Efficient Driving

A Rapid Evidence Assessment for the Department for Transport

January 2016

Department for Transport

GSR GOVERNMENT SOCIAL RESEARCH Social Science in Government

BROOKLYNDHURST

Contents

Acknowledgements

This report has been researched, written and produced by Tom McInnerney, Gareth Williams, Tim Knight, David Fell and Jonathan Bain of Brook Lyndhurst Ltd. Advice and support, for which the Brook Lyndhurst team is extremely grateful, was provided by Craig Morton of the University of Aberdeen. Thanks are also due to Andrew Scott, Department for Transport, for his project management and editorial comment.

Glossary of terms

CO2	Carbon Dioxide
CSR	Corporate Social Responsibility
EST	Energy Saving Trust
DfT	Department for Transport
PAYD	Pay As You Drive
ROI	Return on Investment
SMMT	Society of Motor Manufacturers and Traders

Executive Summary

Introduction

- This report presents the findings from a rapid evidence assessment undertaken to review recent research on efficient driving.
- Efficient driving is based on a series of techniques (including minimising engine idling, maintaining a steady speed, and avoiding sharp acceleration and braking) that drivers can adopt to reduce their fuel consumption and reduce CO2 emissions.
- The objectives of the rapid evidence assessment were to review recent UK and international evidence on current levels of efficient driving; motivations and barriers; measures to increase efficient driving; and synergies between efficient driving and other policy areas.
- The methodology followed Government Social Research guidance on the conduct of rapid evidence assessments. 295 evidence sources were initially identified and assessed; 55 of these were then reviewed and analysed in detail. Overall, there are still significant gaps and limitations in the evidence base on efficient driving, and several areas for potential further research.

Vehicle Ownership, Mileage and Emissions

- There are nearly 30 million licenced cars and 3.5 million licenced vans in the UK. Most cars are privately owned, while vans are split equally between private and company ownership.
- Privately owned cars and vans account for 76% of the CO2 emissions arising from car and van travel; while company owned cars and vans account for 24%.
- Personal travel by cars and vans also account for 77% of the total CO2 emissions compared to 23% for business travel by cars and vans.

Current Levels of Efficient Driving and Future Potential

- The majority of private drivers claim to drive efficiently to the best of their knowledge, but indicative evidence suggests most could do lot more – e.g. UK private drivers average “6 out of 10” on an efficient driving scale.
- There is some indicative evidence of variation by demographics – suggesting well educated, affluent women, aged 25 – 65, with low annual mileage using a small vehicle are the most likely to practise efficient driving.
- No equivalent data on levels of efficient driving among employee drivers was identified in this review – either overall or by different types of employee driver.
- Indicative evidence suggests that around 20% of organisations with a vehicle fleet have provided training on efficient driving for their employees and around 25% have introduced in-vehicle telematics. Larger organisations with larger vehicle fleets are also reported to be most likely to be taking action on efficient driving.

- The potential CO_2 savings from efficient driving being adopted more widely are significant – potentially over 220kg per car per year, up to 0.3 million tonnes annually across the UK. Total potential financial savings for drivers are in excess of £15 billion per year across the EU and circa £96 per driver.
- No evidence was identified on the potential savings from efficient driving being adopted more widely by organisations and employee drivers, although this could be estimated making use of existing data.

Motivations and Barriers

- The principal motivation for private drivers to adopt efficient driving is saving money - cited by over 50% as a motivation. Safety is also a factor (although this is not always included in survey options) and environmental concerns are a more limited motivation.
- Barriers to efficient driving for private drivers include: habit; awareness of efficient driving techniques; competing priorities (e.g. to arrive at a destination as soon as possible); social norms; and the presence of other behaviours that drivers can adopt to save either money or emissions (e.g. buying a more fuel efficient car).
- Motivations and barriers are reported to be similar for employee drivers – although they may not be motivated by saving money to the same extent that private drivers are because their fuel costs are generally met by their employer.
- Organisations are primarily motivated to promote efficient driving amongst their employees by potential financial savings on fuel and other associated costs, although safety is also cited as a motivation, as is a desire to project an environmentally friendly corporate image.
- A key barrier for organisations is the current lack of robust, independent data quantifying the return on investment for introducing measures such as training for their employees and in-vehicle technology.

Measures to Increase Efficient Driving

Training

- Efficient driving is not currently a high profile element of training for learner drivers and is not a pass/fail criterion in the current driving test.
- There is a broad consensus that training for existing private drivers can lead to a reduction in fuel use (and the equivalent in terms of CO_2) of up to 25% immediately following the training; and up to 10% in the long-term.
- Finding on the impact of training on employee drivers is similar – suggesting an immediate reduction of up to 25%; and of up to 6.5% in the long-term.
- There is, however, evidence of very low willingness to pay for such training amongst private drivers and organisations may currently be deterred from investing in training for their employees by the absence of reliable return on investment data.

Technology

- A wide range of technologies are covered by the evidence, and whilst there is a shortage of real-world testing all are generally reported to deliver a long-term 5-10% reduction in fuel use (and equivalent in CO_2) for both private and employee drivers.

- In general there is a preference among private drivers for real-time, tailored, visual feedback, but still, the evidence suggests, a low willingness to pay for such technology if it is not already embedded in the vehicle at the point of purchase. The installation of embedded telematics on new cars is expected to surpass 50% by 2020 and 90% by 2025.

- Technology aimed at organisations generally provides feedback to the individual driver and has the additional functionality to benchmark and compare levels of efficient driving across different employees – meaning it is typically more expensive to purchase and that there are additional costs associated with actively making use of it as a management tool.

Communications

- Communication campaigns to promote efficient driving are sometimes cited in the literature as being a necessary accompaniment to either training-based or technology-based approaches, but only one campaign in the Netherlands – which revealed a cost of €9 per tonne of avoided CO_2 – has been robustly evaluated, meaning drawing conclusions about their effectiveness is difficult.

Synergies With Other Policy Areas

- There is strong evidence of road safety benefits arising from efficient driving (e.g. training for efficient driving has been reported to correlate with reductions in subsequent accidents rates of between 14% and 35%).

- There is convincing evidence, too, of financial benefits (for private drivers and organisations) arising from efficient driving, but these have yet to be quantified in their entirety. Efficient driving is widely reported to result in lower maintenance and insurance costs but these savings are not currently incorporated into calculations of the financial benefits of efficient driving.

- The wider environmental benefits of efficient driving (beyond reductions in CO_2) are reported to be relatively minimal or even negative (e.g. some efficient driving techniques may lead to increased emissions of carbon monoxide and hydrocarbon).

- There has been relatively little attention in the literature given to the extent to which such synergies have been harnessed by policy-makers. Looking ahead, the greatest potential for increasing efficient driving may lie in capitalising on overlaps between efficient driving, safety and insurance (notably pay-as-you-drive models).

Conclusions

- Overall, the current evidence-base on efficient driving is patchy, of variable quality and occasionally ambiguous.

- Key gaps in the evidence identified by this review include:

  - the prevalence of different types of efficient driving
  - definitive potential CO2 and £ savings from efficient driving
  - how motivations and barriers compare between different types of driver
  - the comparative effectiveness of different measures to increase efficient driving, and the added value of combining two or more measures

- Potential areas for future consideration by policy-makers and researchers include:
  - enabling all drivers easy access to technologies promoting efficient driving
  - testing and further exploring the linkages between efficient driving, safety and insurance
  - segmenting and targeting of future measures at key types of driver and organisation

1 Introduction

- This report presents the findings from a rapid evidence assessment undertaken to review recent research on efficient driving.
- Efficient driving is based on a series of techniques (including minimising engine idling, maintaining a steady speed, and avoiding sharp acceleration and braking) that drivers can adopt to reduce their fuel consumption and reduce CO2 emissions.
- The objectives of the rapid evidence assessment were to review recent UK and international evidence on current levels of efficient driving; motivations and barriers; measures to increase efficient driving; and synergies between efficient driving and other policy areas.
- The methodology followed Government Social Research guidance on the conduct of rapid evidence assessments. 295 evidence sources were initially identified and assessed; 55 of these were then reviewed and analysed in detail. Overall, there are still significant gaps and limitations in the evidence base on efficient driving, and several areas for potential further research.

1.1 Background

This report presents the findings from a rapid evidence assessment undertaken to review UK and international research on efficient driving. Efficient driving, frequently also referred to as eco-driving, is a collection of driving behaviours intended to reduce fuel consumption. Key aspects of efficient driving:

- Not using air conditioning.
- Minimising engine idling.
- Maintaining a steady speed, and avoiding sharp acceleration and braking.
- Changing up as soon as possible: generally at or below 2,500 rpm.
- Staying in gear when slowing but removing pressure on the accelerator early.

Additional measures that can also improve the efficiency of driving include:

- regular vehicle maintenance
- using the correct engine oil
- checking and maintaining correct tyre pressure
- minimising the weight of the vehicle
- streamlining the vehicle (e.g. by removing un-used roof racks)

1.2 Scope

The rapid evidence assessment was focused on efficient driving in cars and vans. Other vehicle types, e.g. HGVs, buses and coaches, were not considered.

1.3 Aims

The specific research questions this rapid evidence assessment sought to address were:

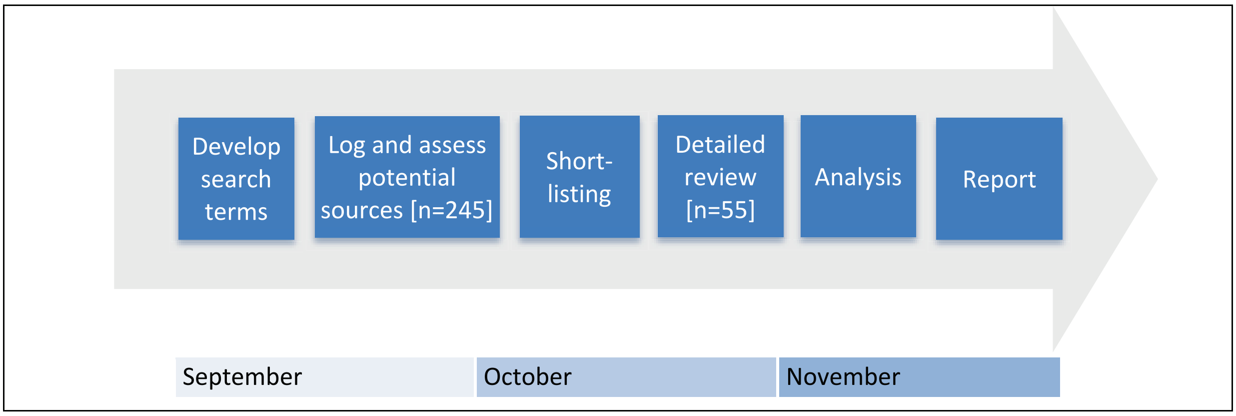
1. How efficiently do UK drivers currently drive and what is the future potential?
2. What are the main motivations and barriers to efficient driving?
3. How effective are different measures in increasing levels of efficient driving?
4. What are the synergies between efficient driving and other policy areas?

Car and van ownership and use in the UK is split between private drivers and organisations that buy vehicles for use by their employees. Each of these questions was considered from the perspective of private drivers and organisations that buy vehicles for use by their employees.

1.4 Methodology

The methodology followed Government Social Research guidance on the conduct of rapid evidence assessments[1], with some tailoring to reflect the specific requirements of the research. Search terms were developed and used to identify potential evidence sources, using commercial and academic search engines, and additional potential sources were identified by members of the research team, academic staff and DfT. This generated a long-list of 245 sources which were logged and assessed in terms of their relevance to the research questions and methodological strength. A shortlist of 40 sources was then agreed with DfT, and 15 further sources were subsequently identified and added during the later phases.

Figure 1. Rapid Evidence Assessment phases



Shortlisted sources were reviewed in detail, and relevant findings extracted into an analytical database.

1.5 Evidence coverage and quality

There are significant gaps and limitations in the current evidence base on efficient driving, across all of the research questions this rapid evidence assessment sought to address. These are highlighted throughout the report but the most pertinent include:

[1] http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance/rapid-evidence-assessment

- A shortfall of robust, independent data on current levels of efficient driving. Evidence that is currently available comes mainly in the form of self-reported data collected through surveys of drivers and employers.
- A lack of depth of insight into the relative importance of different motivations and barriers to efficient driving, how susceptible these may be to change, and how these vary between different types of driver and organisation.

- A persistent lack of methodological rigour in studies that have sought to assess the effectiveness of measures aimed at increasing efficient driving, which has also been noted by other authors:

> *"One of the most notable features of the literature on eco-driving is that, while there is a large body of information reporting success in reducing fuel consumption, relatively little of this data appears to arise from detailed and rigorous evaluations."*
>
> Luther et al (2011)

- A general tendency for efficient driving to be treated as a distinct free-standing topic for research – with few attempts made to consider its relationship with other areas such as road safety, vehicle insurance, and the finances of households and organisations.

Priorities and recommendations for addressing these gaps and limitations are considered in the final chapter of the report.

1.6 Structure of report

The next chapter provides a brief contextual overview of car and van ownership, mileage and emissions in the UK. Chapters 3 to 5 then present evidence for the first four research questions listed in section 1.3 Chapter 6 addresses the synergies between efficient driving and other policy areas. Chapter 7 discusses what conclusions can be drawn from the preceding evidence and priorities for future research.

Note: the terms 'efficient driving', 'ecodriving', 'eco-driving' etc are used interchangeably throughout the report, in general following usage in source material.

2 Vehicle Ownership, Mileage and Emissions

- There are nearly 30 million licenced cars and 3.5 million licenced vans in the UK.
- Most cars are privately owned, while vans are split equally between private and company ownership.
- Privately owned cars and vans account for 76% of the CO2 emissions arising from car and van travel; while company owned cars and vans account for 24%.
- Personal travel by cars and vans also account for 77% of the total CO2 emissions compared to 23% for business travel by cars and vans.

The majority of this report considers private drivers and employees who drive company owned vehicles separately. However, in order to provide some initial context this chapter summarises evidence on the relative mileages and emissions of these two populations of drivers.

It also compares mileages and emissions for personal travel as opposed to business travel. These comparisons are returned to in the discussion of future policy options in relation to efficient driving in the final chapter of the report.

The data drawn on in this chapter is predominantly very robust. The Department for Transport collect data annually on vehicle ownership and mileages through the National Travel Survey, and provide annual forecasts of total mileage levels based on observational data. SMMT also publish annual data on the (advertised) CO2 emissions of cars and vans in the UK.

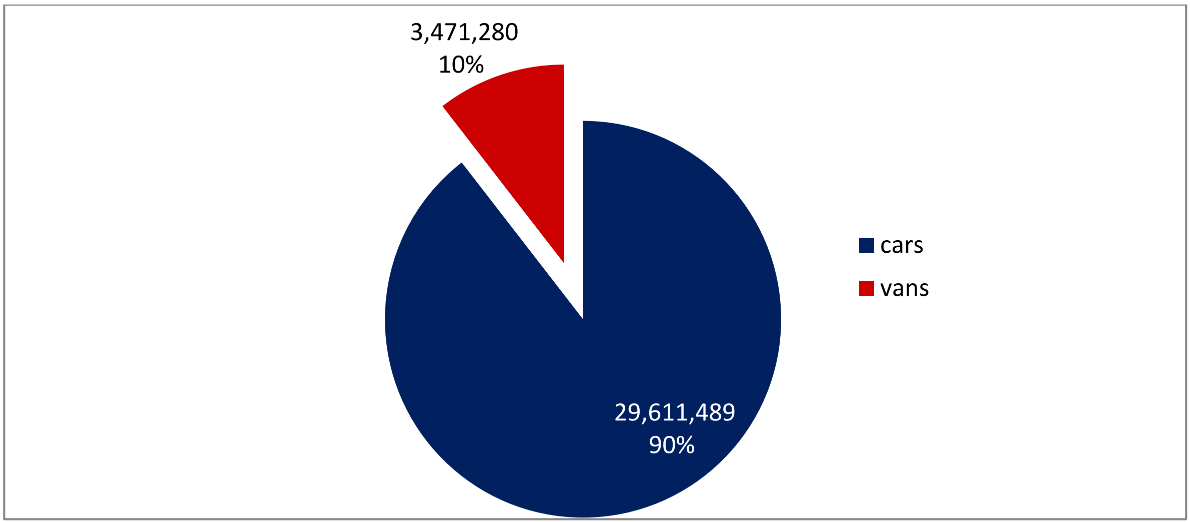
Equally, there are some gaps in the evidence and instances where it has been necessary to provide an estimate rather than robust up to date data. Explanatory notes on the assumptions made in such instances are provided in Annex 1.

Given the focus of this review on cars and vans, data for other types of vehicles have been excluded from the following analysis. However it is worth noting that they also contribute CO2 emissions. For example, HGVs emit an estimated 22% of all CO2 emissions arising from road transport in the UK (DfT, 2014).

2.1 Vehicles

In 2014 there were 29.6 million licenced cars and 3.5 million licenced vans in the UK.

