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Mitigating Transport's Climate Change Impact in Scotland: Assessment of Policy Options

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MITIGATING TRANSPORT'S CLIMATE CHANGE IMPACT IN SCOTLAND: ASSESSMENT OF POLICY OPTIONS

Atkins
University of Aberdeen

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EXECUTIVE SUMMARY

A Commitment to Mitigating Climate Change

In 2006, Scottish transport, including international aviation and shipping, accounted for 15.0 mega-tonnes of carbon dioxide equivalent (MtCO2e), or 24.4% of total Scottish greenhouse gas emissions. This figure, both in terms of absolute emissions and the proportion of total emissions, continues to grow on an annual basis.

Reducing emissions from transport is one of the National Transport Strategy's three key strategic outcomes. On 5th December 2008 the Scottish Government published the Climate Change (Scotland) Bill, which includes a commitment to reduce emissions by 50% by 2030, and by 80% by 2050. The finalised version also includes an interim target of 42% by 2020. These targets demonstrate a bold commitment by the Scottish Government. It signifies the importance Scotland places on playing its part in mitigating one of the most serious threats facing our world.

The Scottish Government's Transport Directorate wants to improve its evidence base on how it can contribute to meeting emission reduction targets and appointed Atkins in partnership with the University of Aberdeen to undertake a study to identify, analyse, and report on the policy options available to the Scottish Government.

Methodology

The study has been carried out using a seven stage methodology:

- Establishment of a preliminary long list of potential policy options;
- Identification of "ownership" of options;
- Finalisation and filtering of the policy option list;
- Comparison of Scottish and UK transport use and requirements;
- Establishment of the baseline 'business as usual' emissions scenario;
- Detailed assessment of policy options; and
- Packing of complimentary policy options into two alternative scenarios;
    - Central Scenario - a package of policy options that could feasibly be deployed with a politically or publicly acceptable degree of "forcefulness", and
    - Ambitious Scenario – a package of policy options, included all the measures from the Central Scenario which could be applied more forcefully, and also some policy options considered too ambitious for the Central Scenario.

Key Findings

Policy Options

The study has identified a broad range of devolved policy options that are available to the Scottish Government to mitigate transport's climate change impact in Scotland. In total 22 policy options have been identified and divided into seven sub-categories, these are summarised in the table below.

Devolved Policy Options

A) Technology	
53	Electric car technology & network development
109	Procurement of low carbon vehicles
B) Driving Style	
1	Active traffic management
98	National motoring package
143	Speed reduction on trunk roads
C) Car Demand Management (Fiscal/Infrastructure)	
15	Bus/rapid/mass transit infrastructure investment (including bus priority)
37	Cycle infrastructure investment
75	High speed Rail links
97	National network of car clubs
99	National road user charging
103	Introduction or increase in public parking charges
115	Rail investment
125	Introduction/raise in residential/private parking charges
127	Bus /LRT fares reductions
131a	Walking infrastructure investment
172	Workplace parking levy
D) Car Demand Management (Smart Measures)	
18	Bus quality contracts / statutory partnerships
173	Widespread implementation of travel plans
204	Provide community hubs
E) Freight	
63	Freight best practice
F) Land Use Planning	
158	Urban density increases
G) Aviation	
205c	Improve public transport surface access to airports

Abatement Potential of Individual Policy Options

Annual Abatement

The annual abatement potential of each policy option varies depending on:

- The scale of implementation – influenced both by rate of implementation and level of intensity; and
- The year under consideration – influence by a number of factors;
    - increasing levels of implementation through time,
    - increasing levels of reference traffic, and
    - increasing efficiency of the vehicle fleet.

A number of broad patterns have emerged in relation to the relative performance of different types of policy options:

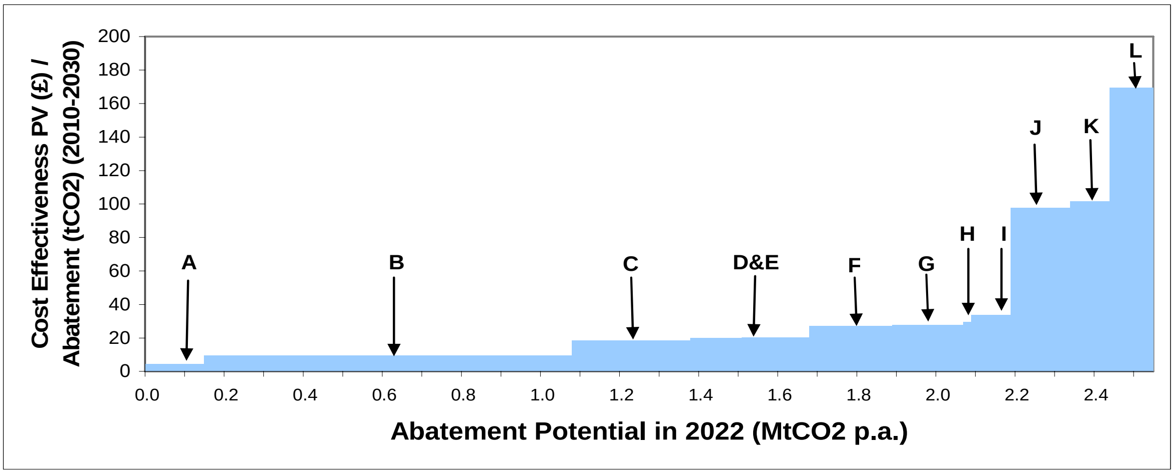
- The analysis undertaken as part of this study suggests that the Car Demand Management (Smart Measures) category has the greatest potential to reduce CO2 emissions. In particular the potential for travel planning considerably exceeds that for all other policy options, reflecting the range of approaches covered in the policy option (from workplace travel plans to individual travel marketing) and the associated scale of the target population;
- The fiscal policy options in the Car Demand Management (Fiscal/Infrastructure) category also offer significant abatement potential, however, the analysis suggests most of the infrastructure policy options in this category would offer significantly less potential; and
- Schemes involving extensive investment in the public transport network generally lie towards the bottom of the list in abatement terms.

Cumulative Abatement

The relative order of abatement potential for the policy options is broadly similar when cumulative abatement and annual abatement in 2022 are considered. However, some minor reordering is evident. This is a consequence of the policy options that are suitable for more rapid implementation performing slightly better and those with a longer build up time performing slightly less well by the cut off date.

Cost Effectiveness and Marginal Abatement Cost Curve (MACC)

Combining the estimated cumulative abatement potential between 2010 and 2030 with the present value of costs incurred over the same interval provides an indicator of cost-effectiveness for each policy option, defined as follows. This can be broadly viewed as the cost in PV terms of each tonne of abatement achieved in total over the 20 year period by each policy option and forms the basis of the Marginal Abatement Cost Curve (MACC). The MACC below illustrates the most cost effective policies.



Key

Code	Measure ID	Measure
A	204	Provide community hubs
B	173	Widespread implementation of travel plans
C	143	Speed reduction on trunk roads
D	103	Introduction or increase in public parking charges
E	98	National motoring package
F	172	Workplace parking levy
G	18	Bus quality contracts / statutory partnerships
H	158	Urban density increases
I	63	Freight best practice
J	53	Electric car technology & network development
K	97	National network of car clubs
L	37	Cycle infrastructure investment

Abatement Potential by Scenario

The model results suggest that the combined effect of the policy options in the Central Scenario would achieve an annual abatement of around 1.35 MtCO2 p.a. in 2022, whilst the Ambitious Scenario would achieve an additional 0.80 Mt CO2, representing a total of 2.15 Mt CO2 p.a. in 2022.

The estimated abatement potential of the Central Scenario therefore accounts for approximately 15% of the difference between the Baseline emissions (including action at the EU/UK level) and the 2022 level of a 44% reduction (as a proxy for the 42% reduction target by 2020) from 1990 total transport emissions[1]. The contribution is nearly 25%, if the comparison is restricted to emissions from the land transport modes targeted by the scenario. The equivalent figures for the Ambitious Scenario are just over 20% of the target difference if all transport emissions are considered and 35% if the focus is on land transport alone.

[1] The Climate Change (Scotland) Bill includes an interim target of a 42% reduction by 2020 on the path to achieving an 80% reduction by 2050. The adoption here of a 44% reduction by 2022 is intended to act as a proxy for this target.

Abatement Beyond 2022

The modelling results suggest that the total absolute abatement potential from the Ambitious Scenario will be very similar in 2030, although the balance between the contributions from different policy options will have changed. For instance, those policy options focussing on efficient driving will have become less significant (as the vehicle fleet becomes increasingly dominated by electric and hybrid vehicles) and those with longer term effects (such as land use planning) will become gradually relatively more significant.

Forecasts of emissions levels and the impact of abatement policy options over the longer term to 2050 inevitably have to be less detailed than those for shorter timescales due to the uncertainties involved in attempting to forecast travel patterns, behaviour and technology in 40 years time.

However it is possible to anticipate likely important future trends. The key influence is likely to be the anticipated increasing use of electricity to power the vehicle fleet either directly or through the production of hydrogen. Sources such as the Committee on Climate Change report and the King Review suggest that such vehicles could feasibly be the standard by 2050.

In this case, emphasis will increasingly be on energy policy and technology and the nature and viability of the electricity network and vehicles rather than the direct reduction in emissions from vehicle exhausts. Suitable vehicle technology and the provision of very low carbon electricity (generated for instance by renewable energy) could potentially result in very low transport carbon emissions levels. However, the role of supporting transport policy options will remain important. Although some of the policy options assessed above will become less relevant as they are related to current technology (particularly those encouraging more efficient driving), the emphasis on improving efficiency and reducing demand will continue to be important. This will potentially be aimed less at reducing carbon emissions directly and more at ensuring demand remains at a level and in a form that could be viably served by the electricity network.

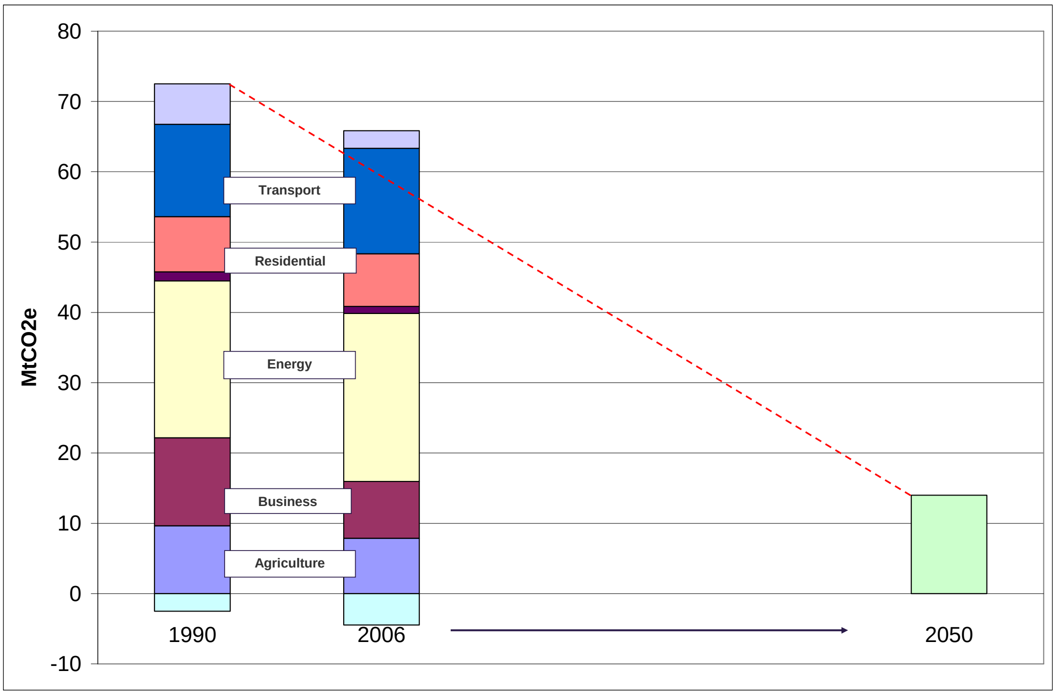
1 INTRODUCTION

A Commitment to Mitigating Climate Change

1.1 In 2006, Scottish transport, including international aviation and shipping, accounted for 15.0 mega-tonnes of carbon dioxide equivalent (MtCO2e), or 24.4% of total Scottish greenhouse gas emissions. This figure, both in terms of absolute emissions and the proportion of total emissions, continues to grow on an annual basis.

1.2 Reducing emissions from transport is one of the National Transport Strategy's three key strategic outcomes. On 5th December 2008 the Scottish Government published the Climate Change (Scotland) Bill, which includes a commitment to reduce emissions by 50% by 2030, and by 80% by 2050. The finalised version[2] also includes an interim target of 42% by 2020. These targets demonstrate a bold commitment by the Scottish Government. It signifies the importance Scotland places on playing its part in mitigating one of the most serious threats facing our world. Figure 1.1 below illustrates the scale of the challenge.

Figure 1.1: The Scale of the Challenge



1.3 The Scottish Government's Transport Directorate wants to improve its evidence base on how it can contribute to meeting emission reduction targets and appointed Atkins in partnership with the University of Aberdeen to undertake a study to identify, analyse, and report on the policy options available to the Scottish Government.

[2] Released at the end of June 2009, post dating the analytical work for this study.

Our Approach

1.4 The study has been carried out using a seven stage methodology:

- Establishment of a preliminary long list of potential policy options;
- Identification of “ownership” of options;
- Finalisation and filtering of the policy option list;
- Comparison of Scottish and UK transport use and requirements;
- Establishment of the baseline ‘business as usual’ emissions scenario;
- Detailed assessment of policy options; and
- Packing of complimentary policy options into two alternative scenarios;
    - Central Scenario - a package of policy options that could feasibly be deployed with a politically or publicly acceptable degree of “forcefulness”, and
    - Ambitious Scenario – a package of policy options, included all the measures from the Central Scenario which could be applied more forcefully, and also some policy options considered too ambitious for the Central Scenario.

Preliminary Report

1.5 A Preliminary Report was produced in March 2009 that detailed the work undertaken on the first four stages of the study.

Final Report

1.6 The Final Report sets out the study methodology, details of the policy options, and the results of the policy analysis that has been undertaken. Following this introduction the report is structured into the following chapters:

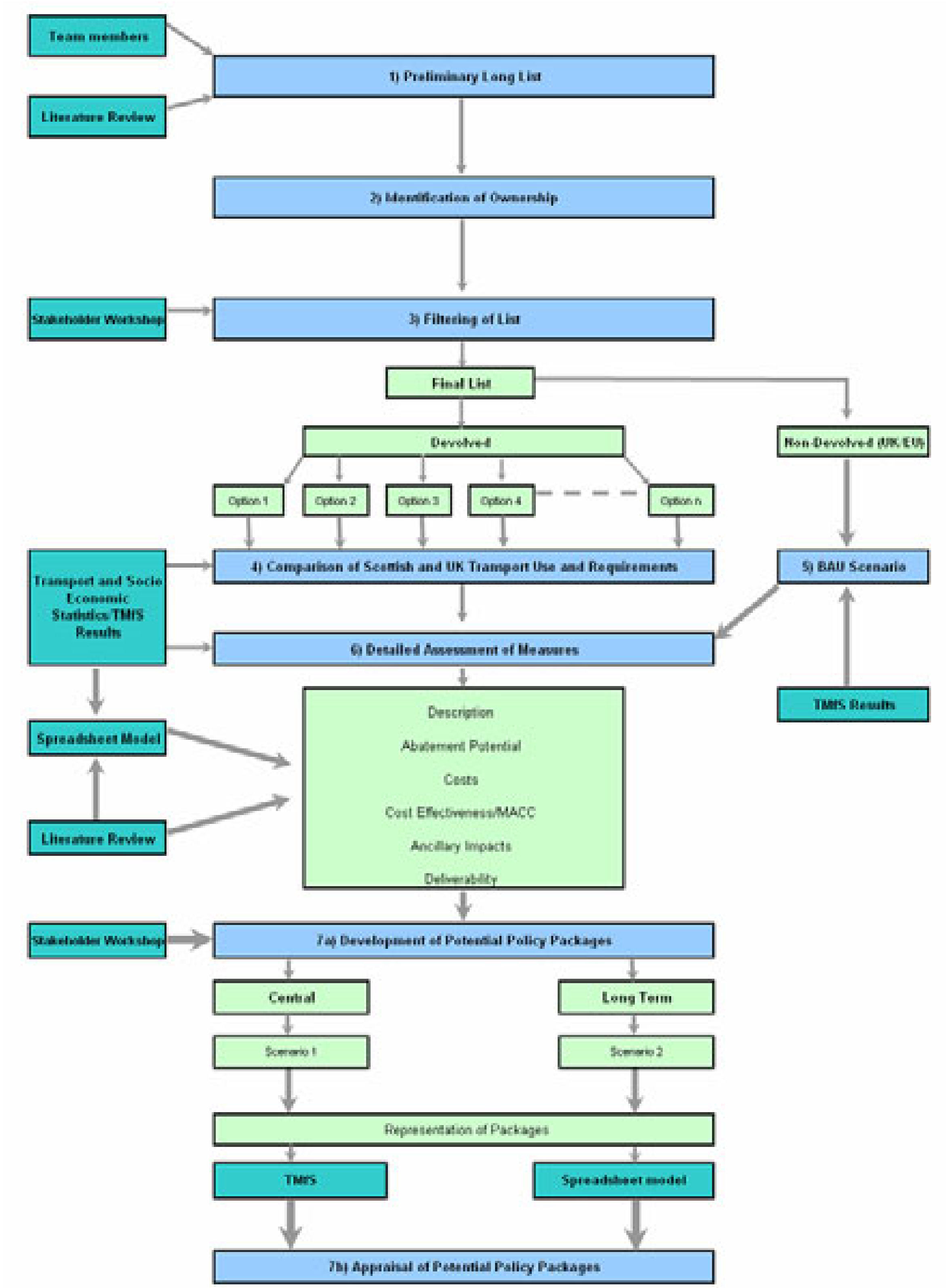
- Chapter 2 – Sets out the methodology for the study;
- Chapter 3 – Details the policy options; and
- Chapter 4 – Presents the detailed assessment of each individual policy, and considers the performance of the Central and Ambitious Scenarios.

2 STUDY METHODOLOGY

Seven Stages

2.1 The study has been undertaken in seven stages and these are illustrated in Figure 2.1 below:

Figure 2.1: Seven Stage Methodology



Preliminary Report

2.2 The Preliminary Report produced in March 2009 details the work undertaken on the first four stages of the study.

Establishment of Baseline and BAU Scenario

2.3 The first stage in the detailed assessment of the potential impact of the identified policy options was to establish a baseline Business as Usual (BAU) scenario for transport carbon emissions throughout the study period. This scenario was intended to provide a reference level of carbon against which to appraise the impacts of each measure. As such it needed to take account of likely changes in key influences on transport volumes and associated emissions including:

- Economic, planning and land use changes (influencing levels and distances of travel);
- Transport infrastructure developments (influencing levels and distances of travel); and
- Action at the national and European level, in particular measures and legislation to instigate changes in vehicle technology and efficiency.

2.4 The following paragraphs outline the approaches adopted to derive the BAU emissions estimates for each mode. Several data sources were used, varying between modes. This varied approach was adopted to ensure that the best available evidence was used for each mode and it should not result in any inconsistency or bias between the modes.

Highway Emissions

Cars and Goods Vehicles

2.5 Model output from Transport Scotland's 'Transport Model for Scotland' (TMfS) formed the first key input to the forecast of baseline emissions from highway transport. The latest version of the Reference Case (RC7) from version 05A v6.0 of the model was used (see Appendix D), providing forecasts of the vehicle kilometres travelled in three future years (2012, 2017 and 2022) on the basis of currently planned infrastructure changes and land use and development proposals. Extended forecasts for 2027 and 2032 were derived by adjusting the trends forecast to 2022 to reflect the relative levels of growth forecast in the later intervals by the DfT's TEMPRO dataset.

2.6 The model outputs (adjusted for traffic on local roads not reflected in the TMfS) forecast a growth in vehicle kilometres of 27% between 2005 and 2022, varying by road type (for instance 25% growth is forecast on minor roads and 33% on trunk roads and motorways) and vehicle type (for instance varying between 25% for cars and 35% for LGVs).

2.7 The other key sets of inputs to the baseline forecast were the estimates of future fleet composition and associated emissions factors, used to convert the vehicle kilometres forecast by the TMfS model output into estimated emissions. Both the fleet and emission factor forecasts were based upon the assumptions derived by industry experts for the Transport Supply model used to support the Committee on Climate Change (CCC) report in December 2008[3].

2.8 Two key scenarios from the CCC report were used for the purpose of this study. The first provided an estimate of emissions and fleet composition should no further action to promote vehicle efficiency be undertaken beyond 2008. This scenario was taken to represent the underlying baseline The second 'Extended Ambition' scenario reflects expert opinion on possible fleet composition and emissions factors should active measures be undertaken to meet the EU target for emissions reductions[4].

2.9 The difference between the two scenarios has been interpreted for this study to represent the likely impact of national and European action on emissions levels and the 'Extended Ambition' scenario was therefore used as the basis for the baseline against which the Scottish Government measures were assessed.

Bus Fleet

2.10 Current emissions from bus operations were derived from the National Atmospheric Emissions Inventory (NAEI) estimates for Scotland[5]. Future year estimates were made on the basis of:

- Details of the current bus fleet composition; and
- Judgements on likely future trends in:
    - Bus operations (assuming that the trend over the ten years to 2008 of an average 1.2% p.a. decline in non-local bus kilometres and 0.8% p.a. increase in local bus kilometres[6] will continue for the next ten years to 2018, after which point bus kilometres will remain static).
    - Fleet composition (based on recent research for the English PTEs[7] and a fleet model assuming a 5.5% p.a. vehicle renewal rate[8] and lower mileage for older vehicles).

[3] Building a Low-Carbon Economy-the UK's Contribution to Tackling Climate Change, Committee on Climate Change, December 2008, Chapter 7, Transport. The data was used with the permission of the CCC but represents the study team's interpretation of the available information. This included extrapolation of assumptions beyond the 2022 end year of the CCC's model to 2030, on the basis of continuing the forecast trends for earlier years. The resultant estimates of emissions for 2030 were then crosschecked against those suggested in the King Review of Low Carbon Cars, 2008.
[4] To meet a target emissions rate of 95g/km for new cars by 2020.
[5] Emissions of the basket of 6 Kyoto GHGs according to Devolved Administration, 30/06/2008
[6] *Scottish Transport Statistics 2008*
[7] Scenarios and Opportunities for Reducing Greenhouse Gases and Pollutant Emissions from Bus Fleets in PTE Areas, Study Report for PTE, December 2008
[8] Based on current fleet composition and age and the PTE report referenced in the previous footnote

Rail Emissions

2.11 Current emissions from diesel trains were also derived from the National Atmospheric Emissions Inventory (NAEI) estimates for Scotland. However, in line with international reporting convention, the emissions produced by the generation of electricity to power electric trains has been included within the total figures reported for the electricity sector by the NAEI and can not be identified separately. Current emissions were therefore derived from the "Rail Industry Report to the Committee on Climate Change" (March 2008).

2.12 The national average central growth emissions forecasts from the same report were used to produce the future year estimates (assuming 10% growth to 2022 for diesel and 15% for electricity, consistent with the assumptions made in the CCC report).

Aviation and Shipping Emissions

2.13 Current emissions from aviation and shipping activity were also drawn from the NAEI. Future year estimates were then made on the basis of national forecasts on future changes in transport volume and emissions by region for each sector[9].

2.14 For aviation, the figures derived from the UK Air Passenger Demand and CO2 forecasts 2009 suggest a growth in Scottish flights and associated emissions of over 70% between 2006 and 2022.

2.15 In contrast, the UK Port Demand Forecasts suggest that the level of Scottish port activity in 2022 will be broadly equivalent to 2006 levels (based on tonnage) following a slight decrease between 2006 and 2012 and 2017.

Estimated Future Year Baseline Emissions

2.16 Table 2.1 below presents the forecast baseline emissions for 2022 (the end of the third CCC Carbon Budget timescale). For comparison, the estimates are set against the NAEI estimate of emissions in 1990 and the reduction required to meet the targets identified in the Climate Change (Scotland) Bill[10] of a 42% reduction in emissions by 2020 (relative to 1990) and 50% reduction in emissions by 2030, intended as interim targets to provide a trend that is on track to meet the 2050 target of an 80% reduction relative to 1990. Assuming a constant annual rate of reduction between 2020 and 2030, the equivalent target for 2022 is taken to be 44%, as shown in the table.

2.17 The table also shows the further potential impact on forecast emissions levels of the measures proposed by the Strategic Transport Project Review and national and regional action on vehicle technology represented through the supply side of the CCC's Extended Ambition scenario.

