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

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1. INTRODUCTION

1.1 The Scottish Government and Climate Change

The Scottish Government (SG) published its Government Economic Strategy in 2007. This states that the Purpose of the SG is to:

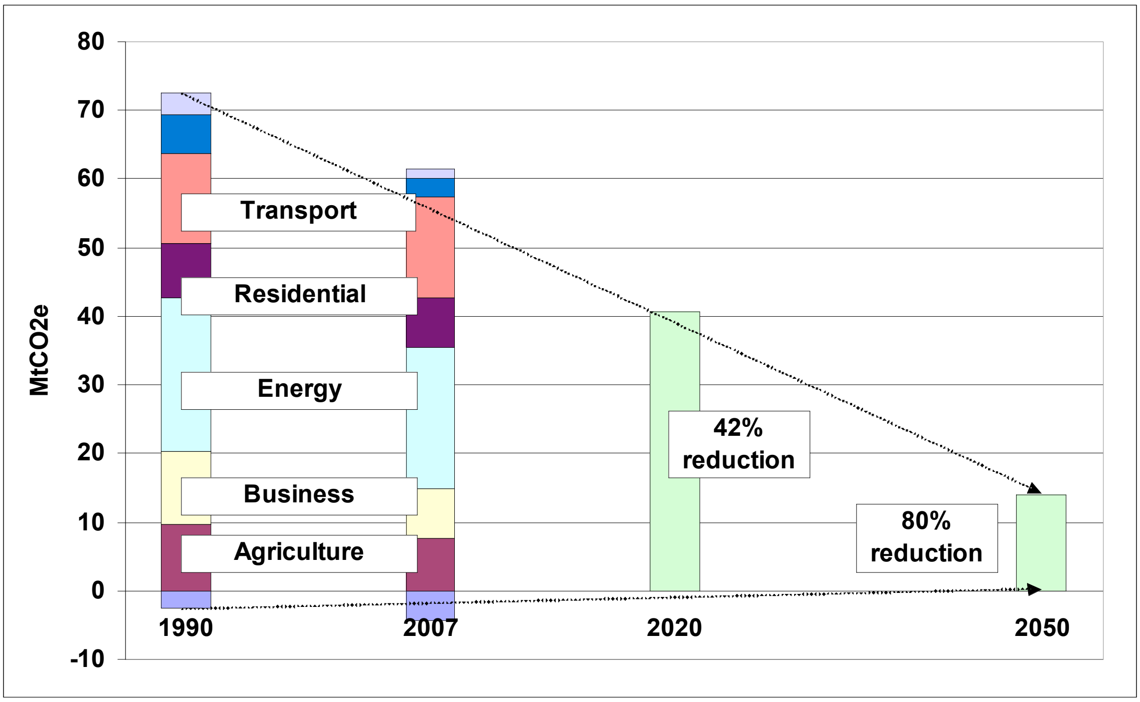
"focus the Government and public services on creating a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth" (The Government Economic Strategy, p1).

In support of the Strategy, the Climate Change (Scotland) Act received Royal Assent on August 4, 2009. The Act sets in statute the Government Economic Strategy target to reduce Scotland's emissions of greenhouse gases by 80 per cent by 2050, one of the Sustainability Purpose Targets. This covers the basket of six greenhouse gases (as recognised by the United Nations Framework Convention on Climate Change), and includes Scotland's share of emissions from international aviation and international shipping.

The Act also establishes an interim target for 2020 of at least 42 per cent reductions in emissions, and allows Ministers, by order, to vary the reduction figure for the interim target based on expert advice from the advisory body. Progress towards these targets will be driven by a framework of annual targets.

The Act is a key commitment of the Scottish Government, and is the most far-reaching environmental legislation considered by the Parliament during the first ten years of devolution. The bold targets signify the importance Scotland places on playing its part in mitigating one of the most serious threats facing our world. Figure 1 overpage graphically illustrates the scale of this challenge.