Figure 2. Licenced Cars and Vans: 2014

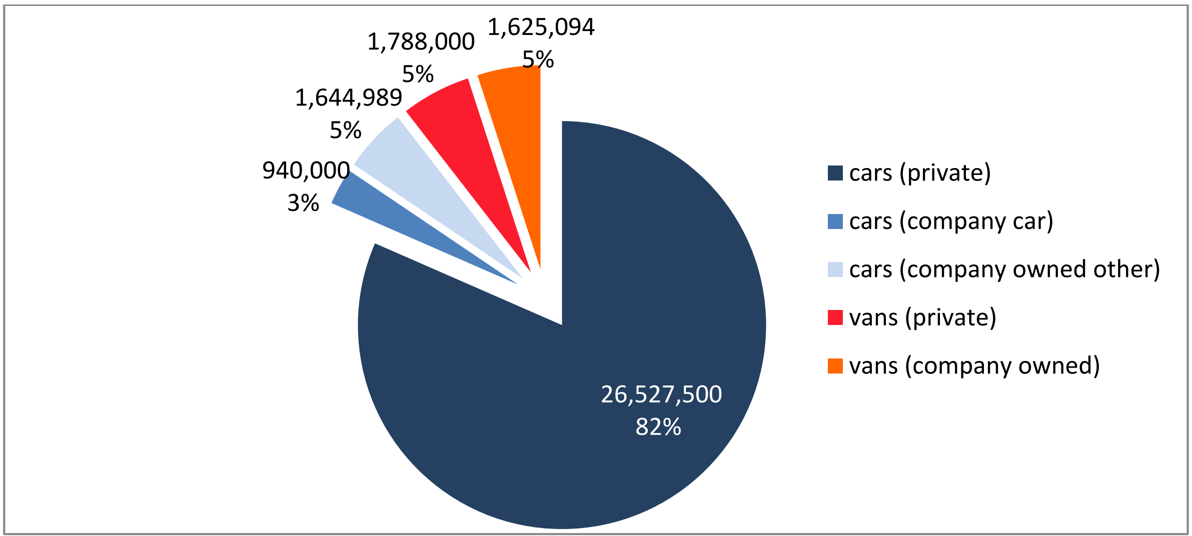


sources: DfT (2015a); DfT (2015b)

2.2 Ownership

The majority of cars in the UK are privately owned, with company owned cars (which includes company cars and other types of company owned cars[2]) representing the minority. Vans are split roughly equally between private and company ownership.

Figure 3. Registered Cars and Vans by Ownership: 2014



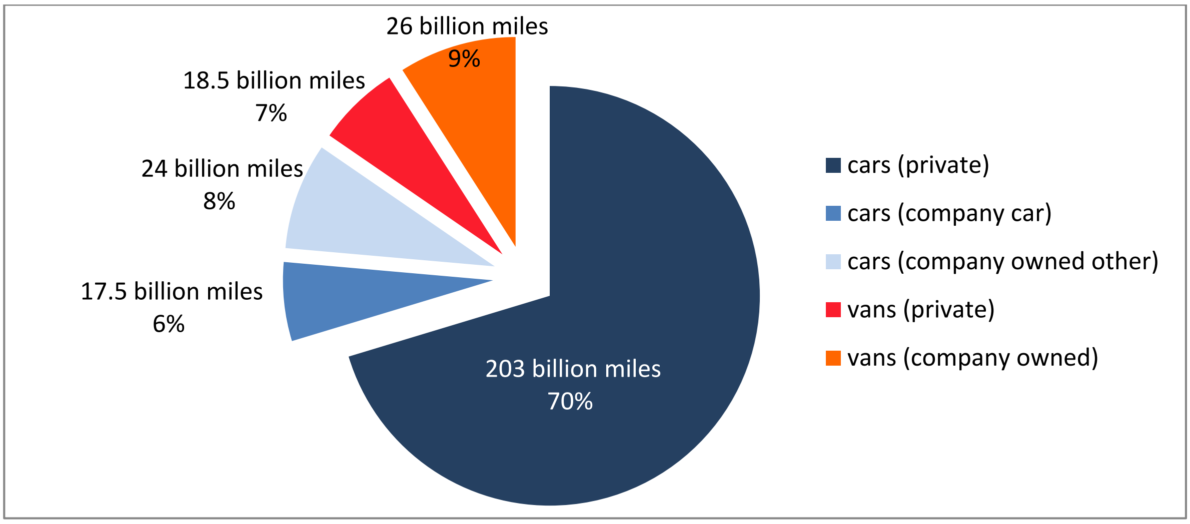
sources: DfT (2015a); DfT (2015b); HMRC (2015)

[2] Other types of company owned cars represent something of a blindspot in the current evidence base but are thought to be primarily pool cars, which are maintained centrally by the company and may be used by more than one employee.

2.3 Mileages

The average annual mileage of privately owned cars in 2014 was 7,500 miles, compared to 19,500 miles for company cars (DfT, 2015c). Data on the mileages of other company owned cars and vans in 2014 is not readily available but can be estimated drawing on other data from previous years (see annex). This suggests that other company owned cars have an average annual mileage of around 17,000 miles, while for privately owned vans this figure is 10,000 miles, and for company owned vans 16,000 miles. In total, cars and vans drove an estimated total of 289 billion miles in 2014. Privately owned cars and vans undertook 77% of this total, compared to 23% for company owned cars and vans.

Figure 4. Estimated Annual Mileage by Vehicle Type and Ownership: 2014

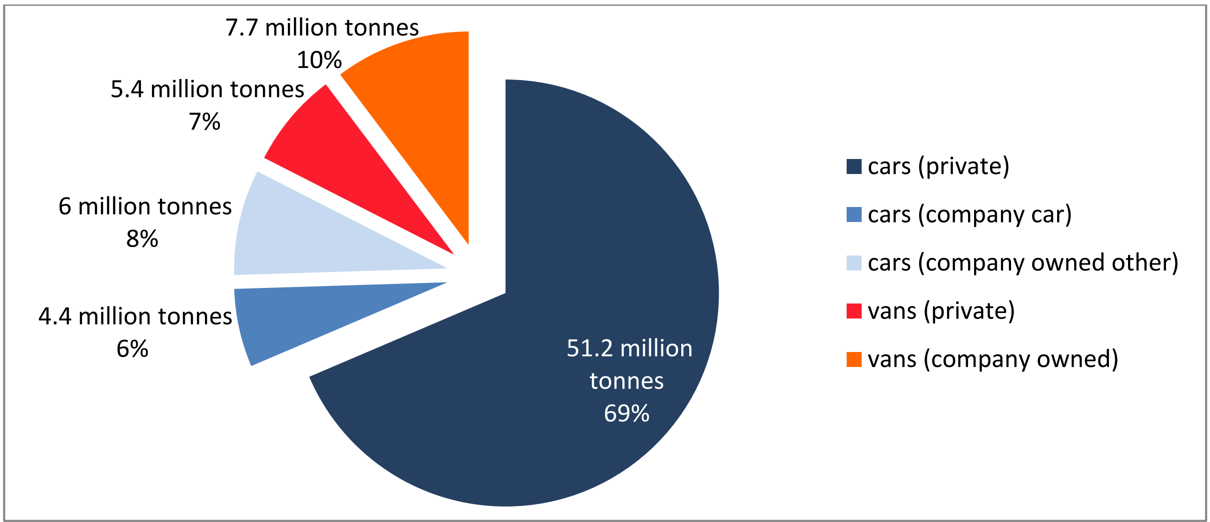


sources: DfT (2015b); DfT (2015c); DfT (2015d) DfT (2004); DfT (2006)

2.4 Emissions

Based on advertised CO2 emission data, SMMT estimate that UK cars emit on average 156.6 grams of CO2 per kilometre. This average is based on all cars purchased new in 2014 and all older cars also on the road in 2014. Comparative data is only available for new vans purchased in 2014 but this suggests that the average UK van emits circa 182.4 grams of CO2 per kilometre (SMMT, 2015). In total, UK cars and vans emitted an estimated total of 74.7 million tonnes of CO2 in 2014. Again, privately owned cars are responsible for the majority of this, and together privately owned cars and vans accounted for 76% of CO2 emissions, compared to 24% for company owned cars and vans.

Figure 5. Estimated CO2 Emissions by Vehicle Type and Ownership: 2014



sources: DfT (2015b); DfT (2015c); DfT (2015d) DfT (2004); DfT (2006); SMMT (2015)

One important caveat to the emissions data presented here is that it is based on advertised emissions data. Firstly, real-world emissions are likely to vary from those advertised, for both cars and vans and irrespective of ownership. Secondly, privately owned cars are older on average than company owned cars, and older cars generally have higher emissions than newer ones. The implications of this are that the relative contribution of privately owned cars to CO2 emissions may be even higher than indicated in figure 5.

2.5 Personal v Business Travel

Another means of classifying travel by cars and vans is in terms of journey purpose. This can be divided into personal travel (which includes journeys to and from work) and business travel.

Privately owned vehicles are not just used for personal travel and likewise company owned vehicles are not all just used for business travel. For example, based on National Travel Survey data for 2014, company cars were driven on average more for personal travel (12,400 miles) than they were for business travel (7,200 miles). In comparison, privately owned cars were driven on average for 7,100 miles for personal travel and 400 miles for business travel[3], while both private and company owned vans are driven for varying combinations of personal and business travel.

In total, just over three-quarters of the estimated mileage and emissions by cars and vans in the UK in 2014 arose from personal travel, and just under a quarter from business travel.

[3] This represents travel by the "grey fleet" - i.e. privately owned cars that are driven for business travel. EST (undated) and Volkswagen (undated) report that there are approximately 4 million such cars in the UK although other sources, e.g. Lex Autolease (2015), suggest this could be as high as 14 million, depending on how these are defined.

Figure 6. Total Estimated Mileage and Emissions by Travel Type: 2014

Vehicles & Ownership	Type of Travel	Miles	Tonnes of CO_2
cars (private)	personal	192.4 billion (67%)	48.5 million (65%)
	business	10.8 billion (4%)	2.7 million (4%)
cars (company cars)	personal	11.2 billion (4%)	2.8 million (4%)
	business	6.4 billion (2%)	1.6 million (2%)
cars (other company owned cars)[4]	personal	0 billion (0%)	0 million (0%)
	business	23.7 billion (8%)	6.0 million (8%)
vans (private)	personal	11.4 billion (4%)	3.3 million (4%)
	business	7.0 billion (2%)	2.0 million (3%)
vans (company owned)	personal	9.2 billion (3%)	2.7 million (4%)
	business	17.0 billion (6%)	5.0 million (7%)
total personal travel		**224.1 billion (78%)**	**57.3 million (77%)**
total business travel		**64.9 billion (22%)**	**17.4 million (23%)**

sources: DfT (2015b); DfT (2015c); DfT (2015d) DfT (2004); DfT (2006); SMMT (2015)

[4] In the absence of published data on the split between personal and business travel for other company owned cars, it has been assumed in this analysis that all their mileage is for business travel.

3 Current Levels of Efficient Driving and Future Potential

- The majority of private drivers claim to drive efficiently to the best of their knowledge, but indicative evidence suggests most could do lot more – e.g. UK private drivers average "6 out of 10" on an efficient driving scale.
- There is some indicative evidence of variation by demographics – suggesting well educated, affluent women, aged 25 – 65, with low annual mileage using a small vehicle are the most likely to practise efficient driving.
- No equivalent data on levels of efficient driving among employee drivers was identified in this review – either overall or by different types of employee driver.
- Indicative evidence suggests that around 20% of organisations with a vehicle fleet have provided training on efficient driving for their employees and around 25% have introduced in-vehicle telematics. Larger organisations with larger vehicle fleets are also reported to be most likely to be taking action on efficient driving.
- The potential CO2 savings from efficient driving being adopted more widely are significant – potentially over 220kg per car per year, up to 0.3 million tonnes annually across the UK. Total potential financial savings for drivers are in excess of £15 billion per year across the EU and circa £96 per driver.
- No evidence was identified on the potential savings from efficient driving being adopted more widely by organisations and employee drivers, although this could be estimated making use of existing data.

This chapter presents evidence of the current level of efficient driving in the UK and investigates the number of, and the extent to which, drivers are currently practising efficient driving techniques, and whether or not this is influenced by driver characteristics. Using evidence from previous reports on efficient driving, an estimate is given of the potential savings that could be made, both financially and in terms of emissions, if more drivers were to adopt efficient driving techniques.

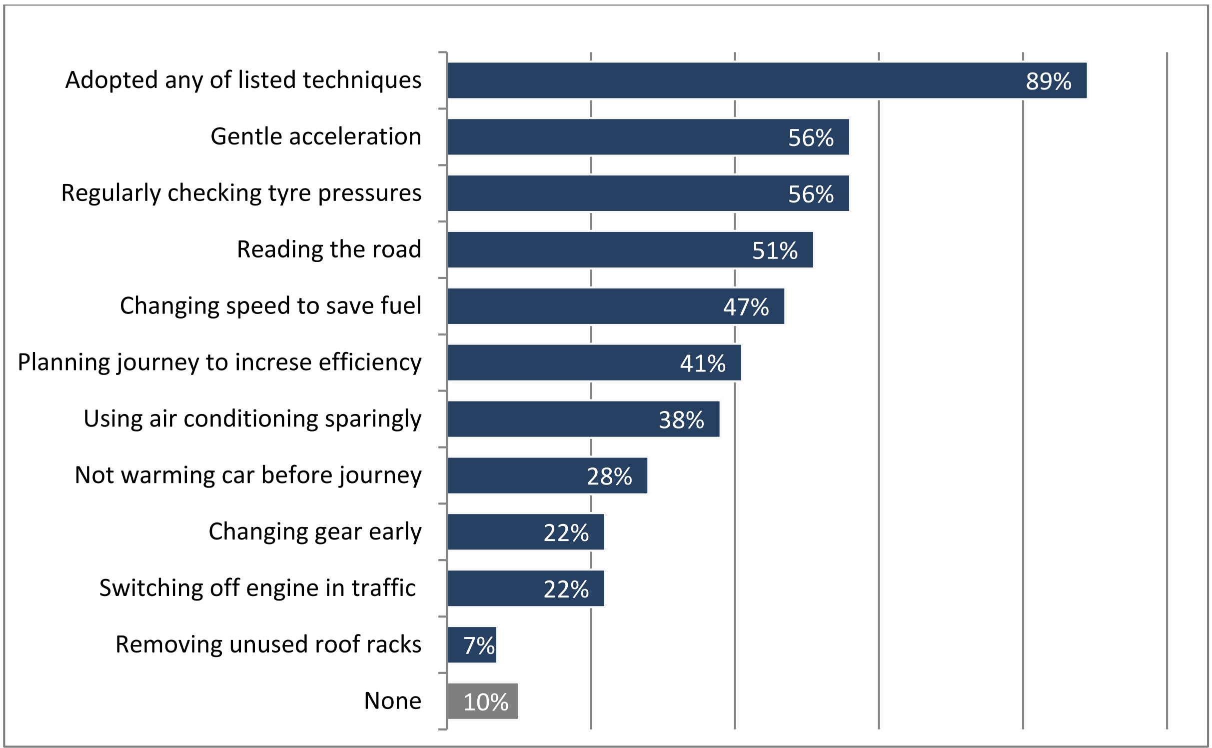
3.1 Current levels of efficient driving

Private Drivers

Evidence from private drivers in the UK suggests that the current level of knowledge and understanding around efficient driving is fairly low. One previous survey of private drivers in the UK found that 75% of participants claimed to know 'little' or 'nothing' about efficient driving – 19% of these had never heard the term 'efficient driving' – and just 5% claimed to know 'a lot' (Thornton et al, 2010). Despite this apparent lack of knowledge, there is evidence that most drivers are aware of some efficient driving techniques, but not necessarily the full range – a study of US private drivers found that the average number of efficient driving techniques which could be named by participants was two (Kurani et al, 2013). However, even with this limited familiarity with efficient driving, it is not to say that drivers are not still using driving techniques which fall under the umbrella of efficient driving. Questionnaires have found that that private drivers see many efficient driving techniques as *'common sense'* and simply as strategies to drive safely, sensibly and smoothly, rather than associating them directly with efficient driving (Campbell-Hall et al, 2011).

In a 2010 survey of UK private drivers, when presented with a list of 10 efficient driving techniques, 89% of respondents claimed to have adopted at least one of the techniques and only 9% had not used any – see below.

Figure 7. Self-reported use of efficient driving techniques by UK drivers

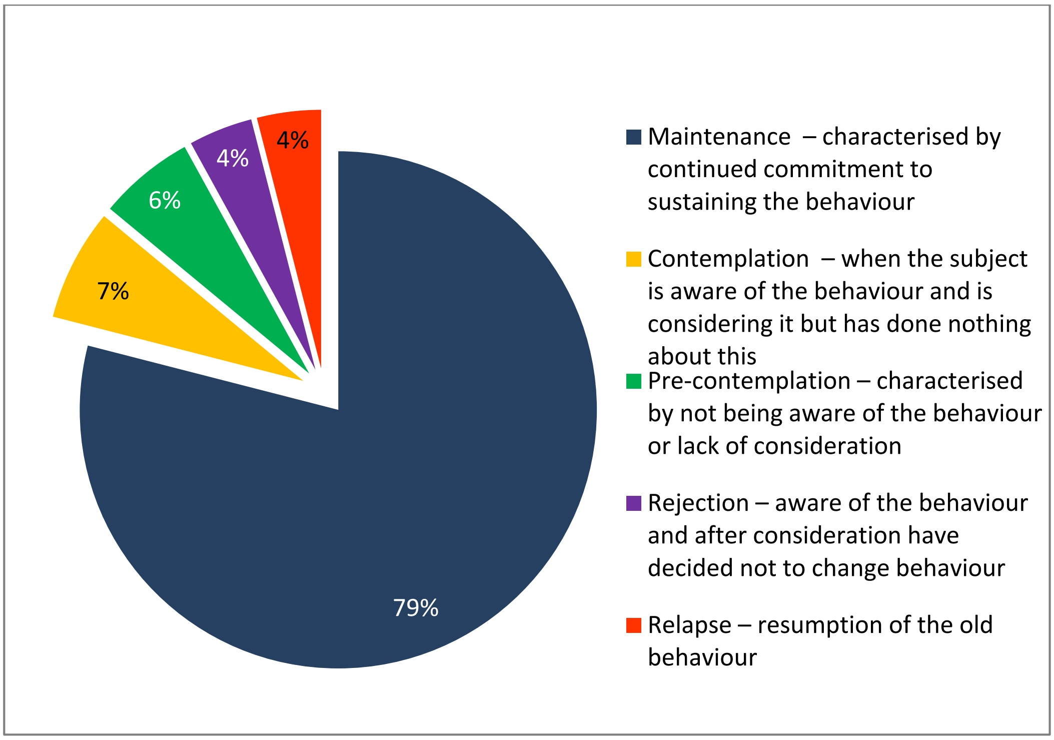


Source: Thornton et al (2010)

The findings above also illustrate that the most commonly used techniques are regularly checking tyre pressures, gentle acceleration and reading the road, which are used by a fairly modest 56%, 56% and 51% of private drivers respectively. The relatively low use of even the most popular techniques supports the notion that drivers are aware of some, but not all, efficient driving techniques, and also raises the point that whilst drivers may be driving efficiently to the best of their knowledge, they may not be fulfilling the potential of efficient driving. This statement is further supported by findings from a large-scale study by Fiat on drivers in Europe and the UK, which used long-term monitoring and recording technology to provide drivers with an efficiency score ('an eco:Index') from 0 to 100, a higher score representing more efficient driving. This study concludes that on average, UK private drivers achieved a score of 61.8. While this was higher than the average score across Europe of 59.2, it still demonstrates substantial room for improvement (Fiat, 2010).

