TRANSPORT TECHNICAL APPENDIX

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On 1st December 2008, the Committee on Climate Change (CCC) produced its first report to Government *Building a low-carbon economy – the UK's contribution to tackling climate change*, which included advice on setting the first three carbon budgets, to 2022. The CCC recommended a unilateral commitment to at least 34% reduction by 2020 compared to 1990, with the intention of increasing this to 42% in the event of an international agreement. Within the domestic transport sector there is substantial potential to reduce emissions: through the technical improvement of vehicles especially private cars and vans but also through influencing travel behaviour through measures to encourage eco-driving, speed-limiting and choosing less carbon intensive forms of transport. Quantities of potential emissions reduction from domestic transport were included within the proposed carbon budgets.

This note provides further detail on calculations behind the estimates of emissions reduction from transport provided in the report. The scope of these calculations covers the supply side for cars, vans and HGVs; and demand side calculations, including 'eco-driving' and speed limiting options.

For some potential from transport, including emissions reduction in rail and from Smarter Choices policy, the CCC did not conduct modelling. References for the DfT-led work which did produce these estimates is given in our December report and not covered here.

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1. OVERVIEW OF APPROACH: DEFINING SCENARIOS

For all sectors, including transport, potential emissions reduction is estimated against a reference scenario. The reference scenario is broadly a projection of emissions as if there were no policy action (unless policies already exist or are 'firm and funded', in which case their impact is reflected in the reference scenario).

For cars, the reference scenario assumes there is no further policy, that is, no policy following on from the EU Voluntary Agreements, which end in 2008-09. A mandatory successor to the VA has been proposed but details of the scheme are still being worked out and will not be in legislation until after the December report is produced.

For vans and HGVs it is assumed that these modes continue to be outside of the EU framework for targets on new vehicle emissions.

For biofuels for road transport, current UK legislation is the Renewable Transport Fuels Obligation (RTFO) which aims for 5% (by volume) of all road transport fuels coming from biofuels by 2010. The EU also proposed, in January 2008, a mandatory target for biofuels for Member States of 10% by energy in 2020. In July 2008, the Gallagher Review of the Indirect Effects of Biofuels collated the latest evidence on biofuels sustainability and greenhouse gas impacts. As a result of the Gallagher Review, the UK and EU targets are both open to change. The CCC, therefore, decided to use the Gallagher recommendations, rather than previous policy commitments in the reference projection.

The CCC reference projection includes biofuels use for road transport increasing to 4% by energy (5% by volume) by 2013, remaining fixed at that level for future years.

Three projections of potential emissions reduction were produced, defined around different levels of policy ambition and technological development. These were called Current Ambition, Extended Ambition and Stretch Ambition, although within transport, the Current Ambition should not be taken to include all existing policies; for example, for biofuels we have not assumed the policy but rather a revision to it (as in the reference projection).

Table 1 summarises the scenarios we considered, the measures we included in each of them and the modelling approach we used. It is important to note that:

The supply side model works in terms of uptake of technology, which can be interpreted as having implications for policies. Targets for new vehicle emissions are not an input to the model. New vehicle emissions reductions are a consequence of the technologies selected.

All demand side calculations are additional to the technological efficiency gains (i.e. when estimating eco-driving, it is the more efficient vehicles using technology from the Extended Ambition scenario which are being 'eco-driven'). This methodology avoids double counting and overstating potential from the demand side.

Table 1. Description of CCC scenarios for the transport sector

Scenario	Description of measures	Modelling approach
Current Ambition	Successor policy on new car emissions, but which does not achieve the proposed EU targets	Supply side model – hybrid technology bundle; plus some non-powertrain (low uptake). Outputs adjusted for rebound effect.
	No strong policies introduced for van and HGV emissions (but uptake of negative cost technology increases over the reference)	Supply side model – stop start technology bundle (vans); plus non-powertrain (vans and HGVs) –low uptake. Outputs adjusted for rebound effect.
	No biofuels additional to the reference projection	
	No demand side policies	
	No abatement from rail	
Extended Ambition	Successor policy on new car emissions, achieving 95 gCO_2/km in 2020	Supply side model – plug-in and electric cars; plus non-powertrain (high uptake). Outputs adjusted for rebound effect.
	No strong policies on van and HGV emissions (but uptake of negative cost technology increases over the reference)	Supply side model – stop start (vans) hybrids (HGVs); plus non-powertrain –high uptake Outputs adjusted for rebound effect.
	Biofuels uptake increases over the reference projection after 2013	Supply side model – % of road fuel used by cars, vans and HGVs which comes from biofuels rises from 2014 to 8% in 2020, by

