider the exercise as a formal Further Assessment i.e. this is the most detailed of review and assessment technical activities and is designed to estimate the contribution of different sources to the local air quality (source apportionment).

3.19. An appropriate further assessment allows air quality arising from baseline and with-policy cases to be calculated that account for the same criteria as those described for detailed emission inventories. By assessing the impacts of measures on the baseline air quality the local authority can then more accurately assess the potential effect on compliance with the air quality objectives associated with the measures.

Specific guidance on assessing retrofit abatement schemes

3.20. These schemes aim to change the emission factors of vehicles that circulate in an authority by promoting the uptake of retrofit abatement equipment. Therefore the emissions and air quality assessments should be designed to include the following parameters or indicators.

- Annual average daily road transport activity (veh.km) disaggregated by vehicle type and road links.
- Implementation year (so that future underlying changes in emission factors are accounted for).
- Fleet inventories (number of vehicles, their breakdown by euro standard and existing retrofit abatement equipment if relevant) for vehicle types affected by the measure.

3.21. During the design phase of a retrofit scheme local authorities should assess the effect (or range of effects) of the scheme on these indicators. In particular the effects of requiring compliance with minimum equivalent Euro standard limits (attained through retrofit) by an implementation date for specific vehicle types will be a key impact. Local authorities should include an assessment of the likely rate of compliance with the scheme, which may vary according to the ‘strength’ of the approach used to regulate the scheme. Applying these changes to the baseline emission inventory and air quality dispersion model will estimate the potential emissions and air quality benefits of the measure.

3.2.3 Detailed assessment guidance

3.22. If assessment of the scheme proceeds to the need for a formal road scheme appraisal consistent with the NATA then local authorities should have full regard for the detailed guidance on completing these appraisals.

3.23. The full Transport Analysis Guidance can be found online at www.webtag.org.uk/. Unit 3.3.3 contains the specific guidance on local air quality assessment.

3.3 Costs Assessment

3.24. The main factors that will affect a consideration of cost and timescale for setting up and operating a retrofit scheme are the types or sub-categories of vehicles that are to be included (and any differences in standards), the size of the scheme and the level of technology used for detection and enforcement. Together these factors contribute much to the level of complexity of a scheme's design.

3.25. Typically, the greater the number of vehicle types within the scheme, the greater the number of vehicles, so set-up and running costs associated with a scheme will tend to rise. In broad terms, the size of the UK fleet rises proportionately from bus/coach to HGV to Light Goods Vehicle (LGV) (vans) to passenger cars. Therefore, a scheme which includes only HDV will tend to cost the scheme operator less than one which only includes passenger cars, all other things being equal. This does not yet take into account operator costs. This relationship fits well with the known contribution to emissions (per vehicle) that tends to show that, due to engine size and power output, each HDV produces more pollutant emission than each passenger car.

3.26. A larger scheme will tend to cost more to set up and operate, if all other factors remain equal. Hence, a small number of strategic access points that effectively controls most of the relevant cross-city traffic or parking in a historic urban area is considerably cheaper than a large city centre scheme with urban dual carriageway through-routes.

3.27. The third major factor is the level of technology used. High technology schemes, based on automatic number plate recognition cameras, will tend to have greater set-up and running costs than paper or sticker-based schemes. However, the relationships is not as simple as that because issues around detection/compliance rate mean that a scheme's more costly operating basis (i.e. technology) may be more *effective* to the extent it is actually more cost-effective. So, for example, there may be concerns about a windscreen sticker-based system working in the UK context. However, if a windscreen sticker-based system works effectively in the UK context, it will tend to be more cost-effective than one closely monitored by camera systems.

3.28. These three factors (vehicle type, scheme size and technology basis) will tend to interact with one another to produce variations in complexity, and hence cost.

3.29. Considering the various cost elements that might be relevant to any scheme, we can divide these into capital costs (i.e. set-up or investment costs) and operating costs. A list of generic cost categories is set out in Table 3 below.

Table 3: Potential cost items for retrofit scheme set-up and operation

Capital costs	Operating costs
• Scheme design and planning • Legal/ set-up costs • Consultation process • Marketing and information campaign • Traffic management / safety • Roadside equipment (signing, detection, enforcement) • Central administration and IT systems (vehicle record, certification, enquiry handling)	• Accommodation • Staff costs • Any new vehicle identification method (for example windscreen stickers) and the issuing process for this • Equipment / software replacement and maintenance costs • Supplies, services and transport • Certification of retrofit devices, suppliers and vehicles fitted with retrofit devices

3.4 Cost-effectiveness and cost-benefit Assessment

3.30. Cost-effectiveness analysis and cost-benefit analysis are both methods for economic appraisal. The Practice Guidance on Economic Principles provides more detailed information on these techniques and how to use them. This section summarises the key points.

3.31. Cost-effectiveness compares different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. However, such a cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently.

3.32. Cost-benefit analysis assesses whether the total benefits of a project or policy exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence. The results of a cost-benefit analysis can then be used to update the cost-effectiveness analysis to consider all environmental goals, by working with 'net' cost-effectiveness, where the capital and scheme costs are expressed net of all environmental costs or benefits, before the cost-effectiveness ranking.

3.33. Note that these two techniques can be complementary. Cost-effectiveness is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals.

3.34. In order to undertake either cost-effectiveness analysis or cost-benefit analysis, it is necessary to collate and assess information on costs for use in an economic framework. It is highlighted that practitioners often confuse financial and economic appraisal. An economic appraisal considers the costs in terms of society as a whole and the overall value for money. A financial appraisal looks at the affordability of a proposal, and is more likely to be more familiar as it will be similar to local budgetary framework, financial costs and accounts (an accountancy based perspective). For any scheme, both the economic and financial case for a proposal will be important, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable. However, for cost-effectiveness analysis and cost-benefit analysis, the economic assessment should be used. The Practice Guidance on Economic Principles provides more details.

3.35. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. The Practice Guidance on Economic Principles provides details of how to analyse cost information so it can be used in cost-effectiveness and cost-benefit analysis. This is likely to require some analysis of cost data (including future costs). It is also necessary to work within an economic framework in the assessment of costs, which requires analysis of all costs (not just those that occur to the local authority in the local authority area), and has to exclude all transfers, such as VAT, taxes or charges. The Practice Guidance on Economic Principles provides more details.

3.36. To undertake a scoping cost-effectiveness analysis, the annual emissions benefits of a measure, as estimated using the approach set out in the previous section, are combined with the cost data, where costs are expressed as an equivalent annual costs. The annual emission benefits are divided by the equivalent annual cost to give the cost (£) to reduce one tonne of emissions (cost per tonne). This gives the cost-effectiveness of a measure – and this allows different options can be compared – those with the lowest cost per tonne abated (the lower cost per tonne) are the most cost-effective. Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately, it is the cost per level of air quality improvement ($\mu g\ m^{-3}$). However, such an analysis only considers one environmental goal, and it is also necessary to consider other environmental objectives in a 'net' cost-effectiveness analysis to correctly prioritise measures (see below).

3.37. It is also possible to use the cost-effectiveness ranking to build up an action plan towards the reduction of an exceedence. Those measures that are most cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance. Note, however, that cost-effectiveness works only with a single pollutant. To address this, it is possible to work with the 'net cost-effectiveness' to consider other environmental objectives. Moreover, the cost-effectiveness of a measure is only one element of the options, and other factors will be important in determining the overall ranking of measures, including the wider assessment, legal and technical issues, practicality and acceptability.

3.38. To undertake a cost-benefit analysis, the same information on emissions and costs is used, though there are important differences. First, the emissions benefits are expressed in monetary terms. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants, such as NO_x and PM_{10}) are estimated, along with the monetary values for other environmental effects such as greenhouse gas emissions, using the Government damage cost (the shadow price for carbon). This is used to generate the total present value of benefits, which can be compared against the total present value of costs of the options (note cost-benefit analysis works with the total stream of costs, i.e. the present value, not the annualised costs used in cost-effectiveness analysis above).

3.39. The cost-benefit analysis simply compares the present value of the stream of benefits divided by the present value of the stream of costs, to generate a net present value (NPV). The NPV is the primary criterion for deciding whether government action can be justified, i.e. whether a scheme has a positive net present value. A higher NPV indicates an option is preferable. However, other factors will be important in determining the overall ranking of measures, including any other benefits or costs, legal and technical issues, practicality and acceptability.

3.40. The cost-benefit analysis results can be used to provide a 'net' cost-effectiveness analysis. The 'net' cost effectiveness is equal to the present value of costs less present value of benefits / by reduction in tonnes pollutant, or in the above case where the cost-effectiveness analysis is concerned with air quality targets in a given year, is equal to annualised costs less annualised benefits / by reduction in tonnes pollutant (or $\mu g\ m^{-3}$). The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other environmental objectives, i.e. reductions of other air quality pollutants or changes in greenhouse gas emissions, and so provides a more holistic overall ranking method for planning.