Although useful, these results do not give a sense of whether or not efficient driving is being practised as a sustained behaviour, rather than occasional actions. There is some evidence to suggest that private drivers in the UK are, to the best of their knowledge, regularly efficient driving, and in a 2009 survey of private drivers, 78% were categorised into the 'maintenance' phase (characterised by continued commitment to the behaviour) with regards to efficient driving (Thornton, 2009). Only 4% of this sample had begun to drive efficiently, before relapsing to less efficient techniques.

Figure 8. Status of UK drivers in relation to efficient driving



Source: Thornton (2009)

Although limited, there is some evidence to suggest that number of efficient drivers in the UK may be increasing, with 45% of participants in a UK study claiming to have begun to drive in a more fuel efficient manner in the past 12 months, and 27% claiming to have actively changed their driving behaviour to minimise their fuel consumption (Thornton et al, 2010). It should be mentioned that these results were taken from a 2010 study, a time during which fuel prices in the UK were rising sharply; we have been unable to find more recent figures which may be more reflective of current attitudes in a time of relatively lower fuel prices.

Some authors writing more recently suggest that efficient driving may become more prevalent as an increasing number of new cars are built with in-built technology to support efficient driving, such as fuel economy displays and stop-start technology (Aecom, 2013; Wengraf, 2012). A 2013 study from the USA also found that of the 72% of drivers who had fuel economy displays in their car, 67% use them regularly (Kurani et al, 2013). However, robust data illustrating trends in the prevalence of efficient driving over recent years is currently lacking, and it is possible that the increasing ubiquity of in-car devices has not, as claimed, translated into higher levels of efficient driving.

In addition, it is possible that the rise of in-car support devices and an increasing frequency of efficient driving could be followed by a greater prevalence of the 'rebound effect' – the idea that the fuel and money savings achieved by efficient driving may encourage longer or more regular car journeys. It is possible that the rebound effect will nullify some of the potential benefits provided by increases in efficient driving behaviours (Ecowill, 2011; Wengraf, 2012).

It is important to note that, with the exception of the Fiat study, the findings so far presented are based on self-reporting by drivers, and that this may result in overestimations in the claims. Further to this, the majority of these figures are taken from studies in which participants are asked directly about their efficient driving habits. This may act, for the duration of the study, to increase the relative importance of efficient driving in the minds of the participants: there is evidence from a 2015 survey that drivers prioritise safety and time saving whilst driving, while only 6% of drivers consider efficiency (Barclaycard, 2015).

Finally, it is pertinent to consider the limited knowledge and perhaps misguided sense of skill possessed by private drivers regarding efficient driving, and that drivers describing the frequency of their efficient driving behaviours can only do so to the best of their knowledge, perhaps unaware of their potential for improvement.

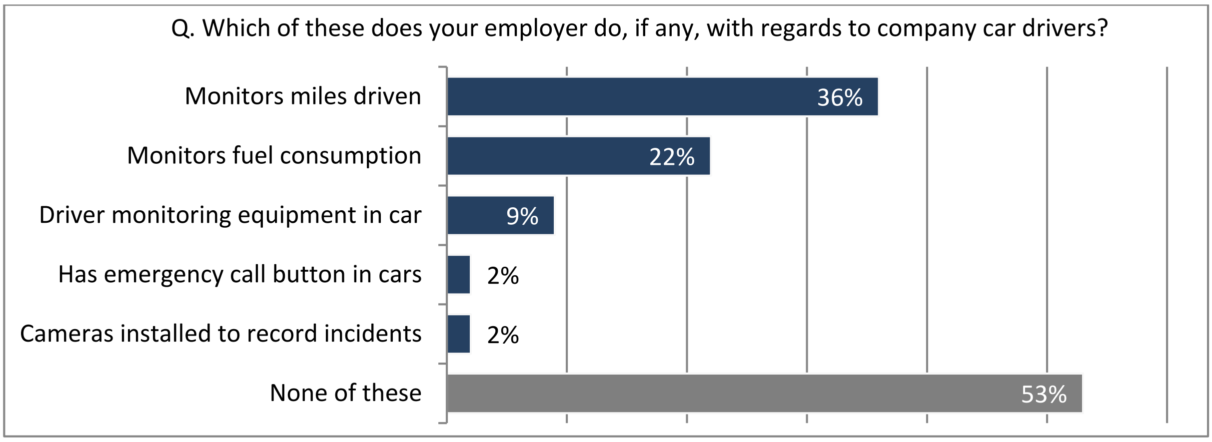
Organisations and Employee Drivers

Overall the evidence in this area is quite limited. Some evidence was identified in this review on the proportions of organisations undertaking certain measures related to efficient driving but this was generally from small-scale surveys which may not be representative of UK employers and their drivers as a whole. Apart from one study for DfT (Campbell-Hall et al, 2011) most of the research in this area has also been produced by companies with a commercial interest in the fleet sector, meaning there is some potential for bias. With these caveats in mind, the findings presented in this section should be treated with caution, and as indicative only.

The available evidence suggests that around a half or more of UK organisations with a car/van fleet are taking some actions aimed at increasing efficient driving by their employees. Qualitative research with a sample of 28 employers, training providers and industry stakeholders conducted in 2011 concluded that "Most companies were already attempting to manage drivers' fuel efficiency..." (Campbell-Hall et al, 2011).

A more recent survey of 72 European fleet managers reported that 49% had a defined program in place aimed at influencing the driving of their employees (GE Capital, 2014). The same source also reported that "72% of fleet managers monitor the actual fuel consumption of their car fleet drivers in order to optimise fuel management." However, evidence from a larger 2015 survey of 501 UK company car drivers suggests a somewhat lower figure – see below.

Figure 9. Measures relating to efficient driving introduced by employers

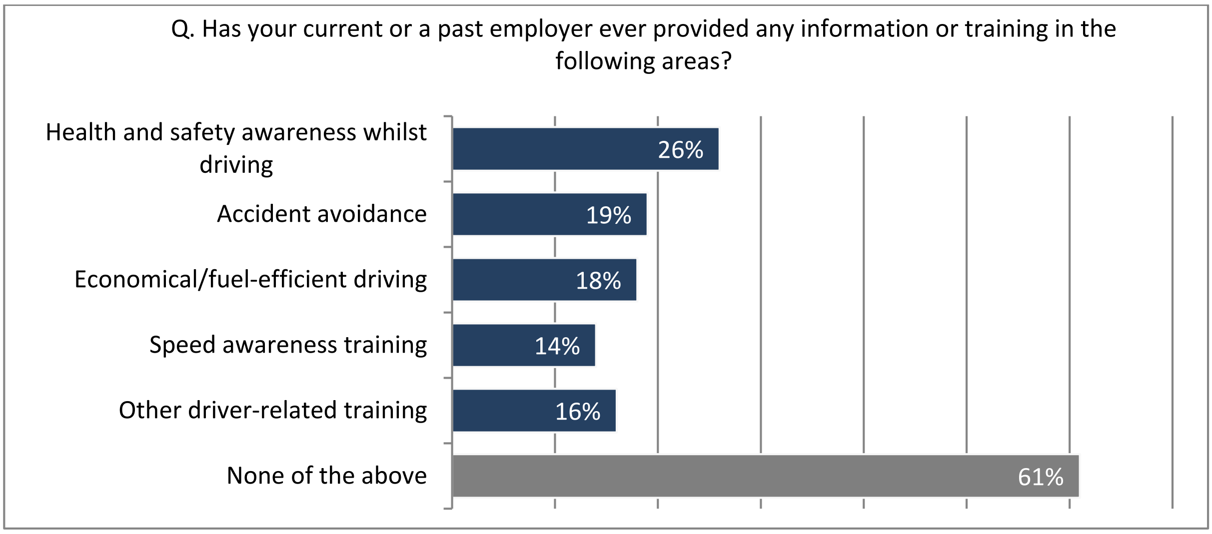


Source: Lex Autolease (2015)

No equivalent findings for van drivers or drivers of other types of company owned car (e.g. pool cars) were found in this review.

There is also indicative evidence on the proportion of UK organisations introducing other measures associated with efficient driving. Firstly, evidence from surveys of employee drivers suggests that around one in five had been provided with training in efficient driving by their employer. Figure 10 is based on a survey of 812 company car drivers and employees who use a privately owned car for work purposes (also known as a member of the "grey fleet"). Figure 11 is based on a survey of 722 light van drivers in six European countries[5].

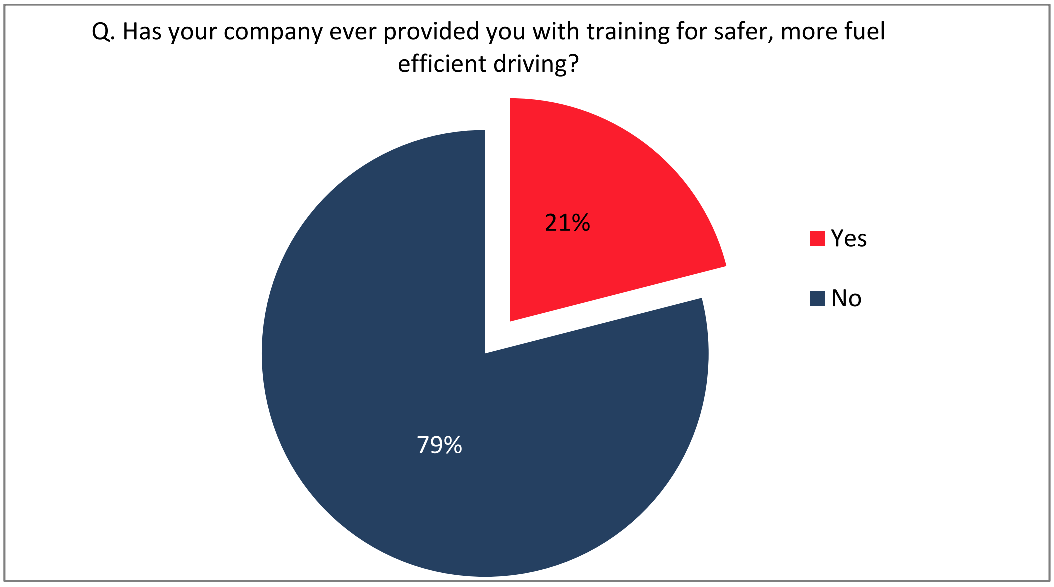
Figure 10. The provision of training by employers



Source: Lex Autolease (2015)

[5] Great Britain, France, Germany, Spain, Netherlands, Italy.

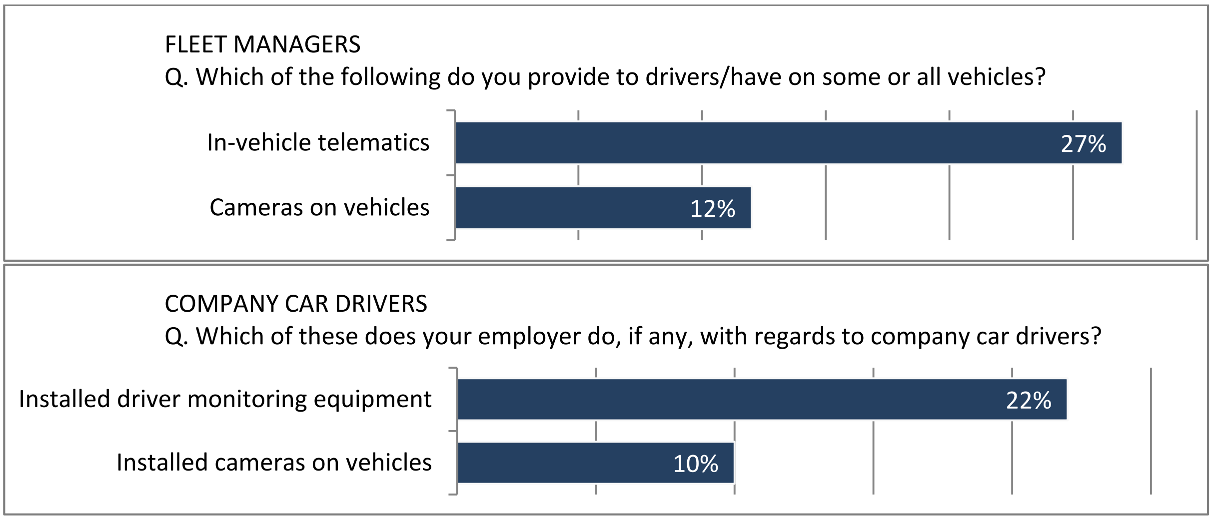
Figure 11. The provision of training by employers



Source: TomTom (2013)

In addition, survey evidence suggests that around a quarter of UK organisations have introduced in-vehicle technology in their fleets.

Figure 12. The provision of in-vehicle technology by employers



Source: Lex Autolease (2014)

Based on their survey of light van drivers in six European countries, TomTom (2013) also report that "a large majority of companies do not appear to operate technology to monitor driving performance and fuel efficiency…only 23 per cent of drivers say their employers have such systems in place." Sources suggest that the general direction of travel is towards more organisations doing more to promote efficient driving by their employees in the future – particularly with regards to technology-based approaches. For example, based on a survey of 249 UK fleet managers, Lex Autolease (2015) report that "a significant minority of those Fleet Managers (17%) not currently using telematics say they are likely to introduce such a system in the next two years, particularly those managing larger fleets".

Evidence on current levels of efficient driving by employee drivers themselves is also limited and even somewhat contradictory. No sources were identified which provide a robust quantitative measure of how efficiently employees currently drive but RAC (2015), based on a survey of 1,526 private car drivers and company car drivers, did compare self-reported levels of efficient driving between the two. They report that:

> *"40% (of company car drivers) said they actively changed their driving behaviour to keep their miles per gallon low, compared to 27% of private vehicle owners (and) 66% said they monitored the fuel consumption of their vehicle, compared to 44% of private vehicle owners."*
>
> RAC (2015)

TomTom (2013), in a survey of light van drivers, also asked respondents: Do you drive more carefully and fuel efficiently when driving your personal rather than your business vehicle? Amongst GB respondents, 39% answered Yes and 61% answered No. Although the wording of the survey question is not ideal, as it conflates careful and efficient driving, the responses indicate that only a minority of employee drivers may drive more efficiently in their private vehicle than in their company owned vehicle.

Equally, other evidence concerning employee drivers suggest they exhibit certain driving behaviours (in general or specifically when driving for work purposes) that may run counter to the principles of efficient driving. Lex Autolease (2015), based on a survey of 1,041 employee drivers, report that "in the last 12 months…63% admit to breaking the speed limits on major roads or motorways...5% admit to drink-driving and 3% to driving under the influence of recreational drugs". 6% also said they had "had a minor accident that was their fault" in the last 12 months. Unfortunately the survey did not ask respondents to differentiate between incidents when they were driving for personal or work purposes. In addition, 77% of light van drivers surveyed by TomTom (2013) said they break the speed limit when driving for work purposes occasionally or regularly, and 59% said time pressures made them more likely to speed and take risks on the road while driving for work purposes.