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[9] UK Air Passenger Demand and CO2 forecasts 2009, DfT, Jan 2009 and Update of UK Port Demand Forecasts to 2030 and Economic Value of Transhipment Study, MDS Transmodal for DfT, July 2007

[10] Finalised in late June 2009 after the completion of the analytical work for this study

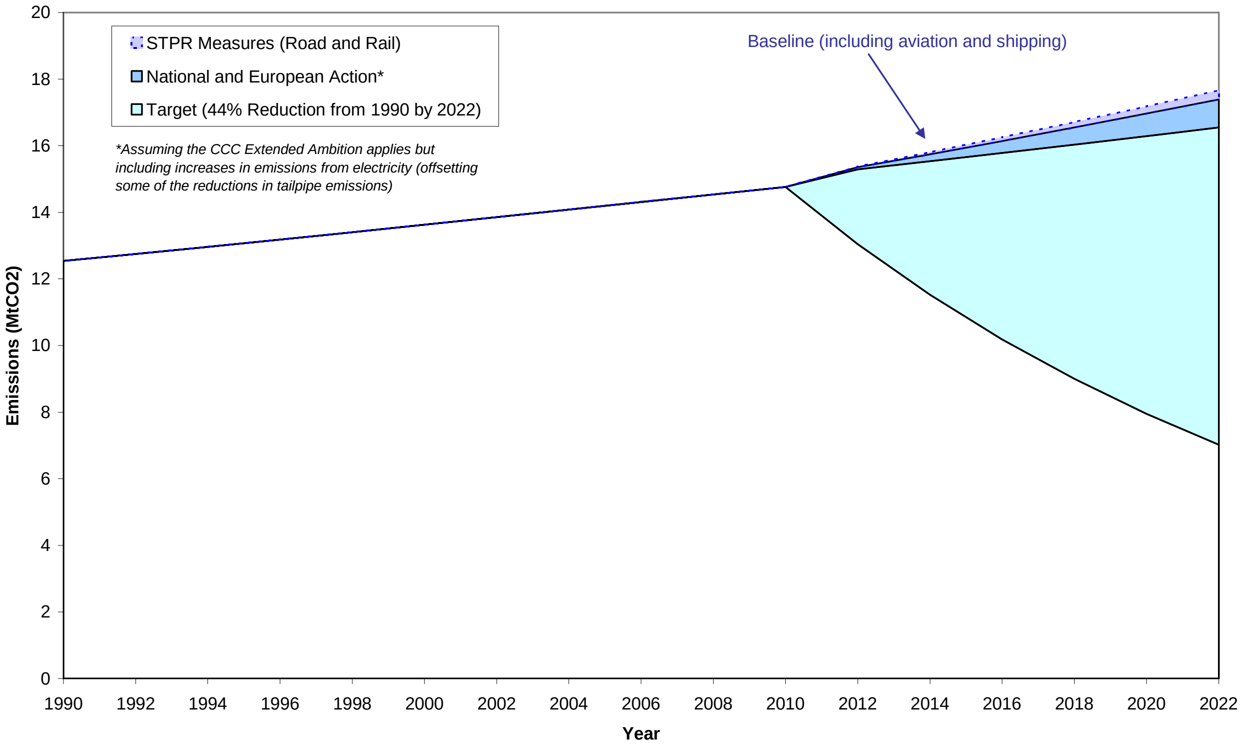
2.18 The net effect is that to meet the target of a 44% reduction in emissions relative to 1990 in 2022, a further reduction of around 6.1 $MtCO_2$ p.a. in emissions from land transport would be required or 9.5 Mt CO_2 if total transport emissions are considered (including domestic and international aviation and shipping). This equates to 50-55% of 2022 forecast emissions in each case. Figure 2.2 presents these comparisons graphically for total transport emissions (including aviation and shipping).

Table 2.1: Baseline Emissions (MtCO2 p.a.)

Source	1990[11]	2006	2022
Cars, vans and HGVS	8.7	9.6	11.7
Bus	0.4	0.4	0.4
Rail (electric and diesel)	0.3	0.3	0.4
Aviation (domestic and international)	0.7	1.8	3.1
Shipping (domestic and international)	2.5	2.1	2.1
Total Land Transport	**9.3**	**10.3**	**12.5**
Target emissions required (56% of 1990 level)			5.2
Reduction required for 44% target			-7.3
STPR Measures[12]			-0.3
Reduction in tailpipe emissions achieved through national vehicle technology measures[13]			-1.3
Increase in electricity generation emissions due to national technology measures [14]			0.5
Net required reduction to meet target			-6.1
Total Transport inc Shipping/Aviation	**12.5**	**14.3**	**17.7**
Target emissions required (56% of 1990 level)			7.0
Reduction required for 44% target			-10.6
STPR Measures			-0.3
Reduction in tailpipe emissions achieved through national vehicle technology measures			-1.3
Increase in electricity generation emissions due to national technology measures			0.5
Net required reduction to meet target			-9.5

[11] 1990 and 2006 figures based on NAEI forecasts
[12] STPR Summary Report, 2008: Figures represent both highway and rail measures (primarily electrification)
[13] These figures include an allowance for the "rebound effect", whereby measures which reduce travel cost as well as emissions (through increased efficiency) encourage increased travel, offsetting some of the abatement achieved. In line with the CCC report, this effect is assumed to reduce the abatement achieved by relevant measures (such as eco-driving) by 15% in 2022.
[14] This figure represents the emissions produced in generating the electricity used to power plug in vehicles. It is unusual to present the carbon emissions from transport electricity use under estimates for emissions the transport sector. By convention, multi-sectoral analyses (such as the CCC report) present only tailpipe emissions for the transport sector, allocating those associated with electric vehicles to the electricity sector. However, for a single sector analysis such as this study, it is important to include all emissions generated by transport operations, wherever they occur to provide a full picture of impacts. Following CCC Extended Ambition assumptions the source of electricity is assumed to be an extension of the current grid mix equating to 130gCO2/MJ in 2022. Emissions associated with increased electricity use therefore offset approximately 45% of the emissions savings from petrol and diesel powered cars once rebound effects have been accounted for. If lower carbon energy sources were assumed that halved the carbon emissions from electricity, the net reduction achieved through the national technology measures would increase by 30%.

Figure 2.2 - Transport CO2 Emissions Trajectories 1990 to 2022



Detailed Assessment of Measures

2.19 The next stage of the study focused at developing each of the policy options, determining their individual abatement potential, quantifying the costs associated with implementing and / or operating each option, and assessing the ancillary impacts and deliverability of each option. This stage of the study was undertaken in six steps and these are described below.

Policy Development

2.20 Each policy option was developed to a degree that allowed the abatement potential and associated costs to be determined. This involved collating information relating to the following:

- Policy description, including objectives / goals;
- Development and implementation timescales;
- Levels of intensity and / or geographical coverage;
- Targets populations; and
- Causal links (the logic behind how a policy intervention could lead to carbon mitigation).

2.21 At this stage of study a number of the policies went through another iteration of evolution / sifting; this resulted in the short list of 27 policy options that were identified in the Preliminary Report being consolidated to 22 policies for detailed assessment. Details of each of the 22 policies are presented in Chapter 3.

Abatement Potential

Spreadsheet Model

2.22 The abatement potential of each policy option was represented through a spreadsheet model representing travel volume in Scotland, disaggregated into a range of segments reflecting key characteristics influencing carbon emissions levels such as vehicle type, road type, speed and level of congestion.

2.23 Emissions rates in terms of grams of CO2 emitted per vehicle kilometre travelled (varying by vehicle type and speed of travel) were used to estimate emissions totals from travel volumes.

Baseline Model

2.24 The Baseline Model drew on information on travel volume from the Reference Case (RC7) run of the Transport Model for Scotland (TMfS)[15], adjusted to represent travel on those local roads not represented within the model (which is intended for strategic analysis) and supplemented by information on the characteristics of trips and trip-makers from statistical sources including the Scottish Transport Statistics[16].

2.25 Assumptions on fleet composition and emissions through time were made for each of 8 broad vehicle type categories (including small, medium and large cars), each disaggregated into up to 15 technology types. The assumptions used were consistent with those underlying the 'Extended Ambition' scenario represented in the transport supply model used to support the December 2008 report by the Committee on Climate Change[17.] Additional information from the emissions functions published by National Atmospheric Emissions Inventory (NAEI) was used to represent the impact of travel speeds on emissions levels.

Representation of Policy Options

2.26 The abatement impact of each policy option was represented through adjustments to one or more of the following input assumptions in the Baseline model:

- Highway vehicle kilometres travelled - identified by vehicle type, road type, level of congestion, average speed and time of day. Adjustments were made on the basis of estimated changes in trip numbers and lengths by purpose and area type (categorised in terms of the 18 area types identified in the DfT's TEMPRO dataset). For example, the impacts of parking charges were identified on the

[15] Run using TMfS:05A v6.0
[16] Scottish Transport Statistics, 2008
[17] Building a Low-Carbon Economy-the UK's Contribution to Tackling Climate Change, December 2008, Chapter 7, Transport

basis of changes in highway trip numbers, identified on the basis of varying impact and length by journey purpose and area type of destination.

- Fleet composition - identified in terms of the proportion of vehicle kilometres travelled by vehicles in each emissions category. For example, the impact of low carbon vehicle procurement support was represented through an assumed increase in fleet renewal and its impact on the fleet composition.

- Vehicle Efficiency - identified in terms of emissions factors applied for relevant vehicle types in relevant conditions. For example, the impacts of eco-driving were represented through an assumed improvement in efficiency for a proportion of petrol and diesel cars driven.

- Speed distribution - identified in terms of the distribution of vehicle kilometres travelled between different speed categories (defined in 5 to 10mph intervals). For example, the impacts of speed enforcement were represented through a reduction in the proportion of vehicle kilometres in categories exceeding the 70mph limit on affected roads.

2.27 The impact of the 'rebound effect'[18] in reducing the abatement potential of policy options that reduce car travel costs as well as emissions was represented using the assumptions on elasticities of travel levels to travel cost adopted in the CCC modelling (based on the DfT's National Transport Model).

2.28 The assumptions applied to represent the effects of each policy option were based on the evidence identified during the literature reviews and workshops undertaken in the development of the short list of policy options, supported by expert judgement where necessary.

2.29 The range and extent of available evidence varied between policy options, with a wider range of evidence generally available for well-established policies (such as cycling investment) allowing cross-referencing of the assumptions used. However, for some of the more innovative and unusual options (such as community hubs), evidence was more limited and a greater degree of expert judgement was required in developing the assumptions made to represent the option in the modelling. In each case a wide-ranging literature review was undertaken to identify potential sources of evidence and the assumptions made were subject to internal critical review. Appendix A identifies the key assumptions made in representing each policy option.

Forecast Years

2.30 Separate models were developed for each of 5 forecast years at 5 yearly intervals between 2012 and 2032. The first three (to 2022) coincide with available TMfS modelled years and the end years of the three budget periods covered by the CCC and relevant information on vehicle kilometres and fleet composition were directly available from the relevant models.

[18] The rebound effect refers to the fact that those measures that reduce travel costs as well as reducing emissions are also likely to lead to an increase in travel (as people are able and encouraged to travel more due to lower costs). This acts to offset the abatement effect caused by the measure.

2.31 Model development for the later years of 2027 and 2032 involved an additional stage of forecasting beyond the existing models in terms of traffic levels (drawing on forecast growth levels from the DfT's TEMPRO dataset) and fleet composition (extending the trends in the CCC model to match the broad indications of future year average fleet and new vehicles emissions rates identified in the King Review[19]).

Costs of Policy Options

2.32 Estimates of the capital and revenue costs have been estimated for each of the policy options. The cost estimate was based on the evidence derived from the literature review, expert stakeholder inputs, and the wider experience of the study team.

2.33 The costs are presented in 2008 prices and as a Present Value of costs over the time period up to 2030. The actual costs used for the analysis are presented in Appendix A.

Cost Effectiveness and MAC Curve

2.34 The assessments of abatement potential and cost for each policy option were combined to produce an indicator of cost effectiveness, defined as follows.

$$\frac{\text{[PV of total capital and operating costs between 2010 and 2030 discounted to 2008 prices/values]}}{\text{[estimated abatement potential between 2010 and 2030 in MtCO2]}}$$

2.35 Both costs and abatement potential were considered over the 20 year period between 2010 and 2030 to provide a sound basis for comparison between policy options with different timescales for abatement and different balances between upfront capital costs and ongoing revenue costs.

2.36 It is noted that the estimates of costs were based on implementation and ongoing operating costs only. Revenue gains were not offset against operating costs as they represent transfer payments (from user to operator).

Ancillary Impacts

2.37 We based our assessment of the ancillary impacts on the STAG multi – criteria framework to ensure that all the potential transport impacts are covered. We provided a qualitative assessment for the following criteria:

- Environment;
- Safety;
- Economy;
- Accessibility; and
- Integration.

[19] King Review of Low Carbon Cars: Part I: The Potential for CO2 Reduction

2.38 The results of the ancillary impacts are presented in appraisal summary tables in Appendix C.

Deliverability

2.39 The relative ease of deliverability will influence the effectiveness of individual policies. We therefore also undertook a deliverability assessment for each policy that considered the following:

- Feasibility - considering issues such as the level of complexity of implementation, risks and uncertainties involved with using new and evolving technology and possible opposition caused by negative implications of the policy option;

- Affordability - based on the costs estimated, the sectors that bear them, their timing and likely split between implementation and ongoing operating costs, plus assumptions on generated revenue from operation; and

- Public and political acceptability - based on an assessment of the extent to which prevailing attitudes might hinder or help implementation.

2.40 The results of the deliverability assessment are presented in Appendix C.

Packaging and Appraisal of Potential Policy Packages

Package Effects

2.41 The assessment undertaken in Stage 6 focussed on providing an insight into the abatement potential and associated cost for each policy option. However, it is recognised that policies will be introduced in packages that will provide synergies and indeed also conflicts in achieving mitigation. It was therefore considered essential to build on the individual policy analysis and to consider potential policy packages.

Two Packages of Policy Options

2.42 Our view is that packaging is very important, both in order to maximise the synergies between policy options and to secure wider acceptability through mixing ‘carrots’ and ‘sticks’. For instance, policy options to reduce in-town parking and increase parking charges might be more successful and acceptable if mixed with park and ride and reallocation of road space to (low emission) buses. We therefore developed and tested two packages of policy options – a Central Scenario and an Ambitious Scenario.

Developing the Central and Ambitious Scenarios

2.43 A Central Scenario was developed by packaging policy options from the short list which could feasibly be deployed with a politically or publicly acceptable degree of “forcefulness”. Initial analysis suggested that the expected outcomes of this abatement scenario were unlikely to be enough to meet the required targets and so it was expected that an Ambitious Scenario will also need to be assessed.

2.44 The assumptions which were made for the Central Scenario were tested for robustness, realism and potential outcomes at the second expert stakeholder workshop, which was held on 3rd April 2009 at the Scottish Government's Victoria Quay offices. At the workshop participants were invited to contribute on whether it is believed that any policy option and its application were too ambitious or not sufficiently ambitious. Participants were then asked to populate a pro-forma for an Ambitious Scenario, this included all the policy options from the central abatement scenario which could be applied more forcefully, they were also asked to identify any further policy options or packaging of policy options they felt should also be included in this scenario.

2.45 The conclusions from the stakeholder workshop were then used to produce two finalised abatement scenarios for detailed assessment.

Assessment of Impacts

Representation of Scenarios

2.46 The packages of policy options included in each scenario were assessed using a combination of TMfS and the spreadsheet model.

2.47 For the Ambitious Scenario, a combined model run for 2022 was undertaken which included all policy options that it was possible to represent effectively within TMfS (broadly those that directly impact on location of trips or on motorised transport costs through charges or improved infrastructure). The levels of vehicle kilometres by category (including road type and vehicle type) forecast by the model run were then fed into the spreadsheet model. This was used to represent all other policy options (largely relating to vehicle composition and efficiency and non-motorised modes) with adjustments made to account for potential synergies and overlaps between the policy options and making use of the output forecast vehicle kilometres from the TMfS model run.

2.48 A separate version of the spreadsheet model was also produced to represent all of the policy options, to provide a validation of the outputs produced by TMfS.

2.49 A similar approach was adopted for the Central Scenario with a single TMfS run undertaken to represent the policy options suitable for representation in the model and the additional policy options modelled within the spreadsheet model.

3 POLICY OPTIONS

3.1 Before assessing the abatement potential, costs and deliverability of each option, the objectives, scope and targets for each policy were developed to a degree that allowed the more detailed analysis to be undertaken. Developing each option was achieved through an evidence review to inform assumptions and stakeholder engagement as described above.

3.2 This section takes each option in turn and provides a brief outline of its components, the nature of the expected contribution to carbon abatement and the broad modelling parameters used in each of the two scenarios. More detailed information on modelling assumptions and cost assessment can be found in Appendix A. In each case, note should be taken of the guiding principles outline in section 2, notably the fact that each policy option has been assessed on its own merit based on the best that could be achieved by it in a supportive policy environment. In other words, almost without exception, each option would be required to be delivered as part of a package of complementary measures which provided both the pull and push mechanisms to galvanise a shift in travel patterns.

3.3 Whilst we have needed to develop assumptions about the nature, scale and intensity of implementation of policies, these in no way reflect firm proposals. They are reasonable interpretations of policy interventions necessary for the purposes of the study.

3.4 There are a variety of ways in which policy options can be categorised. Firstly, in relation to the generation of carbon emissions from transport, approaches may be distilled into two broad areas: (i) the efficiency or carbon intensity of the vehicles and fuels in the fleet and (ii) the use made of vehicles. The first is a reflection of technological availability and purchasing patterns, and the second is an issue of travel patterns and behaviour. Also, for policy and analysis purposes, the sector may be split into surface passenger, surface freight and aviation. Finally the policy approach may be classified into fiscal, regulatory, infrastructure and informational policies. For our purposes, it was helpful to attempt a classification which captured elements of all of these in order to identify areas of overlap and common approach in modelling terms. The policy options were divided into seven sub-categories as follows:

- Technology options;
- Driving style;
- Car demand management (fiscal / infrastructure);
- Car demand management (smart measures);
- Freight;
- Land use planning; and
- Aviation.

3.5 With regard to aviation and shipping, the preliminary scoping exercise and the stakeholder workshop revealed there to be virtually no devolved policies which fit the abatement and affordability criteria applied during our option appraisal and selection process. Exceptions to this included the improvement of surface public transport access to airports (which we appreciate is not a measure to tackle emissions from aviation per se) and high speed rail which is likely to have the effect of switching some domestic journeys from air to rail. These modes are subject to European or International agreements: aviation will be included in the EU ETS from 2012 and the International Maritime Organisation is considering an emissions trading scheme for shipping. Consequently, this study has focussed analysis on other modes.

Technology Options

Electric car technology & network development (53)[20]

3.6 Plug-in hybrids and electric cars are major options for decarbonising road transport, particularly over the medium to long term. This policy is designed to accelerate the roll-out of the supporting infrastructure (e.g. charging points for batteries) required to make the use of electric-powered cars more feasible and attractive to consumers. More specifically, it will focus support for recharging points in areas that are less likely to be served by the private sector, namely small to medium sized towns in Scotland.

3.7 A policy of support such as this has recently been implemented by various London Boroughs with charging points installed outside homes, offices and prime locations across each Borough. In this case, the infrastructure has been funded by a combination of the London Boroughs, Transport for London, the Energy Saving Trust and EDF Energy. Consumers pay a small annual fee to register to use the posts.

3.8 For this study, larger towns (> 40k) are assumed to be covered by the market as electricity companies and motor manufacturers are incentivised to invest in the infrastructure by national and EU carbon reduction commitments. Between 25% (Central) or 50% (Ambitious) of towns with a population of between 25,000 and 40,000 will receive Scottish Government support[21]. In each case, households living in flats or in accommodation rented from the Local Authority are assumed to require priority assistance as they are the least likely to have domestic charging points. In addition, this is seen as being a medium to long term policy.

3.9 In modelling terms, the effect of this is to accelerate the achievement of the rate of take-up of electric vehicles relative to current ambition assumed by the Climate Change Committee (CCC) in their Extended Ambition scenario so as to have an effect on the overall fleet average emissions. Essentially it allows the take-up of the CCC rate of take up to take place at the same rate in the small

[20] The policy numbers in brackets relate directly to those used in the initial long list. As the options developed a further degree of consolidation took place and this resulted in some policies being grouped together.
[21] The upper size of the settlements increased from 25k by the stakeholders who felt 40k would be a more realistic assessment of the minimum settlement size supported by the private sector.

towns as in the larger urban areas increasing the proportion of the total car fleet that is plug-in (hybrid or full electric) by about one third (for instance from the 12% forecast by CCC to 16% in 2022).

Procurement of low carbon vehicles (109)

3.10 This policy covers schemes to incentivise the purchase of low emissions vehicles by both the public sector (through procurement requirements and grants) and private consumers (through grants). In both cases, the initiatives are tied to specific fuel efficiency of the vehicles purchased. Procurement (especially public) capitalises on the substantial buying power of the public sector and, by establishing a market which is able to absorb the initially higher costs of new lower carbon vehicle technologies, can contribute to the expansion of the market by contributing to the economies of scale needed to reduce overall costs.

3.11 There is a UK and EU-wide context for this policy. For instance, in the Low Carbon Transport Innovation Strategy (LCTIS)[22] the Government announced funding of an initial £20m to develop a new programme of financial support for the public procurement of lower carbon vehicles, especially vans[23]. In addition, the EU Energy Services Directive and forthcoming Cleaner and More Efficient Vehicles Directive will require public authorities and certain public transport providers to take into account energy efficiency and environmental impacts when purchasing road transport vehicles. In addition to this, the UK Government will make £250M available for five years to help with the procurement of new vehicles by 'ordinary motorists' with help of up to £5K per vehicle. The UK Government has also recently set aside £300m for a scrappage scheme whereby motorists are offered £2,000 towards a new car or van if they own a vehicle over 10 years old and trade it in for scrap. Only half of the grant is paid by Government and the rest is matched by industry. Developing such a scheme, tied specifically towards incentivising low carbon vehicles was considered for this study, but omitted as preliminary analysis suggested it would be expensive and net impacts not necessarily positive.

3.12 For this study, we assume Scotland goes beyond the UK/ EU plans in the Ambitious Scenario only. The policy will consist of a total of £5m made available to the Scottish public sector to offset the additional costs of purchasing low carbon vehicles. For private vehicles, £100m will be made available to allow grants of £5K to be made for private motorists purchasing low carbon vehicles. The combination of initiatives has the effect of accelerating the rate at which the fleet of cars and vans in Scotland changes beyond that envisaged by the CCC in their Extended Ambition Scenario – by two years from 2015 for cars and by three years for vans.

[22] Low Carbon Transport Innovation Strategy, Department for Transport, May 2007
[23] Low Carbon Vehicle Procurement programme – discussion paper, Department for Transport, 2007

Driving Style

Active traffic management (1)

3.13 Active traffic management (ATM) involves the dynamic management of recurrent and non-recurrent congestion on major roads based on the prevailing traffic conditions. This comprises variable speed limits communicated by variable message signs on gantries after each junction and reinforcement between junctions with signage and average speed cameras. Speed limits of 60mph or 50mph are imposed. An even lower 40mph limit is introduced when required for safety. The system uses inductive loops at nominal 500m spacing across each lane of the carriageway to provide the required speed and occupancy data (coverage is enhanced around junctions). Data are transmitted over compliant cabling back to intelligent outstations, which control the signals.

3.14 There are some examples of implementation of ATM in England on the M25 and the M42. Its implementation so far has primarily been to manage congestion – not carbon emissions - on busy parts of the network by smoothing flow on trunk roads and reducing accidents thus increasing capacity and enhancing reliability. Nevertheless, lower speeds and smoother traffic flow will have the effect of improving vehicle efficiency and reducing CO2 emissions[24].

3.15 We assume ATM will be applied on congested[25] parts of the trunk road network at peak times. This equates to around 165km of road and means that the speed distribution of all traffic will be reduced and evened out with a maximum of 40mph reached for half of the time and 50mph for the other half. The difference between the Central and Ambitious Scenario is that the timescale of delivery is accelerated in the latter case.

National motoring package (98)

3.16 This policy covers initiatives designed to reduce fuel used by cars and motorcycles during driving, including information campaigns and courses on driving style. 'Eco-driving', including adhering to speed limits, changing gear at the optimal time, avoiding idling and ensuring tyres are filled to the optimum, can reduce fuel consumption and emissions by around 10%. Some studies indicate that, over time, and particularly with proper training, drivers could achieve efficiency savings of as much as 15%, which may be further improved through technologies like gear shift indicators, econometers and cruise control[26].

3.17 The ways in which the change in driving style can be brought about vary in effectiveness and cost. Eco-driving information campaigns are less effective

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[24] Advanced motorway signalling and traffic management feasibility study. A report to the Secretary of State for Transport, Department for Transport, March 2008

[25] Defined as traffic exceeding 85% of maximum vehicle capacity for the road.

[26] The King Review of Low Carbon Cars. Part II: recommendations for action. HM Treasury, March 2008

than direct face to face training programmes[27]. We assume an on-going multi-media campaign including promotional material being sent to all licence holders and, depending on whether the Central or Ambitious Scenario, either 65% or 80% of the driving population undertake free face to face training sessions with updates every 5 years in the period up to 2027. The campaign would also involve the distribution of related tools at exhibitions and during the training sessions (such as tyre dust cap pressure indicator and tyre pressure gauges).

3.18 Training programmes and the raising of awareness can start immediately but will take time to reach the majority of drivers. In any given year some people will also stop ecodriving and so the net effect will be slower than the total number of people trained.

3.19 We have also factored in a 'rebound effect' for this policy, assuming that the fuel savings and associated cost savings may translate in part into more travel demand. However, although it follows that ecodriving and lowering speeds could reduce the cost per car mile travelled, thus leading to more distance travelled, this effect is likely to be suppressed by the effect of lower speeds on journey times. Thus this initiative might suppress any 'rebound effect'. However, these latter effects are not explicit in the evidence.

Speed reduction on trunk roads (143)

3.20 This policy proposes either the strict enforcement of speed on all trunk roads in Scotland which currently have a 70mph limit for cars and light goods vehicles (Central Scenario) or the reduction and strict enforcement of the limit on these roads at 60mph (Ambitious Scenario). This would exclude HGVs which are currently speed limited at 60mph on motorways, 50mph on unrestricted dual carriageways and 40mph on single carriageway roads. Whilst Scotland does not have the power to alter the national speed limit with a blanket policy, it does have the power to alter speeds on sections of the network. The argument for lower speed is based on increasing fuel efficiency, ensuring that average speeds are closer to the optimum and driving styles are potentially steadier with less acceleration and deceleration.

3.21 Enforcement would take place through the placement of average speed (time over distance) cameras to provide comprehensive coverage of the approximate 3000km of trunk road in Scotland. New generation average distance technology (such as 'SPECS3[28]) cameras can cover wide areas (enforcement links can be from 250m to 20km) due to the variety of forms of remote communications they can use and, compliance has been found to be extremely

[27] Gross et al. (2009) What policies are effective at reducing carbon emissions from surface passenger transport? A review of interventions to encourage behavioural and technological change. UKERC

[28] SPECS is a speed camera system manufactured by the British company Speed Check Services Limited, from which it takes its name. SPECS3, the first distributed average speed enforcement system, has now successfully completed the technical testing phase for Home Office Type Approval (HOTA). It has been recommended for full HOTA by the Roads Policing Enforcement Technology (RPET) committee and is expected to be fully enforceable once the formalities of the legal agreements are in place and the Home Office have signed the approval certificate. Other average distance cameras are also in development.

high. This means their cost is likely to be much lower than previous technology due to the fact that fewer cameras are required, the need for expensive fibre optic cabling and regular camera technician visits is removed and administrative costs lower[29]. Enforcement coverage and costs are the same whether a 70 or 60 mph limit is being imposed.