Figure 1: The Scale of the Challenge



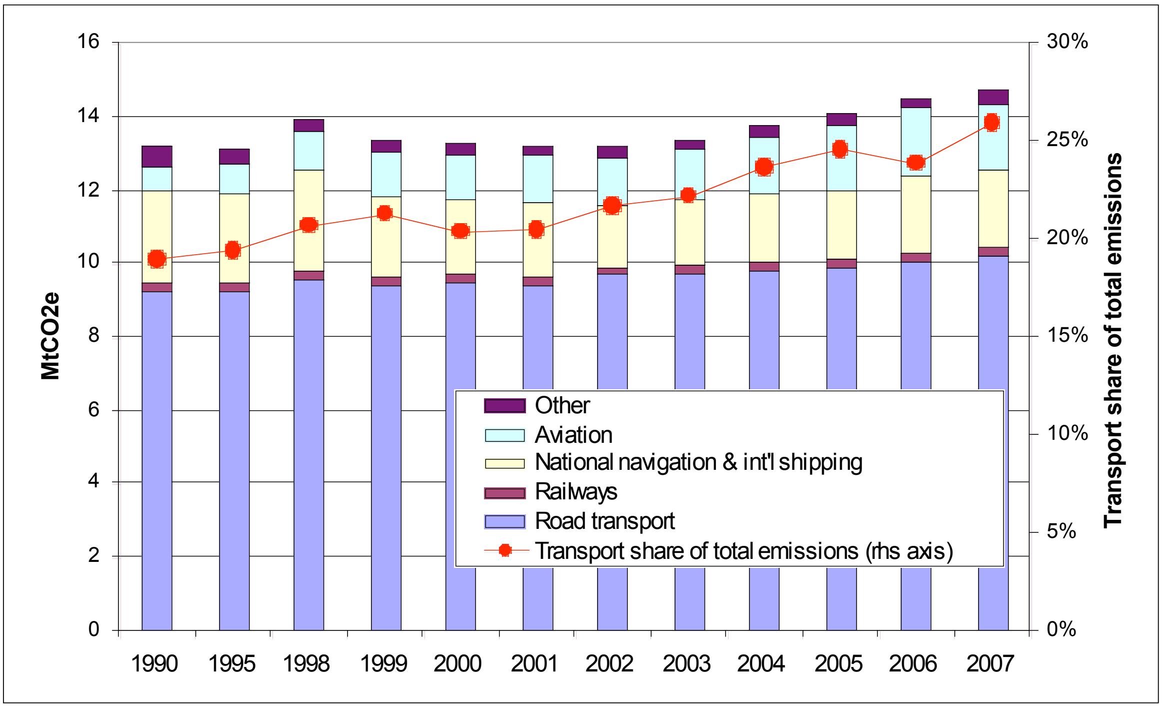
1.2 Transport's Contribution to Climate Change

In addition to the wider Scottish targets referenced above, reducing emissions from transport specifically is also one of the SG's National Transport Strategy's three key strategic outcomes.

In 2007, Scottish transport, including international aviation and shipping, accounted for 14.7 mega-tonnes of carbon dioxide equivalent (MtCO2e), or 25.9% 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. Surface transport is the area with the greatest emissions, with road transport alone accounting for over two-thirds of all Scottish transport emissions during the year. Figure 2 overpage shows the growth in transport emissions by sector, and the proportion of total Scottish emissions accounted for by transport (measured on the right hand axis), since 1990.

As a result of this trend, the Scottish Government's Transport Directorate wanted 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. The subsequent report, *Mitigating Transport's Climate Change Impact in Scotland: Assessment of Policy Options* (MTCCI) will be used as an integral part of the evidence base to be considered in determining the most appropriate action for the Scottish Government to take to reduce greenhouse gas emissions from transport. In doing so, it will help inform transport’s contribution to the 2010 statutory Report on Proposals and Policies, which will formally set out how the SG overall will meet the emissions targets.

Figure 2: Emissions from Scottish transport, 1990 – 2007



2. STUDY METHODOLOGY

2.1 Key Objective:

The key objective of the study was to identify, analyse and report on the devolved policy options available to mitigate transport's climate change impact in Scotland.