3.2 Variations between different types of driver

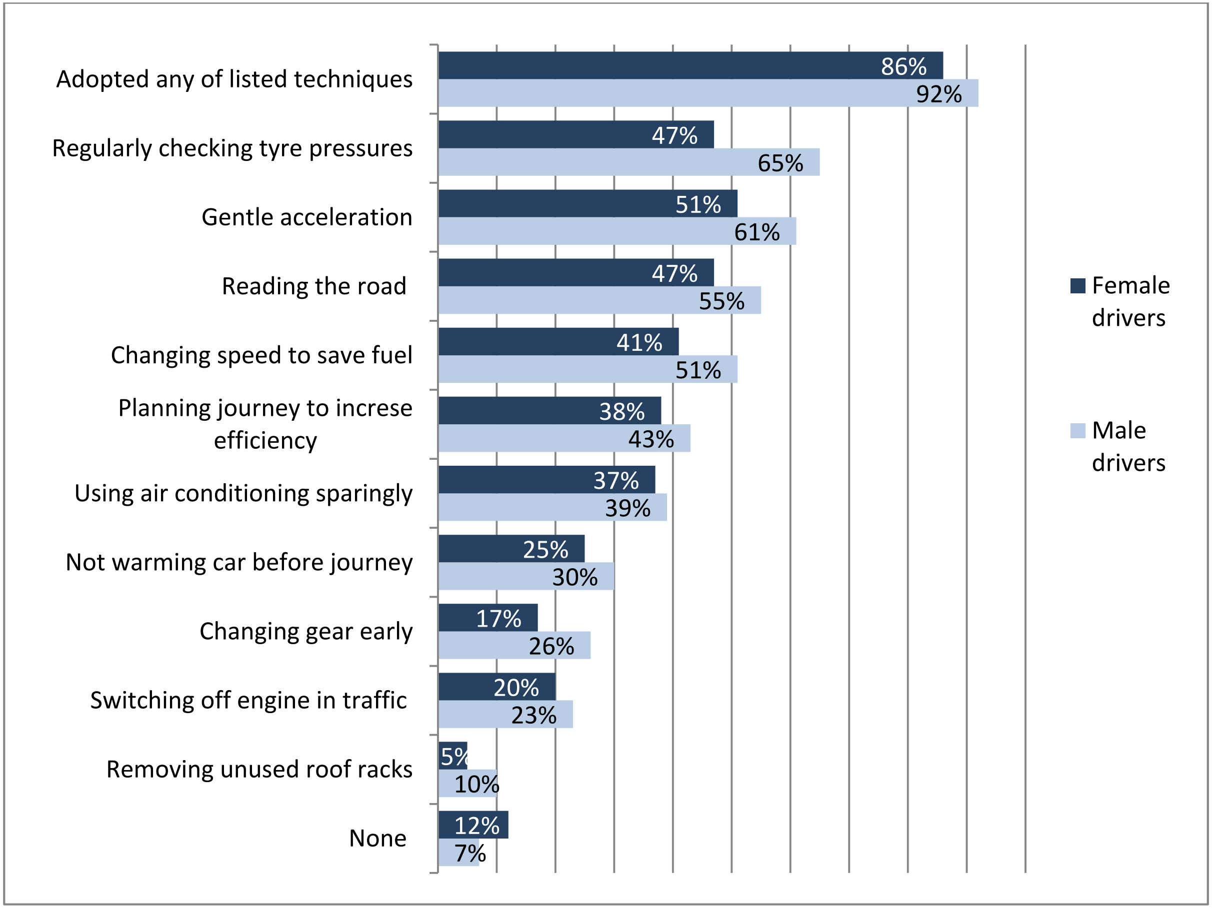
Private Drivers

Inclination to drive efficiently is not uniform across all demographics, and there is evidence which suggests variations by factors including by age, gender and education.

Gender

There is evidence that male drivers claim to have a greater knowledge of efficient driving and efficient driving techniques than female drivers. This is demonstrated in the self-reported findings of a 2011 study, which found 92% of male drivers claimed to have adopted at least one efficient driving technique, compared to 86% of females (Thornton et al, 2010). Males were also more likely than females to have claimed that they have been driving in a more fuel efficient manner over the past 12 months – 52% compared to 36% - see below.

Figure 13. Self-reported use of efficient driving techniques by male and female UK drivers



Source: Thornton et al (2010)

However, it has also been reported that female drivers are more likely to regard the car as an 'object of utility', as opposed to something to have fun in (Trommer et al, 2012). This supports claims from two European studies which find female drivers to be more likely to hold efficiency as an objective while driving, and maintain efficient driving for a sustained period (Trommer et al, 2012; Delhomme et al, 2013). Based on this evidence, it could be suggested that there is a higher level of efficient driving *knowledge* amongst male drivers, but that it is female drivers who are more likely to *practis*e these regularly.

Age

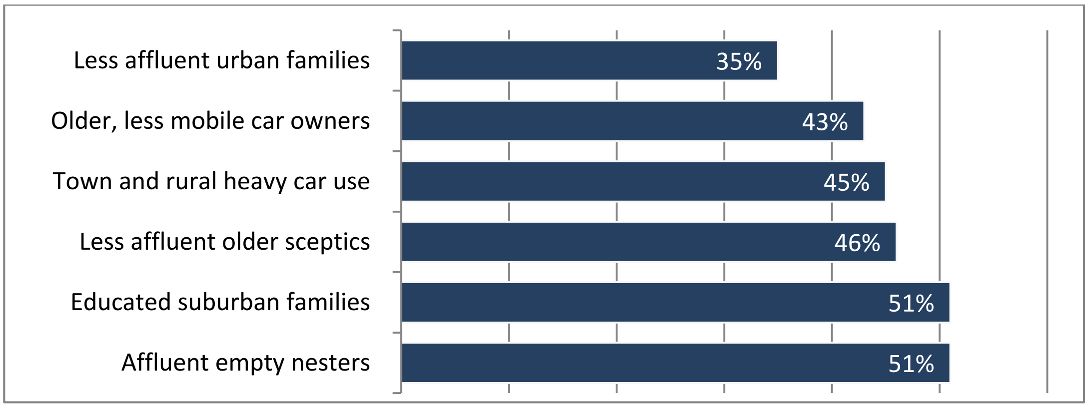
The majority of the evidence suggests that there is a variation in efficient driving by age, and that 'older' drivers are more likely to practise efficient driving than are 'younger' drivers. This is supported by a study from New Zealand which reports that, on average, 51% of 25-44 year olds, compared to 71% of 45-65 year olds 'always' or 'usually' practise efficient driving techniques when driving (King, 2011). Further support for this comes from a 2010 UK study, which reports that 35% of drivers under 30 claimed to have started driving in a fuel efficient manner over the past 12 months, compared to 47% aged over 30 (Thornton et al, 2010). This may be attributed to the greater likelihood for younger drivers (below the age of 24) to exhibit 'sporty' driving, and for older drivers (25 and over) to exhibit a focus on fuel consumption (Trommer et al, 2012). However, one UK study finds that over half (55%) of those aged over 65 admit they don't drive in ways that might save fuel (Barclaycard, 2015). Given the differing definitions of 'young' and 'old' across the evidence, it is difficult to draw strong conclusions on the effect of age on propensity to practise efficient driving. However, from the evidence, three classes of drivers do emerge: younger drivers (below 25), middle age drivers (26 – 65), older drivers (over 65). From these categories, the evidence indicates that the most likely to practise efficient driving are the middle age drivers.

Upon reviewing the evidence, a number of other demographics were mentioned which may impact on efficient driving behaviours. It has been reported that drivers with low annual mileage are more likely to practise efficient driving than higher mileage drivers, who hold time saving as a higher priority than efficiency (Trommer et al, 2012). Furthermore, level of education, and environmental awareness, influence likelihood of efficient driving, with more highly educated drivers more likely to drive efficiently (Schroten, 2012; Thornton et al, 2010). This ties into reports that drivers of small vehicles, as opposed to large vehicles, are more likely to hold pro-environmental attitudes, which correlates with greater tendency to drive efficiently (Campbell-Hall et al, 2011; Delhomme et al, 2013).

Income

Finally, findings from Thornton et al (2010) suggest efficient driving may be more prevalent amongst more affluent segments of UK drivers.

Figure 14. Self-reported use of efficient driving techniques by UK segment



Source: Thornton et al (2010)

Given the contradictions across the evidence, it is difficult to make robust judgements about how efficient driving differs with socio-demographic characteristics. However, the available evidence suggests that male drivers are more knowledgeable about efficient driving techniques than female drivers, but that females are more likely to practise efficient driving regularly. The 'middle' age group (26 – 65) show the greatest tendency to ecodrive, but new and younger drivers may be becoming more aware of efficient driving techniques. Other factors, including annual mileage, education, affluence and car type may also be indicators of efficient driving behaviours.

Organisations and Employee Drivers

The evidence suggests that larger organisations with larger fleets are most likely to be taking action to promote efficient driving by their employees. For example, Lex Autolease (2014), based on a survey of 505 UK company car drivers, reported that 71% of company car drivers in larger organisations (with 250+ employees) have received some form of driver training or information, while this was 45% amongst company car drivers in smaller organisations. Campbell-Hall et al (2011) also reported that "larger employers with bigger vehicle fleets were starting to introduce more actions and strategies aimed at fuel efficient driving". This is reinforced by previous research concerning organisations with truck and HGV fleets (Lawson et al, 2007a; Lawson et al, 2007b) conducted for DfT which found those with larger fleets were more likely to be taking active steps to promote efficient driving by their drivers.

No evidence was identified in this review comparing levels of efficient driving amongst different types of employee driver – e.g. company car drivers compared to drivers of pool cars

3.3 Future Potential

Private Drivers

There is a consensus in the evidence that if drivers consistently adopted all efficient driving techniques at all times then fuel consumption, and thus emissions, could be reduced by around **20% - 25%** (Fiat, 2010; Kurani et al, 2015; Barkenbus, 2010; CICEA, 2007; RAC, 2015; Shaheen et al, 2012; Aecom, 2013). However, the evidence is equally in agreement that drivers are very unlikely to sustain this in the long term. Most suggest a realistic long term reduction of between **5% - 10%** (Fiat, 2010; Schroten, 2012; Kurani et al, 2013; Barkenbus, 2010; CICEA, 2007; Wengraf, 2012; Luther et al, 2011; Alam et al, 2014; Graves et al, 2012; Gonder et al, 2011; Shaheen et al, 2012).

Using figures from a study conducted by Fiat, it can been estimated that if efficient driving was to reduce fuel consumption by 10%, then individual drivers could reduce their annual CO2 emissions by over 220kg, and by over 1,800kg over the life of the car. This would translate into an annual saving of up to £96 for the average driver and £735 over the lifecycle of the car (Fiat, 2010). However, these figures are, of course, dependent on fuel prices, miles driven and the fuel efficiency of the driver's vehicle.

It has also been estimated by the Committee on Climate Change that if 3.9 million of the drivers in the UK (10% of full driving license holders, and 15% of those with access to a car) were to be trained to increase the efficiency of their driving, then by 2020 CO2 emissions could be reduced by 0.3 million tonnes (Wengraf, 2012). On a greater scale, in 2001, the EU European Climate Change Programme projected that the adoption of eco-driving techniques in 15 EU countries[6] had the potential to remove 50 million tons of CO2 per year from the total road traffic emissions resulting in annual cost savings in the region of €20 billion (Luther et al, 2011). These figures for EU-wide savings are perhaps outdated, but they give a sense of the substantial savings, both in terms of money and emissions, that could be made if efficient driving was more prevalent.

Organisations and Employee Drivers

No off-the-shelf answer was found in this review to the question of how much could be saved (in CO2 or money terms) if efficient driving by employee drivers in the UK increases in the future. However, this can be estimated, drawing on various sources of data, some of which have already been highlighted in this review. In terms of CO2, basic estimates were provided in chapter 2 for the tonnes

[6] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

of CO_2 arising from company owned cars and vans in the UK. Evidence presented later in chapter 5 also suggests the scale by which fuel consumption can be reduced if organisations introduce measures to promote efficient driving amongst their employees. CO_2 emissions are known to fall in line with reductions in fuel consumption, meaning it is possible to roughly estimate potential CO_2 savings at a national level.

For example:

- Estimated annual CO_2 emissions arising from travel by company-owned cars and vans in the UK: 18.1 million tonnes.
- Estimated reduction in fuel consumption if measures to promote efficient driving are introduced: 2%-12%.
- Estimated annual CO_2 savings if measures introduced across all company-owned cars and vans in the UK: 0.36 – 2.17 million tonnes.

These results should be treated as indicative only, as there certain caveats with both the estimated CO_2 emissions (see chapter 2) and the estimated reductions in fuel consumptions (see chapter 5). Both could benefit from further research and analysis - which it has been beyond the scope of this review to undertake. The above is also based on certain simplistic assumptions and does not account, for example, for the fact that some UK companies have already introduced measures to promote efficient driving. Further analysis could address such issues and also provide more nuanced results for different scenarios – for example, what are the potential CO_2 savings if only a segment of UK companies introduce measures to promote efficient driving rather than all of them, or if measures are targeted at company-owned vans but not company cars?

In terms of potential financial savings, this is more complex. There are direct and indirect costs associated with a company introducing measures to promote efficient driving. In addition, although the financial savings arising from lower fuel consumption can be relatively easily estimated, there are highly likely to be additional savings (e.g. arising from lower maintenance and insurance costs) that have not yet been comprehensively quantified or monetised in the evidence base on efficient driving (see chapter 6).

4 Motivations and Barriers

- The principal motivation for private drivers to adopt efficient driving is saving money - cited by over 50% as a motivation. Safety is also a factor (although this is not always included in survey options) and environmental concerns are a more limited motivation.
- Barriers to efficient driving for private drivers include: habit; awareness of efficient driving techniques; competing priorities (e.g. to arrive at a destination as soon as possible); social norms; and the presence of other behaviours that drivers can adopt to save either money or emissions (e.g. buying a more fuel efficient car).
- Motivations and barriers are reported to be similar for employee drivers – although they may not be motivated by saving money to the same extent that private drivers are because their fuel costs are generally met by their employer.
- Organisations are primarily motivated to promote efficient driving amongst their employees by potential financial savings on fuel and other associated costs, although safety is also cited as a motivation, as is a desire to project an environmentally friendly corporate image.
- A key barrier for organisations is the current lack of robust, independent data quantifying the return on investment for introducing measures such as training for their employees and in-vehicle technology.

This chapter presents evidence on the motivations and barriers that exist for efficient driving, variations in these between different types of driver, and whether there are any key influencing points for motivating efficient driving. Where the evidence is sufficient, these questions are considered for both private drivers and organisations and their employees.

4.1 Motivations

Private Drivers

A number of key motivations for efficient driving are identified in the evidence, and there is also a reasonable amount of evidence regarding the relative strength or importance of these motivations.

Saving Money
Identified most widely in the evidence are economic motivations, which are also identified as some of the strongest or most important motivations. One source, for example, cites previous research that “A poll by GfK NOP (2009) suggests that the strongest driver for behaviour change is economic. The main reason given for eco-driving by 51% of drivers polled was the financial savings gained by reduced fuel consumption”. Similarly, a Populus survey in 2011 showed that “key motivators for eco-driving were related to finance and safety.” (Wengraf, 2012).

Context may also important in regard to economic motivations and fuel economy. A number of sources suggest that these motivations can become more important or salient to drivers during times of (relatively) higher fuel prices. It is also suggested that rising fuel prices, particularly rapidly rising prices, tend to increase people's motivation to drive more efficiently (Wengraf, 2012). However, as discussed in the previous chapter, trend data is not available for more recent years when fuel prices have been (relatively) low. This means it is not possible to conclude whether economic motivations may actually decrease as well as increase in response to changing fuel prices.

Safety

Another motivation for efficient driving widely identified in the literature is safety (Gonder et al, 2011) although this has not always been included as a response option in surveys of drivers and is likely to operate on a more unconscious level – i.e. drivers may be motivated to drive safely and in so doing also drive in a way that is more fuel efficient. The synergies between efficient driving and safe driving are returned to and discussed in more detail in chapter 6.

Environment

Environmental motivations are also widely identified in the evidence as motivations for efficient driving among private drivers. There were a number of different elements to environmental motivations identified, for example: reducing greenhouse gas emissions, mitigating climate change, and conserving resources such as fossil fuels (Kurani et al, 2013). However, authors generally agree that these are less important, or weaker than economic and safety related motivations.

> *"…although the environmental benefits of eco-driving may be able to convince some drivers, they are for most only a comparatively weak motivator. Successful efforts to promote eco-driving have focused largely on safety and the saving of money, and it is these motivators which are – in the main – stronger, more universal, and less prone to fluctuating than those which stem from environmental concern."*
>
> Wengraf (2012)

Organisations and Employee Drivers

Saving Money

The main motivation for organisations to take action to promote efficient driving by their employees is the expectation that they can save money on fuel costs, as well as benefit from lower maintenance and insurance costs (Aarnink et al, 2015; Campbell-Hall et al, 2011; CICEA, 2007; Ecowill, 2011; Lex Autolease, 2015; RAC, 2015; TomTom, 2013; Trommer et al, 2012; Wengraf, 2012). However, saving money does not feature so prominently as a motivation for efficient driving amongst employees themselves, as most fuel and other costs are generally met by their employer. (Deutscher Verkehrssicherheitsrat, 2009; Ecowill, 2011; Energy Saving Trust, 2014).