3.41. Previous studies have looked at the cost-effectiveness and cost-benefit analysis of retofit schemes. These include for example, the Interdepartmental Group on Costs and Benefits (IGCB) Economic Analysis to Inform the

Review of the Air Quality Strategy (www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm) and the London LEZ (www.tfl.gov.uk/roadusers/lez/default.aspx).

3.42. A worked example is included in the following section. A number of studies have examined the balance of costs, benefits and the effectiveness of these schemes. A consistent set of conclusions has emerged from these studies that local authorities should consider when examining these schemes for their region.

- Cost-effective schemes and enforcement are possible for small specific parts of the fleet (such as buses and taxis) but that are typically significant emitters in AQMAs. However, they are still significant in terms of operator cost.
- Regulating emissions from larger, less regulated parts of the fleet is increasingly costly, much less cost-effective and potentially provide very few local air quality benefits.
- Overall it is judged that there may be significant air quality benefits (in terms of compliance with the air quality objectives at least) in introducing schemes to retrofit abatement equipment to older diesel-fuelled HDVs (pre-Euro, Euro I, Euro II and Euro III vehicles) particularly where they undertake a significant share of the road transport activity within an AQMA or urban centre.
- However, it is much less cost-effective to apply a retrofit strategy to private cars.
- This means that authorities may currently prioritise their efforts to regulate emissions via retrofit incentive schemes in the following order of decreasing priority: buses and coaches>HGV>diesel-fuelled taxis (if significant).

4 Worked example

4.1 Introduction

4.1. To illustrate how the guidance in chapter 3 may work in practice the following worked example provides guidance on assessing emissions effects, costs and cost-effectiveness and cost benefit assessment.

4.2. This worked example assumes a policy is implemented to retrofit existing buses with abatement equipment. The example illustrates the effect of:

- varying the emission standard with which the buses must comply either targeting PM emissions or targeting PM and NO_x emissions;
- varying the year by which buses must comply (i.e. the implementation year).

4.2 Emissions assessment

4.2.1 Do minimum or baseline case

4.3. This policy would affect buses only. The first step would be to collate information on:

- number of vehicles potentially affected;
- their age (i.e. when first registered) and whether they already have abatement equipment fitted;
- planned replacement rates (i.e. how long each is expected to remain in service).

4.4. This information is best obtained from the vehicle operators and this provides an opportunity to engage with these key stakeholders at an early stage of policy development.

4.5. It is also necessary to collate estimates of the total annual vehicle kilometres travelled by these vehicles. The total can again be calculated from data supplied by operators. Note that if the policy to retrofit abatement equipment will only be enforced in a specific zone that the total annual vehicle kilometres travelled by these vehicles in that zone should be estimated. This can be estimated by multiplying the total link length on bus routes by their annual service frequency.

4.6. Note that this example will deal with a single fleet representative of all buses operating in an area but it is possible to disaggregate this fleet according to type of bus operation (commercial, contracted, etc) and/or operator. This level of disaggregation may be important depending on the enforcement approach being considered and also if there are significant differences between the fleets of different operators. An example of the collated data is shown in Table 4.

Table 4: Baseline bus data

Number of buses	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8
Euro III	72	78	53	53	53	53	49	46	46
Euro III + CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total number of buses	151	150	149	149	149	149	149	149	149
Total veh.km (millions) in central zone	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Total veh.km (millions)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

4.7. Note that these data illustrate:

- the ongoing effects of existing vehicle replacement policies;
- that some Euro II and Euro III vehicles already have continuous regenerating particulate traps (CRT) fitted to abate their PM emissions. Manufacturers should be consulted for information on the abatement efficiency of their equipment. In this example the abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions. Later in the example a joint PM_{10} and NO_x abatement system (using SCR to reduce NO_x emissions) is discussed. The NO_x abatement efficiency for this system is assumed to be 60%.

4.8. The next step is to calculate the trend in emission rates for the baseline case. Emission rate/speed data disaggregated by vehicle type and Euro standard are available from the National Atmospheric Emissions Inventory (NAEI) web pages. Using these rates and the data illustrated above the baseline trend in emission rates (average weighted by vehicle age and abatement equipment if relevant) can be calculated. These are presented in Table 5.

Table 5: Age and abatement-weighted emission rates at 30 kph

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83
PM (mg/km)	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63

4.9. Note that this example takes a simple view that an average speed of 30 kph is representative of bus activity. Detailed analysis should include consideration of emissions associated with bus stops, layovers and journey delays due to congestion if these are relevant to the case.

4.10. Emission rates and activity data from Table 5 are multiplied to estimate the baseline bus emissions shown in Table 6.

Table 6: Estimated baseline bus emissions

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x emissions (tonnes) in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78
Total NO_x emissions (tonnes)	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74
PM_{10} emissions (tonnes) in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10} emissions (tonnes)	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23

4.11. Note that the estimates illustrate a decline in emissions over time due to vehicle replacement plans and more stringent Euro standards in new vehicles. In particular there is a large relative decrease in PM_{10} emissions between 2007 and 2008 due to the introduction of CRT equipment to the majority of the Euro II vehicles.

4.2.2 Estimated effect of varying the emission standard to be achieved

4.12. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting future emission standards.

4.13. From 2009 onwards there would normally be only Euro II vehicles remaining that have PM abatement fitted. If CRT abates normal PM emissions by 90% then a Euro II vehicle is in effect equivalent to a Euro IV vehicle in terms of PM emissions. Therefore only the Euro III vehicles in the fleet have a worse PM emissions performance than Euro IV whereas ALL of the Euro III and Euro II vehicles (including those with CRT) have worse NO_x emissions performance than Euro IV. A NO_x abatement system with 60% efficiency would also convert a Euro II vehicle to an equivalent Euro IV vehicle.

4.14. This discussion illustrates the point that aiming the emission standard to be achieved on one pollutant or other can have an important implication in terms of the number of vehicles affected and hence the potential emissions benefits and costs.

4.15. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur if the fleet had by 2009 to achieve:

a) an equivalent Euro IV standard for PM emissions (requires the retrofit of CRT to all the Euro III vehicles in the fleet)
b) a Euro IV equivalent standard for all emissions (requires the retrofit of CRT and SCR to all the Euro III vehicles in the fleet and SCR to all remaining Euro II vehicles in the fleet)
c) a Euro III equivalent standard for all emissions (requires retrofit of SCR to all remaining Euro II vehicles in the fleet).

4.16. The tables include a calculation of the difference in annual emissions relative to the base case.

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Criteria	Euro IV equivalent for PM								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8
Euro II+CRT+SCR	0	0	0	0	0	0	0	0	0
Euro III	72	78	0	0	0	0	0	0	0
Euro III+CRT	0	0	53	53	53	53	49	46	46
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83
PM (mg/km)	123.53	72.52	17.49	17.60	17.60	17.60	17.93	19.47	19.68
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78
Total NO_x	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74
PM_{10} in central zone	0.38	0.22	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Total PM_{10}	0.56	0.33	0.08	0.08	0.08	0.08	0.08	0.09	0.09
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total NO_x	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM_{10} in central zone	0.00	0.00	0.11	0.11	0.11	0.11	0.11	0.10	0.10
Total PM_{10}	0.00	0.00	0.17	0.17	0.17	0.17	0.15	0.14	0.14

Criteria	Euro IV equivalent								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	0	0	0	0	0	0	0
Euro II+CRT+SCR	0	0	38	36	36	36	36	12	8
Euro III	72	78	0	0	0	0	0	0	0
Euro III+CRT	0	0	53	53	53	53	49	46	46
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	2.96	2.95	2.95	2.95	2.88	2.67	2.63
PM (mg/km)	123.53	72.52	17.49	17.60	17.60	17.60	17.93	19.47	19.68
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	9.19	9.16	9.16	9.16	8.94	8.27	8.15
Total NO_x	23.34	20.99	13.34	13.29	13.29	13.29	12.98	12.00	11.83
PM_{10} in central zone	0.38	0.22	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Total PM_{10}	0.56	0.33	0.08	0.08	0.08	0.08	0.08	0.09	0.09
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	2.97	2.81	2.81	2.81	2.81	0.94	0.63
Total NO_x	0.00	0.00	4.31	4.08	4.08	4.08	4.08	1.36	0.91
PM_{10} in central zone	0.00	0.00	0.11	0.11	0.11	0.11	0.11	0.10	0.10
Total PM_{10}	0.00	0.00	0.17	0.17	0.17	0.17	0.15	0.14	0.14

Criteria	Euro III equivalent								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	0	0	0	0	0	0	0
Euro II+CRT+SCR	0	0	38	36	36	36	36	12	8
Euro III	72	78	53	53	53	53	49	46	46
Euro III+CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149
Emission rate									
NO_x (g/km)	5.19	4.67	2.96	2.95	2.95	2.95	2.88	2.67	2.63
PM (mg/km)	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63
Emissions (tonnes)									
NO_x in central zone	16.08	14.46	9.19	9.16	9.16	9.16	8.94	8.27	8.15
Total NO_x	23.34	20.99	13.34	13.29	13.29	13.29	12.98	12.00	11.83
PM_{10} in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10}	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23
Difference from Baseline (tonnes)									
NO_x in central zone	0.00	0.00	2.97	2.81	2.81	2.81	2.81	0.94	0.63
Total NO_x	0.00	0.00	4.31	4.08	4.08	4.08	4.08	1.36	0.91
PM_{10} in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PM_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.2.3 Estimated effect of varying the implementation year

4.17. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting the year by which standards should be achieved.