3.22 Our modelling assumes full coverage and 98% compliance by 2017 with altered speed distributions applied to car and LGV vehicle kilometres travelled on the relevant roads as compared to current speed profiles for Scotland.

Car Demand Management (Fiscal / Infrastructure)

Bus/ rapid/ mass transit infrastructure investment (including bus priority) (15)

3.23 The evidence on the potential for public transport to reduce emissions presents a complex picture and depends principally on the degree to which any increased patronage abstracts from existing car users, the utilisation of any new capacity and the potential for public transport capacity to increase enough to make a difference to increasing levels of car travel.

3.24 This policy involves targeted investment in public transport services and corridors in order to improve the quality and quantity of the service in areas of Scotland where public transport can be directly competitive with the car in terms of journey time and cost. This would include, for example, the expansion of the tram network in Edinburgh beyond the current committed scheme, development of a guided bus corridors Aberdeen and Dundee and an extension to the corridor currently planned in Glasgow, and new or enhanced bus priority corridors in all the conurbations with populations over 25,000 people. In each case, patronage growth is assumed to be further encouraged through the development of smart card technology and on-street ticket machines. Reallocation of road space to public transport and away from the car will help to lock-in the benefits from this policy.

3.25 Based on evidence from the DfT[30], the modelling assumes this investment will achieve a 10% reduction in journey times in the Central Scenario and a 20% reduction in the Ambitious Scenario for all bus journeys to urban areas with populations greater than 25,000 people. Implementation would also be more rapid in the Ambitious Scenario.

3.26 The net CO2 impact of a modal shift from car to bus is not clear cut. If increases in bus patronage cause an increase in bus service levels then emissions would be greater than if no change in service levels arose. The net effect of the offsetting changes in car and bus kilometres is uncertain and could be determined only by detailed analysis of the relevant case. We have made an allowance for additional emissions resulting from increased public transport operations, which equates to an increase of about 1% in bus operating emissions.

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[29] Speed Check Services (undated) SPECS3 Networked average speed enforcement solutions: safe, smoother, greener, fairer.

[30] DfT ITS toolkit evidence suggest individual corridors achieve time savings of up to 20% on sections in congested urban areas - this percentage applies to the full journey

Cycle infrastructure investment (37)

3.27 In 2000 the average person in the UK cycled 75km a year; comparable to levels in France and Greece. The average distance in Germany was 291km, 322km in Belgium and 848km in the Netherlands[31]. The average distance cycled per person in Scotland in 2005/06 per person was 37km.

3.28 This policy targets investment in high quality cycling infrastructure and promotion to secure mode switching from short and medium length car journeys to short cycling trips. Mode shift will be motivated by travel cost reduction, time savings in congested areas and health benefits. Investment is designed to reduce one of the main barriers (safety concerns) through investment in cycle routes and lanes (including shortcuts for cyclists), advanced stop lines, cycle parking facilities, provision of cycles on public transport, cycle rental schemes in cities, strictly enforced cycle parking standards for new developments and cycling promotion in all urban areas.

3.29 Evidence for the potential impact of intensive cycling investment on mode switch and emissions reduction indicates that there is a relationship between improved cycling conditions and trip end facilities and increased rates of cycling. This has been most recently demonstrated in the Cycling Demonstration Towns in England. For example, Darlington (which is also a Sustainable Travel Town) has witnessed an increase in cycling (as measured by town-wide cycle counters) between 2004 and 2008 of up to 95%, compared to an England-wide average reduction in cycling in medium towns of around 9%[32]. Analysis of similar levels of cycling investment elsewhere indicates that about half the growth displaces car trips[33].

3.30 Our modelling assumes that, in the Central Scenario, current cycling levels increase fivefold (broadly 10% mode share over all trips, 13% for those <7. 5 miles) and in the Ambitious cycling levels increase tenfold (broadly 20% mode share over all trips, 25% for those <7. 5 miles).

3.31 We have also considered in the fact that short trips in cars have disproportionately greater CO2 emissions because fuel consumption is higher when the engine is cold and not working at full efficiency[34].

Walking infrastructure investment (131a)

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[31] European Environment Agency http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3512

[32] Sloman, L., Cairns, S., Newson, C., Anable, J., Pridomore, A. and Goodwin, P. (forthcoming) *Smarter Choices Follow on Study*. Report for the Department for Transport

[33] Wardman, M., Tight, M., & Page, M. (2007) Factors influencing the propensity to cycle to work, *Transportation Research Part A: Policy and Practice*, Vol. 41, no. 4, pp. 339-350.

[34] This impact would also be relevant for those measures promoting a switch of short trips from highway to public transport. However, the effect has only been directly modelled for measures promoting walking and cycling for which it affects nearly all switched trips and therefore represents a significant increase in abatement potential. For public transport measures the effect would represent a much less significant uplift to estimated abatement potential as the relevant short trips represent a small proportion of total trips affected by a measure and considerably smaller proportion of abatement achieved (once journey lengths are accounted for).

3.32 Investment in walking infrastructure is treated separately from cycling infrastructure in this study. Improvements to the quality of the walking environment include improvements to lighting, directions, surfaces and crossings and more substantive investment in Home Zones, Safer Routes to School and the implementation of 20mph zones.

3.33 Home Zones are residential streets in which the road space is shared between drivers and other road users in order to transform the street space into extremely low speed environment in which pedestrians and even children playing are given priority. By redefining the streetscapes to be more pleasant and less traffic dominated, walking, cycling and social interaction are encouraged. There are several pilot Home Zone projects in the UK at the moment. They tend to be applied in larger urban areas where the problems of high levels of traffic creating poor walking environments tend to more widespread.

3.34 There is considerable scope for Home Zones that complement wider area initiatives such as safer routes to school programmes, or pedestrian and cycle networks[35]. Homezones will gradually cover 250,000 households by 2027 in the Central scenario and by 2022 in the Ambitious Scenario; that 20mph zones are implemented in all conurbations above 25,000 people and investment in Safer Routes to School is significantly increased.

3.35 Investment is assumed in all urban areas where residents currently make on average 250 walking trips per year. The Central Scenario assumes a 25% increase in current walking levels and the Ambitious Scenario a 50% increase, in line with potential scenarios outlined by Sustrans in their report on carbon abatement potential to the Committee on Climate Change[36]. As with other options considered in this current study, we have attributed the success (i.e. the increases in walking) to this individual policy even though the achievement is based on the best that can be achieved in a supportive policy environment. In this case, walking would not only be encouraged by the 'pull' of the infrastructure investment, but also by the push of car parking management and the encouragement of travel planning.

Bus/ LRT fares reductions (127)

3.36 As well as new and faster routes, public transport users will be attracted by lower fares. Whilst the evidence can be mixed as to the degree to which fare reductions alone can lead to mode switching from car use to public transport modes, it is clear that simplified and competitive pricing can attract car users on to alternative modes.

3.37 Although the evidence suggests that better or cheaper public transport may often have a relatively modest short run potential to reduce net CO_2 emissions, the longer term impacts on land use and travel patterns may be more profound. A significant price differential may contribute over time to the dominance of a

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[35] http://www.scotland.gov.uk/consultations/housing/hzgc-06.asp

[36] Carbon Savings from Active Travel Interventions, Sustrans Report to the CCC, July 2008, Sustrans, 2008

particular mode and 'lock in' to patterns of land use and lifestyle choice that suit that mode. A comparative study across Europe concluded that a 10% decrease in public transport fares can, in the long run increase public transport patronage between 5 – 9% (or more in some markets), but only 10 – 50% of this increase is likely to be drawn from car use. Most of the rest is drawn from pedestrians and cyclists switching to public transport[37].

3.38 This policy assumes the concessionary fares policy in Scotland is supplemented by a reduction in fares on all buses and light rail services by 15% in the Central Scenario and 30% in the Ambitious Scenario. The effects build up over time and long term price elasticities have been used to determine the patronage changes.

Rail investment (115)

3.39 This policy also targets mode switching away from car use towards rail through both increased investment to boost service frequency, quality and journey times. Investment would target rolling stock upgrading and increased track capacity.

3.40 Our modelling assumptions were guided by the Strategic Transport Projects review including potential reduction in journey times and the reported practical difficulties with implementation. We assume that investment would achieve a 10% reduction in journey costs or time on existing rail routes between Aberdeen, Dundee, Edinburgh or Glasgow and other urban areas (> 25,000). Given existing committed expenditure by Transport Scotland up to 2010 and the long lead in times, it is suggested that implementation of this additional investment would begin from 2017. The difference between the Central and Ambitious Scenarios is the speed of implementation after 2017.

3.41 We have made an allowance for additional emissions resulting from increased operations as a result of the investment which equates to an increase of about 0.3% in rail operating emissions.

High speed rail links (75)

3.42 In the Ambitious Scenario only, a high speed rail line linking Edinburgh, Glasgow and English cities is assumed. Construction of the line is assumed to begin in 2012 and be operational by 2022.

3.43 Due to time savings, emissions are reduced by the replacement of air travel journeys between Scotland and England and some long distance inter-city car journeys. A very high speed line from London to Scotland could attract modal shift from air. Around 100 flights from Scotland each day are destined for London Airports accounting for over 80% of the public transport share between

[37] ECMT 2007, Cutting Transport CO2 Emissions - What Progress?

Scotland and London. As a comparison, Eurostar now captures over 70% of the market between London and Paris[38].

3.44 The evidence on the net carbon impacts of High Speed Rail is very limited and often contradictory. In general it suggests that abatement potential is dependent on two key parameters. The first is the degree to which increased patronage is achieved through existing air patronage to the extent that the number of flights is actually reduced[39]. The second is the electricity generation mix assumed.

3.45 The modelling assumes that the scheme would be designed to attract sufficient mode switch from air to enable the operational emissions of the new line to be offset by reduced flight numbers and associated emissions. The abatement potential is therefore drawn from the reduction in car trips on the Scottish road network resulting from the assumed 15% to 20% mode switch from car to rail (based on modelling undertaken for the SRA[40]).

National network of car clubs (97)

3.46 Scotland is home to the UK's first car club (short term, pay as you go car hire), founded in Edinburgh in 1998. There are currently no other clubs in operation in the country. This policy proposes the comprehensive roll out through a coherent national network which is both interoperable (a member in one town can use the service in another town) and integrated in terms of tariffs and physical interchanges with the public transport providers. Most cars will be used as business pool cars during the day and for community use during evenings and weekends.

3.47 The network of car clubs will be rolled out over a 10 year period so that there is one in every main town (over 25k population) in Scotland by 2022 in the Ambitious Scenario or 2027 in the Central Scenario. The service will facilitate lower levels of car ownership whilst preserving and enhancing accessibility by car. Drivers incur the cost of driving at the point of use, reducing car use and therefore emissions. Car club cars are more efficient (due to newer technology and downsizing) and members will increase their use of alternative modes. It will also improve the efficiency of the business car fleet.

3.48 In the UK as a whole, car club membership has seen a dramatic rise in recent times, with 64,000 members in December 2008 compared to 32,000 in the same period of 2007[41]. Recent data collected from the members of the four main commercial car club operators in the UK indicates that 50% of members do not own a car on joining. However, each car club car is estimated to result in an average of 13 private vehicles being sold and a further 9 not purchased. Each car is 33% more efficient than average new car fleet. On average, 25 members share 1 car. Those who did own a car (50%), reduce their car

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[38] Written submission to Scottish Parliament from RMT – 17 October 2008; Scottish Association for Public Transport - High Speed Rail in Britain
[39] North South Line Carbon Impact: BAH Report for DfT, 2008
[40] High Speed Line Study, Milestone 7: Transport Case, Atkins report for the SRA, 2003
[41] Myers, D. and Cairns, S. (2009) Carplus Annual Survey of Car Clubs 2008_ final draft report. Transport Research Labaoratory.

mileage by 54% in response to joining, and make ~15% more journeys by bike and 10% more by public transport.

3.49 In the Central scenario it is assumed that 5% of households in urban areas with populations greater than 25,000 will be members of a car club by 2027. The equivalent figure for the Ambitious Scenario is 10%, but in this case achieved by 2022. The net car mileage travelled is assumed not to change as a result of car club membership as the reduction in mileage amongst previous car owners is offset by the increase amongst those who did not previously own cars. However, emissions are assumed to be reduced by the fact that car club cars are on average 33% more efficient than the average fleet. The increase in public transport journeys amongst previous car owners as a result of car club membership is assumed to be accommodated by existing public transport provision.

3.50 In each case, it is assumed that the number of day-time business trips covered by the car club cars is proportional to the size of the car club fleet, although this amounts to a very small proportion of business journeys.

National road user charging (Scotland) (99)

3.51 Another policy to appear only in the Ambitious Scenario is national road user charging for Scotland. This was considered to be too ambitious for the Central Scenario and the interim measure of charging at smaller geographical scale was considered too controversial and potentially counterproductive. For instance, focussing on individual road types (e. g. trunk roads) is likely to cause rerouting and increased distance travelled[42] whilst charging in individual areas is likely to be more difficult to implement politically (e. g. Edinburgh).

3.52 An equivalent national, distance based scheme is about to be introduced in the Netherlands. Here, a nationwide price per kilometre for all kilometres driven, differentiated by environmental characteristics, time and place, will start in 2012. The effects of this policy have been estimated to decrease car use between 10-13%. Emissions of CO2 from road transport would be reduced by 2.3 Mt, a decrease of more than 10%[43].

3.53 In this study, the charge would be based on distance travelled and emissions of the vehicle. The charge would average 5p/km for cars (varying by vehicles emissions levels), 6.5p/km for LGVs and 15p/km for HGVS. These charges would be in addition to fuel costs as modelling work for the UK based on fiscal neutrality (albeit related to congestion based pricing) indicates increased traffic and CO2 emissions[44].

Workplace parking levy (172)

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[42] Gower, P., Shearn, S. and Mitchell, J. (1998). Motorway tolling: Modelling the impact of diversion, TRL Report TRL. 349. Transport Research Laboratory

[43] Wiegmans, B. W., Beekman, N., Boschker, A., Van Dam, W., & Nijhof, N. 2003, *ICT and sustainable mobility: From impacts to policy*, Growth and Change, vol. 34, no. 4, pp. 473-489.

[44] See Anable, J. & Bristow, A. L. 2007, *Transport and Climate Change: Supporting document to the CfIT report*, Commission for Integrated Transport.

3.54 Private off-street parking spaces at a place of work encourage employees to drive to work in the knowledge that they have a guaranteed, often free, space waiting for them. The WPL is a charge made for each parking space provided by an employer and used by its employees and regular business visitors. It would be a charge on the employer, and it would be up to the employer whether or not to pass the charge on. Employers would be required to apply for an annual licence for the maximum number of spaces regularly used by their employees or regular business visitors, and pay a charge for the licence to cover the levy for the agreed number of spaces.

3.55 The levy has the effect of causing employers to remove guaranteed free parking at the trip end and reduce workplace parking spaces making it less attractive to use the car for work and potentially even own a car. In addition, the levy could be used to fund sustainable transport initiatives to provide alternatives to the car, though this is not assumed in our modelling.

3.56 Nottingham will be the first location in the UK to implement a WPL package in 2010. The package consists of a charge of around £300 per workplace parking space per annum with proceeds being used to extend the tram network, link buses and improvements to the railway station. The package is expected to broadly halve the forecast increase in car journeys to city centre destinations from 15% between 2006 and 2021 to 8%. Overall, the Business Case documentation concludes 'WPL represents a financially efficient, high value for money proposal, with relatively low development costs and shorter implementation timescales than alternative charging mechanisms'.[45]

3.57 Our modelling assumes a levy equivalent to long stay public parking charges is applied to all workplace parking spaces in all urban areas reachable by public transport. Rural locations with few public transport alternatives are exempt. The levy is broadly set at current long stay parking levels and is assumed to increase through time in line with GDP growth. The scheme would be introduced in 2012 after a consultation period and implementation should occur simultaneously in all urban areas to prevent migration of businesses to areas where the levy is not charged. However, it is assumed that it takes longer to reach 100% coverage in the Central than in the Ambitious Scenario.

Introduction or increase in parking charges (public parking) (103)

3.58 Increasing parking charges makes drivers think twice about the need for the trip they plan to make and encourages them to combine trip purposes to make best use of the price of the parking ticket. This leads to a reduction in the number of trips, vehicle miles and hence emissions. Similarly, reducing the number of parking spaces available at the end of the trip dissuades the driver from making the trip in the first place.

3.59 Many towns and cities in Scotland already charge for parking and limit private non-residential (PNR) parking in line with SPP17 through the planning process. Many do not. This policy proposes that all cities and towns should be charging for parking, phasing this in by 2012. This includes limiting free parking

[45] Nottingham City Council (2008) Workplace Parking Levy Business Case. April 2008

provision in urban areas by introducing charges where they currently do not exist with on-street meter bays and in off-street car parks (184). Charges may be tailored to dissuade long stay commuter parking while allowing short stay shopper parking so as not to affect retail vitality. It may also include Controlled Parking Zones (36) focussing on areas of high parking demand outside the CBD to protect residential on-street parking.

3.60 Our modelling assumes that, overall, parking charges would increase by 50% and there would be a 50% increase in the number of trips paying to park in urban areas (> 25k in the Central Scenario and >10k in the Ambitious Scenario). Charging in a hierarchy of concentric zones, working away from the CBD, would be introduced in phases, with lower charges away from centres of parking demand. The effect is locally immediate wherever controls are introduced or strengthened. The effect can dilute with time. In both scenarios, all urban areas would be covered by 2017 and all outlying towns and villages by 2022, although with an accelerated timetable in the Ambitious Scenario.

Introduction/raise in residential/private parking charges (125)

3.61 Resident parking charges are often introduced as a consequence to protect on-street resident spaces from being overrun by visitors. The role of resident parking charges can be extended to help control carbon emissions by extending the coverage and relating the charge to vehicle type. In this way, charging will have the effect of both influencing the *amount* and the *type* of car ownership. For those that choose to own a car, the scale of charges based on emissions will influence their choice of vehicle towards the less polluting models. Limiting car ownership like this will also promote the use of existing public transport and create demand for other sustainable means of travel like car clubs and cycling.

3.62 There are some examples of emissions-related residential parking charges already in operation in England. Richmond Borough Council is the most well-known. The cost of parking permits has been based on the Vehicle Excise bands (A-G) since April 2007. The cost of permits for vehicles in VED bands A-C was reduced from the previous level while the cost for vehicles in bands D-G was increased. A permit for a first vehicle in band A is now free while the cost for the first vehicle in band G is £300[46].

3.63 As with Richmond, we have assumed charges would be set on a sliding scale depending on the published emissions figures of the vehicle. Second (third, fourth etc.) cars would be charged more. The scale of charges would be positioned such that some residents will benefit from the change by virtue of the type of car they already own.

3.64 In physical terms, the policy would consist of the installation of parking ticket machines, painting lines on streets and enforcement through the legal system. Payment could take place through electronic systems and data loggers to reduce the administrative burden and increase compliance.

[46] http://www.richmond.gov.uk/parking_charges_draft_orders_1.pdf

3.65 Many city centres and other areas of high parking demand already charge for on-street resident parking. Many do not. All areas of high parking demand would be charging for resident parking by 2012. Other areas where residents park on-street but there is less demand for visitor parking would be charging for resident parking by 2017 as controlled zones work outwards away from the city's CBD. Surrounding villages would be covered later so that, in total, all areas with on-street parking will be covered by 2022 in both scenarios (although with earlier, quicker action in the Ambitious Scenario).

3.66 The effect of this policy will be to encourage an increased turnover of vehicles so that the fleet is on average 2 years younger than the average and the number of small cars is increased by 50% at the expense of larger cars. As a result, cars will become smaller and less polluting and fewer cars will be owned overall. These impacts will take time to materialise as people replace their cars every 4 years or so. Success will only occur if charges are high enough to change behaviour, though we make no explicit assumptions on charge level.

Car Demand Management (Smart Measures)

Widespread implementation of travel plans (173)

3.67 This policy covers a multitude of travel planning applications at the workplace (173), schools (138), household individualised marketing (107) and general car/van sharing promotion and support (25). Each type of travel plan targets different groups and the combination of strategies targets both the origin and the destination of trips. Altogether, all groups and journey purposes are targeted, but especially commuting traffic. We have integrated these into one umbrella policy in order to account for the potential double counting and synergistic effects between them. We have done this by assuming a combined impact on vehicle kilometres for each journey purpose.

3.68 Travel planning and other smarter choice measures such as awareness campaigns and public transport information and marketing (both of which are assumed here to form part of the travel planning efforts) encourage voluntary behavioural shifts away from single occupancy car use by informing about the alternatives, making small scale improvements to the infrastructure and incentivising change through ticket promotions and parking charges.

3.69 However, as has been mentioned in relation to other policies, travel planning cannot be considered in isolation from the measures necessary to provide greater likelihood that the potential behaviour change will be achieved. This includes the ‘stick’ measures such as workplace parking levy and pull measures such as road space reallocation towards walking and cycling measures in order to attract and facilitate any modal switch. There are clear synergies with other policies in this shortlist as fare reductions and improvements to public transport will all impact on the scale and longevity of the behavioural changes we can assume from smarter choices. These will be discussed in Chapter 4, but suffice to say that we have based our assumptions on the fact that these supporting policies will be taking place in order to provide the supportive policy environment and the locking in necessary for them to succeed.

3.70 There is now good evidence on the potential effectiveness of these measures under different levels of investment. Some of this activity is already taking place in Scotland, but this policy would involve a mainstreaming of activity so as to roll out to the majority of workplaces, schools and other destinations over the first decade with rolling programmes of reinforcement after this date[47]. We assume a gradual intensification starting in 2010 building up to full potential by 2022.

3.71 Workplace travel plans include a combination of promotions, small scale infrastructure improvements, parking management (including charging), facilitation of teleworking and car sharing. Workplaces with over 30 employees are likely to be affected. The modelling assumed this translates in to a 9% reduction in commuting trips in urban areas and 4% of rural trips[48] in the Central scenario and 26% and 10% in the Ambitious Scenario. Business trips will also be affected through the travel planning and development and promotion of high quality tele/video conferencing facilities[49] and are assumed to reduce by 10% and 18% in the two scenarios.

3.72 School travel plans include a combination of promotion, cycle training for children and small scale infrastructure improvements such as cycle parking. Improvements are over and above those implemented by Safer Routes to School initiatives. Fewer children travel to school by car in Scotland compared to England (20% versus 30%) and so the potential impact is assumed to be lower than the equivalent travel plans in England. We assume a 12% reduction in school escort journeys.

3.73 With respect to individualised marketing, it is assumed that all households in Scotland are contacted once in the period up to 2022. This will consist of rolling coverage, never targeting all households in any one neighbourhood at any one time in order to capitalise on the diffusion effect – the idea that intensive marketing campaigns such as these have impacts on friends and neighbours as well as just those people receiving the information. Whilst this is an intensive campaign, it is assumed to augment the savings from the other types of travel planning and, so as to avoid double counting, we have assumed only an extra 3% reduction in trips by car for all non-business journey purposes in both scenarios.

3.74 Travel plans at large leisure destinations are also assumed to result in an 8% or 10% reduction in trips by car for this journey purpose.

Provide community hubs (204)

3.75 This policy is designed to create centres in rural and small urban centres which can act as a focus not only for remote working, but also other services such as health, education, shopping delivery, post office and other financial services. This policy captures the idea of 'relocalisation' (originally included as a

[47] Although individual household marketing is not repeated within individual households as it is assumed that there are diffusion and reinforcement effects which take place as whole community are gradually targeted and as other smarter choice measures are implemented.
[48] Based on Cairns et al. (2004) Smarter Choices – changing the way we travel. Report for the DfT.
[49] The cost for these facilities is assumed to be met by the businesses themselves.

separate policy on the long-list of policies) which suggests that the location of public services in the less densely populated areas needs to be reviewed in order to reduce the need to travel (128). This is now encapsulated under a policy of community hub development.

3.76 The hubs will be located in existing or new buildings in rural and small urban areas (<10K, of which Scotland has 110). They will incorporate ICT and remote office facilities (including videoconferencing suites) and storage for e-commerce deliveries. To the extent that electric vehicle infrastructure and car clubs are rolled out to these areas, they will also be the focal point for parking spaces and charging points.

3.77 If a proportion of journeys to work are being replaced by e-working, business travel by the use of teleconferencing and shopping trips by combined van deliveries, community hubs will have the effect of lowering travel demand and emissions. The existence of a hub and local working could also improve the viability of local shops and services thus reducing travel further. Reducing the dependence on the car for commuting and encouraging the adoption of electric vehicles and car clubs in rural areas could also discourage the purchase of a second car in some rural households and improve efficiency of the fleet.

3.78 Scotland is to be one of the first countries in the world with 100% broadband coverage and e-working could present significant opportunities for reducing travel demand. The potential impacts of telecommuting on travel demand reduction have been studied at a variety of spatial scales. Although the theoretical potential is strong (albeit limited by the number of people who are in a job conducive to teleworking), the evidence on actual effects is mixed. This is not surprising and echoes more general findings on smart measures that the impact can be very large or very small depending on the extent to which e-working changes are supported locally by policies and parallel initiatives[50]. The balance between substituted and induced travel effects (e.g. if people decide to live further from where they work) will depend on complementary policies for travel demand management and planning.

3.79 Home shopping is facilitated by this policy as the 'internet culture' is encouraged and community hubs will provide a central delivery and storage point for the delivery of goods.