Safety

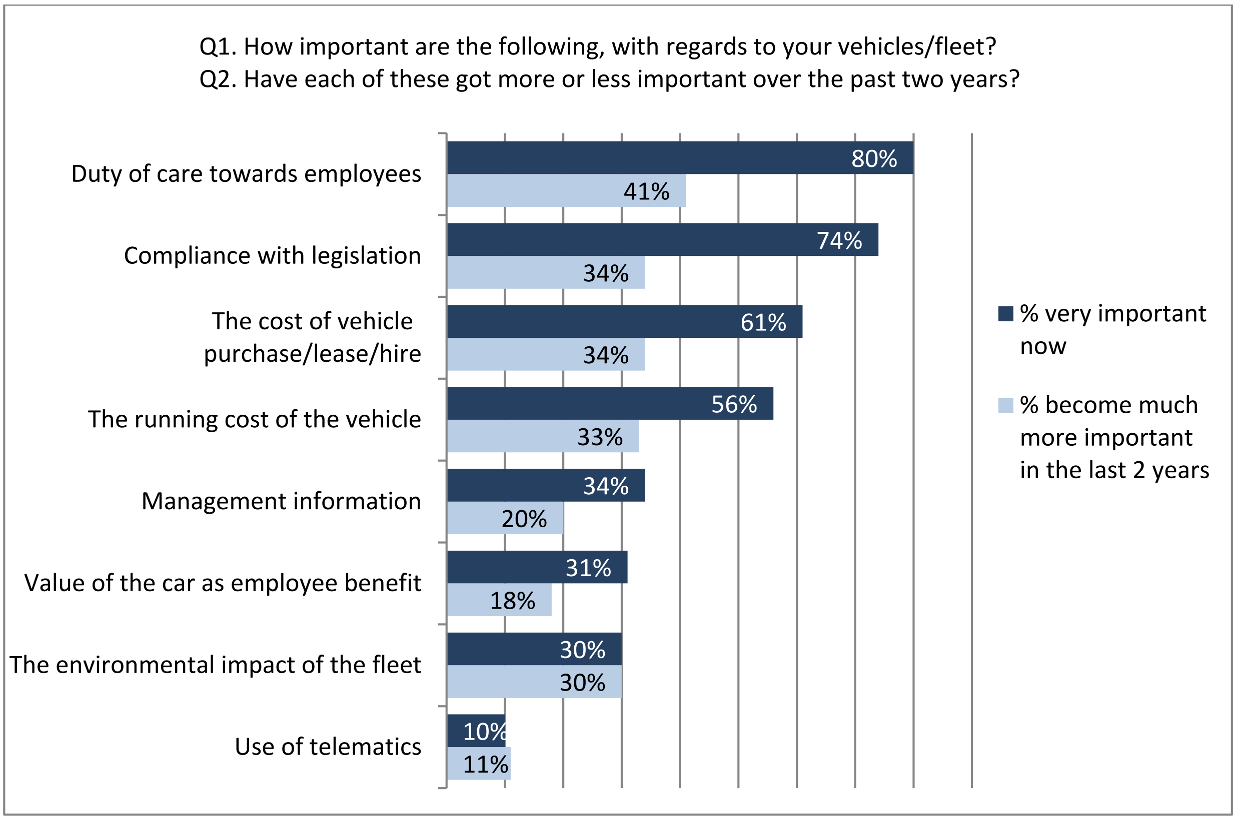
Safety is a key issue for management of fleets, due to factors such as duty of care[7], potential costs (e.g. for injuries, sick-leave or damage) and the benefits of a company having a reputation of being "safe" (Trommer et al, 2012; Ecowill, 2011; Campbell-Hall et al, 2011; CICEA, 2007) and the evidence suggests

[7] All UK employers have a legal duty of care to ensure the safety of their employees when undertaking travel for company purposes.

this is an important motivation for organisations to introduce measures such as training and in-vehicle technology.

There is a pervasive tendency in the literature on efficient driving to treat safety benefits as a by-product of efficient driving, rather than considering this from the reverse perspective. There is some evidence to demonstrate the importance that organisations place on safety. All UK employers have a legal duty of care to ensure the safety of their employees when undertaking travel for company purposes, and this is consistently rated as a high priority in surveys of fleet managers – more important even than the running costs of their vehicles.

Figure 15. Priorities of UK fleet managers



Source: Lex Autolease (2015)

It is also notable that driver training courses and technologies aimed at organisations are typically marketed as being about both safety *and* efficiency, rather than one or the other.

> *"For the most part, training providers were not offering eco-driving training as a standalone course… advanced driving courses, such as fleet driver training contained aspects of eco-driving techniques. These were often referred to as defensive or safer driving rather than overtly labelled as 'ecodriving'."*
>
> Campbell-Hall et al (2011)

No evidence was identified in this review of the role of safety as a motivation for employee drivers themselves.

Environment

Environmental concerns are also commonly identified as a potential motivating factor for organisations (Aarnink et al, 2015; Campbell-Hall et al, 2011; CICEA, 2007; Ecowill, 2011; Trommer et al, 2012; Wengraf, 2012), for several reasons, including: corporate social responsibility objectives, company image, a desire to appeal to consumers, and for green marketing purposes. However, overall the evidence suggests it is still a secondary motivation behind saving money and meeting their safety obligations under the duty of care. Lex Autolease (2015) report that: "While many Fleet Managers say they have adopted a greener fleet policy in the last two years (35%), most rated the environment as a less important factor than vehicle running costs…just 30% rate the environment as 'very important'". Little evidence was identified in this review of the role of environmental concerns as a motivation for employee drivers themselves, although findings from Seewald et al (2013) indicate that it does not feature as a key motivation.

4.2 Barriers

Private Drivers

A number of key barriers for efficient driving are identified in the evidence, and it is in regard to the question of what these barriers are that the evidence is strongest. Unlike motivations, there is less evidence regarding the relative strength or importance of these barriers, however some are more commonly identified in the evidence.

Awareness

This lack of awareness encompasses what efficient driving actually is (i.e. owning an efficient vehicle or driving in a certain way), the actual techniques of efficient driving, and the benefits of driving in a more efficient way. Evidence from one survey revealed that 25% of respondents stated that they know 'a lot' or 'a fair amount' about efficient driving, but that 40% knew 'a little' and 35% knew 'nothing' (Thornton et al, 2010). As chapter 3 demonstrated, many drivers tend to think that they already drive in an efficient way and be unaware that they could be driving more efficiently. UK sources report that demand for training in efficient driving was very low amongst private drivers, even when the costs of this are subsidised, and irrespective of whether the training was explicitly badged as being about safety or efficiency.

> *"Even free ecodriving training is hard to sell."*
>
> Ecowill (2011)

> *"Training providers and stakeholders highlighted the extremely poor take-up of post-test training such as Pass Plus and advanced driving courses. For example, it was reported by one stakeholder that only 1% of the UK population underwent post-test training, a high percentage of which would be the result of mandatory training due to receiving a sanction for being caught speeding. Take-up of dedicated eco-driving courses was equally poor."*
>
> Campbell-Hall et al (2011)

Habit

Driving in general, and certain elements of driving behaviour in particular, are considered highly habitual, and therefore very difficult to change in favour of a more efficient driving style (Schroten, 2012). This means, for example, that drivers will tend to return to habitual driving behaviours after they have received training in efficient driving – contributing to the so called 'time decay' of the effects of training people in efficient driving techniques.

> *"Even if education is always welcome, it is insufficient to effectively alter driving habits that have become entrenched over years of practice... more substantial actions are necessary in order to modify an activity that is done automatically, almost unconsciously"*
>
> Tulusan et al (2011)

Habit can also be seen as a barrier in the persistence of outdated understanding of how to operate cars. Letting cars 'warm up,' for example, is one practice that some drivers still habitually engage in, despite the fact that modern cars no longer require this 'warming up' period (Wengraf, 2012).

Attitude-Behaviour Gap

The wider evidence base on pro-environmental behaviours has consistently highlighted that although most people are aware of climate change and accept that it is, to some extent, caused by human behaviour this does not necessarily translate into changes in behaviour.

> *"There has been a gap between awareness of climate change and individual behaviour. The framing of the problem, with climate change portrayed as a complex global and long term threat, is disconnected from people's day-to-day concerns."*
>
> Campbell et al (2011)

Campbell et al (2011) go on to suggest that this is likely to be a barrier to the wider adoption of efficient driving. It may also explain why environmental concerns do not current feature as a significant motivation for efficient driving amongst most drivers (as discussed above).

Other Barriers

These have generally been accorded less attention in the evidence base but are noted here nonetheless. Firstly it has been suggested that social norms can be a barrier for efficient driving by either discouraging drivers from adopting efficient driving techniques, or by encouraging drivers to adopt driving styles or techniques that are particularly inefficient. The behaviour of other drivers on the road, for example, may encourage drivers to adopt an aggressive (and non-fuel-efficient) driving style (Schroten, 2012). Secondly, certain road conditions may act as a barrier, with one source stating that "traffic congestion and complex road systems affect drivers' abilities to implement some of the key principles of eco-driving; namely, maintaining a consistent speed and minimising acceleration and deceleration." (Fiat, 2010). Thirdly, it has been suggested that some vehicles may be a barrier to efficient driving, for example, high-powered cars are considered harder to maintain at lower cruising speeds (Kurani et al, 2015).

Organisations and Employee Drivers

Awareness

Various sources suggest that a key barrier to organisations investing in measures to promote efficient driving by their employees is an under-appreciation, or a lack of awareness of, the potential financial benefits of doing so. In particular, sources highlight the current lack of robust, independent return on investment data for measures such as training and in-vehicle technology. (Campbell-Hall et al, 2011; Ecowill, 2011; Energy Saving Trust, 2014; Lawson et al, 2007a). This may help to explain why, despite the focus of organisations on finance and the apparent savings that organisations can accrue through efficient driving, more have not invested in such measures. In terms of employee drivers, sources suggest that similar to private drivers, they may also lack awareness of the skills and techniques of efficient driving (Deutscher Verkehrssicherheitsrat, 2009; Ecowill, 2011).

Habit

Habit was not explicitly identified as a barrier for organisations or employee drivers in the review. However it is reasonable to suggest that this may function as a barrier for employee drivers in the same way that it does for private drivers – i.e. they are equally likely to have ingrained driving habits that are not easily modified.

Attitude-Behaviour Gap

As with private drivers, the attitude-behaviour gap in relation to the environmental benefits of efficient driving was also identified by one source as a potential barrier for employee drivers (Trommer et al, 2012).

Other Barriers

Norms were highlighted as a barrier for employees (Campbell-Hall et al, 2011; Ecowill, 2011). In this context, these tended to be workplace norms and cultures, rather than wider social norms. Road conditions (bad weather, heavy traffic, and complicated road systems) were also suggested as a barrier for employee drivers, in the same was that they can represent a barrier for private drivers (Strömberg et al, 2014).

4.3 Variations between different types of drivers

Private Drivers

The evidence in regard to how the motivations and barriers identified above vary between different types of private drivers is, at best, limited. One source (Trommer et al, 2012) hints at variations between drivers; suggesting that older drivers and drivers of small cars are most likely to be motivated by financial and environmental motivations. In terms of barriers it has been reported that older drivers are more susceptible to habit as a barrier because they have been driving for a longer period than younger, more inexperienced drivers. Campbell et al (2011) state that “drivers, especially more experienced and older drivers, felt that their current driving habits were so ingrained that incorporating new techniques would be challenging. For this group, habits were a significant barrier preventing the uptake of eco-driving techniques”.

Organisations and Employee Drivers

There was very little evidence on variations in motivations and barriers across organisation or employee type. Ecowill (2011) suggest that smaller organisations may adopt a more short-termist attitude and be less willing to invest in measures to promote efficient driving by their employees than larger organisations. No direct evidence to prove or disprove this was identified in this review, although as noted in chapter 3, overall larger organisations are reported to be more likely than smaller ones to have taken action on efficient driving. Campbell-Hall et al, 2011 also suggest there may be additional barriers to efficient driving for certain types of employee driver – for example those delivering goods or transporting passengers may have heavy vehicle loads, require frequent stopping, and face particular time pressures – but again there is currently a lack of direct evidence to demonstrate this.

4.4 Key influencing points

This is not an issue that evidence sources on efficient driving have generally sought to address – either for private drivers or organisations and employee drivers. The only potential influencing point that was put forward was at the point of car purchase (Aecom, 2013; Gonder et al, 2011), the assumption being that at the point of vehicle purchase drivers are more interested in fuel economy. However this assertion was not supported or suggested elsewhere in the evidence reviewed.

5 Measures to Increase Efficient Driving

Training

- Efficient driving is not currently a high profile element of training for learner drivers and is not a pass/fail criterion in the current driving test.
- There is a broad consensus that training for existing private drivers can lead to a reduction in fuel use (and the equivalent in terms of CO_2) of up to 25% immediately following the training; and up to 10% in the long-term.
- Finding on the impact of training on employee drivers is similar – suggesting an immediate reduction of up to 25%; and of up to 6.5% in the long-term.
- There is, however, evidence of very low willingness to pay for such training amongst private drivers and organisations may currently be deterred from investing in training for their employees by the absence of reliable return on investment data.

Technology

- A wide range of technologies are covered by the evidence, and whilst there is a shortage of real-world testing all are generally reported to deliver a long-term 5-10% reduction in fuel use (and equivalent in CO_2) for both private and employee drivers.
- In general there is a preference among private drivers for real-time, tailored, visual feedback, but still, the evidence suggests, a low willingness to pay for such technology if it is not already embedded in the vehicle at the point of purchase. The installation of embedded telematics on new cars is expected to surpass 50% by 2020 and 90% by 2025.
- Technology aimed at organisations generally provides feedback to the individual driver and has the additional functionality to benchmark and compare levels of efficient driving across different employees – meaning it is typically more expensive to purchase and that there are additional costs associated with actively make use of it as a management tool.

Communications

- Communication campaigns to promote efficient driving are sometimes cited in the literature as being a necessary accompaniment to either training-based or technology-based approaches, but only one campaign in the Netherlands – which revealed a cost of €9 per tonne of avoided CO_2 – has been robustly evaluated, meaning drawing conclusions about their effectiveness is difficult.

This chapter reviews evidence on measures that have been suggested as means of increasing levels of efficient driving, namely:

- Training
- Technology
- Communications Campaigns

5.1 Training

Reviewing the literature, two distinct categories of training emerge: training for learner drivers (most directly relevant to private drivers) and training for existing drivers (which may be accessed by private drivers and employee drivers).

Training for Learner Drivers

Since 2008, driving instructors in the UK have been encouraged to informally incorporate efficient driving techniques into driving lessons (Campbell-Hall et al, 2011). However, it is not currently a pass/fail criterion in the driving test and, largely as a consequence of this, it is reported that efficient driving is not held as a high priority by instructors or learner drivers and does not feature prominently in driving lessons (Wengraf, 2011; Ecowill, 2011).

The evidence suggests that learner drivers may be more receptive to training in efficient driving techniques than experienced drivers who already have more ingrained driving habits (Ecowill, 2011). Various authors assert that if efficient driving was a pass/fail criterion, this would ensure greater coverage of efficient driving techniques in driving lessons, and ultimately higher levels of efficient driving once learners have passed their test. For example, Wengraf (2011) report that “levels of eco-driving on UK roads could be increased by placing more emphasis on eco-driving in both training and testing – integrating it more deeply into driving instruction, and making eco-driving behaviours critical elements (i.e. pass or fail criteria) of the driving test.” The European initiative Ecowill has also previously recommended the introduction of efficient driving as a pass/fail criterion (Ecowill, 2011). One UK survey found that almost two thirds (63%) of private drivers believe that the practical driving test should cover more on environmentally friendly driving (Department for Transport, 2012).

Evidence on the effectiveness of such an approach is currently lacking. Ecowill (2011) attempted to review the current driving test arrangements in a number of EU countries, through qualitative interviews with driving instructors and other stakeholders in each country. Although interviewees in several countries advocated the introduction of efficient driving as a pass/fail criterion for the reasons set out above, Germany appeared to be the only country in which this was already the case. Even here it was reported that “though it is intended that candidates with poor ecodriving behaviour fail the exam, this was put [in] to practice only rarely” and no further evidence was provided on the effectiveness of this in increasing levels of efficient driving. (Ecowill, 2011).

It has also been postulated that the teaching of efficient driving techniques to learner drivers in the UK may be being held back by a lack of skilled instructors. There is no quality control or efficient driving standard in the UK. Evidence from existing UK driving instructors is that they would be receptive to an efficient driving accreditation scheme. However, unless efficient driving becomes as pass-fail criteria, they could see little demand from learner drivers for further coverage of efficient driving techniques in driving lessons, and consequently little value in the gaining such accreditation (Ecowill, 2011).

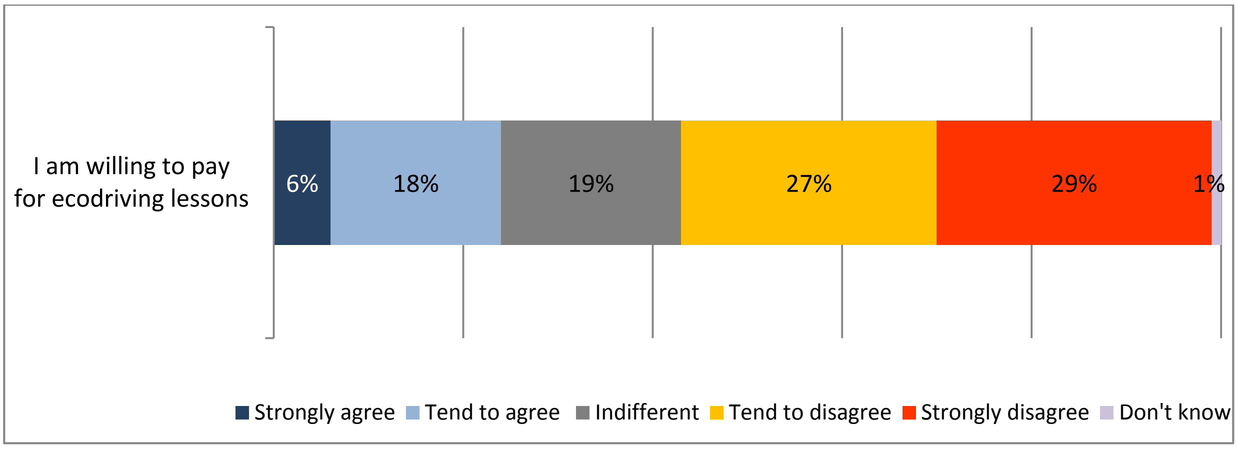
No assessment of the value for money or cost effectiveness of training in efficient driving for learner drivers was identified in this review.

Training for Existing Drivers

Uptake

The evidence suggests uptake of post-test training (in general and specifically training in efficient driving) is currently very low among private drivers. It has been estimated that just 1% of the UK driving population has undergone post-test training, a high percentage of which was mandatory, and undertaken due to receiving a sanction for speeding (Campbell-Hall et al, 2011). UK stakeholders interviewed in Ecowill (2011) also reported little interest in, or demand for, training in efficient driving amongst existing drivers. Reflecting this, the majority of existing drivers also say they are unwilling to pay for additional training in efficient driving (King, 2011; Kurani et al, 2015; Barkenbus, 2010).

Figure 16. Willingness to pay for training in efficient driving



Source: Department for Transport (2012)

In terms of organisations and employee drivers, uptake of training appears to be higher but still some way short of universal. As reported in chapter 3, around 20% of employee drivers say they have received training in efficient driving from their employer.