		energy (i.e. 4% additional to reference by 2020)
	Demand side Smarter Choices policy (estimated by DfT)	
	Eco-driving for cars, vans and HGVs	Off-model adjustment, based on fuel efficiency reached in Extended Ambition supply side modelling (see above).
		Eco-driving for cars and vans therefore reduces emissions by 3% and is taken up at 1% per year, reaching 12% of all cars and 12% of all vans in 2020.
		Eco driving for HGVs reduces emissions by 4% and is taken up in line with the introduction of the mandatory Driver Certificate of Professions Competence, reaching 100% of all HGVs after 2014.
	Abatement from rail (estimated by DfT-led rail carbon trajectories working group)	
Stretch Ambition	EU policy on new car efficiency as in Extended Ambition	
	Strong (EU) policy on vans is introduced	Supply side model -- plug-in hybrid and electric vans (and small rigid HGVs); plus additional non-powertrain for HGVs – high uptake.
	Stronger policy on HGVs is introduced	
	More ambitious policy for 'eco-driving' cars and vans	Off-model adjustment, based on fuel efficiency reached in Extended Ambition supply side modelling (see above).
		Eco-driving for cars and vans reduces emissions by 3% but is now taken up by 40% of all cars and the same for vans in 2020

	Policy achievement of Smarter Choices as in Extended Ambition	
	Eco-driving policy on cars and vans more aggressive	Cars and vans which drive above 60mph now drive at the new speed limit
	Eco-driving policy for HGVs as in Extended Ambition	
	Abatement from rail as in Extended Ambition	
	Speed limits are reduced to 60mph and effectively enforced (on roads which are currently above this)	

2. SUPPLY SIDE CALCULATIONS

2.1 Modelling principles

As introduced in the December report, the supply side emission reduction opportunity was estimated using a marginal abatement cost curve (MACC) model, which orders options for emissions reduction from the most cost-effective (i.e. lowest cost per tonne of abatement, usually negative) to the least cost-effective (i.e. highest cost per tonne of abatement, possibly high above the costs in the reference scenario). The horizontal axis of the MACC graph shows the volumes of emissions reduction from option, so that the total volumes and costs can be seen by 'adding up' across the ordered options.

The CCC supply side model is a bottom-up MACC model which includes detailed stock models of all modes covered (cars, vans and HGVs) and models improvements in efficiency (without changing energy source); and fuel switching to electricity or biofuels. Improvements in efficiency can come from two sources: powertrain technologies (e.g. stop-start or hybrid technology); and non-powertrain technologies (e.g. improved aerodynamic design or low rolling resistance tyres).

For each mode, 2006 data on the stock is taken, which includes a breakdown of vehicles by petrol or diesel and by age. This data therefore gives a profile of the stock (or fleet) of vehicles at one point in time, in 2006.

Cars and HGVs are further disaggregated. The car segments are small, medium and large. The HGV segments are rigid (under and over 7.5 tonnes); and articulated (under and over 33 tonnes). The stock model, technologies, abatement modelling, costs etc are all performed for the segments in the model, which can be aggregated back up to totals by mode. For ease of description, only the modes are referred to below. The model works on the same principles for all segments and modes.

As we are interested in knowing how particular technologies (e.g. petrol hybrids) contribute to abatement opportunities over time, the total petrol vehicles in the stock model are further disaggregated by technology. The emissions (gCO_2/km) of each technology are reconciled with sales figures and total emissions for each mode, to ensure that there is consistency between the stock, technology, and carbon efficiency in the model and in actual recorded data[1].