2.2 Seven Stages

The study took eight months to complete and was undertaken using a seven stage methodology:

i. Establishment of a preliminary long list of potential policy options

ii. Identification of "ownership" of options

iii. Finalisation and filtering of the policy option list

iv. Comparison of Scottish and UK transport use and requirements

v. Establishment of the baseline 'business as usual' emissions scenario

vi. Detailed assessment of policy options

vii. Packing of complimentary policy options into two alternative scenarios:

   a. Central Scenario - a package of policy options that could feasibly be deployed with a politically or publicly acceptable degree of "forcefulness"

   b. 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.

3. 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.

Table 1: Devolved Policy Options

Sub Category	***Policy Option***
A) Technology	Electric car technology & network development
	Procurement of low carbon vehicles
B) Driving Style	Active traffic management
	National motoring package
	Speed reduction on trunk roads
C) Car Demand Management (Fiscal/Infrastructure)	Bus/rapid/mass transit infrastructure investment (including bus priority)
	Cycle infrastructure investment
	High speed Rail links
	National network of car clubs
	National road user charging
	Introduction or increase in public parking charges
	Rail investment
	Introduction/raise in residential/private parking charges
	Bus /LRT fares reductions
	Walking infrastructure investment
	Workplace parking levy
D) Car Demand Management (Smart Measures)	Bus quality contracts / statutory partnerships
	Widespread implementation of travel plans
	Provide community hubs
E) Freight	Freight best practice
F) Land Use Planning	Urban density increases
G) Aviation	Improve public transport surface access to airports

4. BASELINE AND BAU SCENARIO

4.1 Establishment of Baseline and BAU Scenario

The first stage in the detailed assessment of the potential impact of the identified policy options was to establish a Business as Usual (BAU) baseline 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 determinants of transport volumes and associated emissions. Such determinants include: 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.

The table on the next page presents the forecast baseline emissions for 2022 (the end of the third Committee on Climate Change (CCC) Carbon Budget timescale). For comparison, the estimates are set against the 1990 emissions outturns (as measured in the National Atmospheric Emissions Inventory) and the consequent reduction required in order to meet the targets identified in the Climate Change (Scotland) Act.

The table also shows the further potential impact on forecast emissions levels of the measures proposed by the Strategic Transport Project Review (STPR) and national and regional action on vehicle technology represented through the supply side of the CCC's Extended Ambition scenario in their 2008 report *'Building a Low-Carbon Economy - the UK's Contribution to Tackling Climate Change'*.

The net effect is that to meet the target of a 44% reduction in emissions relative to 1990 in 2022 (acting as a proxy for the 42% reduction target by 2020 as specified in the Climate Change (Scotland) Act), a further reduction of around 6.1 MtCO2 p.a. in emissions from land transport would be required or 9.5 MtCO2 if total transport emissions are considered (including domestic and international aviation and shipping).

Table 2: BAU baseline with UK/EU measures

Source	***1990***	***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% proxy target			-7.3
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			-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

4. POLICY ASSESSMENT

4.1 Abatement Potential by Policy Option

The annual abatement potential of each policy option varies with both scale of implementation and the year under consideration as illustrated in Table 3.

The table shows 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.

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 on an ambitious scale.

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 3 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.

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.

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.

Table 3: Abatement Potential by Policy Option in 2022 (Central & Ambitious Scenarios)

Policy Option	***Intensity 2022 (MtCO2 p.a*)***	
	Central	*Ambitious*
Electric car technology & network development	0.08	0.16
Procurement of low carbon vehicles	0.00	0.01
Active traffic management	0.02	0.02
National motoring package	0.11	0.17
Speed reduction on trunk roads	0.18	0.30
Bus/rapid/mass transit infrastructure investment (including bus priority)	0.01	0.01
Cycle infrastructure investment	0.05	0.12
High speed Rail links	0.00	0.02
National network of car clubs	0.04	0.10
National road user charging	0.00	0.33
Introduction or increase in public parking charges	0.02	0.13
Rail investment	0.00	0.00
Introduction/raise in residential/private parking charges	0.02	0.02
Bus /LRT fares reductions	0.00	0.01
Walking infrastructure investment	0.02	0.05
Workplace parking levy	0.22	0.22
Bus quality contracts / statutory partnerships	0.15	0.18
Widespread implementation of travel plans	0.66	0.95
Provide community hubs	0.14	0.14
Freight best practice	0.09	0.09
Urban density increases	0.01	0.02
Improve public transport surface access to airports	0.00	0.01

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

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 can 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%.