4.18. In this example it is assumed that the emission standard to be achieved is a Euro IV equivalent (i.e. PM and NO_x abatement must be fitted to all Euro II and Euro III vehicles). The effects of requiring this change by 2010 and 2015 are examined.

4.19. Examining the baseline bus data table it can be seen that the 2010 compliance date will affect 89 vehicles whereas the 2015 date will affect 54 due to the natural replacement rate of vehicles over this period. Therefore the 2015 compliance date is likely to require lower costs but would also have a lesser effect.

4.20. This discussion illustrates the important point that setting an early compliance date will achieve more local air quality and emission benefits but at higher costs.

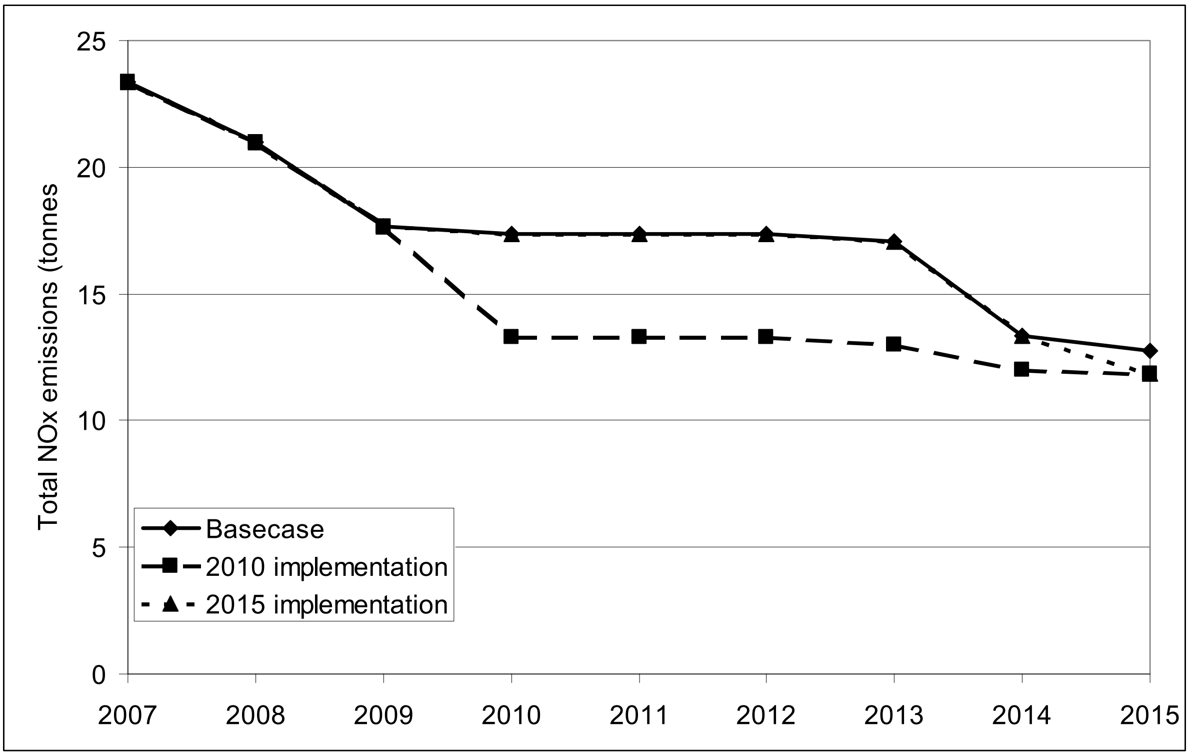
4.21. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur for the examples that if the fleet complies with an equivalent Euro IV standard by:

- 2010 (requires the retrofit of CRT and SCR to all the Euro III vehicles in the fleet and addition of SCR to all Euro II vehicles in the fleet);
- 2015 (requires same interventions as above but dealing with fewer vehicles.

4.22. Figure 1 illustrates the trends in emissions due to the different implementation dates.

4.23. Key points to note in the graph are that the 2010 implementation date would deliver several years of benefits relative to the base case. However, as time passes the gap between the base case and the equivalent Euro IV standard decreases due to replacement of older vehicles. By 2014 the benefits due to the Euro IV standard is very small. The policy of requiring the Euro IV standard by 2015 would only deliver a small benefit – this policy delivers too little too late.

Figure 1: Graph of annual nitrogen oxides emissions for the base case, 2010 and 2015 implementation dates for an equivalent Euro IV standard.



Criteria	2010 Compliance date									2015 Compliance date								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0	9	45	38	36	36	36	36	12	0
Euro II+CRT+SCR	0	0	0	36	36	36	36	12	8	0	0	0	0	0	0	0	0	8
Euro III	72	78	53	0	0	0	0	0	0	72	78	53	53	53	53	49	46	0
Euro III+CRT	0	0	0	53	53	53	49	46	46	0	0	0	0	0	0	0	0	46
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																		
NO_x (g/km)	5.19	4.67	3.92	2.95	2.95	2.95	2.88	2.67	2.63	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.63
PM (mg/km)	123.53	72.52	54.30	17.60	17.60	17.60	17.93	19.47	19.68	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	19.68
Emissions (tonnes)																		
NO_x in central zone	16.08	14.46	12.16	9.16	9.16	9.16	8.94	8.27	8.15	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.15
Total NO_x	23.34	20.99	17.65	13.29	13.29	13.29	12.98	12.00	11.83	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	11.83
PM_{10} in central zone	0.38	0.22	0.17	0.05	0.05	0.05	0.06	0.06	0.06	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.06
Total PM_{10}	0.56	0.33	0.24	0.08	0.08	0.08	0.08	0.09	0.09	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.09
Difference from Baseline (tonnes)																		
NO_x in central zone	0.00	0.00	0.00	2.81	2.81	2.81	2.81	0.94	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63
Total NO_x	0.00	0.00	0.00	4.08	4.08	4.08	4.08	1.36	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91
PM_{10} in central zone	0.00	0.00	0.00	0.11	0.11	0.11	0.11	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Total PM_{10}	0.00	0.00	0.00	0.17	0.17	0.17	0.15	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14

4.2.4 Conclusions

4.24. In terms of emissions and air quality benefits the main points to be considered for any vehicle retrofit policy are as follows.

1. To set an appropriate emission standard for one or more pollutants to achieve an outcome where there are local emissions reductions relative to the base case. The higher the Euro standard the bigger the potential reductions.
2. To set an appropriate implementation year to achieve an outcome where there are local emissions reductions relative to the base case. Earlier is better.
3. To consider setting further Euro standards and implementation years (i.e. subsequent phases of emission reduction) otherwise the benefits of the policies will be eroded over time by natural vehicle replacement rates.
4. That the emission standards and implementation years have to be balanced up against issues of costs but also the level of action required to achieve the air quality objectives in the AQMA.

4.3 Cost-effectiveness and cost-benefit assessment

4.25. A simple example is given below on cost-effectiveness analysis and cost-benefit assessment for retrofit. Note that this example does not follow-on from the detailed emissions example above, it is a separate example to illustrate the concepts.

4.3.1 Cost-effectiveness analysis

4.26. The first example is to generate a simple cost-effectiveness value for retrofit options for buses. The estimated capital and running costs of abatement equipment is summarised in Table 7 below, along with the lifetime. Note that for the economic analysis, it is the resource costs (technology costs) that are used, rather than the market prices. For the financial analysis, the market prices are relevant.

Table 7: Cost input data

Equipment – heavy vehicle	Resource Costs	Annual cleaning / maintenance cost	Annual additive cost	Change in fuel efficiency	Lifetime
Diesel Particulate Filter (DPF)*	1750	240	0	0%	5 years

* source: IGCB Economic Analysis to Inform the Review of the Air Quality Strategy, based on value for articulated HGVs. Note for the analysis here, the lifetime is assumed to be five years. For the IGCB analysis, the actual lifetime of equipment was estimated at ten years. We have assumed the shorter lifetime here to reflect retirements in the fleet for older vehicles.

4.27. The costs of these individual options over their lifetime then has to be calculated, and expressed in equivalent terms, as a present value of costs. For the analysis here, we assume that the scheme starts the following year

(year 1). In each case, the costs in each year are multiplied by the discount factors, to allow the discounted costs to be estimated. The sum of these discounted costs gives the present value of costs. These are then converted to an equivalent annual cost for the cost-effectiveness analysis (using either the Equivalent Annualised Cost equation[6] , or the excel formula, see worksheet example). As an example, the values for the DPF estimation are shown in Table 8 below.