The reasons for this relate back to the motivations and barriers to efficient driving discussed in chapter 4 – private drivers generally have low levels of awareness of efficient driving techniques, may assume they drive efficiently already, and be unaware of the savings they could potentially make. There is some evidence from interviews with UK drivers suggesting that they would be more willing to pay for training if this enabled them to qualify for lower car insurance premiums (Campbell-Hall et al, 2011) but no real-world evidence of this was identified in this review. As discussed in chapter 4, organisations are also thought to be deterred from investing in training for their employees by the current absence of robust, independent evidence on the potential savings they can expect as a consequence - "if the cost is low and the benefits are quantifiable then uptake would be much more likely." (Ecowill (2011). However, their legal obligation to ensure the safety of their employees under the duty of care does appear to serve as an additional motivation for them to invest in training (which combines safer *and* more efficient driving techniques).

In terms of the different forms of training currently targeted at existing drivers, the majority of literature focuses on either in-car tuition from an instructor, theory-based workshops or lessons, or often a combination of the two (Kurani et al, 2015; Beusen et al, 2010; Luther et al, 2011; Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat, 2009). For example, the training delivered in certain European countries through the Ecodriver initiative involved a 30 minute theory session covering the techniques and underlying theories for fuel efficient driving, followed by a 1 hour practical in the driver's usual vehicle, then a 15 minute summary and question-answer session (Luther et al, 2011). Specifically in the UK, the DfT funded Smarter Driving programme delivered by EST has been based on drivers receiving a 50 minute in-vehicle training sessions in efficient driving techniques (EST, 2014). Some online and simulator-based training programmes have also been developed but not, to date, deployed as widely as in-vehicle and classroom-based training.

Effectiveness

In terms of the effectiveness of training targeted at existing drivers, several studies have sought to measure this, but with common weaknesses:

- Timing of data collection – most studies only collected data on drivers' fuel consumption immediately after they had received training, with no follow-up data collected after this point.
- Sample sizes – most studies involved 50 or fewer drivers, which does not provide a robust basis for extrapolating the observed results to the wider population of private and/or employee drivers.
- Comparisons between training formats – most studies only tested one format of training, rather than testing two or more in parallel, which makes making direct like-for-like comparisons between the effectiveness of different formats problematic.

Many studies were initially identified in this review but ultimately not considered in detail because of these weaknesses.

Amongst the more robust sources that were considered, there is a general consensus that training of all formats can lead to significant immediate improvements in fuel consumption but that these decrease over time. For private drivers, these immediate reductions ranged from 5% up to 25% (King, 2011; Kurani et al, 2015; van den Hoed et al, 2006; Graves et al, 2012; Shaheen et al, 2012) while longer-term reductions were reported to be up to 10% (Kurani et al, 2015; Barkenbus, 2010; Wengraf, 2012). For employee drivers, immediate improvements are generally reported to be between 5%-25% and longer term improvements between 2%-6.5% (Aarnink et al, 2015; EcoDrive, 2008; EST, 2014; Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat, 2009). No explanation was provided in the sources reviewed as to why longer term improvements appear to be somewhat lower for employee drivers than private drivers, as the studies concerned were either conducted with one type of driver or the other.

Unfortunately the current evidence-base is also not sufficient to be able to draw definitive conclusions about the relative effectiveness of different formats of training. As already highlighted, most studies have tested only one format of training in isolation, and there is not the sufficient critical mass of robust studies necessary to be able to compare findings between studies involving different formats.

Nonetheless, some indicative findings can be gleaned from the available evidence which may be useful in informing any future research in this area. Firstly, it is generally asserted that practical in-vehicle training is more effective than classroom based or online training, as it allows drivers to practise efficient techniques and can provide direct evidence of the potential benefits of efficient driving to drivers who may be initially sceptical. For example, on the basis of qualitative interviews conducted with UK driving instructors, Campbell-Hall et al (2011) report that "the most effective method of intervention was generally said to be in-vehicle training" and research in Germany has reached similar conclusions (Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat, 2009). Equally, the findings from one study in Australia involving over 1,000 drivers do not fully endorse this. The study trialled five interventions which combined different formats of training:

1. online learning (this included a brochure and on-line learning module of up to one hour)
2. online learning plus a 2 hour classroom session
3. online learning plus a 50 minute in-car lesson
4. online learning plus a classroom session and an in-car lesson
5. online learning plus a half-day workshop (combining a classroom session and an in-car lesson in a car fitted with a telematics device)

It might be expected that the interventions that included an in-car training element would prove most effective – but the authors report that all the interventions resulted in similar long-term reductions in fuel consumption, of between 4% and 7.4%. Although there were some differences between the interventions, none of these were statistically significant (Graves et al, 2012). This one study does not provide a sufficient basis for concluding definitively that online training is as effective as in-car training. However it does serve to illustrate that received wisdom about the effectiveness of different formats of training could usefully be tested and challenged through robust parallel trials of different formats with UK drivers.

Another assertion commonly made in the literature is that the effectiveness of training can be improved if it is complemented with additional follow-up measures – i.e. either refresher training or the installation of in-vehicle technology (Barkenbus, 2010; Beusen et al, 2010; Aarnink et al, 2015). Equally, others have highlighted the relative lack of evidence comparing the effectiveness of training with and without such follow-up measures.

> *"According to Barkenbus (2010), the effects of eco-driving training can be doubled if coupled with in-vehicle feedback devices… However, no empirical studies have been found which verify this claim."*
>
> Strömberg et al (2014)

One study identified in this review did seek to address this shortfall – by undertaking parallel trials with employee drivers who either just received training or who also received various follow-up measures. These follow-up measures were either:

- refresher training
- the distribution of a league table in which drivers were ranked based on their cumulative mpg improvement and provided with pence per mile data
- engagement (the dissemination of results, feedback and tips)

The findings, all based on fuel consumption data collected 12 months after the provision of the initial training, are presented below.

Figure 17. Reductions in fuel consumption amongst drivers receiving different combinations of measures

England Groups	Average MPG improvement
1.Trained once	1.3%
2.Trained once + league table	2.0%
3.Trained twice	2.1%
4.Trained twice + league table	2.5%

Scotland Groups	Average MPG improvement
1.Trained once	4.1%
2.Trained once + engagement	6.4%

Source: EST (2014)

These findings provide indicative evidence of some additional improvement in fuel efficiency where training is complemented with follow-up measures – although the authors do not comment on whether these differences are statistically significant. Certain case-studies were also identified in this review which report positive improvements in fuel efficiency within organisations that have invested in training *and* follow-up measures, see below example.

Figure 18. Case study

Spectrum Property Care	
The Organisation	Spectrum Property Care (SPC) is the property maintenance division of Spectrum Housing Group. SPC maintain over 50,000properties, predominantly in the South West of England. These include properties owned by housing associations and customers such as the NHS, local authorities and private landlords. They have a fleet of 300 light commercial vehicles.
The Challenge	To improve the safety of drivers, improve fuel efficiency and reduce off-road time, through the implementation of a training programme.
The Approach	Over the past three years, SPC has introduced a training programme for all of its drivers. It starts with newly recruited drivers, who are taken for an initial assessment drive with a trainer, in a van similar to the one they will be driving. The driver is then debriefed on their driving habits. There is then a vehicle handover covering maintenance procedures, accident protocol, Lex Autolease contact numbers, weekly vehicle checks and safe loading procedures. After a probationary period, this process is repeated using the SAFED (Safe And Fuel Efficient Driving) programme guidelines. The staff member undertakes a driver, with notes being taken on driving skills and use of controls. The driver is then given a demonstration drive by the trainer,

	highlighting good practice. The driver then repeats their drive, with coaching, to address areas for improvement. Telematics measure improvement in driving performance between the two drives. This phase is to be repeated across all drivers on a rolling programme.
The Outcome	Typical improvements in fuel efficiency during the training process are 10-12%; an improvement in fuel efficiency is maintained in real working conditions (4% on average). There has been a reduction in collisions involving SPC vehicles, and this has been significant in reducing insurance costs.

Source: Lex Autolease (2014)

Value For Money

Across the evidence, the reported cost of in-car and classroom-based training ranged from £15 for short lessons to over £100 for a longer course (Ecowill, 2011; Wengraf, 2012; King, 2011). Campbell-Hall et al (2011) suggest an industry average in the UK of £25-£30 for lessons provided to private drivers, but that "the cost for fleet training was generally slightly more due to increased travel and set-up costs". The costs of online training are widely assumed to be significantly lower, although precise figures to illustrate this are generally lacking. In the Australian study discussed above some figures are provided – they state that the cost of the online training that was trialled was $10 per participant, compared to $65 per participant for the in-car training that was trialled (Graves et al, 2012). As the online training resulted in similar fuel savings to the in-car training, the authors concluded that "the on-line tool is the cheapest and easiest option to implement on a mass scale [and] has the highest benefit-cost ratio" (Graves et al, 2012). However, this was the only study identified in the review that presented findings on the comparative value for money of different types of training. Further studies, ideally conducted with UK drivers, would be necessary to provide a firmer basis for drawing conclusions about the value for money of different training formats.

There is a general consensus in the evidence that the long-term savings that private drivers would benefit from if they undertook training would outweigh the costs of the training. Although detailed evidence demonstrating this is absent, the cost data above (suggesting a one-off cost of £25-£30) and findings presented in chapter 3 (suggesting an annual saving of £96 on fuel costs from driving more efficiently) are supportive of this assertion – i.e. it suggests in very broad terms an average driver might save around £60 in the 12 months after they undertake the training and around £90 in subsequent years. It is also feasible that annual savings would be somewhat higher than this if other related savings were also considered. For example, efficient driving is widely reported to contribute to lower maintenance and insurance costs (Aarnink et al, 2015). However, no evidence was identified in this review which attempted to quantify and incorporate these other potential savings into an overall calculation of the value for money of training for private drivers. The current evidence base also provides little insight into how the savings arising from training may vary between different types of private driver.

Evidence on the costs and benefits of training from the perspective of organisations is slightly more developed but also shares some of these limitations. Studies do not incorporate additional savings of lower maintenance and insurance costs into their calculations. They also do not generally account for additional costs associated with their employees spending time away from their work duties to participate in the training.

Notwithstanding this, attempts that have been made to date are valuable in: a) indicating the potential scale of the costs and savings associated with training; and b) providing a starting-point from which more comprehensive analyses could be undertaken. The first example, provided below, is based on a Finnish company that participated in the EU FLEAT initiative and collected robust data over a two-year period. The cost data used in the case-study is taken from estimates based on all the companies that participated in FLEAT and were able to provide data for this (NB. €300 - €1,000 would be equivalent to £217 - £723 at October 2015 exchange rates).

Figure 19. Case study

Eco-Safe Driving Programme	
The Organisation	A globally leading company in the elevator and escalator industry, headquartered in Finland, with a fleet of 14,000 vehicles.
Implemented measure	An eco-safe driving programme to reduce fuel consumption/CO2 and accidents with: - a driving course - follow-up programme within in-vehicle handbook with handy tips ○ (e.g. closing windows to reduce drag, changing gears, and buckling up before leaving), posters throughout the office, and so on. - an internal competition (Jeu Roule Habile eco-safe driving challenge), which rewards the best driver with a prize
Results	Reduction in accident rate – 13% in two years after implementation Reduction in KONE's fuel consumption/emission of 576 cars and small vans monitored in the FLEAT project: - reduction in fuel consumption: 6% (from 6l/100km to 6.6l/100km) - CO2 saving per year per vehicle: 400kg/year/vehicle
Costs	Costs numbers are not provided by KONE, but have been estimated in the FLEAT monitoring project. They estimate costs of €300-1,000 for the driving course itself, loss of man hours, setting up a feedback scheme and for monitoring. With average fuel costs of 1.47 €/litre (incl. taxes) in the EU in 2014 and KONE's annual mileage of nearly 36,000 km per car/van, the fuel savings of 6% per year result in: - a payback period of 1.3 years (costs of €300) to 4.4 years (costs of €1,000) - abatement costs of -€340 to €55/tonne CO2 over the average lifetime of a company car (4 years)

Source: Aarnink et al (2015)

This example illustrates the variability of the payback period depending on whether the lower or higher cost estimates are used – i.e. the training could pay for itself in less than a year and a half compared to this taking over 4 years. Equally, it is also worth noting that any financial savings arising from the reported 13% reduction in accident rate (which could be significant) were not accounted for in the calculation of these payback periods.

The second example, below, estimates the payback period for training based on various scenarios - designed to reflect the characteristics of different organisations. It illustrates the role these characteristics (such as the pre-training mpg of an organisation's vehicles and their annual mileages) can have in mediating these payback periods. For example, it suggests that for an organisation with 100 vehicles, which have an average mileage of 10,000 miles and pre-training mpg of 40, and assuming that training would reduce their fuel consumption by 3%, the potential savings from training all their drivers would be £4,608 a year, and the payback period 5.2 months.

Figure 20. Estimated financial and CO2 savings arising from efficient driving

MPG Pre	MPG Post	MPG Improve-ment	Annual Business Mileage	Payback Period	Fuel Cost Saving Per Annum Per …			CO_2 Saving Per Annum Per …		
					Driver £s	Fleet ① £s	Company Car Parc ② £millions	Driver Tonnes	Fleet ① Tonnes	Company Car Parc ② Tonnes 000s
20.0	20.6	3.0%	10,000	2.6 mths	92	9,216	461	0.2	17	861
30.0	30.9	3.0%	10,000	3.9 mths	61	6,144	307	0.1	11	574
40.0	41.2	3.0%	10,000	5.2 mths	46	4,608	230	0.1	9	430
50.0	51.5	3.0%	10,000	6.5 mths	37	3,686	184	0.1	7	344
20.0	20.6	3.0%	20,000	1.3 mths	184	18,431	922	0.3	34	1,721
30.0	30.9	3.0%	20,000	2.0 mths	123	12,287	614	0.2	23	1,148
40.0	41.2	3.0%	20,000	2.6 mths	92	9,216	461	0.2	17	861
50.0	51.5	3.0%	20,000	3.3 mths	74	7,372	369	0.1	14	689
20.0	21.0	5.0%	10,000	1.6 mths	151	15,067	753	0.3	28	1,407
30.0	31.5	5.0%	10,000	2.4 mths	100	10,044	502	0.2	19	938
40.0	42.0	5.0%	10,000	3.2 mths	75	7,533	377	0.1	14	704
50.0	52.5	5.0%	10,000	4.0 mths	60	6,027	301	0.1	11	563
20.0	21.0	5.0%	20,000	0.8 mths	301	30,133	1,507	0.6	56	2,814
30.0	31.5	5.0%	20,000	1.2 mths	201	20,089	1,004	0.4	38	1,876
40.0	42.0	5.0%	20,000	1.6 mths	151	15,067	753	0.3	28	1,407
50.0	52.5	5.0%	20,000	2.0 mths	121	12,053	603	0.2	23	1,126
20.0	22.0	10.0%	10,000	0.8 mths	288	28,764	1,438	0.5	54	2,686
30.0	33.0	10.0%	10,000	1.3 mths	192	19,176	959	0.4	36	1,791
40.0	44.0	10.0%	10,000	1.7 mths	144	14,382	719	0.3	27	1,343
50.0	55.0	10.0%	10,000	2.1 mths	115	11,506	575	0.2	21	1,075
20.0	22.0	10.0%	20,000	0.4 mths	575	57,528	2,876	1.1	107	5,373
30.0	33.0	10.0%	20,000	0.6 mths	384	38,352	1,918	0.7	72	3,582
40.0	44.0	10.0%	20,000	0.8 mths	288	28,764	1,438	0.5	54	2,686
50.0	55.0	10.0%	20,000	1.0 mths	230	23,011	1,151	0.4	43	2,149

① 100 vehicles
② 5 million vehicles
③ Cost of training £20
④ Diesel £1.39 / litre

Source: EST (2014)

Two caveats to this example are that a) all the estimates are based on an assumed cost of training of £20 per driver to the organisation, which is lower than some other sources suggest and does not account for any additional costs associated with lost staff time; and b) as with the first example the savings figures are based on fuel cost savings only and don't account for any other additional savings. Equally it does illustrate, in a fairly rudimentary form, a means by which the financial "business-case" for investing in training could be estimated for organisations of all shapes and sizes. It is worth noting that the above source had not been published at the time of writing and no equivalent analysis was identified amongst the other published sources identified in this review.

5.2 Technology

This section reviews evidence on technology to promote efficient driving, in terms of current levels of uptake, its perceived effectiveness, and value for money. The literature identifies a wide range of technologies that provide for more efficient driving, broadly as follows:

- **In-car visual displays**. In the literature reviewed these are generally post-sale additions, but they are increasingly built into new cars. They are of three broad types:
  - **Feedback** - analyse driving style and give the driver feedback and advice about how to drive more efficiently include real time telematics and long term feedback showing change and suggesting improvements (Seewald et al, 2013)
  - **Feedforward** - advice is provided in advance of a driving scenario to help drivers improve their behaviour e.g. eco-routing (Seewald et al, 2013; Gonder et al, 2011; Trommer et al, 2012)
  - **Maintenance** - providing information on e.g. tyre pressure (Wengraf, 2012)
- **Smartphone feedback.** These systems provide real-time and/or post-journey driving feedback via a driver's smartphone (Kurani et al, 2015; Aecom, 2013; Wengraf, 2012)
- **Haptic feedback pedal.** Pedal stiffness is varied to send physical signals back to the driver e.g. to deter heavy acceleration (Seewald et al, 2013; Hof et al, 2014; Luther et al, 2011)
- **Advanced automation.** These include, for example, efficient automatic gear boxes and stop-start technology (Ertico, 2015)

These technologies are equally applicable to private drivers and organisations and employee drivers. However, one difference is that technology marketed at organisations typically has the additional functionality to enable the collection of data from a number of vehicles in a fleet, and provide the basis for monitoring and comparison between vehicles. Whereas the emphasis with private drivers is on providing feedback and/or automating aspects of efficient driving, the emphasis with organisations is more on the collection and use of driving data as a management tool. Hof et al (2014) provide an illustrative example of a Dutch firm which introduced technology in its vehicle fleet to provide feedback to drivers and to a central server. This feedback included data on:

- Fuel consumption
- Lost fuel (Idling - time and fuel consumption)
- Speed
- Acceleration/deceleration
- RPM (over-revving)
- Carbon footprint

The data was used to create league tables of drivers, which were reviewed by local managers on a weekly and monthly basis. The "best" drivers could win €25 per month while the "worst" were called in for 1:1 meetings with managers, and could be sent on a remedial training course.