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.

4.2 Year of Abatement

Table 4 shows 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.

Table 4: Abatement Potential by Policy Option, 2012-2030 (Ambitious Scenario)

Policy Option	***Annual by Year (Ambitious) (MtCO2*)***				***Cumulative***
	2012	2017	2022	2030	2010-2030
Electric car technology & network development	0.00	0.04	0.16	0.16	1.89
Procurement of low carbon vehicles	0.01	0.01	0.01	0.01	0.16
Active traffic management	0.01	0.02	0.02	0.02	0.30
National motoring package	0.12	0.24	0.17	0.06	2.86
Speed reduction on trunk roads	0.22	0.33	0.30	0.30	5.60
Bus/rapid/mass transit infrastructure investment (including bus priority)	0.01	0.01	0.01	0.01	0.17
Cycle infrastructure investment	0.04	0.10	0.12	0.11	1.84
High speed Rail links	0.00	0.00	0.02	0.03	0.25
National network of car clubs	0.01	0.06	0.10	0.08	1.32
National road user charging	0.00	0.00	0.33	0.33	3.62
Introduction or increase in public parking charges	0.09	0.15	0.13	0.12	2.35
Rail investment	0.00	0.00	0.00	0.00	0.03
Introduction/raise in residential/private parking charges	0.01	0.02	0.02	0.02	0.33
Bus /LRT fares reductions	0.00	0.01	0.01	0.01	0.09
Walking infrastructure investment	0.01	0.04	0.05	0.04	0.70
Workplace parking levy	0.00	0.25	0.22	0.22	3.61
Bus quality contracts / statutory partnerships	0.04	0.10	0.18	0.28	3.05
Widespread implementation of travel plans	0.43	0.71	0.95	0.92	15.09
Provide community hubs	0.07	0.11	0.14	0.14	2.23
Freight best practice	0.07	0.11	0.09	0.08	1.72
Urban density increases	0.00	0.02	0.02	0.02	0.25
Improve public transport surface access to airports	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

4.3 Mechanisms for Abatement

Each policy option achieves the estimated abatement potential shown in the tables above 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); and improvement in the emissions efficiency of travel, achieved through both vehicle technology and driver behaviour (including speed).

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 0.9MtCO2 (in 2022) 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).

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.

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).

4.4 Cumulative Abatement

The patterns of abatement through time are also reflected in the final column in Table 4 which shows the estimated cumulative abatement potential for each policy option over the 20 year interval between 2010 and 2030.

The relative ranking 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.

4.5 Cost Effectiveness and Marginal Abatement Cost Curve (MACC)

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

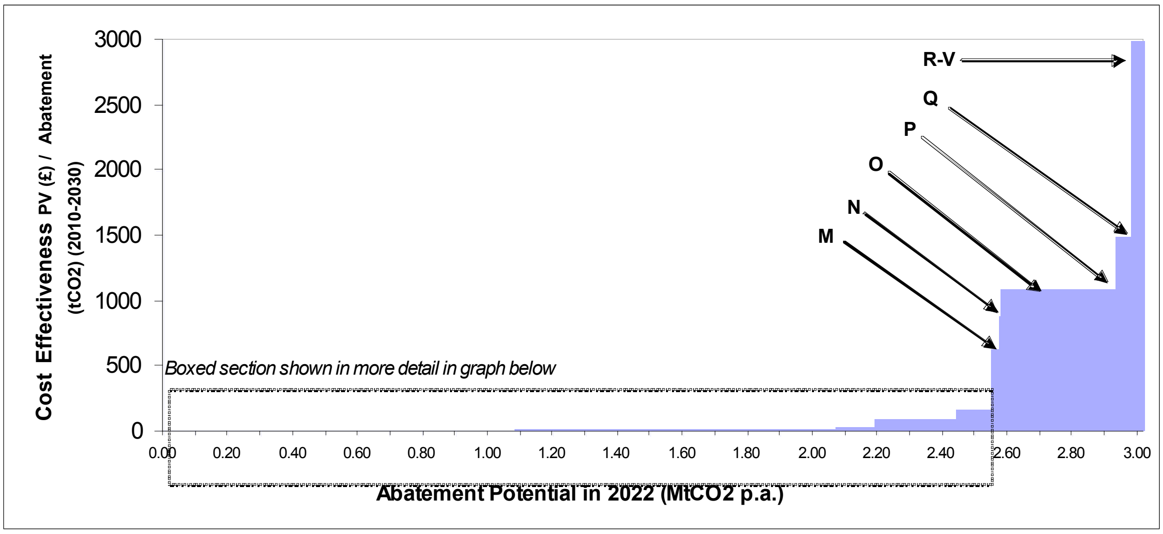
$$\frac{\textit{[PV of total capital and operating costs between 2010 and 2030 discounted to 2008 prices/values]}}{\textit{[estimated abatement potential between 2010 and 2030 in MtCO2]}}$$