Table 8: Estimation of Present Value of Costs, and Equivalent Annual Cost

Equipment – bus (£)	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 5**
DPF capital (resource)	1,750				
DPF maintenance	240	240	240	240	240
DPF fuel efficiency change	0	0	0	0	0
Total	**1,990**	**240**	**240**	**240**	**240**
Discount factor	1.0000	0.9662	0.9335	0.9019	0.8714
Discounted cost	1,990	232	224	216	209
Present value (sum)	2,872				
Equivalent annualised cost	636				

4.28. This provides an estimate of the annualised costs of the equipment, which can be compared with the annual tonnes abated. For the DPF, an abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions.

4.29. The annual emissions benefits are based on buses driving in urban conditions, 30 kph, are shown below from the NAEI webpages. We assume each bus drives 20,000 km a year in the central zone. If it is assumed that there is a flat 90% removal efficiency across all vehicle types and Euro standards, then the cost-effectiveness is determined by the equivalent annual cost above, divided by the annual emissions reduction. The values are first shown for the DPF. As expected, the cost per tonne increases as progressively more modern vehicles are targeted. Note implicit in this assumption is that the equipment will be functional for the potential lifetime (for DPF, five years). For older vehicles, the vehicle lifetime might be shorter, so the capital cost above are spread over less years of operation, and the equivalent annual cost will rise and the cost-effectiveness will fall.

4.30. This shows the general finding that it is more cost-effective to target older vehicles (subject to the caveat about vehicle operating lifetimes). Indeed, it shows that the cost-effectiveness drops very dramatically when targeting

[6] Equivalent annualised cost = NPV multiplied by

$$\left[\frac{r(1+r)^n}{(1+r)^n-1}\right]$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years.

Euro IV vehicles (the costs per tonne rise by a factor of five), showing it is not cost-effective to target this part of the fleet.

Table 9: Cost-effectiveness Analysis Diesel Particulate Filter

	Emissions gPM_{10}/km	PM_{10} t / yr in central zone	PM_{10} abated /yr at 90% effic.	Annualised costs	cost per tonne
Euro II	0.194	0.00387	0.0035	614	£176,242
Euro III	0.139	0.00279	0.0025	614	£244,781
Euro IV	0.029	0.00058	0.0005	614	£1,174,947
Euro IV+	0.029	0.00058	0.0005	614	£1,174,947

4.31. It would be possible to compare to other technologies, such as EGR or SCR (plus DPF) and compare the cost-effectiveness of options using the same approach. However, for some options, for example SCR + DPF, some equipment abates both PM and NO_x emissions. A cost-effectiveness analysis can only take one pollutant into account at a time (this is one of the problems with cost-effectiveness). It is possible to address this by estimating **'net' cost-effectiveness** of options to correctly prioritise measures taking other objectives into account (see below).

4.32. The overall benefits of an option (for example, across pollutants) can also be assessed using cost-benefit analysis, and this highlights the complementary role for using the two approaches together.

4.3.2 Cost-benefit analysis

4.33. The first stage in a cost-benefit analysis is to estimate the monetary value of the benefits.

4.34. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants) are estimated.

4.35. As an example, the values for annual PM emissions from a DPF on a Euro II bus was shown above. However, in this case, it is necessary to look at the full benefits of the scheme (the full value to society) rather than the benefits that only occur in the central zone. For this, it is assumed that the bus also has an annual mileage of 30,000 km in the outer zone of the city. Note that for PM_{10}, it is important to consider the location of the emissions benefits, as these affect the values (for NO_x, all emission benefits are valued the same, irrespective of location). The total benefits are therefore shown in Table 10.

Table 10: Benefits Diesel Particulate Filter

Euro II	Emissions gPM_{10}/km	PM_{10} Tonnes / year	PM_{10} Tonnes abated /yr at 90% effic.
Central zone	0.194	0.00387	0.0035
Outer zone	0.194	0.00581	0.0052

Assumes 20,000 km/year central zone and 30,000 km/year outer zone.

4.36. The values are then entered in the damage cost calculator. In this case, we assume:

- a 2008 start date;
- a five year lifetime;
- The central zone corresponds with area location 12 – inner conurbation;
- The outer zone corresponds with area location 13 – outer conurbation.

4.37. The spreadsheet outputs are shown below. Note in this case, even though we have PM_{10} emissions, because we need to assign different monetary values, we have to separate the central and outer emissions and treat them as two separate pollutants. The two PM calculation sheets are shown below.

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*12*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00349	0.00349	0.00349	0.00349	0.00349		

CALCULATED RESULTS

Central Estimate Present Value	£	0.00	Million
	£	*1,966*	

Estimated Range	£	0.00	-	0.00	Million
	£	*1,537*	-	*2,231*	

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*13*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00523	0.00523	0.00523	0.00523	0.00523		

CALCULATED RESULTS

Central Estimate Present Value	£ 0.00	**Million**		
	£ *1,832*			
Estimated Range	£ 0.00	-	0.00	Million
	£ *1,433*	-	*2,080*	

4.38. These are added together (£1,966 + £1,832) to give a total central estimate of £3,798 present value of benefits.

4.39. This can be compared against the present value of costs in the earlier table, which were £2,872. This shows the option has a positive NPV. A similar analysis could be undertaken with other equipment, importantly comparing equipment that reduces PM and NO_x and estimating the total benefits across pollutants. The option with the highest NPV is preferable.

Table 11: Cost-Benefit Analysis Results

Equipment - bus	Present Value Benefits	Present Value Costs	Net Present Value
DPF	3,798	2,872	+ 926

4.40. The same approach can be used to build up the analysis of cost-effectiveness analysis and cost-benefit analysis for entire schemes, as with the emissions benefit example above.

4.41. The information from a cost-benefit analysis can also be used to consider other environmental objectives as part of a 'net' cost-effectiveness analysis. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant. The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas emissions, in the cost-effectiveness ranking and so provides a more holistic overall ranking method. For the example above, the Present Value of benefits has to be first expressed as an equivalent annual term. It can then be compared to the equivalent annual costs, and to emissions improvements, to estimate the net cost-effectiveness. The advantage of this approach is it allows multiple pollutants (for example NO_x and PM_{10}) benefits to be taken into account when undertaking the cost-effectiveness ranking between options.

Table 12: 'Net' Cost-Effectiveness Results

Equipment - bus	Annualised Costs	Annualised Benefits	'Net' Cost-effectiveness
DPF	£636	£841	-£58,853

5 Examples of retrofit schemes

5.1. The purpose of this chapter is to provide key information on existing or planned retrofit schemes. This includes a brief description of how key implementation and enforcement issues are addressed in these schemes and also a wider discussion of these issues.

5.2. Traffic control schemes are common in UK towns and cities. Linking a variety of access control schemes on sections of the public highway builds up the overall traffic management approach in many city and town centres. A small number of such traffic control schemes in the UK have either been designed to include emission criteria or have been examined for such a modification, and are therefore can be considered examples of retrofit incentive schemes.

5.3. A selection of relevant schemes includes:

- buses and coaches: Quality Bus Partnerships and voluntary action in Oxfordshire among others, London Bus scheme;
- heavy Goods Vehicles: the London LEZ among others;
- taxis (Hackney Carriages): London scheme;
- cars: large scale retrofit of the car fleet is not considered cost-effective currently and is not considered in this guidance note.

5.4. These schemes achieve their emission objectives either by applying regulatory or access controls or charges to more polluting vehicles and discounts to less polluting vehicles. Key summary information on the schemes is provided in Table 13 whereas more detailed information is found in the following text sections.

Table 13: Summary of key information on example schemes in this guidance

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Management of permitted vehicles	Comments (Strengths/weaknesses)
London bus emission strategy	Transport for London specifications	Greater London	London Bus fleets	Minimum of Euro II plus particulate filter and moving to diesel-electric hybrid vehicles in the future	Transport for London		QPS or quality contract schemes are needed outside London to exert a similar level of control over commercial services
Oxfordshire	QBPA	Oxford City	Bus fleets	Under review	Under review		A range of approaches may be necessary to regulate emissions from all relevant bus fleets
London - LEZ	Charge	Greater London	HDV (HGV, Coach etc), with heavy vans to be added later.	From 4th February 2008, a standard of Euro 3 for PM for lorries over 12 tonnes Gross Vehicle Weight (GVW), and buses and coaches over 5 tonnes GVW. From July 2008, a standard of Euro 3 for PM for lorries between 3.5 and 12 tonnes, buses and coaches From October 2010, a standard of Euro 3 for PM for larger vans and minibuses From January 2012, a standard of Euro 4 for PM for lorries over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.	Large network of ANPR cameras. Penalty for non-compliance and non-payment is £500/£1000 depending vehicle size.	Compliant vehicles self-registered via number plate and DVLA records. Non-standard cases and retrofit vehicles required to register vehicle, and retrofit vehicles inspected annually by VOSA. Daily charge (£200 or £100, depending on the size/type of vehicle) for vehicles who do not comply. Retrofit for PM possible.	Phased approach to ensure tightening emission standards.
London Taxi emission policy	Public Carriage Office (PCO) licence conditions	Greater London	Hackney carriages	Euro 3 emission standard by July 2008	Licensing conditions		Scheme allows operators to charge extra fares to cover cost of upgrades. Significant administration to certify upgrades.