Uptake

Despite the growing range and variety of technology relating to efficient driving, evidence is lacking on how many private drivers in the UK are currently accessing and making use of such devices. As with training (see previous chapter) the majority of drivers express low willingness to pay for them and current uptake amongst private drivers is thought to be limited (Trommer et al, 2012; Seewald et al, 2013; Barkenbus, 2010). Evidence reported in chapter 3 also suggested that only around one in four of UK organisations have installed technology in the vehicles used by their employees. Organisations may be unwilling to invest in technology if the resultant savings and overall return on investment are not well evidenced. Some sources also suggest that employee drivers, particularly company car drivers, may initially be resistant to the installation of technology into their vehicles because of concerns over privacy (Hof et al, 2014).

However, unlike training, there is evidence that technology will increasingly become installed as standard on new cars and/or be accessible to drivers at low or zero cost (i.e. through smartphone apps). Firstly, by 2020 it is estimated that 50% of new cars will have telematics which provide drivers with visual feedback fitted as standard, and this is estimated to rise to 90% by 2025 (Aecom, 2013). Secondly, it is projected that up to 55 percent of new vehicles sold in Europe in 2016 will have in-built 'Start-Stop' technology, up from 8 percent from 2010 (Aecom, 2013). Thirdly, smartphones are becoming increasingly ubiquitous, and it is expected they will represent 72% of all active handsets in Western Europe in 2016 (Aecom, 2013). Fourthly, tyre pressure monitors and gear shift indicators are already compulsory on new cars sold in the European Union, and have been since late 2012 (Wengraf, 2012).

The only caveat to this is that new car buyers may be the only (initial) beneficiaries of most of these developments. For example, used car buyers will only have access to cars with inbuilt telematics once new car buyers have bought these, owned them for a number of years, and then decided to sell them on.

Effectiveness

The key feature of these new technologies is that very few have been tested in the real world, with robust samples and over appropriate periods of time. Most of the evidence reviewed concerning private drivers comes from laboratory and/or artificially constrained testing environments; and, since most technologies are assessed in isolation, there is relatively little comparative data.

Despite these constraints, there is a general consensus in the literature about the scale of fuel savings that technologies can achieve when used by private drivers. Three studies that reviewed the findings from numerous previous trials and experiments each concluded that these savings were between 5% and 10% (Kurani et al, 2013; Gonder et al, 2011; Pandazis et al, 2015).

In addition, Fiat undertook possibly the only robust real-world evaluation of efficient driving technology to date in 2010, and this also reported average fuels savings within the 5% to 10% range. The evaluation concerned their own eco:Drive system, that was introduced in certain Fiat models in 2010. The in-built system collects data on vehicle speed, acceleration/deceleration, fuel consumption and other factors. Using a USB stick the driver can upload and view this data on an online 'Ecoville' platform. The platform also gives them an ecodrive "score", allows them to compare this to other drivers using the system, and gives them tailored advice on how to drive more efficiently.

Figure 21. The Fiat eco:Drive interface

Source: Fiat (2010)

The evaluation was based on data collected through the eco:Drive system on 428,000 journeys made by 5,697 drivers in 5 countries over 150 days. Results showed average fuel consumption and CO2 savings of 6%, but with the best 10% of performers achieving savings of 16%. Over the whole lifecycle of a car (8 years), they projected that savings could be as high as 2,895kg of CO2 and €1,575 for the top 10% of drivers. They also found that some changes in driving behaviour were more readily adopted, and brought about more savings, than others. Changing gear at the right time contributed 31% to overall improvements in driving efficiency, and smooth acceleration 29%. Efficient deceleration contributed 25% to overall improvements, and maintaining a steady average speed contributed 15% (Fiat, 2010).

In terms of the effectiveness of technology when it is deployed by organisations in the vehicles their employees drive, the available evidence is even more limited. No robust independent studies into this were identified in this review, or in recent review conducted by others (see, for example ROSPA, 2013). What evidence there is comes from promotional material and case-studies. Selected examples are provided below:

Figure 22. Selected case studies

Britvic	
The Organisation	Britvic is a leading international manufacturer and distributor of soft drinks, employing 1,800 people in the UK. It has a team of 91 technical staff installing drinks dispensing equipment into pubs, clubs and other outlets.
The Challenge	As part of its four-yearly review of suppliers, Britvic were looking to improve the fuel efficiency and running costs of the LCVs used by the Technical Team, in a drive to increase profitability and reduce their environmental footprint.
The Solution	Britvic, in collaboration with Lex Autolease, designed a scheme utilising the latest in telematics combined with detailed management reporting, driver incentives and training to reduce the running costs of their vehicles. The Masternaut telematics systems they now use provide an 'in-cab coach' notifying drivers of poor driving behaviour. This was introduced through a strategy involving an initial pilot scheme, driver briefings, incentives, and follow-up training to improve individual driving styles. In parallel, Lex Autolease provided a dashboard reporting system monitoring off-road time, speeding fines, parking fines and other aspects of total running costs.
The Outcome	Since the introduction of the initiative, fuel efficiency has improved by around 10%, with the fleet now achieving 52mpg on average. Britvic's drivers are performing significantly better than average drivers using the Masternaut system. Simon Mohun from Britvic states that "whilst initially drivers were sceptical, the data has unequivocally shown that the scheme works, and it is now embraced by all the team."

Source: Lex Autolease (2015)

Tesco	Royal Mail
Home delivery firm Tesco.com revealed 12% fuel use savings and a 6% drop in accident damage after fitting telematics. The 2,200 vans on the fleet cover 60 million miles a year, so such significant reductions in costs will have a major impact on the business. Any examples of bad driving are flagged up and bosses can immediately deal with problems such as harsh braking and errant behaviour. To encourage drivers a league table has been produced at each depot. Drivers are rewarded with a set number of points, which they retain if they are shown to have driven carefully and sensibly on the road on an ongoing basis.	Royal Mail reduced its fuel usage by more than 10% - a saving of £4.4 million - whilst improving the efficiency and accident record of its collections and delivery fleet by using tracking. More than 8,000 Royal Mail vehicles were fitted with a tracking system as part of a drive to improve road safety, reduce fleet size and drive down fuel consumption. To date, driver productivity has increased by 3%, accident rates have been reduced by 20% and instances of speeding are down by more than 60%. Meanwhile, harsh braking has been reduced by 70% contributing to greater fuel efficiency.

Source: EST (undated)

The above examples provide very indicative evidence of reductions of 6%-12% in fuel consumption by employee drivers when technology is introduced and used by their employer.

Unfortunately the available evidence does not provide the basis for comparison between the effectiveness of different types of technology – for either private drivers or employee drivers. That being said, there is reasonable evidence on the preferences drivers have in relation to in-vehicle technology. The literature suggests the following:

- drivers prefer visual rather than haptic (physical) feedback
- they prefer to have control over the system (in particular the ability to turn it on and off)
- they do not want the system to be too distracting (feeling that it compromises safety)
- they prefer feedback to feedforward
- gamification and competition is generally appealing
- progress monitoring (especially financial) is appealing
- different people like different interfaces, but it just seems to be personal choice rather than defined by e.g. age, gender, social status
- drivers prioritise safety over efficient driving, so pay less attention to efficient driving technology in situation they perceive as more dangerous

(Hof et al, 2014; Kurani et al, 2015, Seewald et al, 2013)

Value For Money

Most studies to date have not concerned themselves with the question of value for money, and indeed do not generally specify the costs of the technology or technologies they have tested. One study published in 2013 did provide an indicative range, although no details were provided on the basis for this and it may already be somewhat out of date.

> *"The typical unit costs for embedding HMI (human machine interface) technology into the car can vary between €50 and €200, depending on the required functionality of the device and the volume of systems sold."*
>
> Aecom (2013)

If, as predicted, this technology becomes increasingly embedded in vehicles as standard and/or free to access via a smartphone this may not matter. At least currently, the upfront costs of technology are cited as a potential barrier to both private drivers and organisations (see chapter 4). Notably the national Dutch efficient driving programme (discussed in detail in the annex to this report) included subsidisation (tax exemption) of in-car devices. This was credited with contributing to a marked increase in the ownership of these technologies, from 13% in 2000 to 33% in 2004. The evaluation of the scheme (van den Hoed et al, 2006) estimated that 45-60% of the in-car devices would not have been purchased without the tax exemption. The same study reported that CO_2 emissions as a result of the in-car devices has decreased significantly between 2000 and 2004, and that approximately 80% of CO_2 emission reductions could be attributed to the tax-exemption on in-car devices.

In terms of the value for money of technology for organisations, some case-studies (e.g. the Royal Mail one above) specify the financial fuel savings that have been made following the introduction of telematics but provide no further details of the costs of its introduction. Aarnink et al (2015) highlight that there are likely to be additional costs to organisations (beyond the purchase price) associated with their use of the technology as a management tool.

> *"The cost of applying a full eco-driving package include:...Setting up a monitoring and feedback system, and the FTEs spend on the actual execution the system. Costs are highly dependent on the complexity of the monitoring and feedback, wages, etc."*
>
> Aarnink et al (2015)

Any attempt to calculate the cost effectiveness of technology from an organisational perspective would need to incorporate these costs. As with the value for money of training (discussed earlier in this chapter) it would also need to incorporate savings from lower rates of fuel consumption and any wider savings, e.g. through lower maintenance and insurance costs.

5.3 Communications Campaigns

There is little evidence as to either the role of communications (either in conjunction with or instead of training and/or technology) to promote efficient driving or, perhaps more importantly, the costs and benefits of communications campaigns. Among the limited sources there is agreement that communications has an important role to play in improving general knowledge and awareness of efficient driving and its benefits (Hof et al, 2014; Campbell-Hall et al, 2011). Several countries have also invested in campaigns to promote efficient driving, including previously the UK, through the Act on CO2 series (Wengraf, 2012). However the impacts of these have not generally been researched or evaluated. The sole high quality example of an evaluation of a communications campaign is the Dutch 'Het Nieuwe Rijden' scheme, which ran from 1999 to 2010 (see case study provided in Annex B for full details).

The scheme, which combined a number of measures, included a communications campaign delivered through television, newspapers, magazines and printed material. The evaluation study (van den Hoed et al, 2006) reported that the campaign led to an increase in unprompted recognition of the scheme from 18% in 1999 to 31% in 2004; while prompted recognition increased from 36% in 2003 to 50% in 2004. 90% of those aware of the scheme reported that they applied 'some' or 'a lot' of the efficient driving techniques it promoted. Television was the most effective channel: 78% who recognised the scheme did so from TV, 17% from newspaper, 16% from radio. Overall the evaluators concluded that the communications campaign had made a significant contribution (of between 40% and 75%) to the total reductions in CO2 the scheme achieved. The budget for the communications campaign was reported to have been 0.8 – 1 million Euros per annum.

5.4 Combinations and Comparisons Between Measures

All three of the options for promoting efficient driving – training, technology and communications – are, according to the evidence, capable of delivering reductions in CO2 emissions and fuel usage. In general, however, there is a shortage (often significant) of robust evidence to support precise estimation of the benefits; a range of confounding factors; and virtually no evidence on how the different measures compare or interact.

There is a tendency in the literature to assert that both training *and* technology is necessary to effectively sustain efficient driving (Barkenbus, 2010; Wengraf, 2012). However, concrete evidence demonstrating the added value of doing both rather than one or the other is currently lacking, and there is some indicative evidence to the contrary. For example, organisations participating in the EU FLEAT initiative generally introduced both training and technology, but one organisation which just introduced technology was reported to have achieved above average improvements in fuel consumption (Beusen et al, 2010). Another study compared the fuel consumption of bus drivers who had either received training and in-vehicle technology or just in-vehicle technology, and concluded that "No difference was observed between the group that had access to the support system and the group that had access to the system as well as received individual training" (Strömberg et al, 2014). Ultimately more research would be needed in order to properly compare the effectiveness and value for money of training and technology, or combinations of both, in increasing efficient driving.

Communication campaigns to raise awareness of efficient driving are generally seen as worthwhile and the Dutch example illustrates what they can achieve as part of a package of measures. The current lack of awareness and understanding of the potential benefits from efficient driving (see chapter 4) also suggest a role for such campaigns if drivers are to be convinced to proactively invest their time and/or money in measures such as training or in-vehicle technology. However, such campaigns cost Government's money to deliver, and without evidence on the resultant impacts of other campaigns in other countries it is not possible to make an overall assessment of their value for money.

6 Synergies between efficient driving and other policy areas

- There is strong evidence of road safety benefits arising from efficient driving (e.g. training for efficient driving has been reported to correlate with reductions in subsequent accidents rates of between 14% and 35%).
- There is convincing evidence, too, of financial benefits (for private drivers and organisations) arising from efficient driving, but these have yet to be quantified in their entirety. Efficient driving is widely reported to result in lower vehicle maintenance and insurance costs but these savings are not currently incorporated into calculations of the financial benefits of efficient driving.
- The wider environmental benefits of efficient driving (beyond reductions in CO2) are reported to be relatively minimal or even negative (e.g. some efficient driving techniques may lead to increased emissions of carbon monoxide and hydrocarbon.
- There has been relatively little attention in the literature given to the extent to which such synergies have been harnessed by policy-makers. Looking ahead, the greatest potential for increasing efficient driving may lie in capitalising on overlaps between efficient driving, safety and insurance (notably pay-as-you-drive models).

This chapter reviews evidence on the relationship between efficient driving and other policy areas. Firstly, the extent to which efficient driving can bring about wider benefits in these areas is addressed. Secondly, the extent to which policies have capitalised on these synergies, in the UK and elsewhere, is explored.

6.1 Wider benefits of efficient driving

This section focuses on the wider potential benefits of efficient driving in the following policy areas: safety, air quality, noise, and household/organisation finances. It has also been suggested by some authors that there are wider benefits from efficient driving in other areas too, including congestion, passenger comfort and driver relaxation – but without offering much by way of evidence to demonstrate or illustrate this. These may be fruitful areas for future research or a more extensive review of the evidence-base but have not been considered in depth here.

Efficient Driving and Safety

The benefits of efficient driving for road safety are widely cited in the literature on efficient driving (see Strömberg et al, 2014; Fiat, 2010; CICEA, 2007; Shaheen et al, 2012; Graves et al, 2012; Alam et al, 2014; EcoDrive, 2008; Lex Autolease, 2015; EST, 2014; Hof et al, 2014; Ecowill, 2011).

There is also various evidence that goes some way towards quantifying these wider safety benefits, although this is heavily biased towards employee drivers (rather than private drivers) and mainly comes in the form of organisational case-studies (rather than independent research or analysis of accident statistics).

> *"Hamburger Wasserwerke monitored the frequency of insurance claims before and after the introduction of an ecodriving programme and reported a 22% decrease. Another example is Canon, Switzerland, who reported a 35% reduction in accident rates after ecodriving training."*
>
> EcoDrive (2008)

The evidence cited in the above quote, and other sources (see Alam et al, 2014; EST, 2014; Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat, 2009), suggest organisations can benefit from anywhere between a 10%-40% reduction in accident rates if they introduce measures to promote efficient driving by their employee drivers. Equivalent evidence for private drivers was not identified in this review.

Some sources also suggest that there may be certain disbenefits or trade-offs between efficient driving and safety. For example, one source cites the following ways in which efficient driving techniques could compromise safety:

> *"A principle of rapid acceleration to target speed could be taken too literally, and could cause shorter safety distances in traffic.*
>
> *Maintaining a constant speed, if misunderstood, can lead to insufficient safety margins because of delayed slowing down.*
>
> *Applying engine braking too early may result in a different pattern to that of 'normal traffic' and increase the risk of collision.*
>
> *The principle of 'avoiding stopping' could cause problems: if it is applied near pedestrian crossings or intersections without a clear view."*
>
> Wengraf (2012)

Luther et al (2011), Alam et al (2014), Graves et al (2012) and Aecom (2013) cite similar risks. However, no real evidence is ventured to demonstrate or quantify the extent of these by the sources concerned. They appear to have been posited as hypothetical or "in theory…" risks rather than observed impacts from real-world research. On balance, the available evidence does strongly indicate that the relationship between efficient driving and safety is a positive, mutually reinforcing one.

Efficient Driving and Air Quality

Evidence on the impacts of efficient driving on air quality (beyond direct reductions in CO_2) is comparatively weak, and if anything suggests such impacts may be minimal or even negative. Luther et al (2011) point to the relative sparsity of evidence in this area, stating that: *"while many training programmes and eco-driving schemes highlight benefits in this area, no quantified information about specific reductions in pollutants as a result of eco-driving was identified as part of this review"*. Other sources highlight the weakness of the correlation between fuel consumption and pollutants other than CO_2, and assert that certain efficient driving techniques (shifting up early and using the highest possible gear at all times) may increase emissions of such pollutants.