3.80 We have concluded that teleworking will have carbon benefits if it is frequent enough and this will in turn be influenced by adequate facilities including comprehensive and high-speed broadband together with the concept of community hubs in order to facilitate 'local living'. At the moment, around 13.5% of Scottish working adults spend at least some of their time working at home, averaging 2 days per week[51]. We assume that on any given day an upper limit of 20% of the population are teleworking thus reducing peak commuter traffic by a proportional amount by all motorised modes. Business travel would be reduced by up to 30% as tele- and videoconferencing takes off.

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[50] Halden, D. (2006) Scoping the Impacts on Travel Behaviour in Scotland of E-Working and other ICTs

[51] Scottish Household Survey, 2003

Home shopping could reduce demand for shopping trips (all modes) by 10% by 2027 but whilst shopping miles are reduced, there is a net increase in vehicles travelled by light goods vehicles equivalent to one-third of car shopping trip reduction to represent increased deliveries. Car club vehicles do not save any extra travel and emissions for this policy - they are an enabler of the less car dependent lifestyle of which telecommuting is a part. The difference between the Central and Ambitious Scenarios is the speed with which these upper limits are reached.

Bus quality contracts / statutory partnerships (18)

3.81 Initiatives to reduce emissions from buses are included here under the auspices of bus quality contracts. This mechanism will facilitate agreed targets for low carbon bus fleets which will be supported by financial inducements to purchase the cleanest technology in any given year (originally policies 16 and 145). The arrangements will also include targets and subsidies for ecodriving training of bus drivers. Evidence on eco-driving in the bus industry indicates savings in fuel consumption of between 2 and 10%. Other benefits reported include less wear and tear on brakes and hence less maintenance, reductions in driver stress and improved on board comfort[52].

3.82 We calculate these improvements as having an effect on the average efficiency of the fleet. It is possible that measures to improve bus driving style and the quality of the bus fleet will also attract additional passengers.

3.83 The impacts are assumed to be confined to urban areas with populations greater than 25,000. The rate of bus renewal is not assumed to increase, but the improvement in average efficiency of the fleet will be accelerated by this policy – by 4 years in both scenarios (with more rapid implementation in the Ambitious Scenario). Eco-driver training of all bus drivers (updated every 3 years) is assumed to deliver 4% improvement in on-road fuel efficiency and improvements to and modernisation of the fleet are assumed to improve their quality and attractiveness to potential bus passengers.

Freight

Freight best practice (63)

3.84 Eco-driving as applied to the freight sector was been implemented in Scotland since 2005 through the SAFED (Safe and Fuel Efficient Driving) programme. Public funding for HGVs finished in 2007, but courses are now offered on a commercial basis to HGV drivers. A project to establish a SAFED-vans training network is currently underway. For each driver trained, an average 10% improvement in fuel efficiency is achieved[53].

3.85 This policy assumed continued public subsidy for this type of training to ensure eco-driving practices become the norm among HGV drivers and is far more

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[52] Allen H. (2007) Energy savings and increased passenger satisfaction with eco-driving: examples from signatories to the UITP Sustainable Development Charter. Public Transport International. 56(3), pp38-39.

[53] http://www.safed.org.uk/SAFED%20Scotland/news.htm

widespread among LGV drivers in Scotland. For HGV drivers we assume a take-up in line with introduction of mandatory Driver Certificate of Professions Competence - reaching 100% of all HGVs after 2014. For LGVs we assume a take-up at 1% per annum reaching 15% of all vans by 2022 in the Central Scenario and 30% in the Ambitious Scenario. HGV drivers are assumed to reduce emissions by 4% and LGVs by 3%. These assumptions are at the lower end of the evidence but match CCC assumptions based on averages per trained driver across all road types.

Land Use Planning

Urban density increases (158)

3.86 To achieve higher density development, planners and clients (developers and land owners) will be required to locate developments to minimise potential car use and maximise walking and cycling. The whole development will be required to be designed as more locally self contained with access to retail, services and some employment on site. Sites would also maximise the potential for home working through broadband access and IT services and a well designed set of measures might include regulations for energy generation as well as density and accessibility standards.

3.87 The policy depends on the intensity of application of regulation through the planning system together with fiscal incentives and penalties. We have assumed funding will be allocated to a review of national, regional and local planning policies and their development based on good practice. It would also include training and skills development in order to train planners and architects in designing for high density.

3.88 The greatest impact of this policy will be felt in the longer term as the proportion of the population living in higher density developments will increase. However, it will have the short term effect of minimising incremental increases in carbon emissions from new development including residential and retail uses. Overall, this option must be considered as an enabling measure which constitutes a significant role in creating the 'supportive policy environment' discussed in relation to many of the options. As will be seen in the next section, large carbon savings are unlikely to be attributed to land use planning as a distinct option, but this should not undermine its importance as a vital ingredient to facilitate and lock-in the abatement achievable by other mechanisms.

3.89 The modelling assumes that a proportion[54] of the forecast underlying employment and population growth set for rural areas and the fringes of large urban areas is reallocated to central urban areas with average car mileage per relocated household reduced to the lower average for urban areas (reflecting different levels of car ownership and travel patterns). In essence, this does not amount to a great deal of growth by 2027.

Aviation

[54] 25% by 2022 in the Central scenario and 50% in the Ambitious.

Improve public transport surface access to airports (205c)

3.90 This policy relates to the carbon emissions arising from passengers and employees travelling to and from Scottish airports and concentrates on improvements to the time taken to travel by public transport.

3.91 Currently, surface access to airports is largely dependent on private cars. For example, 49% of passengers travelled to Edinburgh airport by car in 2005, and a further 20% by taxi[55]. Yet, the emphasis on public transport access is a feature of many airports, particularly other major European hubs. Achievement of improvements will require improvements to services, particularly in terms of journey time savings and changes to parking management. While better rail access to airports is important, buses are more flexible and more immediate and less costly than new rail services, but are vulnerable to road congestion.

3.92 This policy option aims to enhance public transport access to Edinburgh, Glasgow, Aberdeen, Prestwick, and Dundee airports by packages of measures to improve public transport, especially bus services. The effect is to reduce public transport journey times by 10% for bus and rail in the Central scenario and 20%/10% in the Ambitious Scenario.

[55] BAA Edinburgh (undated) A surface access strategy for Edinburgh airport.

4 POLICY ASSESSMENT

Abatement Potential by Policy Option

Annual Abatement

4.1 The annual abatement potential of each policy option varies with both scale of implementation and the year under consideration as illustrated in Table 4.1.

Scale of Implementation

4.2 The first two columns of figures in the table show estimated annual abatement potential in 2022 (the end of the third carbon budget period) for each policy option assuming the intensity of implementation defined for each one in firstly the Central and then the more Ambitious Scenario outlined in Chapter 3.

4.3 The figures show that the scale of abatement varies considerably from those policy options that achieve less than 0.01 MtCO2 p.a. of abatement in both Central and Ambitious Scenarios to several that achieve over 0.1 MtCO2 and travel planning which generates an estimated 0.9 MtCO2 reduction in CO2 emissions in 2022 if implemented at an ambitious scale.

4.4 The difference between the central and ambitious figures illustrates the significance of intensity of implementation. More ambitious implementation in each case involves a combination of more rapid progress (so that implementation is further advanced by 2022) and/or a more stretching overall target, either in terms of geographical coverage or level of intended change. Table 4.1 shows that the combination of these factors has a considerable impact on the annual abatement potential with the ambitious implementation generating more than twice the abatement potential of the central implementation scale in most cases[56].

4.5 A number of broad patterns can be identified in the abatement figures in terms of the relative performance of different types of scheme.

- The forecast potential for travel planning considerably exceeds that for all other policy options, reflecting the range of approaches covered in the policy option (from workplace travel plans to individual travel marketing) and the associated scale of the target population. This will be discussed further below, but suffice to say here that the way in which we have evaluated this option assumes a suite of travel planning activities will be implemented which simultaneously and comprehensively targets almost every journey purpose, social group and most geographical areas. In addition, we assume that the abatement potential is achieved in the context of supporting policies which enable and lock-in the behavioural change.

[56] For a few measures the level of implementation is the same for both the ambitious and central definitions. The difference for these measures occurred in previous years with more rapid implementation occurring in the ambitious scenario but both scenarios having reached in 100% by 2022.

- Other policy options towards the top of the list of annual potential include those that promote behaviour change through enforcement (speed limit reductions) or charges (parking charges and road user charge).

- Schemes involving extensive investment in the public transport network generally lie towards the bottom of the list in abatement terms.

4.6 A number of issues should be noted when interpreting the results:

- The estimates of abatement presented by policy option can not simply be summed to provide an estimate of the total abatement potential generated if all policy options were introduced together. In some cases overlaps exist, for instance eco-driving assumes some compliance with speed limits on trunk routes and so there would be some double counting with enforcement of speed limits and the introduction of active traffic management. Similarly synergies are important. For example, the presence of policy options such as extensive cycling provision would be necessary to support the high levels of response forecast to policy options such as travel planning.

- The figures presented should be considered as indicators of relative scale rather than detailed estimates, given the inevitable uncertainty in the forecasting process.

- The impact of the policy options is strongly influenced by the underlying assumptions on vehicle technology. The estimates presented assume that national and European action has resulted in improvements in the vehicle fleet in line with the Extended Ambition scenario set out by the Committee on Climate Change (CCC). This results in a considerable reduction in emissions per vehicle kilometre compared to current conditions meaning that those policy options that achieve abatement through reductions in vehicle kilometres travelled or improved efficiency have less effect per vehicle kilometre than they would with the current fleet mix (between 10% and 20% less in 2022). Similarly, the abatement impacts per vehicle kilometre removed decrease through time as the fleet's average efficiency improves.

- The abatement figures include an allowance for the "rebound effect", which occurs when policy options intended to reduce emissions also reduce travel costs (through increased efficiency). The cost reduction encourages increased travel, offsetting some of the abatement achieved. In line with the CCC report, this effect is assumed to reduce the abatement achieved by relevant measures (such as eco-driving) by 15%.

- The estimated totals include emissions produced in the generation of electricity used to power electric vehicles. This is an unusual form of presentation, by convention multi-sectoral analyses (such as the CCC report) present only tailpipe emissions for the transport sector, allocating those from electric vehicles to the electricity sector. However, for a single sector analysis such as this study, it is important to include all emissions generated by transport operations, wherever they occur to provide an overall view of the net impact.

- The assumptions on the energy mix used to generate the electricity powering electric vehicles and plug-in hybrids therefore influence the scale of impact of the policy options. The results presented are based on the assumptions included in the CCC Extended Ambition scenario, which assumed a continuation of the current mix of energy, resulting in a relatively high carbon emissions rate per kilometre travelled by electric or hybrid cars. If electricity could be assumed to be generated from a lower carbon source, the relative effects of the policy options would alter. Those acting to accelerate fleet turnover would have a larger effect as the emissions savings caused by switching to hybrid and electric vehicles would be greater. However, those acting to reduce demand and improve efficiency would have a relatively smaller effect in later years due to the lower emissions associated with each vehicle kilometre. Halving the assumed carbon emissions from electricity generation would reduce the abatement potential of demand management or efficiency improvements by 3% to 4% in 2022, with the impact growing in later years with the growth of the electric fleet. However, the lower emissions levels would also mean that the emissions reductions achieved by national action to promote electric/hybrid vehicles would be greater, leaving a smaller ‘gap’ to be met by action by the Scottish Government.

- The impacts of some of the policy options are potentially understated as they are only fully implemented towards the end of the period and so their full effects do not materialise by 2030. The three key examples are road user charging (introduced in 2022) and the policy options to increase urban density and support extension of the electric car network which continue to expand in scale beyond 2022.

Table 4.1 - Abatement Potential by Policy Option

Policy Option		Intensity 2022 (MtCO2 p.a*)		Annual by Year (Ambitious) (MtCO2*)				Cumulative
		Central	Ambitious	2012	2017	2022	2030	2010-2030
A) Technology								
53	Electric car technology & network development	0.08	0.16	0.00	0.04	0.16	0.16	1.89
109	Procurement of low carbon vehicles	0.00	0.01	0.01	0.01	0.01	0.01	0.16
B) Driving Style								
1	Active traffic management	0.02	0.02	0.01	0.02	0.02	0.02	0.30
98	National motoring package	0.11	0.17	0.12	0.24	0.17	0.06	2.86
143	Speed reduction on trunk roads	0.18	0.30	0.22	0.33	0.30	0.30	5.60
C) Car Demand Management (Fiscal/Infrastructure)								
15	Bus/rapid/mass transit infrastructure investment (including bus priority)	0.01	0.01	0.01	0.01	0.01	0.01	0.17
37	Cycle infrastructure investment	0.05	0.12	0.04	0.10	0.12	0.11	1.84
75	High speed Rail links	0.00	0.02	0.00	0.00	0.02	0.03	0.25
97	National network of car clubs	0.04	0.10	0.01	0.06	0.10	0.08	1.32
99	National road user charging	0.00	0.33	0.00	0.00	0.33	0.33	3.62
103	Introduction or increase in public parking charges	0.02	0.13	0.09	0.15	0.13	0.12	2.35
115	Rail investment	0.00	0.00	0.00	0.00	0.00	0.00	0.03
125	Introduction/raise in residential/private parking charges	0.02	0.02	0.01	0.02	0.02	0.02	0.33
127	Bus /LRT fares reductions	0.00	0.01	0.00	0.01	0.01	0.01	0.09
131a	Walking infrastructure investment	0.02	0.05	0.01	0.04	0.05	0.04	0.70
172	Workplace parking levy	0.22	0.22	0.00	0.25	0.22	0.22	3.61
D) Car Demand Management (Smart Measures)								
18	Bus quality contracts / statutory partnerships	0.15	0.18	0.04	0.10	0.18	0.28	3.05
173	Widespread implementation of travel plans	0.66	0.95	0.43	0.71	0.95	0.92	15.09
204	Provide community hubs	0.14	0.14	0.07	0.11	0.14	0.14	2.23
E) Freight								
63	Freight best practice	0.09	0.09	0.07	0.11	0.09	0.08	1.72
F) Land Use Planning								
158	Urban density increases	0.01	0.02	0.00	0.02	0.02	0.02	0.25
G) Aviation								
205c	Improve public transport surface access to airports	0.00	0.01	0.00	0.00	0.01	0.01	0.05

* rounded to the nearest 0.01Mt and including emissions generated by electricity required to power electric and plug-in hybrid vehicles

Year of Abatement

4.7 Columns 3 to 6 of Table 4.1 show estimated annual abatement for each policy option assuming the ambitious level of implementation for each of the years of 2012, 2017, 2022 and 2030. The figures show that the potential for most policy options grows to a maximum in either 2017 or 2022 and then decreases thereafter. This pattern is the net effect of the timescale related influences raised above which have opposing impacts on abatement levels.

- Influences acting to increase abatement potential include:
  - Increasing level of implementation - the extent to which each policy option has been implemented builds up to 100% in either 2017 or 2022 for most policy options;
  - Increasing levels of reference case traffic - underlying growth in traffic is forecast meaning that each percentage reduction in vehicle kilometres achieved represents a greater absolute number and associated level of emissions.
- Those acting to decrease potential include:
  - Increasing efficiency of the vehicle fleet. As outlined above, the underlying assumptions on vehicle fleet composition and efficiency (drawn from the CCC's Extended Ambition scenario) involve increasing use of more efficient vehicles such as hybrids. Consequently the average emissions per vehicle kilometre travelled reduce with an associated decrease in the scale of absolute emissions reduction achieved by a given percentage improvement in efficiency or reduction in vehicle kilometres travelled.

Mechanisms for Abatement

4.8 Each policy option achieves the estimated abatement potential shown in Table 4.1 through its impacts on one or both of the following two key mechanisms for emissions reduction:

- Reductions in the amount of travel (particularly by highway vehicles);
- Improvement in the emissions efficiency of travel, achieved through both vehicle technology and driver behaviour (including speed).

4.9 Reduced travel is the main abatement mechanism for several of the policy options. For example, the 0.1MtCO2 abatement forecast to be generated by the ambitious implementation of cycling measures is largely the result of a 2% reduction in car kilometres relative to the baseline, focussed particularly on roads in built-up areas (offset to an extent by increased congestion due to road space reallocation). Similarly, the 1MtCO2 of abatement achieved by the ambitious implementation of travel plans is largely the result of a 12% reduction in vehicle kilometres (equating to a 15% reduction in car kilometres).

4.10 The short list also includes several examples of policy options for which improved efficiency is the key mechanism for abatement, particularly through alterations to driver behaviour. For example, the national motoring package achieves an estimated average reduction in emissions per vehicle kilometre of nearly 2% across the vehicle fleet, as a result of a reduction of nearly 3.5% for the car fleet.

4.11 The enforcement of a 60mph speed limit also achieves abatement through alterations to behaviour. The limit forces drivers on trunk roads to drive at more fuel efficient speeds, reducing average emissions per car vehicle kilometre by around 10% on affected roads and up to 20% for lights goods vehicles (which experience a much more rapid deterioration in fuel efficiency at higher speeds). These effects result in a net reduction in average emissions per vehicle kilometres of 3% across the whole network, offset to an extent by a 0.3% increase in vehicle kilometres (due to drivers rerouting as a result of increased journey times).

Cumulative Abatement

4.12 The patterns of abatement through time are also reflected in the final column in Table 4.1 which shows the estimated cumulative abatement potential for each policy option over the 20 year interval between 2010 and 2030[57].

4.13 The relative scale of abatement potential for each policy option is broadly the same when considered in cumulative terms as when annual abatement in 2022 is considered. However, some minor reordering does occur. Those policy options that are suitable for more rapid implementation perform slightly better and those with a longer build up time perform slightly less well.

Cost Effectiveness and Marginal Abatement Cost Curve (MACC)

4.14 Combining the estimated cumulative abatement potential between 2010 and 2030 with the present value of costs incurred over the same interval provides an indicator of cost-effectiveness for each policy option, defined as follows.

$$\frac{\text{[PV of total capital and operating costs between 2010 and 2030 discounted to 2008 prices/values]}}{\text{[estimated abatement potential between 2010 and 2030 in MtCO2]}}$$

4.15 This can be broadly viewed as the cost in PV terms of each tonne of abatement achieved in total over the 20 year period by each policy option and forms the basis of the Marginal Abatement Cost Curve (MACC) presented in Figure 4.1 and 4.2 below.

4.16 A number of points are relevant in interpreting the curve:

- Policy options are arranged across the graph horizontally in order of descending cost effectiveness;

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[57] Abatement potential for intervening years was estimated assuming steady annual change rates

- The width of each bar represents the broad annual abatement potential of the policy option in 2022 (in MtCO2 p.a.);

- The height of each bar represents the measure of the cost effectiveness of each policy option[58];

- Costs were based on implementation and ongoing operating costs only. Wider social impacts were not included and revenue gains were not offset against operating costs as they represent transfer payments (from user to operator); and

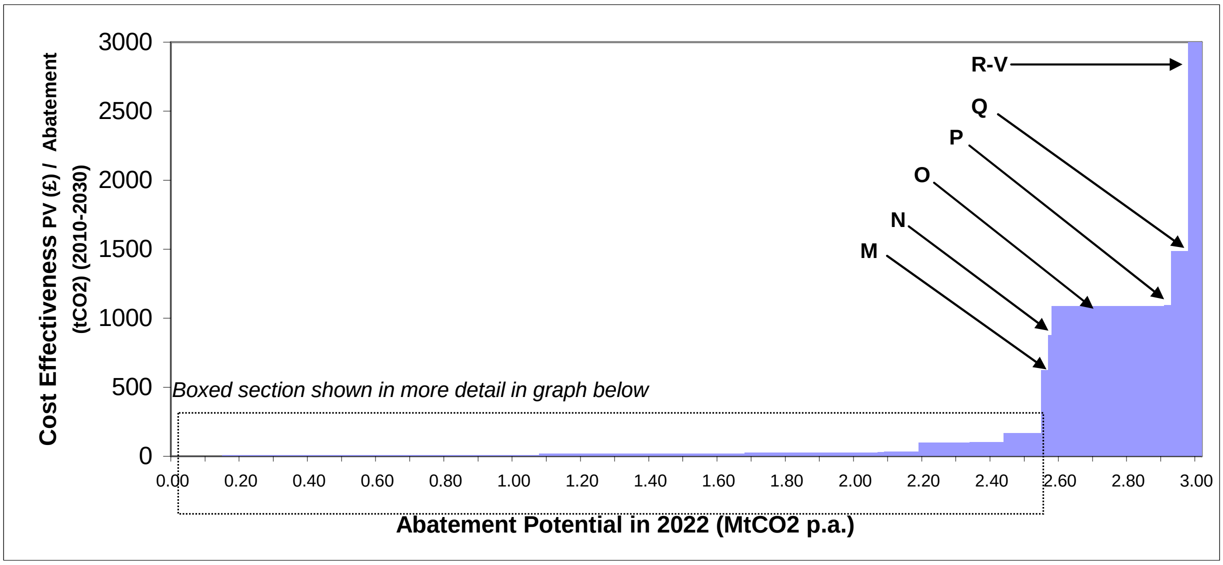
- Given the inevitable uncertainties in both the cost and abatement measures, the figures presented should be considered as indicative of scale rather than detailed estimates.

[58] (NPV of total capital and operating costs* of the scheme between 2010 and 2030 discounted to 2008 prices and values) divided by (estimated abatement potential between 2010 and 2030 in MtCO2) *NB revenue gains are not offset against operating costs as they represent transfer payments (from user to operator)

Table 4.2 - Cost Effectiveness by Policy Option (Ambitious Implementation)

Policy Option		**Cost Effectiveness (£PV/tonne abated 2010-30)**
A) Technology		
53	Electric car technology & network development	100
109	Procurement of low carbon vehicles	880
B) Driving Style		
1	Active traffic management	1090
98	National motoring package	20
143	Speed reduction on trunk roads	20
C) Car Demand Management (Fiscal/Infrastructure)		
15	Bus/rapid/mass transit infrastructure investment (including bus priority)	>3000
37	Cycle infrastructure investment	170
75	High speed Rail links	>3000
97	National network of car clubs	100
99	National road user charging	1090
103	Introduction or increase in public parking charges	20
115	Rail investment	>3000
125	Introduction/raise in residential/private parking charges	625
127	Bus /LRT fares reductions	>3000
131a	Walking infrastructure investment	1490
172	Workplace parking levy	25
D) Car Demand Management (Smart Measures)		
18	Bus quality contracts / statutory partnerships	30
173	Widespread implementation of travel plans	10
204	Provide community hubs	5
E) Freight		
63	Freight best practice	35
F) Land Use Planning		
158	Urban density increases	30
G) Aviation		
205c	Improve public transport surface access to airports	>3000

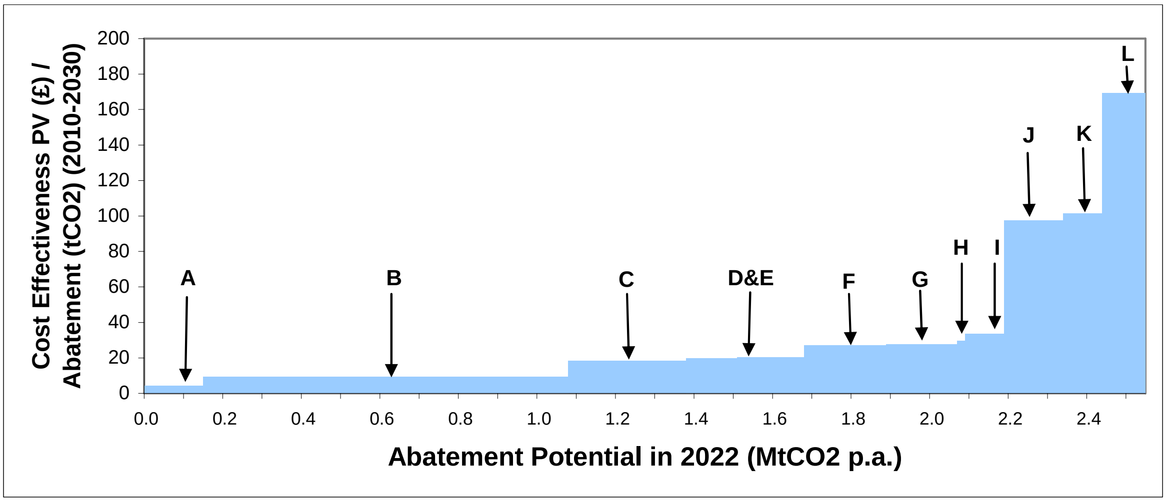
Figure 4.1 - Marginal Abatement Cost Curve - Ambitious Implementation of Policy Options



Key

Code	Measure	Measure
M	125	Introduce/ raise residential/private parking charges
N	109	Procurement of low carbon vehicles
O	99	National road user charging
P	1	Active traffic management
Q	131a	Walking Infrastructure Investment
R	205c	Improve public transport surface access to airports
S	15	Bus/rapid/mass transit infrastructure investment (including bus priority)
T	127	Bus/LRT fares reductions
U	75	High speed rail links
V	115	Rail investment

Figure 4.2 - Marginal Abatement Cost Curve - Most Cost Effective Policy Options - Detailed View



Key

Code	Measure ID	Measure
A	204	Provide community hubs
B	173	Widespread implementation of travel plans
C	143	Speed reduction on trunk roads
D	103	Introduction or increase in public parking charges
E	98	National motoring package
F	172	Workplace parking levy
G	18	Bus quality contracts / statutory partnerships
H	158	Urban density increases
I	63	Freight best practice
J	53	Electric car technology & network development
K	97	National network of car clubs
L	37	Cycle infrastructure investment

4.17 The curve illustrates that the policy options considered vary widely in cost effectiveness from less than £10 (present value) per tonne abated (between 2010 and 2030) to over £3000. Four broad categories of policy option can be identified within this range:

- Those with a cost effectiveness ratio of less that £35 per tonne are largely policy options intended to affect behaviour which require the introduction of only very limited new physical assets and infrastructure (including demand management through parking charges);

- Those in the next band up of less than £200 per tonne are largely policy options that require a fairly modest level of infrastructure or asset provision (charging points for electric vehicles, vehicles for car clubs and cycle provision);

- Two of the four policy options in the third category of up to £1100 per tonne entail the provision of fairly complex (and therefore expensive) technological infrastructure (ATM and Road User Charging). The other two involve encouraging increased purchase rates for new, more efficient vehicles. The provision of infrastructure to encourage walking falls just above this category with a ratio of £1500 per tonne; and

- Finally, most of the policy options in the fourth category (with a ratio of over £3000 per tonne) are likely to involve the provision of significant physical infrastructure on the public transport network. The only exception is the policy option to support concessionary bus fares.