Buses and coaches

Oxfordshire

5.5. Oxfordshire is reviewing the costs and effects of introducing an emissions protocol into a QBPA (and other approaches to regulating emissions from commercial bus fleets). Any regulatory approach is likely to remain technology neutral meaning that emission reductions may be achieved via retrofits or vehicle replacement. Also within Oxfordshire, the Oxford Bus Company has placed air quality and emission control centrally within its commercial strategy. It has undertaken a benchmarking exercise to ensure that its fleet is among the best in the UK in controlling PM, NO_x and other emissions. All vehicles have CRTs retrofitted as a minimum requirement and the fleet average age is currently six years old and vehicles are now replaced by ones that are Euro V standard or better.

London

5.6. The London Bus Emission Strategy is a long term programme of bus upgrading in part to improve the fleet's emissions performance. As at March 2007 there were 8181 vehicles in the fleet. In advance of the London LEZ going operational the fleet was improved mainly via emissions abatement retrofits (further information on the London LEZ can be found in Chapter 5 of the Practice Guidance for LEZs). As a result the fleet contained 36% Euro II vehicles plus particulate filters, 61% Euro III vehicles plus particulate filters and 3% Euro IV vehicles with in-built SCR or EGR NO_x abatement.

5.7. Compared to the fleet as it was in 2000 TfL has estimated that emissions of PM_{10}, CO and hydrocarbons has been reduced by 90% as a result of the particulate filter policy. Nitrogen oxides emissions are assessed to have been largely unchanged but one negative effect of the filters is an increase in the proportion of NO_x that is emitted as NO_2 as has been noted previously in this guidance.

5.8. In addition to local pollutant emission reductions the London bus fleet priority is also to reduce carbon emissions. As a result there are now strategies to replace conventional diesel powered vehicles with diesel-electric hybrid vehicles in the short to medium term. These technologies are already under trial in London and are predicted to result in further reductions of local pollutant emissions and NO_x emissions in particular. Further information on LEVs can be found in the Practice Guidance on uptake of LEVs.

Heavy Goods Vehicles

London – Low Emission Zone

5.9. The London LEZ started operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine HDVs including lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered vehicles, thereby prioritising PM reduction. The largest number of vehicles that will potentially be affected in the first phase of the scheme are HGVs .

5.10. The LEZ commenced on 4 February 2008 for lorries over 12 tonnes, with different vehicles affected over time and tougher emissions standards due to be introduced in January 2012.

5.11. The London LEZ emission standards describe the minimum Euro standard which vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using a vehicle whose engine was type approved to this standard (or better) or by retrofitting exhaust after-treatment technology to raise the emission standard. The standards by vehicle/weight and timescale are as follows.

- From 4 February 2008, a standard of Euro III for PM for lorries over 12 tonnes.
- From 7 July 2008, a standard of Euro III for PM for lorries between 3.5 and 12 tonnes and buses and coaches over 5 tonnes.
- From 4 October 2010, a standard of Euro III for PM for larger vans and minibuses.
- From 3 January 2012, a standard of Euro IV for PM for lorries over 3.5 tonnes and buses and coaches over 5 tonnes.

5.12. The important point to note is that defining compliant vehicles in these Euro standard terms is in effect technology neutral. Operators are free to choose between vehicle replacement and retrofit using one of the approved technologies on the market. Depending on the age and use of the vehicle it may be much more cost-effective to choose a retrofit strategy over a vehicle replacement strategy.

5.13. The London LEZ actually operates as a road charging scheme. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not pay. It was set up using a Scheme Order, which is the same legal basis as the London CCS. However, it is not a congestion charge as the objective is not to reduce traffic levels.

5.14. The London LEZ began operation in 2008 and there has not yet been an ex-post analysis made of the scheme impacts. Transport for London has planned a work programme that will undertake this analysis and it is expected that results will be made public in due course. The scheme has been scrutinised closely during its development and a recent TfL analysis of the potential impacts of the scheme[7] found the following. The LEZ is anticipated to produce significant air quality benefits both within and beyond the LEZ boundary. In 2008 the scheme is expected to reduce the area of Greater London that exceeds the daily PM_{10} limit by 7% and by 15% by 2012. By 2010 the scheme is expected to reduce the area of Greater London that exceeds the annual mean NO_2 limit by 4% and by 16% by 2012. Health benefits associated with these changes are estimated to be £170-250 million

[7] TfL (2007). Report to the Mayor following consultation with stakeholders, businesses, other organisations and the public on the Scheme Order 2006.

due to predicted reduction in illness and extended life expectancy (years of life gained).

5.15. Information on a wide number of other current and planned low emission zones across Europe can be found via the EU-wide LEZ Network (www.lowemissionzones.eu). The web site provides information about network members' schemes and is a mechanism for members to publicise access restrictions on a pan-Europe basis.

Taxis and Private Hire Vehicles

London

5.16. The Public Carriage Office (PCO) of TfL administers the Emission Strategy for London Taxis. Under the scheme all taxis must meet Euro 3 emission standards for NO_x and PM_{10} by July 2008. Pre-Euro, Euro 1 or Euro 2 vehicles presented for annual licensing inspection from July 2007 onwards were required to have fitted either approved emission reduction equipment or an approved conversion to run on an alternative fuel. Approved emission reduction equipment and fitters have been published by TfL. Impacts of costs of abatement equipment have been partially subsidised by the temporary addition of a £0.2 environmental fee per journey. Prior to the strategy the London taxi fleet was estimated to be responsible for 12% of NO_x and 24% of the PM_{10} from road transport emissions in central London. More information on the scheme can be obtained at www.tfl.gov.uk/businessandpartners/taxisandprivatehire/1414.aspx.

6 Conclusions

6.1. A range of schemes have been and could be developed by local authorities to directly influence the emission standards of vehicles downward in sensitive areas on the public highway or private land. Retrofits have been almost exclusively applied to HDVs and there remain significant benefits in many cases to reducing the emissions of pre-Euro III HDVs in the short to medium term but in the medium to long term focus should shift to reducing the emissions of pre-Euro IV or V HDVs. For these vehicles there are a range of proprietary PM and NO_x abatement systems.

6.2. Existing schemes have been implemented by a wide variety of approaches illustrating the large number of options available to local traffic authorities to introduce an element of emissions control into their policies regardless of vehicle type.

6.3. At the voluntary level authorities can encourage the uptake of retrofits via QBPS. The authority can do much to facilitate uptake providing adequate facilities for bus services. The success of such approaches will necessarily rest on the efforts to engage with the vehicle operators in a detailed and constant manner.

6.4. If voluntary approaches are not realistic then there is a range of methods to encourage or compel the uptake of retrofits.

6.5. Traffic and parking restrictions can be developed into schemes by the Highway Authority, and development control schemes by Planning Authorities. So far the LEZ Scheme is the most developed UK instance of controlling emissions via traffic access restrictions but smaller schemes of these types are being considered in other areas of the UK.

6.6. Traffic access restrictions may be the only practical approach to manage emissions from HGVs (and could be used to manage all vehicle types) unless significant traffic could be regulated via development control schemes. The Greenwich Peninsula scheme is a good example of attempting to manage emissions from these vehicles as far as possible. These schemes tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Small areas, road networks with limited access points, and areas with existing traffic restrictions (for example pedestrian zones) provide the scope for adding emission criteria components at lower cost than areas without, and if air quality assessments justify it can be the most cost-effective areas to tackle first.

6.7. For buses a number of approaches are necessary since bus and coach services are supplied under a variety of commercial, contracted and ad hoc models. The options for regulating emissions of commercial services are changing with the advent of the Local Transport Bill. Once regulations under this are produced there should be an improved route to including emissions based criteria within Quality Partnership and Quality Contract Schemes.

Emissions based contract conditions could and are being included now for contracted services in some local authorities.

6.8. Since many buses undertake a large proportion of their activity in urban centres (and by extension within many AQMAs) and since there are still many Euro III or older vehicles in fleets, local authorities are strongly encouraged to fully explore all of the available voluntary and regulatory options to manage emissions from these vehicles.

6.9. Within scheme design and appraisal the environmental objectives of the scheme are a key consideration. Source apportionment should be used to determine which vehicles and which pollutants are the most relevant to target and to determine the cost-effectiveness of various options.