Matching the data in this way means that a lot of detail can be obtained from the model, for example, how many stop-start petrol cars there are, average emissions of new diesel cars, total fuel consumed by HGVs (as carbon efficiency can be easily translated into energy and therefore fuel).

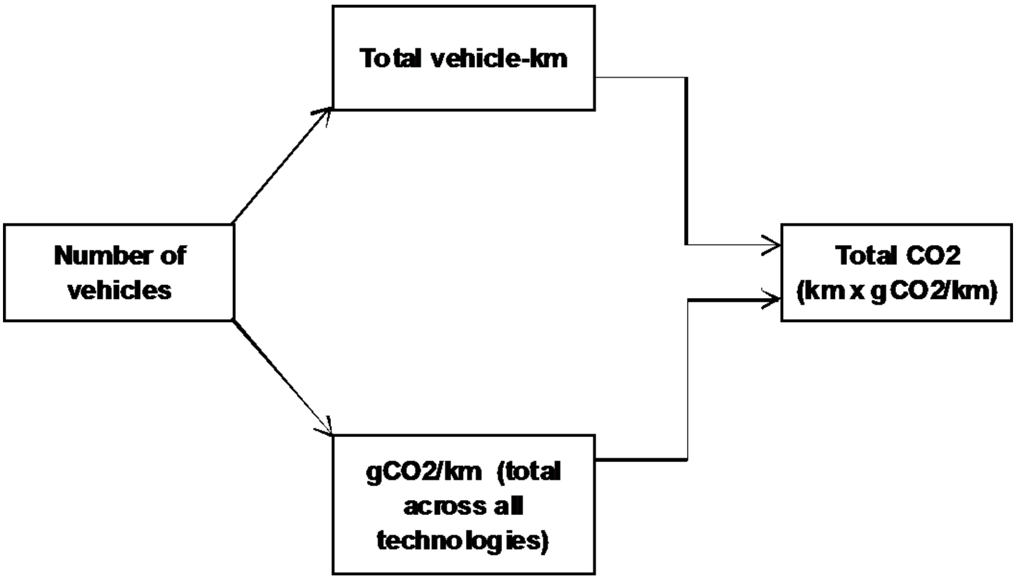
Total vehicle stock also influences total distance travelled (i.e. vehicle-km) in the model. The model does not produce vehicle-km data by mode endogenously – these data have been provided by running the Department for Transport's National Transport Model using the CCC's input assumptions. As vehicle-km are not directly modelled, the rebound effect (increased distance travelled as efficiency improvements reduce costs per km) is not taken into account. As described in the December report, all results are adjusted for the rebound effect, using an elasticity derived from the NTM, which does endogenously account for rebound and congestion impacts[2].

With total vehicle stock, vehicle-km and emissions by technology, total emissions can be calculated as follows:

Figure 1. Basic schematic of supply side model calculation

1 This reconciliation exercise was undertaken by the consultants, AEA, with input on efficiency by technology from Ricardo.

2 For details of the adjustment please see p15 in the supporting document 'Building a UK transport supply side marginal cost curve'.



In producing a MACC graph, the model also contains costs by technology, then by vehicle segment, corresponding to the detailed technology data. The model then takes these costs data and the changes in volumes of emissions as a result of applying the technology bundle, to calculate the costs per tonne of CO_2 abated.

For MACCs, 'cost-effectiveness' is a judgement made from the cost of abatement per tonne of emissions abated. The threshold for cost-effectiveness of MACC options can be taken as the cost of carbon permits (i.e. the cost of emissions reduction in sectors covered by emissions trading schemes). This equalises costs of abatement across sectors.

2.2 Reference projection

The stock model uses information on the age of vehicles, the survival rate of vehicles at each age, and projections of the total number of vehicles in the fleet[3] to produce a number of new vehicles to be purchased each year. Each new vehicle has to be characterised by a powertrain technology and potentially by distinctive non-powertrain technologies. These are modelled using 'technology bundles' which assign uptake rates by technology, such that

3 Projections of the total number of cars is produced using the TEMPRO model by the Department for Transport. For vans and HGVs, the model assumes a 1% p.a. growth in total stock.

total uptake across all technologies equals 100% of new vehicles entering the stock.