4.18 It should be noted that the MACC represents an assessment of the relative performance of abatement policy options from a particular perspective and for a particular snapshot in time. Alternative perspectives could produce different results. In particular:

- The figures shown represent abatement potential in 2022 horizontally across the graph. Presenting results for different years would show a different balance between the potential for each policy option. To illustrate this point equivalent curves for potential in 2017 and 2030 are shown in Appendix B.

- Cost effectiveness is defined in terms of a 20 year timescale for both costs and abatement. This provides a sound basis for comparison between most policy options, allowing for varying timescales for abatement and varying balance between upfront and ongoing costs. However, it potentially underestimates the effectiveness of some of the longer term policy options. Notably, road user charging is first implemented in 2022 and the impact of support for electrical vehicles and increasing density of urban development will have ongoing impacts that continue to grow in later years.

- Abatement is considered in terms of operational emissions only and excludes the impact of embodied carbon (as discussed further below).

- The MACC uses a particular definition of cost, including only implementation and ongoing operating costs. The results produced would vary with differing possible definitions. For instance, if costs were considered from the point of view of the Scottish Government only, the cost-effectiveness of each of the fiscal policy options would be significantly improved by the generation of an incoming revenue stream to offset expenditure. Including consideration of increased revenue would also improve the cost-effectiveness to operators of public transport schemes. Similarly, expanding the definition of costs to include wider social impacts would potentially change the balance of the policy options, by taking account of issues such as accessibility and local environmental benefits (as discussed further below).

Embodied Carbon

4.19 The analysis presented above focuses on carbon emissions during the operation of the transport system. The embodied carbon implied in the provision of structures and infrastructure required to support each policy option has not been directly included because of the lack of available evidence and degree of uncertainty on the subject.

4.20 However a number of general observations can be made. Several of the policy options have embodied carbon implications, particularly those involving the provision of new transport infrastructure (public transport, cycling and walking). The policy options relying on technology also imply a physical infrastructure and associated (smaller) level of embodied carbon and policy options to accelerate fleet turnover also imply the acceleration of the production of new vehicles with their embodied carbon (estimated to represent 10% of total carbon emissions associated with an average cars lifespan[59]).

4.21 The level of embodied carbon implied by each policy option is therefore closely related to the level of supporting physical infrastructure and assets required. As noted above, the policy options already fall into cost-effectiveness bands that can be broadly described in terms of levels of supporting physical infrastructure and assets required. On this basis, including embodied carbon in the calculation of cost-effectiveness would generally tend to reinforce the ranking in the list above.

Ancillary Impacts and Deliverability

4.22 A full qualitative assessment of the ancillary impacts and deliverability of each policy option is presented in Appendix C.

Abatement Potential by Scenario

4.23 The scenarios tested were built up from combinations of the policy options identified and analysed above, implemented at either central or more ambitious levels of intensity. However, as discussed the cumulative abatement effect of the scenario cannot be viewed as simply the combined effect of each of the policy options included as interlinkages, overlaps and synergies exist between them.

4.24 Allowances have been made for these effects in modelling the estimated combined effect of the policy options in each scenario, and on this basis the model results suggest that the policy options in the Central and Ambitious Scenarios would achieve significant abatement, generated through both of the key mechanisms identified above for the individual policy options (reduction in travel volume and improved emissions efficiency of travel).

4.25 For instance, the Central Scenario is forecast to cause a reduction in vehicle kilometres of approaching 10%, focussed particularly on car kilometres. The

[59] The 9th Sustainability Report, The Automotive Sector 2007 data, SMMT, 2008

equivalent estimate reduction caused by the Ambitious Scenario is 15%, again largely the result of reductions in car kilometres.

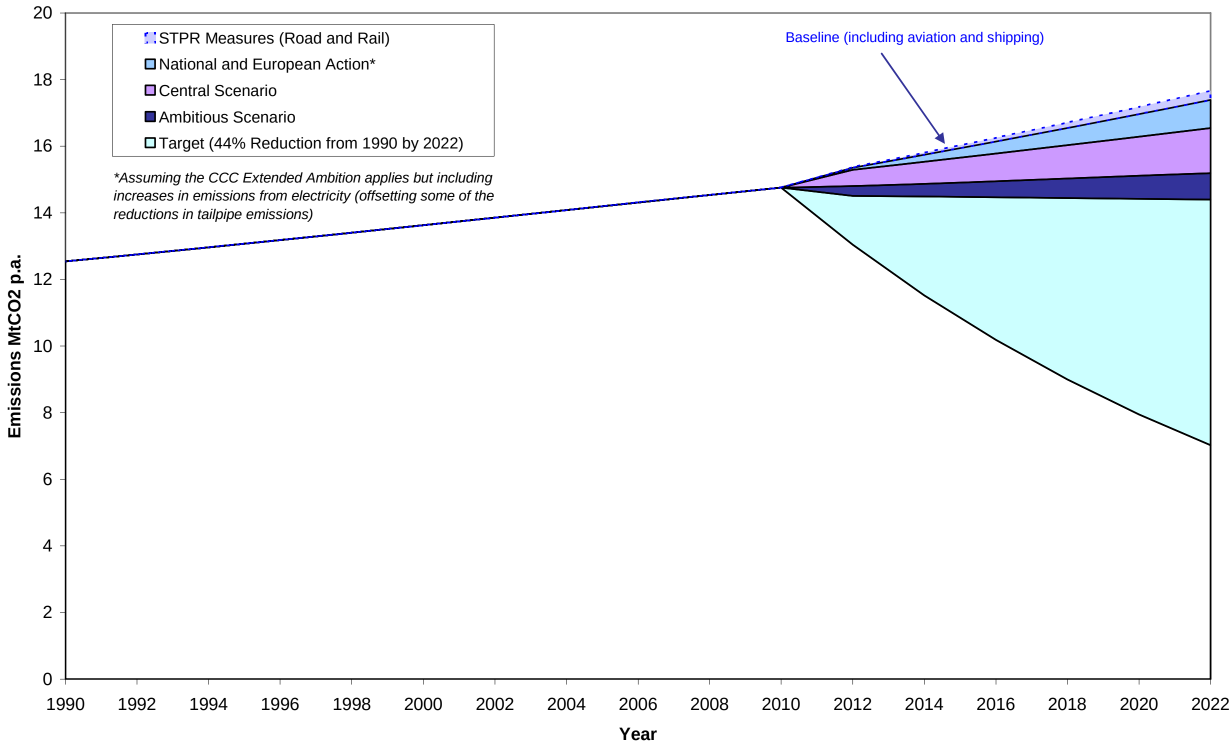
4.26 Viewing impacts from an efficiency perspective, the impact of the Central Scenario is to reduce average emissions per vehicle kilometre by around 5% across the road network, again focussed particularly on a reduction in emissions from cars. The equivalent reduction for the Ambitious Scenario is 8% (largely resulting from reduced car emissions).

4.27 These combined effects would achieve an estimated combined annual abatement of approximately 1.35 MtCO2 p.a. for the Central Scenario in 2022. The Ambitious Scenario would achieve an estimated additional 0.80 MtCO2, representing a total of 2.15 MtCO2 p.a. in 2022.

4.28 The estimated abatement potential of the Central Scenario therefore accounts for approximately 15% of the difference between the Baseline emissions (including action at the EU/UK level) and the 2022 level of a 44% reduction (as a proxy for the 42% reduction target by 2020) from 1990 total transport emissions[60]. The contribution is approximately 25% if the comparison is restricted to emissions from the land transport modes targeted by the scenario. The equivalent figures for the Ambitious Scenario are just over 20% of the target difference for 2022 if all transport emissions are considered and 35% if the focus is restricted to land transport alone. Figure 4.3 presents these comparisons graphically for total transport emissions (including aviation and shipping).

[60] The 42% target is based on the interim targets of a 42% reduction in 2020 (from 1990) and 50% reduction in 2030 identified in the final Climate Change Bill as the necessary interim targets to stay on track for achieving an 80% reduction by 2050, as shown in Table 2.4.

Figure 4.3 - Abatement to 2022, relative to baseline forecasts



4.29 As highlighted above for individual policy options, the estimated abatement potential of the scenarios should be considered as indicative and are dependent on a range of factors including the assumed scale of implementation and response to each option, the inclusion of a rebound allowance (of 15% for relevant options), the inclusion of emissions produced in generating the electricity required for electric vehicles and the assumption of the energy mix used to generate the electricity.

4.30 Varying these assumptions would alter the results presented. For instance, if it was assumed that the rebound effect could be avoided through extra measures, the abatement potential of the Ambitious Scenario would increase by nearly 5%.

4.31 In contrast, assuming that electricity was generated from lower carbon energy sources (producing half of the level of CO2 per KWh assumed in the main tests), the abatement potential would actually slightly reduce (by 2%). This reflects the fact that more of the abatement potential in the main scenario test is derived from reducing travel by electric vehicles than is derived from increasing the proportion of travel undertaken by electric vehicles. However, lower carbon electricity generation would increase the abatement potential of the national measures (to a net total of 1.1MtCO2, as opposed to 0.8MtCO2 otherwise), reducing the size of the ‘gap’ to be met by devolved action.

Abatement Beyond 2022

4.32 The modelling results suggest that the total abatement potential from the Ambitious Scenario will be very similar in 2030, although the balance between the contributions from different policy options will have changed. For instance, those policy options focussing on efficient driving will have become less significant (as the vehicle fleet becomes increasingly dominated by electric and hybrid vehicles) and those with longer term effects (such as land use planning) will become gradually relatively more significant.

4.33 Forecasts of emissions levels and the impact of abatement policy options over the longer term to 2050 inevitably have to be less detailed than those for shorter timescales due to the uncertainties involved in attempting to forecast travel patterns, behaviour and technology in 40 years time.

4.34 However it is possible to anticipate likely important future trends. The key influence is likely to be the anticipated increasing use of electricity to power the vehicle fleet either directly or through the production of hydrogen. Sources such as the Committee on Climate Change report and the King Review suggest that such vehicles could feasibly be the standard by 2050.

4.35 In this case, emphasis will increasingly be on energy policy and technology and the nature and viability of the electricity network and vehicles rather than the direct reduction in emissions from vehicle exhausts. Suitable vehicle technology and the provision of very low carbon electricity (generated for instance by renewable energy) could potentially result in very low transport carbon emissions levels. However, the role of supporting transport policy options will remain important. Although some of the policy options assessed above will become less relevant as they are related to current technology (particularly those encouraging more efficient driving), the emphasis on improving efficiency and reducing demand will continue to be important. This will potentially be aimed less at reducing carbon emissions directly and more at ensuring demand remains at a level and in a form that could be viably served by the electricity network.

Next Steps

4.36 Clearly, there are many uncertainties looking to the future, particularly in relation to future traffic volumes and the future sources of energy. The analysis undertaken as part of this study has to be viewed within this context and it needs to be recognised that these uncertainties will influence the estimated abatement potential of the policy options assessed and consequently the Scottish Government's ability to achieve its targets.

4.37 An important area of uncertainty also exists in relation to the extent to which travel behaviour will change in the future. Much of the modelling work undertaken here assumes a pure substitution of like for like car journeys with cycling, walking or public transport. This does not take in to account the fact that destinations as well as mode choice might change. It seems logical to consider the potential further abatement impact of total travel reduction by shifting people's travel choices from longer to shorter trips and the multiplier effect of impacts beyond short-term modal shift as people become more confident and experienced with sustainable travel choices.

4.38 It is possible that if people choose to live, work and socialise in locations that are accessible by walking or cycling, that over time this could have a multiplying effect on travel behaviour choices. In such circumstances, some people may prefer not to own a car, but rather hire a car occasionally or join a car club – particularly if accompanying policy options make routine sustainable travel a more attractive option. Such cumulative and reinforcing impacts would help to accelerate abatement potential beyond the estimated levels reported in Chapter 4.

4.39 The policies that have been assessed are all considered to fall within the control of the Scottish Government's devolved powers. Out with these powers there a number of areas where the Scottish Government could seek to influence emissions from transport. Most notably is the challenge of tackling emissions from aviation and shipping where the Scottish Government might need to put pressure on UK/ EU Governments to make substantial progress in these areas. In addition to this the Scottish Government can also maintain pressure on UK/ EU Governments to make further progress with vehicle technology and also wider fiscal frameworks for managing demand.

4.40 Our analysis identifies the policy areas that will have the most efficient and effective abatement potential, and also the importance in trying to do as much as possible before 2030. The results do reinforce the importance of demand management; slowing down demand will leave less work for technology and infrastructure investment to have to achieve. It is also recognised that there is merit in delivering packages of complementary policy options that offer both sticks and carrots. The complementary policy options will work best if they are supported by planning policies that facilitate increases in the density of development and hence reduce the need to travel - again the benefits from planning policies will be increased if action is taken sooner rather than later. Finally, it will be important to ensure that any technological benefits that do emerge will need to be locked in and action taken to minimise any 'rebound effects'.

4.41 The decision making process required to progress these policies will involve considering their abatement impact in the context of their wider impacts, raising the wider issue of the relevant weighting to place on carbon in multi-criteria appraisal. Current appraisal processes, including STAG[61], tend to apply a relatively low weighting and value to carbon savings in relation to other welfare benefits such as time saving. Attributing a higher weighting to abatement is likely to play an important role in promoting progress.

4.42 If successfully implemented the policies identified would create a new business as usual platform from which to go forward with further policies - in particular focussed around behavioural change - a momentum that can be reinforced by complementary policies and incentives. Hence moving beyond 2030 would involve more of the policies already examined, but applied at a greater scale

[61] http://www.transportscotland.gov.uk/stag/home

and intensity. Also additional approaches could be considered that introduce a new regulatory framework in Scotland, such as personal carbon budgets that will be much easier to achieve if the majority have already become use to working within the required budget level.

Appendix A - Key Modelling Assumptions

The modelling structure used to assess the abatement potential of each policy option consisted of four key components, summarised below:

1) Database of TMfS Matrices

Contents

- Trip and travel cost matrices for each modelled year, time period and purpose (Commuting, Business and Other home based and non home based). Including trip numbers, time, fares, parking charges and trip distances. Short/local trips (excluded from TMfS) represented on the basis of planning data and trip rates underlying TMfS); and

- GIS correspondence between TMfS zones and DfT Tempro zones (which identify each zone in terms of size of urban area it falls within e.g. <10,000 pop, 10-25,000 etc).

Usage

- Allows the number of trips and vehicle kms associated with identified journey purposes/ time periods and or areas or area types to be selected. This in turn allows the vehicle kms associated with a particular area/group targeted by a measure (e.g. 10% reduction in commuting trips by residents of large urban areas) to be identified and represented as a proportion of total vehicle kilometres - providing a percentage change to feed into 3) to provide an estimate of emissions impacts; and

- Feeds 2) and 3).

2) Travel Cost Response Database

Contents

- automatic links to the cost and trips matrices in 1);

- elasticity's relating to:

    - changes in PT demand to changes in travel cost (from TRL Report 593: Public Transport Demand, adjusted for consistency with TMfS modelling elasticities; and

    - changes in Car demand to changes in travel cost (from EU TRACE handbook, varying by purpose and availability of a PT alternative for a journey).

- Census Journey to Work data on local public transport mode split between bus and rail (TMfS information).

Usage

Allows:

- changes in journey costs to represent measures to be applied to identified journeys by OD(e.g. selected according to size of urban area at the origin etc);
- the change in PT or Car demand caused by the cost change to be estimated at the TMfS origin/destination zone level; and
- change in demand to be converted into changes in vehicle kilometres using TMfS matrices of travel distances between each OD pair.

3) Emissions/Fleet Spreadsheet

Contents

- vehicle kilometre information;
- detailed information from TMfS on vehicle kilometres travelled disaggregated by:
    - average speed on link;
    - road type (Motorway, Trunk Urban/Rural, A Urban/Rural, Minor Urban/Rural);
    - vehicle type (broad categories Car, LGV, HGV - split into technology categories using CCC assumptions - see below);
    - level of congestion on link (determined in terms of ratio between traffic volume and road capacity; and
    - uplift to TMfS vehicle kilometres to represent local traffic not represented (due to the size of zones.
- speed profiles: applied to estimate variation in speed around the average for each link (currently based on GB profiles);
- fleet composition: based on CCC Extended Ambition Scenario (8 main vehicle types, small, medium and large cars, vans, rigid goods vehicles (< and > 7.5tonnes) and articulated goods vehicles (< and > 33tonnes) subdivided into over 80 technology categories); and
- emissions factors based on CCC assumptions but with additional information on variation in emissions with speed built in (based on NAEI functions).

Usage

Allows policy options to be represented by altering:

- vehicle kilometres (by road type, vehicle type, time period and congestion level);
- speed profiles (defined separately by vehicle type, road type and average speed);
- fleet composition; and
- emissions factors by vehicle type.

4) Offline Calculations

Separate calculations for measures not covered by the main models (drawing on TMfS output and information from sources such as Scottish Transport Statistics):

- electric car network;
- walking/cycling; and
- fleet modelling for procurement/residential parking and bus purchase measures.

Summary Tables of Modelling Assumptions

The following tables summarise the key assumptions used in modelling each of the policy measures.

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**53**
Measure Description	**Electric car technology & network development**
Further Detail	Support for development of electric car charging network, focussed on less densely populated areas that won't naturally be served by the private sector

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2010	2015	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£184	Within the TfL scheme each charge point costs around £2.5K, and in the Westminster £3.3K per unit, so cost estimate assumes £3K per unit in Scotland. Estimate also assumes 80,000 households would receive units, plus 3000 units to be provided for 50% of towns with a population between 10K and 40K (for visitors). Plus an allowance for maintenance.

Modelled Coverage

Central	Support for expansion of electric network to 25% of urban areas between 10,000 and 40,000
Ambitious	Support for expansion of electric network to 50% of urban areas between 10,000 and 40,000

Implementation Timescales

Implementation **(% of extent described above)**

	2012	2017	2022	2027
Central	0%	2%	12%	20%
Ambitious	0%	2%	12%	20%

Modelling Approach

Database of TMfS matrices	Y	Calculation of vehicle kilometres generated by trips in urban areas between 10,000 and 40,000 as a proportion of those generated by trips in urban areas greater than 40,000
Travel Cost Response Model		
Emissions/Fleet Spreadsheet		
Separate Calculations/Assumptions	Y	Calculation of abatement caused by introduction of electric vehicles in urban areas >40,000 from CCC assumptions and implied potential in urban areas <40,000 on the basis of relative levels of vehicle km, assuming equivalent levels of take up

Assumptions

1	Expansion of electric fleet assumed in CCC Extended Ambition scenario relates to vehicles in urban area > 40,000 only
2	Scottish Government support will allow expansion of network to urban areas between 10,000 and 40,000 (25% in Central Scenario, 50% in Ambitious)
3	Take up rate in the small urban areas will be equivalent to take up in the areas >40,000

Comments on Approach

1	Indicative assessment to illustrate potential scale rather than represent specific schemes

References/Background Sources for Assumptions

1	CCC Extended Ambition scenario assumptions for details and impacts of core implementation
2	Vehicle kms by urban area size from TMfS Ref Case outputs

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**109**

Measure Description	**Procurement of low carbon vehicles**
Further Detail	Scheme to incentivise purchase of low emissions vehicles by public sector (through procurement requirements and subsidy) and private purchasers (through grants). Intended to accelerate the fleet change envisaged in CCC Extended Ambition scenario (assumed to be achieved solely through EU/UK measures) with a particular emphasis on the van fleet

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	Around 2 (gradual feed through fleet decisions)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£135	Based on DfT figures, cost estimate assumes that a total of £5M p.a. will be made available to Scottish public sector to offset the additional costs of purchasing low carbon vehicles. In addition to this the UK Government will make £250M available for five years to help with the procurement of new vehicles by 'ordinary motorists' with help of up to £5K per vehicle. Cost estimate assumes the Scottish Government will make £5M p.a. available.

Modelled Coverage

Central	Not implemented
Ambitious	Whole vehicle fleet - affecting purchase of approximately 5000 private vehicles and 200 public sector vehicles p.a.

Implementation Timescales

Implementation (% of extent described above)

	2012	**2017**	**2022**	**2027**
Central	0%	0%	0%	0%
Ambitious	50%	100%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of fleet composition of affected proportions of the fleet
Separate Calculations/Assumptions		

Assumptions

1	Fleet turnover rate assumed to be 10% p.a., average fleet age to be 6 years
2	Grants of £5000 per vehicle for public and private sector
3	Impact of increased turnover reduces average age of affected fleet by approximately 2 years and assumed to increase proportion of small cars increase by 50% (at the expense of medium and large cars)
4	Scheme potentially causes a rebound effect (i.e. people drive more because it costs less) - estimated as 15% reduction in abatement in 2022- in line with CCC assumptions

Comments on Approach

1	The net impact depends on what happens to cars sold on and whether they are used more or less (this is a complex area and not captured in the modelling)

References/Background Sources for Assumptions

1	Fleet turnover based on fleet size and licensing statistics from Scottish Transport Statistics, 2008
2	Average fleet age from Scottish Transport Statistics, 2008
3	BAU fleet composition - CCC Supply Model as used in the spreadsheet model for this study

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**1**
Measure Description	**Active traffic management**
Further Detail	Dynamic management of recurrent and non-recurrent congestion based on the prevailing traffic conditions. This comprises variable speed limits, variable message signs. Also can include dynamic hard shoulder running during peak congestion periods (as on M42)

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	**Implementation**	
2010	2012	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£324	Cost estimate assumes that there are approximately 165kms of congested trunk road. The policy's capital costs would be in the order of £560K per km, revenue costs £70K per km.

Modelled Coverage

Central	All congested trunk roads
Ambitious	As central

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	50%	100%	100%	100%
Ambitious	75%	100%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of speed distribution profile applied to congested trunk roads
Separate Calculations/Assumptions		

Assumptions

1	Applies to all traffic on trunk road links that are identified as congested in the TMfS network in each time period (i.e. where traffic volume > 85% of road capacity)
2	Speed distributions within emissions/fleet spreadsheet are altered for affected links to reflect - speed limits of 40mph for 50% of the time and 50mph for 50% of time and - more even flow conditions (all over 20 mph)
3	Scheme potentially causes a rebound effect (i.e. people drive more because it costs less) - estimated as 15% reduction in abatement in 2022- in line with CCC assumptions

Comments on Approach

References/Background Sources for Assumptions

1	Original speed distributions used before alteration are based on distributions from the DfT Speed Survey, reported in Transport Statistics for Great Britain, 2008

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**98**
Measure Description	**National motoring package**
Further Detail	Ecodriving training for car/ motorcycle drivers, coupled with awareness campaigns

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£58	Cost estimate assumes that there are around 2.74M license holders in Scotland. Policy will target 85% of those using non-trunk roads, so approximately 2.5M license holders. Assumed annual costs are: leaflet to all license holders = £300K, multimedia awareness campaign and free face to face training sessions = £500K, and £50K allowance for distributing tools (such as tyre pressure gauges) at exhibitions etc. Plus £10 per licence holder for face to face discussion (based on PTP costs), repeated every 5 years.

Modelled Coverage

Central	60% car drivers
Ambitious	85% car drivers

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	20%	50%	90%	100%
Ambitious	30%	75%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of assumed emissions rates for car vehkms on all road types
Separate Calculations/Assumptions		

Assumptions

1	Affects the vehicle kms travelled by identified %age of car drivers on all road types
2	Achieves a reduction in fuel use assumed to be: - 10% in conventional petrol/diesel (in line with research evidence) - 5% for advanced petrol/diesel (assumption) - 2.5% for non plug in hybrid (assumption) - 0% for plug in hybrid/electric (in line with CCC assumption) (all represented through altered emission factors)
3	Causes a rebound effect (i.e. people drive more because it costs less) - estimated as 15% reduction in abatement in 2022- in line with CCC assumptions

Comments on Approach

1	Improved evidence on the impacts on different vehicle types would be valuable

References/Background Sources for Assumptions

1	Various sources of evidence on potential scale of efficiency savings quoted in UKERC 2009
2	CCC December 08 Report assumptions on impacts for hybrid/electric vehicles

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**143**
Measure Description	**Speed reduction on trunk roads**
Further Detail	Enforcement of 70mph or implementation of 60mph limits on all trunk roads where 70mph is currently in place

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2010	2012	0

* time before carbon savings begin after implementation

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£102	Cost estimate assumes costs of £67k per 2km for around 3000km of trunk road, plus an allowance for maintenance.

Modelled Coverage

Central	All trunk roads with 70mph speed limit
Ambitious	As Central (but implementing a 60mph limit)

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	30%	100%	100%	100%
Ambitious	30%	100%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of speed distribution assumed for those travelling in free flow conditions on trunk roads
Separate Calculations/Assumptions		

Assumptions

1	Altered speed distributions applied to uncongested links with 70mph speed limits: Central Scenario: changed so that only 2% exceed 70mph (distributed in the same proportions as those who currently exceed the limit) Ambitious Scenario: changed so that only 10% exceed 60mph (distributed between excess speed categories in same proportions as those who currently exceed limit).
2	Speed distributions at lower speeds remain unchanged: - Central Scenario: Below 70mph - Ambitious Scenario: Below 60mph
3	Allowance for reduction in trip making and rerouting due to increased journey time for 60 mph limit based on TMfS model run.

Comments on Approach

1	Results consistent with CCC for UK as whole

References/Background Sources for Assumptions

1	Original speed distributions used before alteration are based on distributions from the DfT Speed Survey, reported in Transport Statistics for Great Britain adjusted to reflect Scottish data suggesting lower levels of speeding in Scotland than UK as a whole (fewer drivers break the speed limit in Scotland and those that do travel at lower speeds)

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**15**
Measure Description	**Bus/rapid/mass transit infrastructure investment (including bus priority)**
Further Detail	Investment in measures to improve urban public transport journey times - bus priority initially and rapid transit in later years - including an element of reallocation of road space

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£770	Cost estimate assumes the implementation of 300km of new/enhanced bus priority corridors in all conurbations with populations over 25K @ £500K per km (two way corridor). It also assumes that Edinburgh Tram network will be developed further @ £500M, that implementation and development of guided bus in Glasgow will need around £200M, and that the implementation of sections of guided bus in Aberdeen and Dundee will cost in the order of £50M. Cost estimate also includes an allowance for maintenance.