6.10. From existing examples, the most common vehicles to target in a scheme with enforceable restrictions are HDVs (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. The worked example in this guidance illustrated the key points that the scheme should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Between now and 2010-2012 a Euro III standard should be considered as the minimum standard for LEZ schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local authorities will need to consider their own case, costs and benefits when setting emission standards and compliance dates.

6.11. Similar standards within a country are useful, but not essential to setting up and operating schemes. Emissions standards described in technology neutral terms will be important if it is intended that operators will be able to comply via a retrofit strategy rather than a vehicle replacement strategy. A common framework, with cities free to choose the level of standard within it forms a possible model (seen in Germany). A common set of standards across all vehicles, with authorities choosing which vehicles from the framework to include in their scheme and how to enforce it, might provide another model. When choosing standards, co-operation between neighbouring authorities can be useful, to harmonise standards and reduce competition between those with schemes and those without.

6.12. The most common toxic pollutant to target is PM, shown by schemes that include LDV setting standards that are more difficult for diesel vehicles to meet. It is likely this is due to a number of factors:

- Heavy Duty Vehicles produce higher levels of emissions than lighter, smaller engined vehicles;
- the options for retro-fitting HDV are better developed and more cost-effective given the cost of PM abatement equipment compared to NO_x abatement, cost of retrofitting as a proportion of HDV value, and the potential reduction in overall level of emissions (compared to a LDV);
- a scheme that encompasses more vehicles will generally be more costly to set-up and administer, therefore in value for money terms it is more cost effective to target those vehicles with the highest overall emission

contribution first (for example bus fleets with large urban centre activity), which is also where any grants or subsidies for retrofitting should be aimed;
- diesel vehicles tend to produce higher levels of PM emissions than the equivalent petrol vehicle, and reduction in PM emission generates significant levels of health benefits.

6.13. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Unfortunately, existing systems will probably not provide a complete solution and the example LEZs showed that new systems and processes were required (see Practice Guidance on LEZs). Taking a practicable approach to completing gaps in information, and making the scheme as straightforward as possible for the user is recommended. There may need to be some trade-off between the optimum operation of a scheme (for emission reduction and cost) against ease of use and acceptance. The examples of QBPA illustrate that management solutions need not be complex.

6.14. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

6.15. Planning condition and obligation schemes can have significant potential for specific locations. The cost of designing and operating a planning condition and obligation scheme can be borne by the developer. A scheme can apply to both construction and operational phases of a development, with obligations passed onto future occupiers. Such an approach provides a useful method of incorporating vehicle specific environmental criteria into planning decisions.

6.16. The assessment of emissions, air quality, cost-effectiveness and cost-benefits of such schemes may be a necessary task in order to develop the evidence to allow decisions on such schemes to be determined. This is particularly true of schemes with either significant costs or ones that affect many vehicle operators. The guidance makes it clear that existing capacity and tools to assess emissions and air quality may have to be supplemented with specific local data to improve the accuracy of assessments. Local authorities that wish to consider schemes are therefore encouraged to plan their data and assessment needs in advance of any stage where the costs and benefits of different scheme options are to be assessed.

Appendix 1: Glossary

ANPR	Automatic number plate recognition
AQMA	Air Quality Management Area
CCS	Congestion Charge Scheme
CO	Carbon monoxide
CO_2	Carbon dioxide
CRT	Continuous regenerating particulate traps
Defra	Department for Environment Food and Rural Affairs
DSRC	Dedicated Short Range Communication
DfT	Department for Transport
EA 1995	Environment Act 1995
EGR	Exhaust Gas Recirculation
FPN	Fixed Penalty Notice
GIS	Geographical Information Systems
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	Interdepartmental group on costs and benefits
LAQM	Local air quality management
LDV	Light Duty Vehicle
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
LGV	Light Goods Vehicles
NAEI	National Atmospheric Emissions Inventory
NATA	New Approach to Transport Appraisal
N_2	Nitrogen
NH_3	Ammonia
NO	nitric acid or nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen or nitrogen oxides
NPV	Net Present Value
OCR	Optical Character Recognition
PCN	Penalty Charge Notice
PM_{10}	Particulate matter smaller than 10 microns
QBPA	Quality Bus Partnership Agreement

QPS	Quality Partnership Schemes
QC	Quality contracts
RPC	Reduced Pollution Certificate
RTRA 1984	Road Traffice Regulation Act 1984
SAFED	Safe and Fuel Efficient Driving
SCR	Selective Catalytic Reduction
TfL	Transport for London
TMA 2004	Traffic Management Act 2004
TRO	Traffic Regulation Order
VED	Vehicle Excise Duty
VRM	Vehicle Registration Mark
WebTAG	Web-based Transport Analysis Guidance

ANNEX I

Planning and Environmental Policy Group

Part III of the Environment (Northern Ireland) Order 2002

Local Air Quality Management Guidance

Worked Examples for the Practice Guidance

December 2009

YEAR	Discount Factor
0	1
1	0.9662
2	0.9335
3	0.9019
4	0.8714
5	0.8420
6	0.8135
7	0.7860
8	0.7594
9	0.7337
10	0.7089
11	0.6849
12	0.6618
13	0.6394
14	0.6178
15	0.5969
16	0.5767
17	0.5572
18	0.5384
19	0.5202
20	0.5026
21	0.4856
22	0.4692
23	0.4533
24	0.4380
25	0.4231
26	0.4088
27	0.3950
28	0.3817
29	0.3687
30	0.3563

for Government recommended 3.5% discount rate

Example of the use of discounting
This shows how the present value of £1,000 declines in future years with a discount rate of 3.5 per cent.
The value of £1000 in each year is multiplied by the discount factor

Year	0	1	2	3	4	5	
Value	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (left)
Discounted Present Value	£1,000	£966	£934	£902	£871	£842	

Source: Green Book, Annex 6, Page 100.
http://www.hm-treasury.gov.uk/media/F/D/Green_Book2_03.pdf

In this example, the costs of the scheme are expressed as a present value
See Box 6 of economic guidance document

Note that it is assumed that the base year is year 0, so the discount factor for year 0 is 1

Scheme A	**0**	**1**	**2**	**3**	**4**	**5**	
Capital costs	£50,000						
Operating costs	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	
Costs	£51,000	£1,000	£1,000	£1,000	£1,000	£1,000	
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (previous worksheet)
Present value	£51,000	£966	£934	£902	£871	£842	The value in each year is multiplied by the discount factor
Sum of PV	£55,515						The sum of these present values give the present value

Scheme B	**0**	**1**	**2**	**3**	**4**	**5**	
Capital costs	£10,000						
Operating costs	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	
Costs	£20,000	£10,000	£10,000	£10,000	£10,000	£10,000	
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (previous worksheet)
Present value	£20,000	£9,662	£9,335	£9,019	£8,714	£8,420	The value in each year is multiplied by the discount factor
Sum of PV	£65,150						The sum of these present values give the present value

In this example, the equivalent annual cost of the schemes are estimated
See Box 7 of economic guidance document

The net present value (previous sheet) can be used to derive an equivalent annualised cost (EAC)

The formula to do this is Equivalent annualised Cost = $\left[\frac{r(1+r)^n}{(1+r)^n - 1}\right]$ where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years

However, there is an excel function that can be used to generate this value
take a NPV of £10000 and ten year

NPV	£10,000
Discount rate, r	3.50%
Number of year, n	10
Fomula	£1,202
Excel	£1,202

There is an excel formula to do this (see cell). Note strictly speaking, this formula (and formula above) provides an EAC for a scheme starting in year 1

This can be applied to the example scheme

Scheme A	0	1	2	3	4	5	
Capital costs	£50,000						
Operating costs	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	
Costs	£51,000	£1,000	£1,000	£1,000	£1,000	£1,000	
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (previous worksheet)
Present value	£51,000	£966	£934	£902	£871	£842	The value in each year is multiplied by the discount factor
Sum of PV	£55,515						The sum of these present values give the present value
Discount rate	3.50%						
Number of years	6						
EAC (formula)	£10,418						The EAC formula is applied to the sum of PV to generate the equivalent annual cost (annualised costs)
EAC (excel)	£10,418						It requires the discount rate - 3.5% - and the number of years to annualise over - in this case 6

Scheme B	0	1	2	3	4	5	
Capital costs	£10,000						
Operating costs	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	
Costs	£20,000	£10,000	£10,000	£10,000	£10,000	£10,000	
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (previous worksheet)
Present value	£20,000	£9,662	£9,335	£9,019	£8,714	£8,420	
Sum of PV	£65,150						
Discount rate	3.50%						
Number of years	6						
EAC (formula)	£12,227						**In this case example A has a lower equivalent annualised cost**
EAC (excel)	£12,227						**of 10418 compared to 12227**

In this example, the cost-effectiveness of the schemes are compared
See Box 7 of economic guidance document

The cost-effectiveness calculation combines the EAC (annualised) costs with the annual emission reduction

Option A reduces emissions by 10 tonnes of NOx a year in the area.