- As powertrain technologies are not additive (i.e. car cannot be a petrol car and a diesel car) the mix of powertrain technologies always has to equal 100% of vehicles and, because a mix of technologies currently exists and would be expected to into the future, there is never 100% penetration of any single powertrain technology for cars.

- As non-powertrain technologies are additive in the sense that a petrol car can have low rolling resistance tyres and be of aerodynamic design, uptake of any non-powertrain technology could in principle reach 100% of all vehicles (allowing for supply constraints and costs).

The reference scenario assumes no new policy on reducing emissions from transport after the end of the current Voluntary Agreements. Specific assumptions for the reference projection include:

- for cars, the recent popularity of diesels continues (although diesel uptake in new car sales remains below 50% by 2022.

- uptake of non-powertrain measures (such as low rolling resistance tyres) remains at zero for cars, vans and HGVs.

- zero plug-in or electric vehicles (i.e. no fuel switching to electricity).

- increasing uptake of biofuels, to 4% by energy in 2013 and fixed at that level. This is calculated by taking the carbon efficiency by technology (as described above) and converting it into energy efficiency. Across cars, vans and HGVs this gives total energy. The biofuels uptake rate in each year then reduces emissions against the total emissions from 100% petrol and diesel. Biofuels are accounted for as zero emissions in the supply side model[4].

Figure 2 below shows the uptake of technologies in the reference projection, for 2008 to 2022. The Figure shows that there is a mix of technologies in the fleet, consistent with actual car purchases. The mix of technologies is fixed over time, with only the balance of petrol and diesel changing (rather than increased uptake of lower emitting technologies). In each year, total uptake across all technologies equals 100%.

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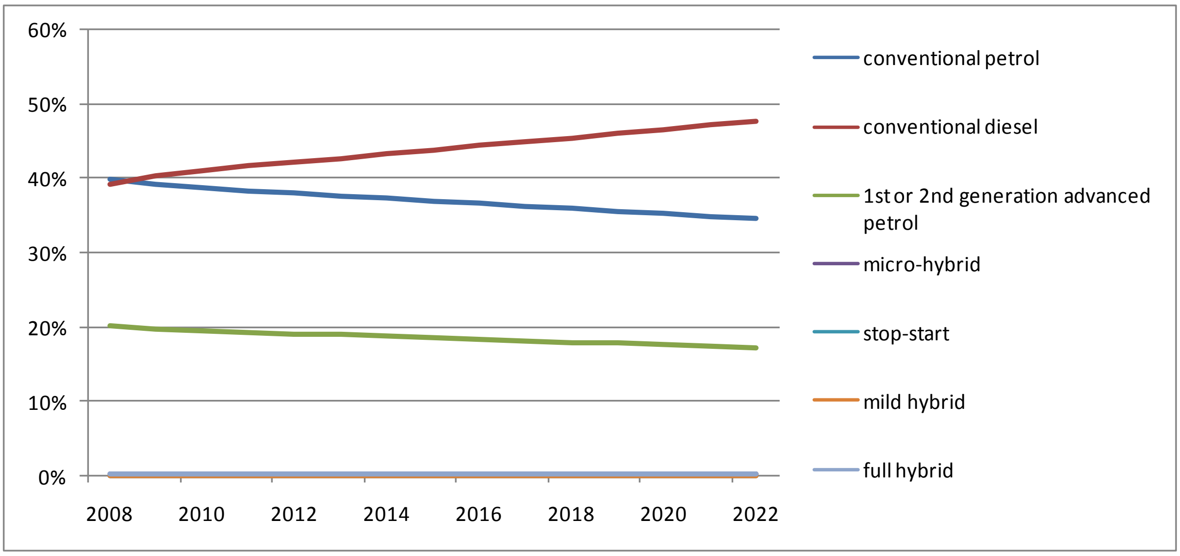
[4] This follows standard tailpipe accounting, plus the CCC is only to address emissions produced in the UK and avoids double-counting with emissions from biofuels grown or processed in the UK, as other MACC models cover other sectors.