Modelled Coverage

Central	Illustrative example of scale: e.g. schemes achieving a 10% reduction in journey costs for all bus journeys to urban areas with populations >25,000
Ambitious	Illustrative example of scale: e.g. schemes achieving a 20% reduction in journey costs for all bus journeys to urban areas with populations >25,000

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	15%	55%	85%	100%
Ambitious	25%	75%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average bus travel costs (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in patronage based on elasticity responses and calculation of implied reduction in car kilometres based on assumed switch from car and average car travel distances for same journey
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch Adjustment of vehicle kilometres by V/C category to reflect reduction in road capacity caused by reallocation from highway to bus use
Separate Calculations/Assumptions	Y	Impact of capacity reallocation on V/C categories

Assumptions

1	10% reduction in journey times for all bus journeys to areas in DfT's Urban Medium category (i.e. 25,000+) and above (e.g. Inverness, Greenock, Irvine, Saltcoats, Perth, Ayr, Stirling, Livingston, Aberdeen, Dundee, Edinburgh and Glasgow) - applied to journey cost matrices derived from TMfS model outputs
2	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Change in patronage in response to cost reduction (as %age total journey cost) estimated on basis of elasticities (by purpose)
4	25% of increased trips assumed to have switched from being car driver trips
5	Average car trip length for given journeys from TMfS cost matrices

Comments on Approach

1	Indicative assessment to illustrate potential scale rather than represent specific schemes

References/Background Sources for Assumptions

1	Saving used based on DfT ITS toolkit evidence suggest individual corridors achieve savings of up to 20% (on sections in congested urban areas)
2	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
4	Average car trip length for given journeys from TMfS cost matrices
5	25% of increased trips assumed to have switched from being car driver trips, judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009 , Affordable Mass Transit Guidance, 2005

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**37**

Measure Description	**Cycle infrastructure investment**

Further Detail	Widespread high quality investment in cycling infrastructure including cycle routes and lanes (including shortcuts for cyclists), advanced stop lines, cycle parking facilities, provision of cycles on public transport, cycle rental schemes in cities, strictly enforced cycle parking standards for new developments & cycling promotion

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£311	Intensive cycling investment programmes in Europe have involved expenditure in the order of £5 per person per year over a 10 to 15 year period; cost estimate assumes spending of around £20M capital per year, plus an allowance for maintenance. Estimate also assumes that more investment will be made in the early years to help change the current culture of very low cycle use.

Modelled Coverage

Central	All urban areas, increasing cycling fivefold from current levels
Ambitious	All urban areas, increasing cycling tenfold from current levels

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	15%	55%	85%	100%
Ambitious	25%	75%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch Adjustment of vehicle kilometres by V/C category to reflect reduction in road capacity caused by reallocation from highway to cycle use
Separate Calculations/Assumptions	Y	TMfS Planning data - household numbers Scottish Household Survey data -average number & length of cycle trips per person

Assumptions

1	BAU cycling trip rates and lengths per person remain as now
2	BAU future trip levels based on population numbers in planning data underlying TMFS
3	Investment increases trip levels 5 or 10 fold with average lengths remaining unchanged
4	33% of additional trips have switched from car driver trips
5	Car driver trips before switching assumed to be same length as cycle trip after switching
6	Average emissions for switched trips assumed to be 10% greater than overall average to reflect the fact they are short and therefore a higher proportion are travelled with cold engines than over the average driving cycles used to generate emission factors
7	All vehicle kilometres lost assumed to be on minor and A roads (as replaced by cycle trips)
8	Reallocation of road space to cycle lanes assumed and reflected through adjustment of traffic in different V/C categories in urban areas

Comments on Approach

1	Indicative representation of potential scale of increase rather than specific identified schemes
2	Available evidence on scale of mode shift is limited

References/Background Sources for Assumptions

1	Current cycling rates/lengths from Scottish Transport Statistics, 2008
2	Future population levels from TMFS planning data
3	Assumption on mode switch derived as judgement based from various evidence sources quoted in UKERC,2009, supporting documentation
4	Potential increase in cycling rates based on Sustrans, 2008 report to Committee on Climate Change and evidence of European best practice quoted in UKERC, 2009 supporting documentation
5	10% uplift in emissions, estimate based on various evidence sources stating the higher emissions rates associated with short trips, quoted in UKERC, 2009

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**75**
Measure Description	**High speed rail links**
Further Detail	High Speed rail line linking Edinburgh, Glasgow and English cities

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2012	2022	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£4,040	Atkins report in 2003 reported £32.7B costs for national (UK) scheme. Cost estimate assumes that Scotland would contribute 10% to costs of national network, plus the implementation costs of 50 miles of twin track between Edinburgh and Glasgow, plus a maintenance allowance.

Modelled Coverage

Central	Not included
Ambitious	Full HSR to England

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	0%	0%	0%	0%
Ambitious	0%	0%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres on motorways and trunk roads to reflect mode switch
Separate Calculations/Assumptions	Y	Calculation of Scottish share of vehicle kilometre reduction forecast in 2003 HSL Study for SRA

Assumptions

1	HSR operational emissions can be offset by air mode switch and associated reduction in flights (either implying extensive mode switch or the development of a low carbon HSR system)
2	Reductions in long distance classic rail emissions are offset by an increase in local services making use of released capacity
3	Approximately 15%-20% of HSR trips switch from highway
4	All passengers forecast to use the HSR between Glasgow and Edinburgh are travelling to England
5	Reduction in vehicle kilometres applied calculated on the basis of journey distance to the border from Glasgow and Edinburgh and removed from motorways and trunk roads in the Emissions/Fleet spreadsheet
6	No account is taken for local mode switch from highway to revised classic rail or for induced traffic on the strategic road network

Comments on Approach

1	The evidence is very uncertain and the net effect on carbon could be positive or negative depending on scale of impact on aviation and flight numbers, scale of highway mode switch and induced traffic and the mode of HSR operation
2	The figures quoted represent one possible interpretation

References/Background Sources for Assumptions

1	Length and number of car trips for household in towns >25,000 from TMFS planning and modelling data
2	Assumption on fleet size required from details of current operation of clubs from sources such as UKERC, 2009
3	Relative efficiency of vehicles from Carplus, 2008 Monitoring Car Clubs

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**97**
Measure Description	**National network of car clubs**
Further Detail	Car clubs (short term, pay as you go car hire) rolled out through a coherent national network which is both interoperable (a member in one town can use the service in another town) and integrated in terms of tariffs and physical interchanges with the public transport providers. Most will be used as business pool cars during the day and for community use during evenings and weekends

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2010	2010	0 (immediate impact occurs but builds up through time)

* time before carbon savings begin after implementation

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£133	Cost estimate assumes the scheme would cover approximately 110,000 households. It also assumes 1 car covers 35 members, so scheme would need around 3200 cars @ on average £14K per car (including telematics) renewed every 4 years, plus an allowance for ongoing revenue costs.

Modelled Coverage

Central	5% of households in urban areas > 25,000
Ambitious	10% of households in urban areas > 25,000

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	8%	25%	67%	100%
Ambitious	10%	50%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of vehicle kilometres travelled for affected car trips
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of assumed efficiency of affected car trips
Separate Calculations/Assumptions		

Assumptions

1	5% (Central) or 10% (Ambitious) of households in urban areas >25,000 are members of car clubs
2	Total membership causes no net change in mileage. Although evidence suggests 50% reduction in mileage from previous car owners joining clubs, the reduction is offset by the 50% of members who did not previously own a car
3	Car club vehicles are 33% more fuel efficient than previous cars used by members
4	Car club vehicles are used for all non business car trips for affected households
5	2/3 of vehicles are available for business use and are parked for every 1.5 hours they are driven This represents around 0.5% of business trips

Comments on Approach

1	Mileage effects might build up over time as an increasing proportion of membership comes from previously car owning households

References/Background Sources for Assumptions

1	Length and number of car trips for household in towns >25,000 from TMFS planning and modelling data
2	Assumption on fleet size required based on details of current operation of clubs from sources such as UKERC, 2009
3	Relative efficiency of vehicles from Carplus, 2008 Monitoring Car Clubs

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**99**
Measure Description	**National road user charging**
Further Detail	Road user charge based on distance travelled (and emissions of vehicle) - low level but in addition to existing fuel costs

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2012	2020	0

* time before carbon savings begin after implementation

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£3,941	Based on an estimate of between £10 and £60 billion to implement a UK scheme, the cost estimate assumes £3 billion for a Scottish scheme. Operating estimates range between £2 and £5 billion per year (UK), so cost estimate assumes £350M for Scottish scheme.

Modelled Coverage

Central	Not included
Ambitious	Full national scheme with per km charges, averaging at 5p/km for cars, 6.5p/km for LGVs and 15p/km for HGVs

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	0%	0%	0%	0%
Ambitious	0%	0%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average travel costs by car, LGV and HGV (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in trip numbers based on elasticity responses and calculation of implied reduction in car kilometres
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres by vehicle type, time period and road type category to reflect demand reduction
Separate Calculations/Assumptions		

Assumptions

1	5p/km for cars, 6.5p/km for LGVs and 15p/km for HGVs (2008 prices) applying on all road types
2	Change in trip numbers in response to increased cost, based on elasticities from TRACE hand book for car (varying by purpose and PT availability) and elasticities derived from TRACE and DfT modelling of RUC for LGV and HGV

Comments on Approach

1	Further evidence on impact on LGV/HGV required

References/Background Sources for Assumptions

1	Charge rates: broadly central points from the ranges suggested in modelling by Imperial College (used by IPPR) and Open University (used by Low CVP) and quoted in UKERC,2009
2	Relative rates by vehicle type based on relative emissions rates by type based on DEFRA Company Reporting Guidelines, Transport Methodology (2009)
3	Elasticities of vehicle trip numbers to travel cost from EU TRACE handbook, LGV and HGV derived from business, low PT availability elasticities for car, adjusted for consistency with the DfT NTM RUC modelling, quoted in 2007

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**103**
Measure Description	**Introduction or increase in public parking charges**
Further Detail	Increase parking charges in public on-street meter bays and off-street car parks or introduce charges where they presently do not exist, supported by measures to reduce the maximum number of parking spaces allowed for new development and manage use of free parking at shopping centres etc

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£47	Cost estimate assumes that to increase coverage and charges by 50% in all urban areas cost must be the equivalent of implementing and operating 5 schemes of a comparable size to the Edinburgh CPZ extension; 5 x £4.5M to implement, plus 5 x £0.5M per year to operate.

Modelled Coverage

Central	All urban areas > 25,000
Ambitious	All urban areas

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	25%	50%	100%	100%
Ambitious	50%	100%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average travel costs by car (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in trip numbers based on elasticity responses and calculation of implied reduction in car kilometres
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres by vehicle type, time period and road type category to reflect demand reduction
Separate Calculations/Assumptions		

Assumptions

1	Charges extend current TMfS assumptions and rise in line with real value of time
2	Change in trip numbers in response to increased cost, based on elasticities from TRACE hand book for car (varying by purpose and PT availability)

Comments on Approach

References/Background Sources for Assumptions

1	Elasticities of vehicle trip numbers to travel cost from EU TRACE handbook
2	Average car trip length for given journeys from TMfS cost matrices

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**115**
Measure Description	**Rail investment**
Further Detail	Increasing service frequencies, rolling stock upgrading, increased track capacity, reducing rail fares and increasing investment subsidy.

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2012	2017	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£12,051	Based on current levels of rail investment it is assumed that expenditure of £1B per year would be needed to enhance the network and rolling stock further up to 2022, with a revenue allowance for maintenance after that.

Modelled Coverage

Central	10% reduction in rail travel time on journeys between Aberdeen, Dundee, Edinburgh and Glasgow and another urban areas >25,000
Ambitious	As Central

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	0%	33%	67%	100%
Ambitious	0%	50%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average rail travel costs (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in patronage based on elasticity responses and calculation of implied reduction in car kilometres based on assumed switch from car and average car travel distances for same journey
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch
Separate Calculations/Assumptions		

Assumptions

1	10% reduction in rail travel time on journeys between Aberdeen, Dundee, Edinburgh and Glasgow and another urban area >25,000 - applied to journey cost matrices derived from TMfS model outputs
2	Average rail mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Change in patronage in response to cost reduction (as %age total journey cost) estimated on basis of elasticities (by purpose)
4	25% of increased trips assumed to have switched from being car driver trips
5	Average car trip length for given journeys from TMfS cost matrices

Comments on Approach

1	Indicative assessment to illustrate potential scale rather than represent specific schemes

References/Background Sources for Assumptions

1	Assumptions guided by evidence in the STPR on the practical difficulty of achieving rail improvements
2	Average rail mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
4	Average car trip length for given journeys from TMfS cost matrices
5	25% of increased trips assumed to have switched from being car driver trips, judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009 , Affordable Mass Transit Guidance, 2005

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**125**
Measure Description	**Introduction/raise in residential/private parking charges**
Further Detail	Implementation of residents' parking charges that relate to emissions characteristics of vehicles

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2010	Around 2 (gradual feed through fleet decisions)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£203	Cost estimate assumes that approximately 1.5M households are currently in a conurbation of 10K and above, but are not covered by a CPZ. To cover this population would require the equivalent of 30 schemes that have a comparable coverage to the Edinburgh CPZ extension; 30 x £4.5M to implement, plus 30 x £0.5M per year to operate.

Modelled Coverage

Central	All households with on-street parking
Ambitious	As central

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	25%	50%	100%	100%
Ambitious	50%	75%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of vehicle kilometres associated with households with on street parking
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of fleet composition for affected fleet
Separate Calculations/Assumptions		

Assumptions

1	Proportion of trips with on street parking - varying from 13% in rural areas to 31% in metropolitan areas
2	Fleet composition for affected fleet is altered so that it becomes on average 2 years younger and the proportion of small cars increases (at the expense of large/medium cars)
3	Scheme potentially causes a rebound effect (i.e. people drive more because it costs less) - estimated as 15% reduction in abatement in 2022- in line with CCC assumptions

Comments on Approach

1	Actual effect might be more complicated, depending on what happens to the older/larger cars sold on by those affected. If they end up in rural areas, travelling longer distances, the effect will be reduced
2	Forecast change in fleet composition judged reasonable on the basis of current fleet age and turnover (based on information in Scottish Transport Statistics, 2008)

References/Background Sources for Assumptions

1	Proportion of households with on street parking, National Travel Survey, DfT
2	BAU fleet composition - CCC Supply Model as used in the spreadsheet model for this study
3	Current fleet age and turnover - Scottish Transport Statistics, 2008

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**127**
Measure Description	**Bus/LRT fares reductions**
Further Detail	Reduction in fares as part of integrated transport provision purchasing (public transport and car clubs)

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2012	2017	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost		
Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£1,284	Cost estimate is based on the assumption that the Scottish bus market currently generates approximately £400M revenue per year.

Modelled Coverage	
Central	15% reduction in all bus and LRT fares
Ambitious	30% reduction in all bus and LRT fares

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	0%	33%	67%	100%
Ambitious	0%	50%	100%	100%

Modelling Approach		
Database of TMfS matrices	Y	Calculation of average bus travel costs (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in patronage based on elasticity responses and calculation of implied reduction in car kilometres based on assumed switch from car and average car travel distances for same journey
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch
Separate Calculations/Assumptions		

Assumptions	
1	10% reduction in journey times for all bus journeys to areas in DfT's Urban Medium (i.e. 25,000+) and above (e.g. Inverness, Greenock, Irvine, Saltcoats, Perth, Ayr, Stirling, Livingston, Aberdeen, Dundee, Edinburgh and Glasgow) - applied to journey cost matrices derived from TMfS model outputs
2	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	25% of increased trips assumed to have switched from being car driver trips
3	Change in patronage in response to cost reduction (as %age total journey cost) estimated on basis of demand/cost elasticities (by purpose)
4	Average car trip length for given journeys from TMfS cost matrices

Comments on Approach	
1	Indicative assessment to illustrate potential scale rather than represent specific schemes

References/Background Sources for Assumptions	
1	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
2	Elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
3	Average car trip length for given journeys from TMfS cost matrices
4	25% of increased trips assumed to have switched from being car driver trips: judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009, Affordable Mass Transit Guidance, 2005

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**131a**
Measure Description	**Walking infrastructure investment**
Further Detail	Widespread investment to improve the quality of the walking environment including improvements to lighting, directions, surfaces and crossings

Potential Timescales

Start Date		Phase-in time (yrs)*
Development	Implementation	
2010	2012	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£1,042	Cost estimate assumes a package of measures - Safer routes to all schools (Living Streets estimate £3B for UK: allow £500M for Scotland). Home zones covering 250K households @ £2K per household. 20mph zones in all conurbations above 25k; on average £500K per conurbation. Allowance also made for maintenance.

Modelled Coverage

Central	All urban areas, increasing walking by 25% from current levels
Ambitious	All urban areas, increasing walking by 50% from current levels

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	15%	55%	85%	100%
Ambitious	25%	75%	100%	100%

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch
Separate Calculations/Assumptions	Y	TMfS Planning data - household numbers Scottish Household Survey data -average number & length of cycle trips per person

Assumptions

1	BAU walking trip rates and lengths per person remain as now
2	BAU future trip levels based on population numbers in planning data underlying TMFS
3	Investment increases trip levels by 25% or 50% with average lengths remaining unchanged
4	33% of additional trips have switched from car driver trips
5	Car driver trips before switching assumed to be same length as walk trip after switching
6	Average emissions for switched trips assumed to be 10% greater than overall average to reflect the fact they are short and therefore a higher proportion are travelled with cold engines than over the average driving cycles used to generate emission factors
7	All vehicle kilometres lost assumed to be on minor and A roads (as replaced by walk trips)

Comments on Approach

1	Indicative representation of potential scale of increase rather than specific identified schemes
2	Available evidence on scale of mode shift is limited

References/Background Sources for Assumptions

1	Current walking rates/lengths from Scottish Transport Statistics, 2008
2	Future population levels from TMFS planning data
3	Assumption on modeswitch derived as judgement based from various evidence sources quoted in UKERC,2009, supporting documentation
4	Potential increase in walking rates based on Sustrans, 2008 report to Committee on Climate Change and evidence of European best practice quoted in UKERC, 2009 supporting documentation
5	10% uplift in emissions, estimate based on various evidence sources stating the higher emissions rates associated with short trips, quoted in UKERC, 2009

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**172**
Measure Description	**Workplace parking levy**
Further Detail	Apply levy equivalent to long stay public parking charges to all workplace parking spaces

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2010	2012	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£98	Nottingham business case states £2.5M cost to develop and implement this type of scheme, and £0.5M per year to operate. Population of Nottingham UA is approx 300K. Cost of Scottish scheme would therefore be approx 15 times the Nottingham scheme = £40M, plus £8M per year for operation.

Modelled Coverage

Central	All commuting trips
Ambitious	As central

Implementation Timescales

Implementation (% of extent described above)

	2012	**2017**	**2022**	**2027**
Central	0%	50%	100%	100%
Ambitious	0%	100%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average travel costs by car (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in trip numbers based on elasticity responses and calculation of implied reduction in car kilometres
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres by vehicle type, time period and road type category to reflect demand reduction
Separate Calculations/Assumptions		

Assumptions

1	Charges equivalent to current long stay charge (based on current TMfS assumptions) and rising in line with real value of time (applied to all commuting trips)
2	Change in trip numbers in response to increased cost, based on elasticities from TRACE hand book for car (varying by purpose and PT availability)

Comments on Approach

References/Background Sources for Assumptions

1	Elasticities of vehicle trip numbers to travel cost from EU TRACE handbook
2	Average car trip length for given journeys from TMfS cost matrices

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**18**
Measure Description	**Bus quality contracts / statutory partnerships**
Further Detail	Measures to improve bus driving style and quality of bus fleet to improve efficiency and attract additional passengers

Potential Timescales

Start Date: Development	Start Date: Implementation	Phase-in time (yrs)*
2010	2012	0 (immediate impact occurs but builds up through time)

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£84	Cost estimate assumes training is provided every 3 years for 10000 drivers @ £500 per driver, plus investment to reduce the average age of fleet through 50/50 public / private investment for 250 new vehicles p.a. @ £30K to £60K per vehicle (public contribution).

Modelled Coverage

Central	All bus services/operators
Ambitious	As central

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	Driver training: 50%	Driver training: 100%	Driver training: 100%	Driver training: 100% Fleet/Passenger
Ambitious	Driver training: 50% Fleet/Passenger Perception: 40%	Driver training: 100% Fleet/Passenger Perception: 75%	Driver training: 100% Fleet/Passenger Perception: 100%	Driver training: 100% Fleet/Passenger Perception: 100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of average bus travel costs (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in patronage based on elasticity responses and calculation of implied reduction in car kilometres based on assumed switch from car and average car travel distances for same journey
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch Adjustment of emissions factors for buses to reflect eco-driving and altered fleet composition
Separate Calculations/Assumptions	Y	Fleet model to calculate impacts on changes in fleet composition and emissions

Assumptions

1	Bus quality improvement as a result of fleet upgrades etc equates to 5% reduction in travel time
2	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Change in patronage in response to cost reduction (as %age total journey cost) estimated on basis of elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
4	25% of increased bus trips assumed to have switched from being car driver trips
5	Operators encouraged to buy cleaner hybrid vehicles on renewal rather than default diesel
6	Fleet turnover of 5.5% p.a., average age 8 years
7	Relative average mileage of buses declines by 5% p.a. after 5 years (i.e. newer buses are used more)
8	Recent trends of change in bus veh kms continue to 2018
9	All drivers are trained in eco-driving achieving a 4% reduction in emissions

Comments on Approach

1	Limited information available on perceived impact of quality improvements on passengers
2	Assumed change in fleet is calculated based on turnover rates

References/Background Sources for Assumptions

1	Elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
2	Average car trip length for given journeys from TMfS cost matrices
3	25% of increased trips assumed to have switched from being car driver trips, judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009 , Affordable Mass Transit Guidance, 2005
4	Current fleet age and turnover - Scottish Transport Statistics, 2008
5	Eco-driving benefits from evidence quoted in UKERC, 2009

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**173**
Measure Description	**Widespread implementation of travel plans**
Further Detail	Widespread implementation of travel plans in workplaces, leisure sites, residential areas, schools and households (also including car sharing and job/house swap schemes) - to promote reduced travel and reduced car use

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2010	2012	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£143	Cost estimate assumes £55M to provide PTP for approx 100% of households, plus £1M per year to monitor and enhance. £60M to provide school travel plans for 100% schools - rolling programme topped up every 8 years. £6M to target approx 123K daily business trips - rolling programme topped up every 8 years.

Modelled Coverage

Central	50% of households, workplaces and schools
Ambitious	100% of households, workplaces and schools

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	33%	67%	100%	100%
Ambitious	50%	75%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of vehicle kilometres associated with households affected by time period and purpose
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres by vehicle type, time period and road type category to reflect demand reduction
Separate Calculations/Assumptions		

Assumptions

1	Central trip number reductions: Commuting: 9% reduction urban car trips, 4% rural Business: 18% reduction urban and rural School: 12% reduction escort Leisure: 8% reduction escort For Individualised marketing: 3% reduction all personal trips per person
2	Ambitious trip number reductions: Commuting: 26% reduction urban car trips, 10% rural Business: 18% reduction urban and rural School: 20% reduction escort Leisure: 10% reduction escort For Individualised marketing: 3% reduction all personal trips per person
3	Vehicle kilometres associated with relevant purposes and time periods drawn from TMfS matrices

Comments on Approach

1	Assumes comprehensive change in travel behaviour

References/Background Sources for Assumptions

1	Potential proportions affected drawn from Smarter Choices, Cairns et al, 2004
2	Vehicle kilometres associated with relevant purposes and time periods drawn from TMfS matrices

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**63**
Measure Description	**Freight best practice**
Further Detail	Measures to accelerate uptake of freight best practice in terms of SAFED etc

Potential Timescales

Start Date: Development	Start Date: Implementation	Phase-in time (yrs)*
2010	2012	0

** time before carbon savings begin after implementation*

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£58	Cost estimate assumes that in the order of 34,000 HGV drivers and 40,000 LGV drivers receive training that is repeated every five years @ £400 per driver each time.

Modelled Coverage

Central	15% LGVs, 100% HGVS
Ambitious	30% LGVs, 100% HGVS

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	33% Vans 75% HGVs	75% Vans 100% HGVs	100% Vans 100% HGVs	100% Vans 100% HGVs
Ambitious	33% Vans 75% HGVs	75% Vans 100% HGVs	100% Vans 100% HGVs	100% Vans 100% HGVs

Modelling Approach

Database of TMfS matrices		
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of assumed emissions rates for LGV and HGV vehkms
Separate Calculations/Assumptions		

Assumptions

1	Affects the vehicle kms travelled by identified %age of car drivers on all road types
2	Achieves a reduction in fuel use assumed to be: - 4% for conventional petrol/diesel HGVs - 3% for conventional/petrol diesel LGVs
3	Causes a rebound effect (i.e. people drive more because it costs less) - estimated as 15% reduction in abatement in 2022- in line with CCC assumptions

Comments on Approach

1	Improved evidence on the impacts on different vehicle types would be valuable

References/Background Sources for Assumptions

1	Various sources of evidence on potential scale of efficiency savings quoted in UKERC 2009
2	Average trip length by journey for given vehicle types from TMfS

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**158**

Measure Description	**Urban density increases**
Further Detail	Much denser form of development for new residential areas combined with retail and other facilities on site. Investment in walkable design / street forms. Requirement that new development meets criteria on location and public transport accessibility

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2012	2012	Long term - 40 years for full impact

* time before carbon savings begin after implementation

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£7	Cost estimate assumes in the order of £500K per year to help develop national, regional and local policies / good practice.