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 3 and 4 below.

A number of points are relevant in interpreting the curve:

i. Policy options are arranged across the graph horizontally in order of descending cost effectiveness;
ii. The width of each bar represents the broad annual abatement potential of the policy option in 2022 (in $MtCO_2$ p.a.);
iii. The height of each bar represents the measure of the cost effectiveness of each policy option ;
iv. 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
v. 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.

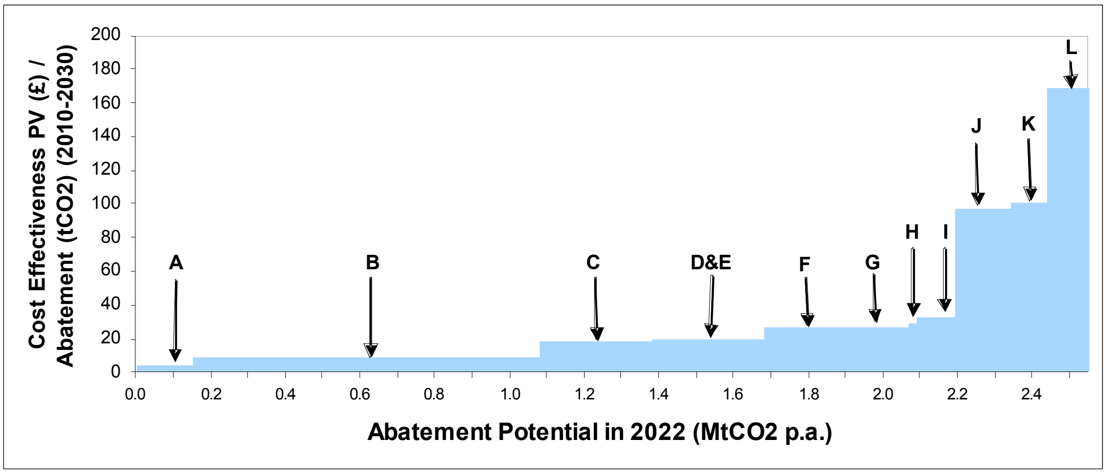
Figure 3: Marginal Abatement Cost Curve - Ambitious Implementation of Policy Options



Key

Code	Measure ID	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: 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

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:

i. 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);
ii. 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);
iii. 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

iv. 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.

4.6 Embodied Carbon

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.

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).

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.

4.7 Abatement Potential by Scenario

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.

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).

For instance, the Central Scenario is forecast to cause a reduction in vehicle kilometres of approaching 10%, focussed particularly on car kilometres. The equivalent estimate reduction caused by the Ambitious Scenario is 15%, again largely the result of reductions in car kilometres.

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).

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.

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 proxy 2022 level of a 44% reduction from 1990 total transport emissions. 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.

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 effect (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.

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%.

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.

4.8 Abatement Beyond 2022

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.

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 future trends that are likely to be important. The key influence is expected 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 CCC 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 both the transport and electricity networks.

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