Figure 2. Reference projection technology bundle for cars



For vans, existing technology is simply split between conventional diesel and conventional petrol (which makes up a small proportion of vans). This split remains static from 2008 to 2022.

All HGV segments in the model use only conventional diesel technology for the whole period 2008 to 2022, in the reference projection.

2.3 Abatement opportunities

Abatement opportunities[5] are described by alternative sets of technology bundles which see an increasing uptake of lower-carbon technologies (and a simultaneous falling uptake of conventional technologies, as total uptake across all technologies must equal 100% of all

5 Reductions in emissions could also be achieved through downsizing vehicle choices, with less action on technologies themselves.

new vehicles). The names of the technology bundles relate to the key lower carbon technology that ultimately characterises them (e.g., micro-hybrids), but in each bundle there is still a mix of technologies being taken-up, with uptake of the lower-carbon technologies being constrained by feasible development and supply.

To reflect uncertainty about feasible uptake rates for most technology bundles a ‘low’ and ‘high’ variant have been defined, with different levels of uptake of the key lower-carbon technology they refer to. For example, in the low van stop-start technology bundle, uptake of stop-start reaches a maximum of 46% of new vans in 2020, compared to a maximum of 79% of new vans in 2020 in the high van stop-start technology bundle. Overall therefore, two sets of technology bundles (low and high) have been identified across the spectrum of key lower-carbon technologies.

Scenarios are then identified by selecting a compatible set of technology bundles across modes and market segment (subject to the non-additivity constraint for powertrain scenarios within each market segment). In particular, the CCC scenarios have been defined as follows:

For the **Current Ambition scenario**, the hybrid technology bundle for cars is used (excluding plug-in hybrids); for vans is stop-start technology. Current Ambition also includes uptake (at low rates) for non-powertrain technologies, for cars, vans and HGVs.

For the **Extended Ambition scenario**, the plug-in and electric technology bundle for cars is used; with stop-start for vans (at high uptake rates) and hybrid rigid HGVs (at high uptake rates). Non-powertrain technologies are also taken up at high uptake rates for cars, vans and HGVs. However, as the extended scenario still assumes no policy action on vans and HGVs, only negative cost (i.e. money saving) more efficient technologies are taken up. This means that some non-powertrain measures for HGVs are not included (e.g. some weight reduction and aerodynamics).

For the **Stretch Ambition scenario**, there is no further modelling for cars (the most abating technologies, plug-in hybrids and electric cars are already taken up at high feasible rates in the Extended Ambition scenario). Stretch Ambition assumes policy action on vans and HGVs, so technology bundles with lower emissions technologies are now modelled, at high uptake rates, including remaining non-powertrain technology for HGVs.

Table 2 shows the uptake rates for various technologies for cars, vans and HGVs across the scenarios modelled. The table shows how, in moving from reference to Stretch Ambition, the uptake of lower emitting technologies increases.

Table 2. Uptake rates for different technologies in CCC scenarios in 2020

	Reference projection	Current Ambition	Extended Ambition	Stretch Ambition
Car technology				
Petrol or diesel (conventional or advanced)	99.4%	12.9%	2.9%	2.9%
Stop-start + micro hybrid	0.5%	64.5%	38.1%	38.1%
Hybrids	0.3%	22.6%	38.3%	38.3%
Plug-in hybrids	0.0%	0.0%	8.7%	8.7%
Electric vehicles	0.0%	0.0%	12.1%	12.1%
Van technology				
Conventional petrol or diesel	100.0%	54.0%	21.4%	14.2%
Stop-start +micro hybrid	0.0%	46.0%	78.6%	47.4%
Hybrids	0.0%	0.0%	0.0%	16.8%
Plug-in hybrids	0.0%	0.0%	0.0%	5.6%
Electric vehicles	0.0%	0.0%	0.0%	16.0%
HGV technology				
Conventional petrol or diesel	100.0%	100.0%	34.4%	33.0%
Stop-start + micro hybrid	0.0%	0.0%	53.7%	48.2%
Hybrids	0.0%	0.0%	7.8%	7.8%
Plug-in hybrids	0.0%	0.0%	4.1%	4.1%
Electric vehicles	0.0%	0.0%	0.0%	6.9%

The marginal abatement quantity of emissions reduction is reached as the model takes the total emissions produced by running the technology bundle away from the total emissions in the reference projection. The result is the difference in emissions between the reference projection and the technology bundle (i.e. the reduction in emissions).