Modelled Coverage

Central	25% growth in fringe/ rural areas
Ambitious	50% growth in households/employments in fringe/rural areas

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	0%	0%	100%	100%
Ambitious	0%	0%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Calculation of vehicle kilometres associated with households affected by time period and purpose
Travel Cost Response Model		
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres by vehicle type, time period and road type category to reflect demand reduction
Separate Calculations/Assumptions		

Assumptions

1	25% (or 50%) of forecast growth in households and employment in rural and fringe areas, assumed to relocate to large areas
2	Relocated growth picks up the travel car ownership characteristics of new location in terms of car ownership, trip numbers and lengths

Comments on Approach

1	Slow to show progress - growth and change is small as a proportion of total households

References/Background Sources for Assumptions

1	Forecast growth change/growth in households from TMfS underlying planning data
2	Average trip length/travel patterns by area type from TMfS Ref Case outputs

Mitigating Transport's Climate Change Impact in Scotland: Abatement Measures:

Assessment of Abatement Potential: Technical Details

Measure ID	**205c**
Measure Description	**Improve public transport surface access to airports**
Further Detail	Measures to improve the time taken to travel to the airport on public transport

Potential Timescales

Start Date		Phase-in
Development	Implementation	time (yrs)*
2012	2012	0 (immediate impact occurs but builds up through time)

* time before carbon savings begin after implementation

Estimated Cost

Ambitious (£m NPV, 2010-2030, 2008 prices/values)	£201	Cost estimate assumes in the order of £25M capital is spent every year, plus a revenue allowance for maintenance. This is based on the costed surface access strategy for West Midlands Airport.

Modelled Coverage

Central	10% reduction in all PT journey times to Aberdeen, Dundee, Edinburgh, Glasgow & Prestwick Airport
Ambitious	10% reduction in rail journey times to Aberdeen, Dundee, Edinburgh, Glasgow & Prestwick Airport and 20% reduction in bus journey times

Implementation Timescales

Implementation (% of extent described above)

	2012	2017	2022	2027
Central	15%	55%	85%	100%
Ambitious	25%	75%	100%	100%

Modelling Approach

Database of TMfS matrices	Y	Identification of airport zones & calculation of average bus and rail costs travel costs (by purpose and time period)
Travel Cost Response Model	Y	Calculation of percentage change in costs and associated change in patronage based on elasticity responses and calculation of implied reduction in car kilometres based on assumed switch from car and average car travel distances for same journey
Emissions/Fleet Spreadsheet	Y	Adjustment of vehicle kilometres in relevant time period/road type/vehicle type categories to reflect impacts of mode switch
Separate Calculations/Assumptions		

Assumptions

1	10% reduction in journey times for all rail journeys and 10 or 20% reduction in bus journeys to Aberdeen, Dundee, Edinburgh, Glasgow and Prestwick airports - applied to journey cost matrices derived from TMfS model outputs
2	Average bus/rail mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Change in patronage in response to cost reduction (as %age total journey cost) estimated on basis of elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
4	25% of increased trips assumed to have switched from being car driver trips, judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009 , Affordable Mass Transit Guidance, 2005
5	Average car trip length for given journeys from TMfS cost matrices

Comments on Approach

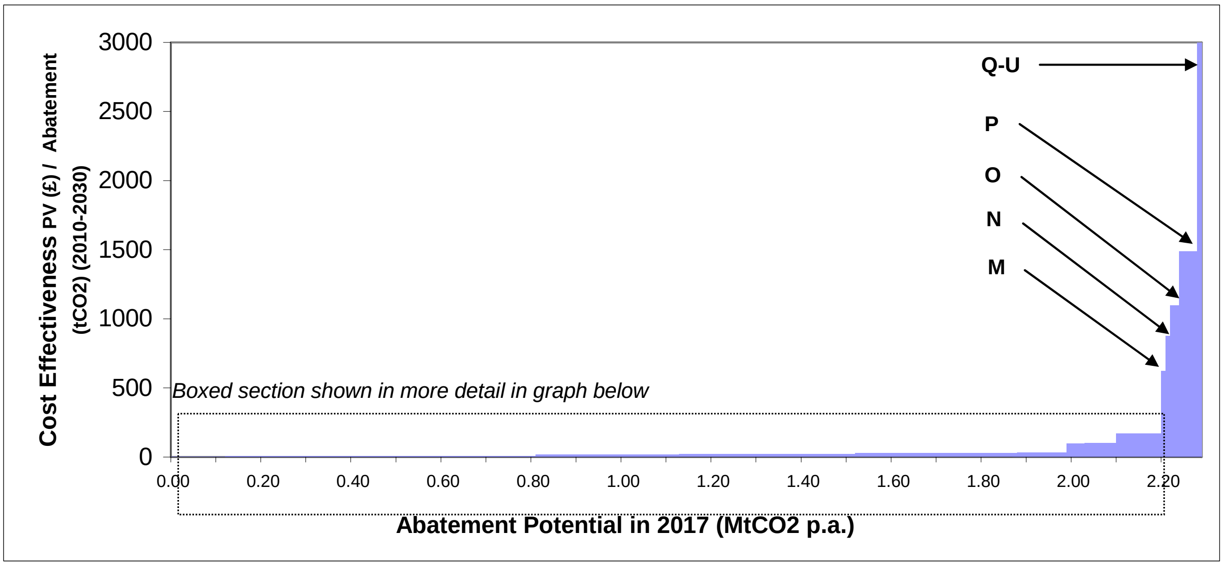
1	Indicative assessment to illustrate potential scale rather than represent specific schemes

References/Background Sources for Assumptions

1	Saving used based on DfT ITS toolkit evidence suggest individual corridors achieve savings of up to 20% (on sections in congested urban areas)
2	Average bus mode split based on information from Census Journey to Work data by area type (TMfS produces output for a single public transport mode)
3	Elasticities (by purpose) from TRL 593: Public Transport Demand a Practical Guide, adjusted for consistency with TMfS modelled elasticities
4	Average car trip length for given journeys from TMfS cost matrices
5	25% of increased trips assumed to have switched from being car driver trips, judgement based on range of evidence including, Webtag 3.13.2, Table 1, Brand and Preston, 2003 cited in UKERC, 2009 , Affordable Mass Transit Guidance, 2005

Appendix B - Marginal Abatement Cost Curves

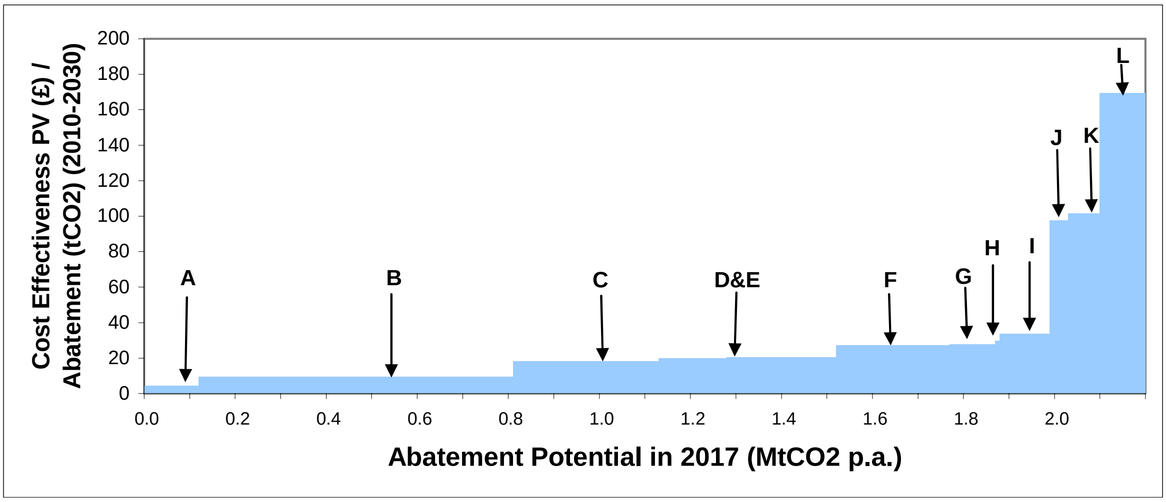
Figure B.1: Marginal Abatement Cost Curve 2017 Annual Abatement



Key

Code	Measure	Measure
M	125	Introduce/ raise residential/private parking charges
N	109	Procurement of low carbon vehicles
O	1	Active traffic management
P	131a	Walking Infrastructure Investment
Q	205c	Improve public transport surface access to airports
R	15	Bus/rapid/mass transit infrastructure investment (including bus priority)
S	127	Bus/LRT fares reductions
R	75	High speed rail links
U	115	Rail investment

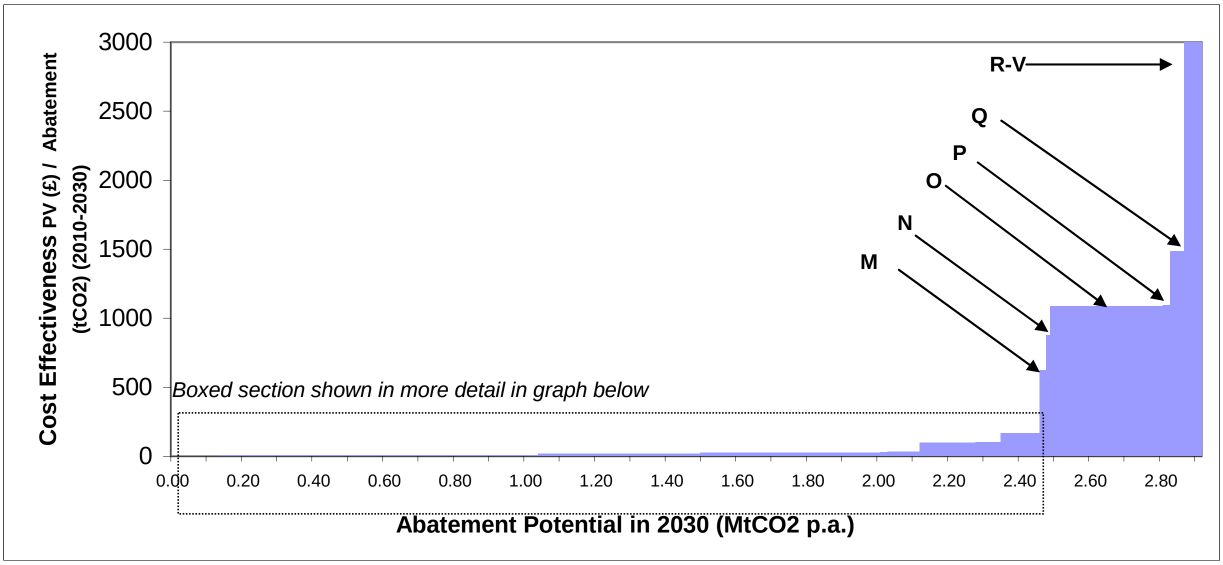
Figure B.2 - Marginal Abatement Cost Curve 2017 Annual Abatement - Most Cost Effective Measures - Detailed View



Key

Code	Measure ID	Measure
A	204	Provide community hubs
B	173	Widespread implementation of travel plans
C	143	Speed reduction on trunk roads
D	103	Introduction or increase in public parking charges
E	98	National motoring package
F	172	Workplace parking levy
G	18	Bus quality contracts / statutory partnerships
H	158	Urban density increases
I	63	Freight best practice
J	53	Electric car technology & network development
K	97	National network of car clubs
L	37	Cycle infrastructure investment

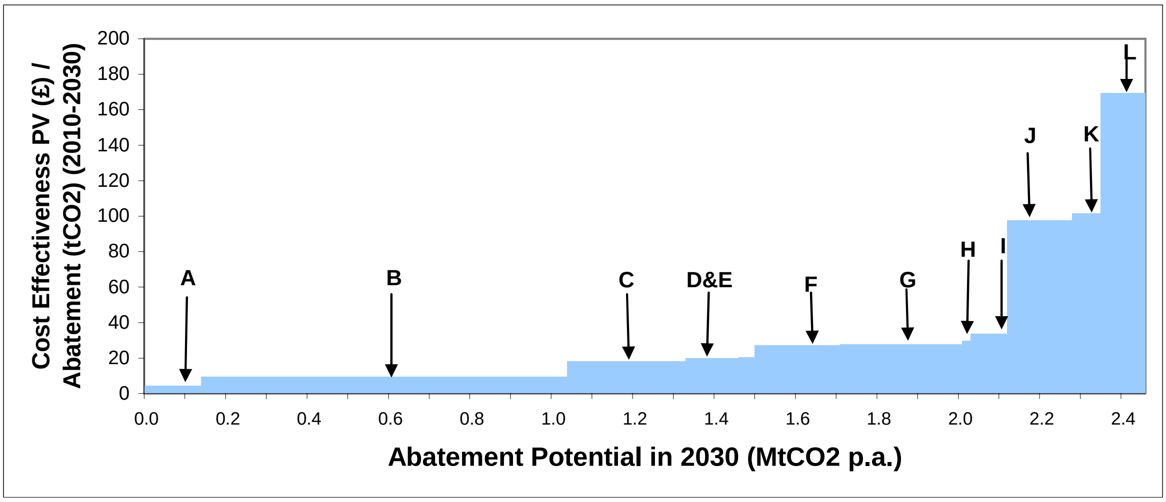
Figure B.3 - Marginal Abatement Cost Curve 2030 Annual Abatement



Key

Code	Measure	Measure
M	125	Introduce/ raise residential/private parking charges
N	109	Procurement of low carbon vehicles
O	99	National road user charging
P	1	Active traffic management
Q	131a	Walking Infrastructure Investment
R	205c	Improve public transport surface access to airports
S	15	Bus/rapid/mass transit infrastructure investment (including bus priority)
T	127	Bus/LRT fares reductions
U	75	High speed rail links
V	115	Rail investment

Figure B.4 - Marginal Abatement Cost Curve 2030 Annual Abatement - Most Cost Effective Measures - Detailed View



Key

Code	Measure ID	Measure
A	204	Provide community hubs
B	173	Widespread implementation of travel plans
C	143	Speed reduction on trunk roads
D	103	Introduction or increase in public parking charges
E	98	National motoring package
F	172	Workplace parking levy
G	18	Bus quality contracts / statutory partnerships
H	158	Urban density increases
I	63	Freight best practice
J	53	Electric car technology & network development
K	97	National network of car clubs
L	37	Cycle infrastructure investment

Appendix C - Ancillary Impacts and Deliverability

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions 2012-2027	Responsibility for delivery
53	Technology	**Electric car technology & network development**	Support for development of electric car charging network, focused on less densely populated areas that will not naturally be served by the private sector	Gradual build up in fuel efficiency / alternative fuels. Consumer choices and improved fuel efficiency dominate to 2030. In the longer term possibly by 2050 almost complete decarbonisation of road transport is a possibility	Scottish Government in partnership with Universities and private sector

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								Depends on technology type
Complexity of Implementation	Moderate adverse								Relies on commercialisation of technological advances
Public acceptability	Moderate positive								Electorate unlikely to be against
Political acceptability	Large positive								Supports new tech and knowledge economy, creates jobs
Affordability	Slight adverse								Likely to be expensive but could generate patent revenue
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Quieter vehicles
Global and local air quality	Large positive								No tailpipe emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New refuelling stations
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight adverse								
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Quieter vehicles
Wider Economic Benefits (WEBs)	Moderate positive								
Economic Activity and Location Impacts (EALIs)	Moderate positive								
Integration (STAG)									
Transport Integration	Slight positive								Compatible with car clubs
Transport and Land-Use Integration	Neutral								
Policy Integration	Large Positive								Consistent with National Transport Strategy
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								
Local Accessibility	Neutral								
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								`

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
109	Technology	**Procurement of low-carbon vehicles**	Scheme to incentivise purchase of low emissions vehicles by public sector (through procurement requirements) and private purchasers (through grants). Aim is to accelerate fleet transformation, with emphasis on van fleet.	Links to CCC Extended Ambition scenario, itself assumed to be achieved solely through EU / UK measures	Scottish Government and local authorities

Appraisal of Deliverability	**Score**	**Adverse**			**Neutral**	**Positive**			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Large positive								Should be relatively easy to carry out
Complexity of Implementation	Large positive								Adjustment to procurement rules and Best Value objectives
Public acceptability	Large positive								Should be seen as a positive step being taken by public sector
Political acceptability	Large positive								Concrete action, boosts developing technology
Affordability	Slight adverse								LGVs currently relatively expensive, no revenue generation
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Quieter vehicles
Global and local air quality	Moderate positive								Lower tailpipe emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New refuelling stations
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight adverse								
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Neutral								
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Slight positive								
Transport and Land-Use Integration	Neutral								
Policy Integration	Moderate positive								Contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								
Local Accessibility	Neutral								
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
1	Driving style	**Active traffic management**	Dynamic management of recurrent and non-recurrent congestion on major roads based on the prevailing traffic conditions. This comprises variable speed limits and variable message signs. Can also include dynamic hard shoulder running during peak congestion periods (as on M42)		Transport Scotland

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Large positive								Proven concept on M42 (England)
Complexity of Implementation	Moderate positive								A number of processes to be gone through
Public acceptability	Large positive								Journey time reliability more important that speed
Political acceptability	Large positive								Generally contributes to congestion mitigation and road safety objectives
Affordability	Slight adverse								Requires quite a lot of infrastructure work
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Neutral								M42 study found noise reduction to be negligible
Global and local air quality	Moderate positive								More efficient engine use. Local air quality benefits demonstrated in ATM areas
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								Requires new infrastructure
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Moderate positive								High speeds eliminated, reductions in injury accidents of 10% and damage incidents down 30% on M25
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Moderate positive								Increases road capacity and journey reliability, reduced delay and accidents
Wider Economic Benefits (WEBs)	Moderate positive								Less congestion and fewer accidents
Economic Activity and Location Impacts (EALIs)	Slight positive								Increased journey time reliability
Integration (STAG)									
Transport Integration	Neutral								
Transport and Land-Use Integration	Neutral								
Policy Integration	Moderate positive								Contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility	Neutral								
Public Transport Network Coverage	Neutral								
Local Accessibility	Neutral								
Comparative accessibility	Neutral								
People group	Neutral								
Geographic location	Neutral								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
98	Driving style	**National motoring package**	Ecodriving training for car/ motorcycle drivers is coupled with awareness campaigns and subsidies for in-car instruments such as fuel economy meters, gear shift indicators, tyre pressure gauges and 'green sat nav'		Scottish Government

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Neutral								Partly depends on success of behaviour change
Complexity of Implementation	Slight adverse								Requires public and private sector engagement
Public acceptability	Moderate positive								Nothing seems really controversial, but GPS may say 'Big Brother'
Political acceptability	Large positive								Again seems generally acceptable, unless GPS seen as overbearing
Affordability	Slight adverse								Some elements relatively low-cost, some may not accrue to government
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Neutral								
Global and local air quality	Slight positive								
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								In car instrumentation and moderated driving styles reduce accidents
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Neutral								
Transport and Land-Use Integration	Neutral								
Policy Integration	Slight positive								Contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Slight adverse								Does not encourage modal shift
Local Accessibility	Slight adverse								
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
143	Driving style	**Speed reduction on trunk roads**	Strict enforcement or reduction of speed limit on trunk roads		Transport Scotland / Police

Appraisal of Deliverability	**Score**	**Adverse**			**Neutral**	**Positive**			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Each individual location has to be treated separately to vary national (UK) limit
Complexity of Implementation	Slight adverse								Requires cooperation of police forces
Public acceptability	Slight adverse								Vocal minority opposed to speed cameras
Political acceptability	Slight adverse								Low priority for politicians perceiving low public opinion
Affordability	Slight adverse								Technology is becoming substantially cheaper, some revenue generation
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Slower speeds reduce noise
Global and local air quality	Slight positive								Slower speeds improve fuel efficiency
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								Some new infrastructure required
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Moderate positive								Cutting high speed more beneficial than reducing average speed
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight adverse								Longer travel times, but improved reliability in congested areas
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Neutral								
Transport and Land-Use Integration	Neutral								
Policy Integration	Moderate positive								Contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								
Local Accessibility	Neutral								
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option		Description			Assumptions				Responsibility for delivery
15	Car demand management (fiscal/ infrastructure)	**Bus/Rapid Transit infrastructure investment (including bus priority)**		Provision of new and extended priority public transport schemes							Scottish Government, Regional Transport Partnerships, local authorities and operators
		Appraisal of Deliverability	Score	Adverse			Neutral	Positive			**Commentary on appraisal**
				---	--	-	0	+	++	+++	
		Feasibility	Large positive								Achievable with will
		Complexity of Implementation	Moderate adverse								Planning, T&W(S) Act 2007 processes required
		Public acceptability	Moderate adverse								Lengthy processes, disruption during construction
		Political acceptability	Moderate adverse								Much political effort, with risk of negative outcomes
		Affordability	Moderate adverse								High capital costs, ongoing revenue support, but 15% additional revenue gen.
		Appraisal of ancillary impacts STAG criteria and the Government Purpose									
		Environment (STAG)									
		Noise and vibration	Slight adverse								Negative effect on 'frontage' properties
		Global and local air quality	Moderate positive								Modal shift from car to PT
		Water quality, drainage, flood defence	Neutral								
		Geology	Neutral								
		Biodiversity and habitats	Neutral								
		Landscape	Neutral								
		Visual amenity	Moderate adverse								New infrastructure
		Agriculture and Soils	Neutral								
		Cultural heritage	Neutral								
		Safety (STAG)									
		Accidents	Slight positive								Reduction on VMT
		Security	Slight adverse								More use of public space
		Economy (STAG)									
		Transport Economic Efficiency (TEE)	Slight positive								
		Wider Economic Benefits (WEBs)	Slight positive								
		Economic Activity and Location Impacts (EALIs)	Slight positive								
		Integration (STAG)									
		Transport Integration	Slight positive								As a result of good design
		Transport and Land-Use Integration	Slight positive								Supports established plans
		Policy Integration	Slight positive								Appropriate to government policies
		Accessibility and social inclusion (STAG)									
		Community accessibility									
		Public Transport Network Coverage	Slight positive								
		Local Accessibility	Slight positive								Reduces car traffic
		Comparative accessibility									
		People group	Slight positive								Provides access for all mobile population
		Geographic location	Slight adverse								Accessible rural/urban areas benefit but worse for remote rural

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
37	Car demand management (fiscal/ infrastructure)	**Cycle infrastructure investment**	Widespread high quality investment in cycling infrastructure including cycle routes and lanes (including shortcuts for cyclists), advanced stop lines, cycle parking facilities, provision of cycles on public transport, cycle rental schemes in cities, strictly enforced cycle parking standards for new developments & cycling promotion		Scottish Government and local authorities Private developers and businesses through incentives or planning system

Appraisal of Deliverability	Score	Adverse ---	Adverse --	Adverse -	Neutral 0	Positive +	Positive ++	Positive +++	Commentary on appraisal
Feasibility	Slight positive								Technically feasible
Complexity of Implementation	Moderate positive								Relatively simple
Public acceptability	Moderate positive								Generally high apart from need for road space reallocation
Political acceptability	Moderate positive								Generally high apart from need for road space reallocation
Affordability	Moderate adverse								£5 per head over 10-15 years
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Moderate positive								Fewer cars
Global and local air quality	Moderate positive								Reduction in number of short car journeys
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New infrastructure
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight adverse								Increased cycle kms but may be compensated by reduced car journeys and more segregation
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Reduction in congestion
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Moderate positive								Effect of cycling to public transport interchange
Transport and Land-Use Integration	Large positive								Development design incorporates direct cycle routes
Policy Integration	Large positive								Fits with health agenda / contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Slight positive								PT accessibility increased
Local Accessibility	Large Positive								
Comparative accessibility									
People group	Moderate positive								Levelling of accessibility to all mobile groups, potential to improve for mobility impaired
Geographic location	Slight positive								Greater benefits for urban areas. Regeneration/deprived areas not priority emissions group but could benefit

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
75	Car demand management (fiscal/ infrastructure)	**High speed rail links**	Rail investment - increased service frequency, rolling stock, track capacity Includes Rail fares and investment subsidy (114) includes High Speed Rail (links between Scottish cities and to England) (76)		UK Government and Scottish Government

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Moderate adverse								Major infrastructure projects difficult to implement
Complexity of Implementation	Large adverse								Likely to need support from high air taxes and RUC
Public acceptability	Large positive								Popular concept, but some may think too expensive.
Political acceptability	Slight positive								Cost reduces acceptability
Affordability	Large adverse								Very high capital costs counterbalanced by revenue generation
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Moderate positive								Reduction in vehicle kms
Global and local air quality	Slight positive								Careful mitigation measures needed during construction phase
Water quality, drainage, flood defence	Moderate adverse								
Geology	Moderate adverse								
Biodiversity and habitats	Moderate adverse								
Landscape	Moderate adverse								Substantial impacts, needing careful design and mitigation
Visual amenity	Moderate adverse								
Agriculture and Soils	Moderate adverse								
Cultural heritage	Moderate adverse								
Safety (STAG)									
Accidents	Moderate positive								Modal shift from road to safer rail
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Large positive								Depends on route, but expected to deliver benefits along route corridor
Wider Economic Benefits (WEBs)	Moderate positive								
Economic Activity and Location Impacts (EALIs)	Large positive								
Integration (STAG)									
Transport Integration	Moderate positive								Widens accessibility of public transport network
Transport and Land-Use Integration	Large positive								Good fit with transport and land use policies if it serves city centres
Policy Integration	Moderate positive								City centre stations rather that 'parkway' stations
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Moderate positive								
Local Accessibility	Neutral								
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
97	Car demand management (fiscal/ infrastructure)	**National network of car clubs**	Car clubs (short term, pay as you go car hire) rolled out through a coherent national network which is both interoperable (a member in one town can use the service in another town) and integrated in terms of tariffs and physical interchanges with public transport	Rolled out over a 10 year period so network extends to every main town (over 30k population) in Scotland. The service will facilitate lower levels of car ownership whilst preserving and enhancing accessibility	Regional Transport Partnerships/Local Authorities plus PT and car club operators

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Technically feasible
Complexity of Implementation	Slight adverse								Requires private sector: interoperability affected by competition
Public acceptability	Moderate positive								Generally good but effects on parking availability may have negative effect
Political acceptability	Large positive								Generally high but case needs to be made with clarity as relatively unknown concept
Affordability	Moderate positive								Cost shared with private sector, potential for profit
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Fewer private cars
Global and local air quality	Moderate positive								Reduction in number of short car journeys
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Neutral								More walking/cycling increases risks, but over time fewer cars compensates
Security	Slight positive								Cars available for times/journeys that are less safe for walking/cycling (e.g. at night)
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Investment in new businesses, with associated infrastructure and reduction in congestion
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Slight positive								New employment sector and boost for car manufacturers through lease or sale of new models
Integration (STAG)									
Transport Integration	Large positive								Interoperability and one-way journeys contribute to developing notion of end-to-end journeys
Transport and Land-Use Integration	Moderate positive								Reduced parking requirement at new developments
Policy Integration	Large positive								Contributes to health and social inclusion agendas
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Slight positive								Improves access to public transport for some groups
Local Accessibility	Neutral								
Comparative accessibility									
People group	Large positive								Access to cars for people currently excluded
Geographic location	Slight positive								Best in built up areas but potential for rural areas to develop community-based car share options

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
99	Car demand management (fiscal/ infrastructure)	**National road user charging**	Distance based Road User Charging applied to the Scottish road network (with differential charges depending on type of road and time of day)		Scottish Government

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Technically feasible to introduce in short term
Complexity of Implementation	Large adverse								Large-scale roll out of technology and establishment of equitable pricing structure
Public acceptability	Large adverse								Data protection issues and already highly contentious
Political acceptability	Moderate adverse								Lack of public acceptability outweighs good BCR for politicians
Affordability	Large positive								High capital cost and revenue costs, but high revenue generated
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Moderate positive								Discourages car use and modal shift on cost grounds
Global and local air quality	Large positive								Reduces convenience trips and overall number of journeys
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New infrastructure
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Large positive								Reduced number of journeys should reduce accident rate
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Large positive								
Wider Economic Benefits (WEBs)	Large positive								Journey time reductions and improved reliability beneficial to businesses
Economic Activity and Location Impacts (EALIs)	Moderate positive								
Integration (STAG)									
Transport Integration	Large positive								
Transport and Land-Use Integration	Large positive								
Policy Integration	Large positive								
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Large positive								If revenue is invested in public transport
Local Accessibility	Large positive								If revenue is invested in infrastructure
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								Pricing structure should not be regressive on dispersed rural areas

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
103	Car demand management (fiscal/ infrastructure)	**Introduction or increase in public parking charges**	Increase parking charges in public on-street meter bays and off-street car parks or introduce charges where they presently do not exist.		Local Authority for controlled parking zones and charges. Scottish Government for changes to SPP17.