Option B reduces emissions by 14 tonnes of NOx a year in the area

The cost-effectiveness is then the annual emission reduction divided by the equivalent annual cost
EAC was given on previous work sheet

	EAC	Tonnes abated/year	Costs per tonne abated
Option A	10418	10	1042
Option B	12227	14	873

So option B is the more cost-effective option, as it achieves a reduction in NOx for lower cost per tonne

Note that to consider other environmental objectives, the 'net' cost-effectiveness should be estimated

SPC In this example, the economic benefits of GHG reductions are estimated
See Box 4 of economic guidance document

Guidance available at

http://www.defra.gov.uk/environment/climatechange/research/carboncost/step1.htm.

Year	2007	2008	2009	2010	2011	2012
CO_2 reduction (tonnes)	100	80	60	40	20	0

Year	2007	2008	2009	2010	2011	2012	
SPC in 2007 prices (w2%)	25.5	26	26.5	27	27.6	28.1	
Total Values	2550	2080	1590	1080	552	0	Multiply CO2 reduction by SPC value
Discount factor	1	0.9662	0.9335	0.9019	0.8714	0.842	from HMT scheme (previous worksheet)
Discounted value	2550	2010	1484	974	481	0	The value in each year is multiplied by the discount factor
Net Present Value	7499						The sum of these present values give the net present value

In this example, the economic benefits of NOx reductions are estimated
See Box 9 of economic guidance document

The benefits of air pollution reductions can be valued in economc terms

These benefits can be obtained using 'damage costs', which provide the benefits of marginal air quality improvements, in benefits (£) per tonne of pollutant reduced.
These damage costs are presented on the Defra web-site

http://www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm

To estimate benefits, it is necessary to select the pollutant, and specify the year that the scheme starts and the length of time

	Tonnes abated/year Nox	Present Value benefits (£)
Option A	10	53148
Option B	14	74407

These calculations can be undertaken with the damage cost calculator, as below

1. What length (in years) is your policy appraisal?	6
2. When is the first year of your appraisal?	2007
3. What pollutant are you assessing? (click box to select from drop-down menu)	*1*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Change in emissions (tonnes)	10	10	10	10	10	10	

CALCULATED RESULTS

Central Estimate Present Value	£ 0.05	Million
	£ *53,148*	

1. What length (in years) is your policy appraisal?	6
2. What is the base year for the appraisal?	2007
3. What pollutant are you assessing? (click box to select from drop-down menu)	*1*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	
Change in emissions (tonnes)	14	14	14	14	14	14	

CALCULATED RESULTS

Central Estimate Present Value	£ 0.07	Million
	£ *74,407*	

If additonal PM10 emissions are included
With the location

	Tonnes abated/year	PM10	Present Value benefits (£)	NOX + PM10
Option A		0.1	65,602	118,750
Option B		0.05	32801	107,208

1. What length (in years) is your policy appraisal?	6
2. What is the base year for the appraisal?	2007
3. What pollutant are you assessing? (click box to select from drop-down menu)	12
4. Input the annual changes in emissions below (in tonnes)	

Year	2007	2008	2009	2010	2011	2012	
Change in emissions (tonnes)	0.1	0.1	0.1	0.1	0.1	0.1	

CALCULATED RESULTS

Central Estimate Present Value	£ 0.07	Million
	£ 65,602	

1. What length (in years) is your policy appraisal?	6
2. What is the base year for the appraisal?	2007
3. What pollutant are you assessing? (click box to select from drop-down menu)	12
4. Input the annual changes in emissions below (in tonnes)	

Year	2007	2008	2009	2010	2011	2012	
Change in emissions (tonnes)	0.05	0.05	0.05	0.05	0.05	0.05	

CALCULATED RESULTS

Central Estimate Present Value	£ 0.03	Million
	£ 32,801	

In this example, the cost benefit analysis is undertaken
See Box 9 of economic guidance document

First if only NOx is included

	Present Value costs (£)	Present Value benefits (£)	Net Present Value	
Option A	55515	53148	-2367	This scheme has a negative net present value
Option B	65150	74407	9257	This scheme has a positive net present value
	see earlier sheet	see earlier sheet	benefits - costs	

Then in NOX and PM10 are included

	Present Value costs (£)	Present Value benefits (£)	Net Present Value	
Option A	55515	118750	63235	This scheme now has a positive net present value
Option B	65150	107208	42058	and it is now greater than scheme B
	see earlier sheet	see earlier sheet	benefits - costs	

In this example, a 'net' cost-effectiveness analysis is undertaken
See Box 10 of economic guidance document

The estimation of the net cost-effectiveness analysis nets benefits from the pure cost aspects to give the cost-effectiveness ranking

Option A reduces emissions by 10 tonnes of NOx a year in the area.

Option B reduces emissions by 14 tonnes of NOx a year in the area

The cost-effectiveness is then the annual emission reduction divided by the equivalent annual cost
for costs, the EAC was given on previous work sheet
For benefits, the total benefits (NOX and PM) have to be annualised

	A	B
Sum of PV	£118,750	£107,208
Discount rate	3.50%	3.50%
Number of years	6	6
EAC (formula)	£22,286	£20,120
EAC (excel)	£22,286	£20,120

	EAC	EAB	Net	NOX Tonnes abated/year	Costs per tonne abated
Option A	10418	£22,286	-£11,867	10	-1187
Option B	12227	£20,120	-£7,893	14	-564

option A now is more cost-effective
when the other environmental aspects are taken into account

Cost-Effectiveness

Example on Retrofit technology

This is for a DPF, using the costs from the IGCB economic analysis

Base year	2008	
Scheme start	2008	Note in this example, the base year is the same as the start year, so the discount factor is 1 for year 0
Discount rate	3.50%	
Number of years	5	

	2008	**2009**	**2010**	**2011**	**2012**	
Equipment - bus	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	
DPF capital (resource)	1,750					
DPF maintenance	240	240	240	240	240	
DPF fuel	0	0	0	0	0	
Total	**1,990**	**240**	**240**	**240**	**240**	
Discount factor	1.00000	0.96620	0.93350	0.90190	0.87140	from HMT scheme (previous worksheet)
Discounted cost	1,990	232	224	216	209	The value in each year is multiplied by the discount factor
Present value	2,872					The sum of these present values give the present value
Equivalent annualised cost	£636					Use equation or the simple excel formula (PMT)

Annual emission benefits

PM10	emissions g/km	emission per year tonnes	benefit at 90% abatement	cost per tonne
Euro II	0.194	0.00387	0.0035	£182,409
Euro III	0.139	0.00279	0.0025	£253,346
Euro IV	0.029	0.00058	0.0005	£1,216,062
Euro IV+ (2008)	0.029	0.00058	0.0005	£1,216,062
	source NAEI	Assume 20 000 km peryear in area		

Cost-benefit analysis

The benefits for a Euro II bus are based on a five year lifetime

	benefit at 90% abatement	
Euro II	0.0035	in the central zone

This value is entered into the Defra damage cost calculator

http://www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm

The length of the scheme and the base year need to be entered
In this case, we are using a 2008 base year and a 5 year scheme

To estimate benefits, it is necessary to select the pollutant, and specify the year that the scheme starts and the length of time

A 5 year lifetime

The central zone corresponds with area location 12 - inner conurbation

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*12*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00349	0.00349	0.00349	0.00349	0.00349		

CALCULATED RESULTS		
Central Estimate Present Value	£ 0.00	Million
	£ *1,966*	

Estimated Range				
	£ 0.00	-	0.00	Million
	£ *1,537*	-	*2,231*	

This gives the benefits, however, the total benefits are relevant for the Cba, so it is also necessary to add the benefits outside the zone
We assume the vehicle also does 30 000 km outside the zone each year

Annual emission benefits

PM10	emissions g/km	emission per year tonnes	benefit at 90% abatement
Euro II	0.194	0.00581	0.00523
	source NAEI	Assume 30 000 km peryear in area	

This value is also entered into the damage cost spreadsheet.
However, for PM, the location of emissions is important, and so a new page must be used

The outer zone corresponds with area location 13 - outer conurbation

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*13*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00523	0.00523	0.00523	0.00523	0.00523		

CALCULATED RESULTS

Central Estimate Present Value	£	0.00	Million
	£	*1,832*	

Estimated Range	£	0.00	-	0.00	Million
	£	*1,433*	-	*2,080*	

The main page then shows the total benefits, i.e. the two sets of benefits are added together

IGCB Damage Cost Calculator - Total Appraisal Results

Key:

Central Estimate: *This is the most likely estimate of damage costs based on the probability distribution used for Monte-Carlo analysis of air quality impacts*

Estimated Results: *This is the main central results of the calculator using the range of damage cost values as agreed by the IGCB.*

Sensitivity Damage Cost Range: *These are the sensitivity low and high values of the central damage costs.*

Central Estimate Present Value	£ 0.0	Million
	£ 3,798	

Estimated Range	£ 0.0	-	0.0	Million
	£ 2,970	-	4,311	

This is compared against the NPV of costs

Equipment - bus	NPV Benefits	NPV Costs	Net NPV
DPF	3,798	2,872	926

To estimate the net cost-effectiveness analysis, the benefits need to be expressed as an equivalent annual cost.