Table 3 shows the emissions reduction for the supply side modelling in 2020. The table shows that in using plug-in and electric technology for vans, rather than stop-start technology, potential emissions reduction increases from 0.3 MtCO2 to 2.4 Mt CO2. In other words, the emissions reduction from the Stretch Ambition scenario is not additive to those in the Extended Ambition scenario – one technology bundle replaces the other.

Table 3. Summary of 2020 supply side emissions reduction by CCC scenarios

Measure	Current Ambition	Extended Ambition	Stretch Ambition
Car- powertrain- hybrid	-4.1		
Car- nonpowertrain- large cars	-0.2		
Van-powertrain- stop start (slower uptake)	-0.1		
Van-nonpowertrain (slower uptake)	-0.3		
HGV- nonpowertrain (slower uptake)	-0.3		
Car- powertrain- plug-in hybrid and electric		-8.7	
Car- nonpowertrain- all cars		-2.9	

Van-powertrain- stop start	-0.3	
Van-nonpowertrain	-0.8	
HGV- powertrain- hybrid	-0.2	
HGV- nonpowertrain	-0.7	
Van-powertrain- plug-in hybrid and electric		-2.4
HGV-powertrain- plug-in and electric		-0.3
HGV- nonpowertrain- incl aero and weightreduction		-0.7

The Extended and Stretch scenarios also modelled abatement from fuel switching. In the Extended scenario, this included electricity for cars; and increased biofuels for cars, vans and HGVs. Fuel switching abatement opportunities are modelled in the same way as biofuels in the baseline. For each technology bundle modelled, carbon efficiency can be converted into energy efficiency, and total energy for cars, vans and HGVs calculated. Uptake of biofuels is then applied (to a maximum of 8% energy by 2020). Similarly, for electric vehicles, energy efficiency figures give the amount of electricity demanded[6].

2.4 Costs of supply side abatement opportunities

The costs data cover powertrain and non-powertrain technologies and biofuels. As with the technology bundles, a range of cost estimates was gathered from the literature. Current

6 As with biofuels, emissions from electricity are counted as zero. This is partly because this is traditional tailpipe accounting; and partly because the CCC was asked to assess traded and non traded sector emissions and electricity is part of the traded sector (unlike the rest of transport). This does not mean emissions from electric cars are zero; however, CCC power sector modelling includes emissions from electricity, so including them under transport would be double counting.

costs of technology are estimated as 'high' or central' and the model can be run using either set.

Whether the high or cost estimates is used, the model explicitly links uptake rates and learning rates in projecting costs of the technology bundles in being modelled. Learning rates define how quickly costs fall as production increases. For technology which is well established (e.g. conventional petrol engine), costs will not fall with increased production. For technology still in development (e.g. electric vehicles) costs fall more rapidly.

The uptake rates by technology in each technology bundle describe how production changes over time. The model applies the learning rates by technology to these data, to give estimates of costs by technology in each year which endogenously accounts for learning. It should be noted however that while in modelling terms learning is endogenised, this reflects the implicit assumption that under each scenario/set of technology bundles the broader EU vehicle market would follow a similar path of development in terms of technology mix. Unilateral UK moves towards adoption of low-carbon technologies would not be sufficient to unlock the learning effects assumed in the model (as well as being a very unlikely policy outcome).

To draw the final MACC, for each technology bundle, the model plots the total emissions saved on the horizontal axis against the cost per tonne of abatement on the vertical axis.

In estimating the costs, the model can run either social or private costs. The December report describes the differences in discount rates and treatment of taxes between the two approaches[7], and presents final MACC graphs.