Appraisal of Deliverability	**Score**	**Adverse**			**Neutral**	**Positive**			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Easy to introduce and operate, except in dispersed rural centres where enforcement is harder
Complexity of Implementation	Large positive								Simple existing mechanisms (Traffic Regulation Order process and revision of government guidance)
Public acceptability	Slight adverse								Generally contentious, although public/business concerns may be unfounded
Political acceptability	Slight positive								Green agenda and clean air targets make this acceptable but vulnerable to local economic imperatives
Affordability	Large positive								Relatively low capital costs and ongoing revenue support, generates good revenue
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Neutral								Contributes to stabilised traffic growth, thus no net increase in noise/vibration
Global and local air quality	Neutral								Contributes to stabilised traffic growth, thus no net increase in emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Neutral								
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Surplus revenue can be invested in sustainable transport measures
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Slight positive								Local economy not hampered by traffic growth
Integration (STAG)									
Transport Integration	Neutral								
Transport and Land-Use Integration	Slight positive								Stricter parking standards through SPP17 should promote development with good public transport accessibility
Policy Integration	Neutral								
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								If pricing set correctly, improves viability of public transport network
Local Accessibility	Slight positive								Residents parking better protected by controlled zones
Comparative accessibility									
People group	Slight adverse								Risk of discrimination against less well off
Geographic location	Slight adverse								Will be disadvantageous for some town centre residents

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
115	Car demand management (fiscal/ infrastructure)	**Rail investment**	Increasing service frequencies, rolling stock		Scottish Governme nt, Network

Appraisal of Deliverability	**Score**	**Adverse**			**Neutral**	**Positive**			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Technically feasible
Complexity of	Slight adverse								Several organisations involved, but complexity depends on scale
Public acceptability	Moderate positive								Measure would meet with public approval
Political	Slight positive								Positive political attributes, but depends on cost
Affordability	Large adverse								Likely to be high Capital and Revenue costs. Will generate income.
Appraisal of ancillary impacts STAG criteria and									
Environment									
Noise and vibration	Slight adverse								More intensive use of railway infrastructure
Global and local air	Moderate positive								Shift from car to more efficient mode
Water quality,	Neutral								
Geology	Neutral								
Biodiversity and	Neutral								
Landscape	Neutral								
Visual amenity	Moderate adverse								New infrastructure
Agriculture and	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Rail is statistically safer than car
Security	Slight adverse								More use of public space
Economy (STAG)									
Transport	Slight positive								
Wider Economic	Slight positive								
Economic Activity	Slight positive								
Integration									
Transport	Slight positive								Achieved through good design
Transport and	Slight positive								Supports established plans
Policy Integration	Slight positive								Appropriate to government policy
Accessibility and									
Community									
Public Transport	Slight positive								Network is improved
Local Accessibility	Slight positive								Removes car traffic
Comparative									
People group	Moderate positive								Brings rail option to greater proportion of mobile population
location	Moderate positive								Beneficial for rural areas with rail links

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
125	Car demand management (fiscal/ infrastructure)	**Introduction/ raise in residential/private parking charges**	Areas of high on-street parking demand often coincide with residential districts that have no private off-street parking. In these areas on-street visitor demand is controlled by charging. Resident parking charges are often introduced as a consequence to protect on-street resident spaces from being overrun by visitors. The role of this resident parking charge can now be extended to help control carbon emissions.		Local Authority

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Large positive								Easy extension of existing parking permit schemes
Complexity of Implementation	Large positive								Suitable models exist (eg several London Boroughs)
Public acceptability	Moderate adverse								More acceptable if some residents clearly benefit from change, otherwise difficult
Political acceptability	Slight positive								Fits with green agenda and emissions policies, but may be seen as another tax
Affordability	Neutral								Significant capital and operating costs, raises revenue to balance costs
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Fewer / smaller cars
Global and local air quality	Slight positive								Fewer / more efficient cars
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Slight positive								Better air quality contributes to habitat improvement
Landscape	Slight adverse								If garden space is converted to parking
Visual amenity	Slight positive								Fewer, smaller cars improves on-street visual amenity
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Fewer smaller cars result in less serious accidents
Security	Slight positive								Pedestrians more visible when traffic levels lower
Economy (STAG)									
Transport Economic Efficiency (TEE)	Large positive								Small costs bring high benefits
Wider Economic Benefits (WEBs)	Slight adverse								If city living is made too unattractive
Economic Activity and Location Impacts (EALIs)	Moderate positive								Fuel efficient cars have lower running costs
Integration (STAG)									
Transport Integration	Large positive								Takes away dominance of car and enables better modal choice on the basis of true costs
Transport and Land-Use Integration	Large positive								Enables prioritisation of rapid transit in dense urban areas
Policy Integration	Large positive								True cost of car travel made more transparent
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Slight positive								Network coverage improves as a result of higher demand
Local Accessibility	Slight positive								Cycling and walking facilities improved as a result of higher demand
Comparative accessibility									
People group	Slight positive								Better public transport assists disadvantaged groups, and disabled drivers are unaffected
Geographic location	Slight adverse								Penalises inner city residents more than rural residents, but doesn't affect deprived areas

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
127	Car demand management (fiscal/ infrastructure)	**Bus / LRT fares reductions**	Targeting high carbon intensity groups, involves subsidy for introducing lower fares on buses and light rail, and SmartCard systems for ticket integration and car club interoperability		Transport Scotland and public transport operators

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								Technically feasible
Complexity of Implementation	Slight adverse								Requires legislation and cooperation of operators
Public acceptability	Neutral								Universal fare concession not fair (wealthy benefit more)/public spending issue
Political acceptability	Moderate adverse								High level of public finance liability
Affordability	Moderate adverse								Requires on-going revenue support
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Fewer cars/more buses and light rail
Global and local air quality	Moderate positive								More efficient vehicle use
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Moderate positive								Reduction in vehicle kms
Security	Slight adverse								More use of public space
Economy (STAG)									
Transport Economic Efficiency (TEE)	Moderate positive								Less road congestion
Wider Economic Benefits (WEBs)	Moderate positive								Less road congestion
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Moderate positive								
Transport and Land-Use Integration	Moderate positive								
Policy Integration	Moderate positive								
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Moderate positive								Likely to increase public transport network
Local Accessibility	Slight positive								Reduce car impacts
Comparative accessibility									
People group	Moderate positive								A levelling of accessibility for all groups
Geographic location	Slight adverse								Improvement for urban areas but not for rural services

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
131a	Car demand management (fiscal/ infrastructure)	**Walking infrastructure investment**	Implementation of dedicated pedestrian routes, which may require road space reallocation in some circumstances		Scottish Government and local authorities

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								Technically feasible
Complexity of Implementation	Slight adverse								Requires high quality design
Public acceptability	Slight adverse								If it takes road space from drivers
Political acceptability	Slight adverse								If it takes road space from drivers
Affordability	Moderate adverse								Not including unquantified wider health benefits
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								More walking and fewer cars reduces engine noise
Global and local air quality	Slight positive								More walking and fewer cars reduces emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New infrastructure
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Improved conditions for pedestrians
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Reduction in congestion
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Moderate positive								Effect of walking to public transport interchange
Transport and Land-Use Integration	Large positive								Development design incorporates direct walking routes
Policy Integration	Large positive								Fits with health agenda / contributes to transport and climate change policy aims
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								Improving walking infrastructure is not in itself improving network coverage
Local Accessibility	Slight positive								Better routes for pedestrians
Comparative accessibility									
People group	Slight positive								More equity of accessibility in walkable areas
Geographic location	Neutral								Rural effects negligible or negative, but large benefits in urban areas

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
172	Car demand management (fiscal/ infrastructure)	**Workplace parking levy**	Private off-street parking spaces at a place of work encourage employees to drive to work in the knowledge that they have a guaranteed free space waiting for them. The levy applies a charge to that space to make it less attractive to own and use. The levy will fund sustainable transport initiatives to provide alternatives to the car		Scottish Government

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Moderate adverse								Taking spaces out of commission/paying for conversion to other uses, maintaining flexibility for disabled drivers
Complexity of Implementation	Moderate adverse								Registration/survey of all private workplace car spaces, need for simultaneous introduction
Public acceptability	Slight adverse								Current positive shift in employer attitudes may be set back by credit crunch
Political acceptability	Slight adverse								May be characterised as tax on business/work or infringement of civil liberties
Affordability	Moderate positive								Nominal capital costs, some operating costs but generates revenue
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Reduction in traffic
Global and local air quality	Slight positive								Reduction in traffic-related emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Slight adverse								New infrastructure
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Reduction in traffic
Security	Slight adverse								Could displace parking to less secure areas
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Reduced congestion improves journey times
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Moderate positive								Savings from reduced congestion outweigh costs to business of WPL
Integration (STAG)									
Transport Integration	Moderate positive								Takes away dominance of car and enables better modal choice on the basis of true costs
Transport and Land-Use Integration	Moderate positive								Enables prioritisation of rapid transit in dense urban areas
Policy Integration	Moderate positive								True cost of car travel made more transparent
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Slight positive								If revenue used to support public transport investment
Local Accessibility	Neutral								
Comparative accessibility									
People group	Neutral								If disabled parking is protected
Geographic location	Neutral								Rural areas without public transport network would be exempt

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
18	Car demand management (Smart Measures)	**Bus quality contracts/statutory partnerships**	Managing the bus network to achieve a level of quality to attract users.		Scottish Government, regional transport partnerships, local authorities and bus operators.

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								Necessary legislation in place
Complexity of Implementation	Slight adverse								Legal aspects of contracts are demanding
Public acceptability	Large positive								Promised standards need to be met and maintained
Political acceptability	Large positive								Political consensus has existed for sometime (?)
Affordability	Neutral								Low capital costs, revenue support required, but revenue generation
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight adverse								Increased bus operations
Global and local air quality	Slight positive								Greater use of energy efficient vehicles
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Reduction in vehicle kms
Security	Slight adverse								More public space use
Economy (STAG)									
Transport Economic Efficiency (TEE)	Neutral								
Wider Economic Benefits (WEBs)	Slight positive								Enhanced local area image
Economic Activity and Location Impacts (EALIs)	Slight positive								Enhanced local area image
Integration (STAG)									
Transport Integration	Moderate positive								Better transport network
Transport and Land-Use Integration	Moderate positive								Designed to achieve integration
Policy Integration	Slight positive								Fits with transport policy but not enterprise culture
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Large positive								Better network
Local Accessibility	Slight positive								Reduction in private car use
Comparative accessibility									
People group	Moderate positive								Increases network availability to all mobile population
Geographic location	Moderate positive								Can be utilised in urban and rural areas to enhance accessibility

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
173	Car demand management (Smart Measures)	**Widespread implementation of travel plans**	Widespread implementation of travel plans in workplaces, leisure sites, residential areas, schools and households	Based on extending existing efforts to reduce single occupancy car journeys through lift-sharing and encouragement of modal shift	Scottish Government and local authorities, schools and businesses

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Builds on existing work, but needs more travel plan officers and liaison
Complexity of Implementation	Moderate positive								No new legislation required, but liaison with businesses, schools and PT operators
Public acceptability	Large positive								Generally uncontroversial as long as individuals feel not being forced
Political acceptability	Moderate positive								Would require convincing of the benefits
Affordability	Slight adverse								Revenue costs
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Reduced traffic congestion in peak periods
Global and local air quality	Slight positive								Reduced traffic congestion in peak periods
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								Reduced traffic improves visual amenity, but increase in PT movements may cancel out
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Reduced traffic congestion in peak periods lowers risk of accidents
Security	Slight adverse								More reliance on public transport/liftshare may pose security risks at some times of day.
Economy (STAG)									
Transport Economic Efficiency (TEE)	Moderate positive								
Wider Economic Benefits (WEBs)	Moderate positive								
Economic Activity and Location Impacts (EALIs)	Moderate positive								
Integration (STAG)									
Transport Integration	Slight positive								Contributes to reducing car-mentality and improving modal choices
Transport and Land-Use Integration	Moderate positive								Builds on existing policy integration work
Policy Integration	Slight positive								Fits with health, land use policy and sustainable development policies
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Moderate positive								Successful travel plans boost public transport network provision
Local Accessibility	Slight positive								Travel planning policies may influence locational decisions that permit walking and cycling
Comparative accessibility									
People group	Neutral								
Geographic location	Neutral								

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ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
204	Car demand management (Smart Measures)	**Provide community hubs**	Community Hubs will be mainly in rural areas and will incorporate ICT and remote office facilities (including videoconferencing suits), storage for e-commerce deliveries and parking and charging points for electric vehicles and car clubs	Reductions in carbon emissions as a result of enabling shorter/no commute for rural residents, creating consolidation centre for e-shopping deliveries and reducing dependence on car ownership by creating a model for rural car clubs and electric vehicles	Local Authority but with national programme to support the development of community hubs and fastest broadband roll out. Businesses need to support teleworking.

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			Commentary on appraisal
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								This should be feasible but employers need to support teleworking
Complexity of Implementation	Slight adverse								Coordination between public and communications sector: technical issues?
Public acceptability	Slight positive								Attractive for rural areas
Political acceptability	Slight adverse								Needs work on proof of concept
Affordability	Neutral								Should generate revenue from access charges/workspace rental to balance costs
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Reduction in traffic
Global and local air quality	Slight positive								Reduction in traffic
Water quality, drainage, flood defence	Neutral								Location dependent impacts relating to any new buildings, but outweighed by reductions in journey length and number of trips
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Fewer long journeys
Security	Slight positive								Shorter commute or working at home reduces exposure to risk
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								
Wider Economic Benefits (WEBs)	Slight positive								
Economic Activity and Location Impacts (EALIs)	Slight positive								
Integration (STAG)									
Transport Integration	Slight positive								Provides a locus for public transport and car club provision in rural areas
Transport and Land-Use Integration	Moderate positive								Strengthens rural economy whilst improving locational/transport integration
Policy Integration	Slight positive								Contributes to rural digital economy, health and sustainable development policies
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								Provides a locus for public transport/car club provision in rural areas but possible rebound effects
Local Accessibility	Neutral								Shorter journeys, possible boost to rural cycling but could be rebound effect
Comparative accessibility									
People group	Slight positive								Contributes to digital inclusion for currently disadvantaged
Geographic location	Slight positive								Could improve service levels to rural areas more commensurate with urban expectations

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
63	Freight	**Freight best practice**	Measures to accelerate further uptake of Freight Quality Partnerships and other 'best practices' such as SAFED (Safe and Fuel Efficient Driver) and consolidation.		Scottish Government

Appraisal of Deliverability	Score	Adverse			Neutral	Positive			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Moderate positive								Builds on existing work
Complexity of Implementation	Moderate positive								Builds on existing work
Public acceptability	Large positive								If seen as making lorry drivers safer/reducing vehicle movements
Political acceptability	Large positive								Not likely to lose votes
Affordability	Slight adverse								Low revenue costs
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Overall reduction in vehicle movements
Global and local air quality	Slight positive								Reduction in emissions
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Reduction in vehicle kms and improvements to driver behaviour
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Reduced in congestion and more efficient operations
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Neutral								Achieved through good design
Transport and Land-Use Integration	Neutral								Supports established plans
Policy Integration	Slight positive								Appropriate to government policy
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Neutral								Network is improved
Local Accessibility	Neutral								Removes car traffic
Comparative accessibility									
People group	Neutral								Brings alternative options to greater proportion of mobile population
Geographic location	Neutral								Beneficial for rural areas with better PT links

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
158	Landuse planning	**Urban density increases**	Much denser form of development for new residential areas combined with retail and other facilities on site; walkable design / street forms; requirement that new development meets criteria on location and public transport accessibility		Scottish Government

Appraisal of Deliverability	Score	Adverse ---	Adverse --	Adverse -	Neutral 0	Positive +	Positive ++	Positive +++	Commentary on appraisal
Feasibility	Slight adverse								Limits to land supply in urban areas/city regions
Complexity of Implementation	Slight positive								Needs to be integrated with housing, population, employment and energy policies
Public acceptability	Slight adverse								Restricts choice in housing location
Political acceptability	Slight adverse								Local councils compete for housing and business - some will be advantaged
Affordability	Neutral								Low capital costs, some operating costs for incentives/compensation, revenue from planning applications
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Reduces vehicle kms
Global and local air quality	Moderate positive								Reduces traffic
Water quality, drainage, flood defence	Neutral								There will be variations between sites, but overall neutral
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Moderate positive								Reduces traffic levels
Security	Neutral								Site dependent
Economy (STAG)									
Transport Economic Efficiency (TEE)	Moderate positive								
Wider Economic Benefits (WEBs)	Moderate positive								
Economic Activity and Location Impacts (EALIs)	Moderate positive								Some local impacts may be strong
Integration (STAG)									
Transport Integration	Moderate positive								
Transport and Land-Use Integration	Large positive								
Policy Integration	Large positive								
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Moderate positive								
Local Accessibility	Moderate positive								Shorter distances between homes and destinations
Comparative accessibility									
People group	Moderate positive								Site dependent
Geographic location	Moderate positive								

Mitigating Transport's Climate Change Impact in Scotland: Policy Appraisal Summary Tables

ID	Type	Policy Option	Description	Assumptions	Responsibility for delivery
205c	Aviation	**Improve public transport surface access to airports**	Measures to improve time taken to travel to airport by public transport		Scottish Government and local authorities / Airport Operators

Appraisal of Deliverability	**Score**	**Adverse**			**Neutral**	**Positive**			**Commentary on appraisal**
		---	--	-	0	+	++	+++	
Feasibility	Slight positive								Improvements should be feasible with will and resources
Complexity of Implementation	Slight adverse								Existing progress has been slow (GARL, EARL, Dyce station shuttle bus)
Public acceptability	Moderate positive								Not likely to be viewed in a negative light unless very expensive
Political acceptability	Moderate positive								Likely to be viewed as good for the economy and passengers unless very expensive
Affordability	Moderate adverse								Some types of infrastructure very costly, revenue support required, loss of parking income
Appraisal of ancillary impacts STAG criteria and the Government Purpose									
Environment (STAG)									
Noise and vibration	Slight positive								Overall reduction in vehicle movements
Global and local air quality	Slight positive								Shift from car to more efficient modes
Water quality, drainage, flood defence	Neutral								
Geology	Neutral								
Biodiversity and habitats	Neutral								
Landscape	Neutral								
Visual amenity	Neutral								
Agriculture and Soils	Neutral								
Cultural heritage	Neutral								
Safety (STAG)									
Accidents	Slight positive								Reduction in vehicle kms
Security	Neutral								
Economy (STAG)									
Transport Economic Efficiency (TEE)	Slight positive								Reduction in congestion
Wider Economic Benefits (WEBs)	Neutral								
Economic Activity and Location Impacts (EALIs)	Neutral								
Integration (STAG)									
Transport Integration	Slight positive								Achieved through good design
Transport and Land-Use Integration	Slight positive								Supports established plans
Policy Integration	Slight positive								Appropriate to government policy
Accessibility and social inclusion (STAG)									
Community accessibility									
Public Transport Network Coverage	Moderate positive								Network is improved
Local Accessibility	Moderate positive								Removes car traffic
Comparative accessibility									
People group	Moderate positive								Brings alternative options to greater proportion of mobile population
Geographic location	Moderate positive								Beneficial for rural areas with better PT links

Appendix D - Do Minimum and Reference Case Assumptions

Information Note

Subject: TMfS:05A 'Do Minimum' and Reference Case Scheme Assumptions

Ref: C34918\04

Version No: 1

Date: 12 November 2007

1 Introduction

1.1.1 The specification of the Do Minimum and Reference Case options for TMfS is a fluid situation based on existing known schemes and other project requirements. The specification does not constitute any greater commitment to the completion of any\all of the schemes noted.

1.1.2 This note outlines the general scheme based assumptions included in the current Do Minimum and Reference Case Transport Networks included in the Transport Model for Scotland 05.A (TMfS:05.A). For further information on the economic assumptions included in forecast years, please contact the TMfS team directly (tmfssupport@mvaconsultancy.com).

1.2 'Do Minimum' Schemes

2012 Do Minimum schemes

1.2.1 The following schemes are to be included in the 2012 Do Minimum.

- Existing Forth Crossing - no tolls
- Tay Bridge – no tolls
- M74 Completion
- M9 Spur Extension
- Finnieston Bridge
- A68 Northern Bypass
- Ferrytoll Link Road
- Second Upper Forth Crossing
- M8 Baillieston to Newhouse and Associated Improvements (Raith Interchange and Adjacent Network Improvements)
- M80 Upgrade
- Aberdeen Western Peripheral Road
- A830 Arisaig to Loch Nan Uahm
- A96 Fochabers to Mosstodloch (Bypasses)
- A90 Balmedie to Tipperty (Dualling)
- Stirling – Alloa – Kincardine Rail Link
- Airdrie – Bathgate Rail Reopening
- Edinburgh Tram Link Phase 1a

- Glasgow Airport Rail Link
- Borders Rail Service
- Larkhall to Milngavie Rail Project
- Edinburgh Waverley Station Upgrade
- Scotland's Railway Short Term infrastructure:
  - new rail station at Laurencekirk with 1 service every two hours;
  - platform extension at Bishopbriggs with six-car trains on Glasgow to Dunblane services;
  - platform extension at Elgin and Insch with six-car trains on Aberdeen to Inverness services;
  - Lugton and Stewarton loop with two trains per hour between Glasgow and Kilmarnock;
  - Haymarket station (no modelled impact in TMfS); and
  - Gourock Transport Interchange (no modelled impact in TMfS).
- Cross Forth rail scenarios associated with Larbert-Stirling and Forth Bridge re-signalling:
  - additional park and ride capacity at Kirkcaldy, Markinch, Rosyth and Perth;
  - Edinburgh to Aberdeen express rail services;
  - new Edinburgh to Dundee rail services stopping at Fife stations;
  - hourly Edinburgh to Perth service; and
  - Newcraighall services no longer integrated with Dunblane and Bathgate services and extended to Fife.
- Development Management led infrastructure:
  - Heartlands;
  - Pollock;
  - A68 new roundabout at Newton St Boswells;
  - A90 new interchange at Portlethen; and
  - A82 Strathleven Roundabout.

2017 Do Minimum schemes

1.2.2 No additional schemes are to be included in the 2017 Do Minimum.

2022 Do Minimum schemes

1.2.3 No additional schemes are to be included in the 2022 Do Minimum.

1.3 Reference Case schemes

2012 Reference Case schemes

1.3.1 The following additional schemes are to be included in the 2012 Reference Case, supplementing the 2012 Do Minimum:

- Cross Forth rail scenarios associated with Larbert-Stirling and Forth Bridge re-signalling:
  - additional park and ride capacity at Cupar, Dunfermline Town, Leuchars, Markinch, and Dunfermline Queen Margaret.
- Development Management led infrastructure:
  - Bishopton;
  - A77 south of Whitlett dualling; and
  - Glasgow East End Regeneration Route.

2017 Reference Case schemes

1.3.2 The following additional schemes are to be included in the 2017 Reference Case:

- Cross Forth rail scenarios:
  - hourly Edinburgh to Inverness service;
  - remove Dalmeny and North Queensferry stops from Fife Circle services; and
  - extend Borders rail services to Inverkeithing stopping at all stations.

2022 Reference Case schemes

1.3.3 The following additional schemes are to be included in the 2022 Reference Case:

- Cross Forth rail scenarios:
  - all Edinburgh to Dundee services to be operated by six-car trains.

The Scottish Government

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