	A
Sum of PV	£3,798
Discount rate	3.50%
Number of years	5
EAC (formula)	£841
EAC (excel)	£841

	EAC Costs	EAC Benefits	Net	Tonnes abated	Net cost effectiveness
Net cost effectiveness	£636	£841	-£205	0.00349 in central area	-£58,853

Annualised Costs

In this example, we are estimating the costs of alternative schemes

	Base scheme	Scheme A Bus	Scheme B Heavy	Scheme C All
Start-up (capital)				
Equipment	150,000	250,000	250,000	350,000
Central system	50,000	100,000	150,000	200,000
Other	70,000	100,000	200,000	250,000
Total	**270,000**	**450,000**	**600,000**	**800,000**
Operating costs (end of year 1)				
Maintainance	10,000	20,000	20,000	30,000
Central system, premises and supplies	65,000	75,000	80,000	150,000
Staff costs	120,000	170,000	230,000	330,000
Total	**195,000**	**265,000**	**330,000**	**510,000**

BASE

Base year	2007	This is year 0
Scheme start year	2008	This is year 1. This is important in picking the correct discount factor note below that this starts with year 1 discount factor
Discount rate	3.50%	
Number of years	8	

	2008	2009	2010	2011	2012	2013	2014	2015		
Base	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**		
Capital costs	270,000									
Ongoing costs	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000		
Total	465,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000		
Discount factor	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940		
Discounted cost	449,283	182,033	175,871	169,923	164,190	158,633	153,270	148,083		
Net present value	1,601,285									
Equivalent annualised cost	£232,949									

Scheme A

Discount rate	3.50%
Number of years	8

A	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**
Capital costs	450,000							
Ongoing costs	265,000	265,000	265,000	265,000	265,000	265,000	265,000	265,000
Total	715,000	265,000	265,000	265,000	265,000	265,000	265,000	265,000
Discount factor	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940
Discounted cost	690,833	247,378	239,004	230,921	223,130	215,578	208,290	201,241
Present value	2,256,374							
Equivalent annualised cost	£328,250							

Scheme B

Discount rate	3.50%
Number of years	8

B	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**
Capital costs	600,000							
Ongoing costs	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000
Total	930,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000
Discount factor	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940
Discounted cost	898,566	308,055	297,627	287,562	277,860	268,455	259,380	250,602
Present value	2,848,107							
Equivalent annualised cost	£414,333							

Scheme c

Discount rate	3.50%
Number of years	8

Capital costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**
Capital costs	800,000							
Ongoing costs	510,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000
Total	1,310,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000
Discount factor	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940
Discounted cost	1,265,722	476,085	459,969	444,414	429,420	414,885	400,860	387,294
Present value	4,278,649							
Equivalent annualised cost	£622,444							

Thee summary of present value and equivalent annual cost values are shown below

	Base	**A**	**B**	**C**
PV	**1,601,285**	**2,256,374**	**2,848,107**	**4,278,649**
EAC	**232,949**	**328,250**	**414,333**	**622,444**

The EAC can be compared against the emission benefits of the schemes, to look which is most cost-effective
The PV can be used to compare against the present value of (ecnomic) benefits to look at the net present value of the scheme

However, to assess cost-effectiveness and cost-benefit analysis fully, it is necessary to also consider the costs to operators
This would include, for example, the costs of fitting DPF to older vehicles, see retrofit example

Cost-Effectiveness

Example on Retrofit technology

This is for a SCR using the costs from the IGCB economic analysis

Base year	2008	
Scheme start	2008	Note in this example, the base year is the same as the start year, so the discount factor is 1 for year 0
Discount rate	3.50%	
Number of years	10	

For fuel consumption

Annual mileage	50000	km per year				Conversion (DfT)	
Fuel efficiency	2.8	km per litre	7.8 miles per gallon	source	TSGB, table 3.4	1 kilometre = 0.6214 mile	1 Gallon = 4.546 litres
Cost fuel per litre (resource)	0.947	no tax included		source	TSGB, table 3.3		
Change in efficiency	-6%						
Fuel cost	17148						

http://www.dft.gov.uk/pgr/statistics/datatablespublications/tsgb/2007edition/section3energyenvironment.pdf

	2008										
Equipment - bus	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	
SCR capital (resource)	430										
SCR additive	219	219	219	219	219	219	219	219	219	219	
SCR fuel penalty	1029	1029	1029	1029	1029	1029	1029	1029	1029	1029	
Total	**1,678**	**1,248**	**1,248**	**1,248**	**1,248**	**1,248**	**1,248**	**1,248**	**1,248**	**1,248**	
Discount factor	1.00000	0.96620	0.93350	0.90190	0.87140	0.84200	0.81350	0.78600	0.75940	0.73370	
Discounted cost	1,678	1,206	1,165	1,125	1,087	1,051	1,015	981	948	916	
Net present value	11,172										
Equivalent annualised cost	£1,343										

Annual emission benefits

Nox	emissions g/km	emission per year tonnes	cost per tonne	
Euro IV	3.629	0.07259		
LEV	1.815	0.03629		
Difference	1.815	0.036	£37,011	£38,237

source NAEI Assume
20 000 km
peryear in area

This is for a EGR using the costs from the IGCB economic analysis

Base year	2008		
Scheme start	2008		
Discount rate	3.50%		
Number of years	6		
For fuel consumption			
Annual mileage	25000	1 kilometre = 0.6214 mile	1 Gallon = 4.546 litres
Fuel efficiency	11	km per litre — Diesel cars 39 miles per gallon, increase fc by 130% for LGVs	source TSGB, table 3.4
Cost fuel per litre (resource)	0.947		
Change in efficiency	-2%		
Fuel cost	2229		

Equipment - bus	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**		
SCR capital (resource)	288							
SCR maintenance	12	12	12	12	12	12		
SCR fuel	45	45	45	45	45	45		
Total	**345**	**57**	**57**	**57**	**57**	**57**		
Discount factor	1.00000	0.96620	0.93350	0.90190	0.87140	0.84200		
Discounted cost	345	55	53	51	49	48		
Present value	600							
Equivalent annualised cost	£113							

Annual emission benefits

		Nox	emissions	emission per	cost
			g/km	year tonnes	per tonne
		Euro IV	0.425	0.00849	
		LEV	0.340	0.00679	
0.084925	20%	Difference	0.085	0.0017	£66,302
	reduction				
		Annual emission benefits			
		PM10	emissions	emission per	cost
			g/km	year tonnes	per tonne
		Euro IV	0.051	0.00102	
		LEV	0.005	0.00010	
0.045866	90%	Difference	0.046	0.001	£122,764

20 000 inside the main area, 5000 outside

Cost-benefit analysis

The benefits for a LEV rigid vehicle based on a ten year lifetime

Additional benefits outside the zone double total benefits

LEV benefit 0.0726

This value is entered into the Defra damage cost calculator

http://www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm

To estimate benefits, it is necessary to select the pollutant, and specify the year that the scheme starts and the length of time

a ten year lifetime
a 2008 base year

1. What length (in years) is your policy appraisal?	10
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*1*
4. Input the annual changes in emissions below (in tonnes)	

15. PM Tr
16. PM Tr
17. PM Tr
18. PM Tr
19. CO_2

Year	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2016*	*2017*
Change in emissions (tonnes)	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259

CALCULATED RESULTS		
Central Estimate Present Value	£ 0.00	Million
	£ *640*	

The same approach is used for the EGR

Note for PM, it is necessary to enter the location of the emissions

The benefits are
Nox
PM (central conurbation)
PM (outer conurbation)

For all 25000 annual mileage

Annual emission benefits

		Nox	emissions	emission per	
			g/km	year tonnes	
		Euro IV	0.425	0.01062	
		LEV	0.340	0.00849	
0.084925	20%	Difference	0.085	0.0021	
	reduction				
		Annual emission benefits			
		PM10	emissions	emission per	
			g/km	year tonnes	
		Euro IV	0.051	0.00102	
		LEV	0.005	0.00010	
0.045866	90%	Difference	0.046	0.001	

central zone

		Annual emission benefits			
		PM10	emissions	emission per	
			g/km	year tonnes	
		Euro IV	0.051	0.00025	
		LEV	0.005	0.00003	
0.045866	90%	Difference	0.046	0.000	

outer zone

Total present value benefits
724

Equipment - bus	PV Benefits	PV Costs	Net Present Value
EGR LGV	724	600	124
SCR rigid	640	11,172	-10532
	640	11,542	-10902

Note that in this case, the scheme should also take account of the changes in fuel consumption, and GHG emissions using the SPC values to provide estimates of the monetary benefits or costs of changes in CO_2 emissions
This is particularly important for LEVs (though not included in this example)