3. DEMAND SIDE CALCULATIONS

3.1 Eco driving: cars, vans and HGVs

Eco-driving is a means of driving any vehicle more efficiently, saving money and reducing emissions. Savings come from driver behaviour (good gear change; smooth acceleration and braking; intelligent use of air conditioning and heating) and from vehicle maintenance (keeping tyres pumped up). Such efficiency gains can be made by drivers of any vehicle[8].

[7] See p 271 of the main report; 'Building a low carbon economy – the UK's contribution to tackling climate change'

[8] As eco-driving improves efficiency, it lowers fuel costs. There are therefore likely

For cars, vans and HGVs, it is likely that higher savings from eco-driving are gained during tests (a range of 5 –10% is commonly reported) than are seen in 'real world' conditions. It is unlikely that everyone will eco-drive in the most efficient possible way, all of the time – so this consideration factors down the test-measured savings. In addition, there is the risk of double-counting with speed adherence measures and with some technologies (for example, gear shift indicators are included in our non-powertrain measures). The gains from eco-driving also depend on traffic conditions and technology of the vehicle being driven.

For these reasons, we have assumed that eco-driving results in efficiency savings of 3% for cars, and the same for vans.

As HGVs are commercial operations, likely to be more strongly motivated to save money and able to put in place enforcement policies within firms, eco-driving results in efficiency savings of 4%.

In order to avoid double counting, we have taken the fuel efficiency produced in the Extended Ambition technology and applied eco-driving to this (for cars, vans and HGVs). This takes account of the fact that saving 3%of emissions from a low emitting vehicle saves a smaller quantity of emissions than a 3% reduction from a higher emitting vehicle. In addition, as the option for eco-driving plug-in and electric vehicles is more limited, they have been excluded from the calculation (i.e. eco-driving is only taken up among the remaining car stock).

There are no available figures on the number of people who are already practising eco-driving techniques or how many emissions may already be being saved. Although eco-driving is now compulsory part of the driving test for cars, it is not known how many of the 75,000 people who gain a drivers licence per year will become regular car drivers immediately or how many would maintain eco-driving or at what level. Some of the emissions abatement, therefore, could be part of 'business as usual' under the reference projections, rather than additional abatement.

The supply side model works in terms of number of vehicles – cars, vans and HGVs – not in terms of the number of people or drivers. For this reason, we have made the simplifying assumption that the cars owned are being driven more efficiently, rather than identifying people. Where we have assumed eco-driving is taking place, this is equivalent to assuming that, on average, everyone who drives that car is eco-driving 3% more efficiently than previously. On average, this assumption should not make a large impact on the estimates as it is reasonable to assume that only people who drive regularly would take up eco-driving (the main motivator probably being to save money) and, if they drive more than one car, it

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to be no costs, or even net benefits, to eco-driving.

might be reasonable to assume they would eco-drive in all of them.

Cars. In calculating eco-driving in cars, we have defined two possible scenarios. For the Extended Ambition scenario, 1% of cars owned are driven by people eco-driving (saving 3% of emissions) cumulatively each year, starting from 2009 (i.e. by 2022, 14% of cars are being eco-driven). This is consistent with estimates of car eco-driving by the Department for Transport[9]. In the Stretch Ambition scenario, it is assumed that 40% of cars are being eco-driven in 2020 and a straight line trajectory is pulled backwards to 2009 when the policy starts with 1% of cars. This is consistent with assumptions on car eco-driving training by the Commission for Integrated Transport (CfIT)[10].

Vans. With some existing policy action (e.g. Safe And Fuel Efficient Driving) but with a lack of a policy framework to ensure van eco-driving is strongly implemented, we have used the same assumptions for vans as for cars. Again, we have avoided double counting (gear shift indicators are taken up by vans in the Extended Ambition supply side modelling) and the uptake varies by the Extended and Stretch Ambition scenarios.

HGVs. For HGVs, there will be the introduction of mandatory training from September 2009, with every driver compulsorily covered by the Driver Certificate of Professional Competence by 2014 (this covers bus as well as HGV drivers). This will include five days of training every five years; and commercial operators are more likely to be able to achieve eco-driving savings. Therefore, HGV eco-driving is modelled in the Extended scenario as reaching 100% of HGVs from 2014 and remaining at that level.

3.2 Effective speed enforcement and reduction

Emissions from vehicles and numbers of vehicles travelling at different speeds has been based on data from the National Atmospheric Emissions Inventory and the Department for Transport[11]. Across these various tables, data are provided on emissions by speed for

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9 For example, see Department for Transport (2008), *Carbon Pathways Analysis: Informing Development of a Carbon Reduction Strategy in the Transport Sector*, DfT.

10 Commission for Integrated Transport (2007) *Transport and Climate Change: Advice to Government from the Commission for Integrated Transport.* London.

11 See, for example: http://www.dft.gov.uk/162259/162469/221412/221546/226956/227020/227084/vehiclespeedsingreatbritain2005

typical vehicles; numbers of vehicles and average speeds (in various speed bands) on by road type; and vehicle-km by vehicle type by road type. These data show that distances travelled above 60mph are most significant for cars and vans on motorways and A roads, and so this is what is covered in our calculations. These data are used to calculate emissions by type of road and by vehicle type (e.g. cars on motorways) as follows:

Total vehicle-km on each road by each vehicle type are split into speed bands using the proportions of vehicles in each speed band. Average efficiency by vehicle type is then adjusted for the speed-efficiency relationship. Total emissions in each speed band (for each vehicle type and road type) are calculated as gCO_2/km multiplied by vehicle-km. The emissions abatement from sticking to speed limits is calculated by taking away the total emissions in all bands higher than the speed limit; then adding on emissions from increased vehicle-km travelled at the speed limit (at an improved efficiency).

The technologies from our Extended Scenario result in improved efficiency at all speeds and increased vehicle-km compared to those in these published tables. As efficiency improves, the emissions to be saved from speed limiting reduce. Therefore, we have calculated emissions savings[12] in 2020 from lowering and enforcement of the speed limit by taking the projected Extended Ambition efficiency and vehicle-km and then applying the same methodology (we have assumed the same proportion of total vehicle-km is driven in each speed band, as in the current data).

4. TOTAL EMISSIONS REDUCTION FROM TRANSPORT

The total available emissions reduction from transport is calculated across all the supply and demand side together. As demand side calculations are based on the Extended Ambition technologies used, supply and demand can be added together. It is only when moving between powertrain technology bundles between Current, Extended and Stretch Ambition that abatement is no longer additive, but bundles substitute for each other. The total abatement identified includes the Smarter Choices and rail abatement, which was not modelled by the CCC. Table 4 shows the total transport abatement identified by the CCC.

[12] Costs or benefits of enforcing and lowering speed limits were not estimated. Factors which are likely to be important include time costs (although there could be reductions in journey times if steady speeds improve traffic flow); journey quality and possibly rebound effects as people adjust journey choices with changes in travelling times.

Table 4. Total transport abatement

Measure	Current Ambition	Extended Ambition	Stretch Ambition
Car- powertrain- hybrid	-4.1		
Car- nonpowertrain- large cars	-0.2		
Van-powertrain- stop start (slower uptake)	-0.1		
Van-nonpowertrain (slower uptake)	-0.3		
HGV- nonpowertrain (slower uptake)	-0.3		
Total	**-5.0**		
Biofuels		-5.0	
Car- powertrain- plug-in hybrid and electric		-8.7	
Car- nonpowertrain- all cars		-2.9	
Van-powertrain- stop start		-0.3	
Van-nonpowertrain		-0.8	
HGV- powertrain- hybrid		-0.2	
HGV- nonpowertrain		-0.7	
Rail- efficiency measures		-0.6	
Demand- Smarter Choices		-2.9	
Demand- Eco driving - cars		-0.3	
Demand-Eco driving - vans		-0.1	
Demand-Eco driving -HGV		-0.9	
Total abatement		**-23.3**	
Van-powertrain- plug-in hybrid and electric			-2.4
HGV-powertrain- plug-in and electric			-0.3
HGV- nonpowertrain- incl aero and weightreduction			-0.7
Speed reduction and enforcement at 60mph			-5.2
Eco-driving cars - far reaching			-1.0
Eco-driving vans - far reaching			-0.3
Total			**-31.7**