> *"While CO_2 emissions and fuel consumption are highly correlated, they are less correlated with other regulated pollutants: carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxides (NOx) ...driving at the lowest possible cruising speed in the highest possible gear uses the least fuel, but this requires high torque engine operations resulting in greater HC and CO emissions."*
>
> Kurani et al (2015)

In terms of quantifying these impacts on air quality, Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat (2009) cite previous Swiss research conducted in 2002 in which the emissions of drivers adopting different driving styles were compared. The "Normal 3,000" driving style was based on the driver shifting up at 3,000 rpm while the "Eco 2,000" driving style was based on the driver shifting up at 2,000 rpm. Comparing the two, they concluded that adopting the "Eco 2,000" driving style led to decreases in CO_2 and nitrogen monoxide emissions but increases in carbon monoxide and hydrocarbon. Further details of the study methodology are lacking, and engine technology has evolved since the timing of the research, but the findings are indicative of there being an inverse relationship between at least one efficient driving technique and air quality. More comprehensive and up to date evidence is ideally needed to measure the emissions of pollutants arising from all efficient driving techniques.

Efficient Driving and <u>Noise</u>

The assertion that efficient driving can reduce traffic noise is widely made in the literature (see Aarnink et al, 2015; CICEA, 2007; Luther et al, 2011) and no evidence was identified in this review to contradict this. Equally, evidence on the scale of the potential benefits in this area appears to be currently lacking. The following source cites research which provides a rough indicator of this.

> *"Eco-Driving Europe (undated) indicates that reduced local traffic noise would result from the reductions in engine revving associated with eco-driving techniques. The paper states that the engine noise of one vehicle revving at 4000 rpm is equivalent to the noise of 32 vehicles revving at 2000 rpm. "*
>
> Luther et al (2011)

Again, there is an apparent need for further research if the scale of the wider benefits that efficient driving can offer in this area are to be better understood.

Efficient Driving and <u>Household / Organisation Finances</u>

Earlier chapters have highlighted the financial impacts associated with efficient driving for both private drivers and employers. Although there is scope for more sophisticated analyses of these impacts (see discussion in chapter 8) the evidence is already sufficient to be able to state confidently that households and organisations can benefit financially from efficient driving. Future research is needed, however, to understand the scale of these benefits, how this may vary for different individuals and organisations, and the extent to which such benefits are, or are not, significant for the individuals and organisations concerned.

Beyond this, little attention has been given to the potential wider impacts that savings made through efficient driving may have – for example on the finances of low-income households, on the economic health of UK businesses or the UK economy as a whole. Wengraf (2012) was the only source identified in this review which approached this issue. Although they stop short of considering the potential financial impacts of efficient driving in these domains, they do raise some salient points, particularly in relation to the rising costs of car ownership and car insurance specifically.

> *"49% of households in Great Britain in the lowest income quintile group had a car or van in 2009. The costs to consumers of transport have also been rising markedly... ONS data shows that in 2009, motoring costs made up 13% of all household expenditure in the UK... For many people, other transport costs, such as insurance, are becoming prohibitively expensive... The issue of transport poverty is a growing threat to both economic and social well-being."*
>
> Wengraf (2012)

As noted above, vehicle insurance is one of the areas in which efficient driving is asserted to save organisations money. This can be assumed to apply to private drivers too, although this is currently given less emphasis in the literature. However, some of the more forward-looking evidence identified in this review did explore the potential role of insurance, particularly newer pay as you drive (PAYD) forms of insurance, in motivating organisations and individuals to adopt efficient driving – see further discussion below.

6.2 Harnessing synergies between efficient driving and other areas

This section attempts to address the extent to which government policies in the UK and elsewhere have effectively harnessed synergies between efficient driving and the other areas already discussed in the previous section.

The sources identified in this review have not generally sought to address this question directly. However, some have reported on how government initiatives aimed at promoting efficient driving have been designed and marketed over time. The overall pattern that emerges is of an initial focus on the environmental benefits (in terms of reducing CO2) of efficient driving, followed by a shift towards emphasising other, wider, benefits. For example, in the UK efficient driving was initially promoted using the term "eco-driving" through the government-funded Act on CO2 series (Wengraf, 2012; Luther et al, 2011).

Previous EU-funded programmes, e.g. ECODRIVEN and EcoDriver, have also put forward an explicit environmental message. More recent government-funded programmes have increasingly combined an environmental message with safety and/or financial messages. For example, EcoDrivingUSA was developed to "help spread the word about meaningful ways to both save money at the pump and reduce carbon dioxide emissions at the same time", and the UK's Smarter Driving programme has emphasised financial responsibility while still incorporating safety and environmental benefits. Germany has possibly gone furthest in moving away from the original environmental beginnings of efficient driving. For example, their "Neues Fahren – Clever, Sicher, Weiter" programme (meaning "new driving – clever, safe, further") promotes a frugal and safe driving style, but reminds drivers that this will not be at the expense of either fun or comfort (Wengraf, 2012; Luther et al, 2011).

Unfortunately there is little basis for contrasting the effectiveness of these different approaches to promoting efficient driving - but the shift towards emphasising safety and financial benefits does accord with the evidence highlighted in the previous section as to the motivational "power" of these factors.

Overall, the UK emerges as being fairly typical in its policy approach to efficient driving. One possible variation is in the extent to which certain governmental bodies and policy-makers, particularly those working in road safety, have been actively engaged in actions to promote efficient driving. For example, in Germany the Road Safety Council (DVR) has been a leading advocate, funder and provider of training in efficient driving (EST, 2014).

What also emerges from the review is that no country appears to be using policy (of any kind) to promote or exploit the link between safer, more efficient driving and lower insurance costs. The emergence of PAYD insurance has been identified by some authors (S Barkenbus, 2010; Gonder et al, 2011; Ecowill, 2011; Campbell-Hall et al, 2011; Wengraf, 2012) as a potential means by which the wider financial benefits arising from efficient driving can be made more quantifiable and immediate. PAYD insurance is based on the installation of a telematics device by the insurer in the driver's car, and the use of data from the device to monitor how safely it is being driven. Insurance costs are calculated on this basis, and drivers are also provided with real-time or accumulated feedback on their driving from the device. Although PAYD insurance is based on how *safely* drivers drive, the overlaps with efficient driving are self-evident – by driving more safely to reduce their insurance costs, drivers are highly likely to also be driving more efficiently (Wengraf, 2012).

What is currently lacking in the published evidence-base is robust, independent data on the scale of the fuel efficiency gains, and the financial savings, that arise as a result of PAYD insurance. No evidence was identified in this review addressing this.

Several insurers (including Norwich Union, Motaquote, the Co-operative Insurance and the AA) have introduced PAYD insurance products in the UK in the last five years. Initial uptake has predominantly been amongst younger drivers, who otherwise face paying the highest flat-rate premiums (ROSPA, 2013).

Despite its rapid emergence, industry data suggests PAYD insurance currently still only represents a small proportion of the UK car insurance market. For example, last year Auto Express (2014) reported that "there are around 300,000 live car insurance policies in the UK where the driver is hooked up to telematic technology" – which is equivalent to roughly 1% of the total number of cars in the UK.

Another gap in the current evidence-base is around barriers and motivators for further uptake of PAYD insurance, and not just amongst younger drivers but also older private drivers and employee drivers. What evidence there currently is suggests that driver concerns about data security and privacy is likely to be one potential barrier (ROSPA, 2013).

7 Conclusions

- Overall, the current evidence-base on efficient driving is patchy, of variable quality and occasionally ambiguous.
- Key gaps in the evidence identified by this review include:
  - the prevalence of different types of efficient driving
  - definitive potential CO2 and £ savings from efficient driving
  - how motivations and barriers compare between different types of driver
  - the comparative effectiveness of different measures to increase efficient driving, and the added value of combining two or more measures
- Potential areas for future consideration by policy-makers and researchers include:
  - enabling all drivers easy access to technologies promoting efficient driving
  - testing and further exploring the linkages between efficient driving, safety and insurance
  - segmenting and targeting of future measures at key types of driver and organisation

Overview

Perhaps the most striking thing to be revealed by this Rapid Evidence Assessment is that the evidence on efficient driving is patchy, of variable quality and occasionally ambiguous. It is certainly not the case that a rich and reliable body of evidence exists for each of the research questions used to frame and guide this review.

It is worth reflecting on why this should be the case – not least because there may be important lessons for considering how best to meet any outstanding research needs. One clear reason for a relative shortage of reliable evidence is the practical difficulty of gathering the necessary data. Monitoring actual driver behaviour, over sufficiently long periods of time and with sufficient sample sizes, can be extremely expensive. Efficient driving is, furthermore, a cluster of possible behaviours rather than a single (and more easily identifiable) behaviour, making the process of monitoring it still harder.

A further important factor is raised by the fact that there is, relatively speaking, much less evidence available concerning commercial driving compared to private driving (this despite the fact that, in the UK at least, publicly-funded efforts to promote efficient driving have so far been focused principally on the former rather than the latter). This would appear to reflect the difficulty of researching activities by businesses that may be commercially sensitive and/or may be considered by an individual business to represent a means by which they may have, or achieve, competitive advantage over their rivals. It is, in general, extremely difficult to use 'standard' research techniques to investigate the detail of behaviour by commercial organisations (consider, for example, the fact that legislation was required to oblige companies to make public details of their energy consumption).

The commercial imperative may also have a bearing on a third factor limiting the availability and/or quality of evidence available, in particular with respect to technological solutions for efficient driving. In this case, while this review identified a large number of standalone studies, few of these were based on intelligence gathered from 'real world' settings; and fewer still were in any sense comparative between technologies. The inference we draw is that, whilst each individual research team in assessing each individual piece of technology has no doubt conducted their work to a high standard and on a firm ethical basis, in the round there is a suggestion of something similar to that which has been taking place in pharmaceutical research – namely, only 'successful' technologies are the subject of published material. The fact that virtually all technologies currently entering or expected to enter the market in the next few years are reported as having the same potential impact on fuel savings only reinforces this feeling.

Finally, it has to be acknowledged that, from a funder's perspective, 'efficient driving' may be less appealing than, say, 'electric vehicles'. Not only is the research into efficient driving expensive; the 'returns' from that research are diffuse and small scale. This factor, too, may be contributing to the relative paucity and poor quality of the research to hand.

Nevertheless, across a number of important questions the review has identified evidence that is sufficiently robust to support a series of clear statements:

- Privately owned (and driven) vehicles account for three-quarters of all mileage (and vehicular CO2 emissions) in the UK. The greatest gains from efficient driving could therefore be achieved from this segment of the market.

- The main motivations for why organisations and employees *should* adopt efficient driving techniques (such as cost control, health & safety, corporate reputation) are well-researched and understood – but the actual *extent* of efficient driving techniques among employers and employees is *not* well documented.

- The motivations for why private drivers should adopt efficient driving techniques are also well evidenced; but, in this case, there is also good evidence that these techniques are not widely deployed. Key reasons for this are also well researched and understood, and they include habit, the low importance with which the issue of efficient driving is regarded, and a widespread perception that the benefits of efficient driving are too small to bother with.

- Similar barriers are thought to apply to employers and employees, though the evidence base is relatively weak in this case.

- The evidence base is consistently weak when attempting to draw distinctions between different types of driver, whether on the basis of age, gender or socio-economic group; whether on the basis of driving style; or whether on the basis of employment in a small or large business in this or that sector.

- 'Benefits' from efficient driving generally fall into one of three camps – environmental, financial and safety. The evidence is relatively good that the environmental benefits of efficient driving are of lesser importance to drivers; that the financial benefits appear insufficient to act as powerful motivations; but that safety may offer a more fruitful area.

- The evidence is relatively strong that 'safe' driving techniques and efficient driving techniques have many overlaps, and the synergies between them (in terms both of driver behaviours and policy options) represent a potentially important opportunity.

Scope for intervention

Insofar as there may be options for policy to increase the amount of efficient driving, there are three main domains available, the evidence for which is broadly:

- **training** – has been shown to be reasonably and consistently effective in reducing fuel usage and emissions, but it is expensive, is delivered to relatively small numbers of drivers and is not appealing to drivers even when delivered at no cost

- **technology** – there is a plethora of technologies that have either recently or will soon become available with the potential to have a positive impact on efficient driving – however virtually all available evidence is an estimate of potential on the basis of tests in artificial conditions and there is little or no objective assessment either of the relative merits and demerits of different technologies nor of how technologies might work in concert (or the opposite)

- **communication** – there is a widespread assertion across the research base that communications are a necessary part of the mix to increase the amount of efficient driving, but there is virtually no robust evidence on the most appropriate scale of a communications campaign nor on the costs and benefits thereof

It is beyond the scope of this rapid evidence assessment to make a judgment as to which (mix of) interventions may be most appropriate in the current UK context. The review has, however, revealed a range of evidence gaps that may be relevant to such a judgment.

Evidence gaps

Key gaps in the evidence identified by this review are as follows:

- The evidence on the prevalence of different types of efficient driving is weak. Additional primary research would be needed to address this gap – and would be useful if future policy wished to focus on particular methods and/or behaviours.

- Data on potential CO_2 and £ savings from efficient driving is currently weak; but could be improved through secondary analysis.

- Whilst the main barriers to and motivations for, efficient driving are reasonably well known, how they vary between different types of driver is not. Further primary research would be required here; and there may be a case for segmenting the driver population so as to inform more accurate targeting of future interventions.

- The comparative effectiveness of different forms of training is not clear, and nor is their comparative value for money/cost effectiveness. The same is also true in relation to technology. Significant research effort would be required to address these gaps.

- There is a particular shortfall of evidence about efficient driving in the business/employee sector. Significant primary research would be required to address this. The results from such research could potentially be used to target particular sectors/types of driver.

- Data on potential CO_2 and £ savings in the commercial sector is also lacking; and both additional primary and secondary research would be required here. Making a strong financial business case for efficient driving – which is currently largely absent in the evidence base, and which would be necessary in order most effectively to guide businesses towards investing in either training or technology – would depend on the availability of this additional research.

As mentioned at the beginning of these conclusions, the cost of filling these gaps would be substantial; and significant time would also be required. Some sort of prioritisation would therefore appear necessary.

Possible prioritisations

In the researchers' judgment, the most appropriate method for prioritising future research would be to focus on policy options that are considered most achievable and affordable in the current context. Given that it is not for this report to make policy recommendations, we therefore offer the following as **illustrations only,** based on our interpretation of the evidence presented in this report:

Tackling technology

Both the road transport market in general and the market for efficient driving technologies in particular are presently experiencing very high rates of technological innovation. Much of this is associated with the ongoing revolution in information technologies. The recent emergence of systems for providing efficient driving feedback directly to a smartphone is such an example.

It would be wholly inappropriate for policy to 'back' one or other technology through some sort of intervention (indeed, it may even be formally impossible to do so[8].) It would seem likely to be un-necessary, too. The projections uncovered by this review suggest that new cars will increasingly be fitted with telematics to deliver efficient driving as standard, and a combination of market forces[9] and diffusion of vehicles into the second-hand market will make considerable in-roads.

There is, nevertheless, the likelihood that a fair proportion of vehicles still on the road in ten years' time will not have modern telematics installed and this represents an opportunity for policy intervention.

[8] See 'The Origin of Wealth: Evolution, Complexity and the Radical Remaking of Economics', Beinhocker, E. (2006) McKinsey & Co

[9] It may even be that the recent travails of VW, by highlighting the issues of emissions, will act to further boost the efforts of manufacturers to achieve efficiency gains <u>and</u> raise awareness among the general public.

- *Recommendation*: that policy-makers consider a programme to promote (potentially through minor subsidy) a concise range of affordable telematics solutions that could easily be retrofitted to second hand private vehicles.
- *Research required*: subject to feasibility, a secondary review of known and upcoming technologies to identify not one but a suitable suite of appropriate technologies, including calculation of potential uptake, potential abatement and likely costs.

Linking efficient driving with safety and insurance

The link between safety and efficient driving would seem to have been under-appreciated to date, not just in the UK but more widely. It appears that many of the techniques either overlap or are synergistic; motivations for safe driving apply powerfully in both the private and commercial sphere; and there is evidence to show that programmes focused on efficient driving have had significant safety spillover effects, and vice versa.

In addition, recent years have seen the emergence of telematics that monitor driving styles and are being used by insurance companies to reduce insurance premiums for drivers that can demonstrate safer driving.

The possibility is raised that synergies between evolving technology, the insurance market, driver preferences for safety and the links between safe and efficient driving provide an exciting opportunity for targeted and effective intervention to accelerate progress.

- *Recommendation*: that policy-makers explore linkages and relationships between relevant stakeholders with a view to running pilot schemes to assess effectiveness.
- *Research required*: secondary research to detail the overlaps and synergies between safer and efficient driving; to explore the potential for PAYD devices to monitor and log efficient driving; to conduct such research as necessary to be able to specify the number and scale of suggested pilots.

Identifying and targeting segments

Across the evidence base there is a shortage of data about how different segments of both the private and the commercial market behave towards efficient driving. This is a key omission, since improved targeting (of both communications, retrofitted telematics and, potentially, training) would seem essential. Targeting training at – say – private drivers that are most amenable, or most willing to pay, or most likely to benefit etc is much more likely to prove cost-effective than an untargeted blanket approach.

- *Recommendation*: that policy-makers identify key segments within both the commercial and private driver markets upon which to focus its efforts, so as to improve the take up, effectiveness and cost effectiveness of prospective interventions.
- *Research required*: secondary research to confirm details of what is and is not known about existing variations in behaviours, attitudes etc; develop and then test preliminary segmentation (or similar) models; explore key axes of variation between segments so as to be able to prioritise between segment.

Bibliography

Aarnink, S., van Essen, H., Schroten, A. and Otten, M. (CE Delft) (2015) Saving fuel, saving costs: Impacts and reduction potential for corporate fleets. Greenpeace.

Aecom (2013) Literature study on the effect on traffic and CO2 and on implementation of ICT measures in the Eco-Driving and Eco-Freight and Logistics Management scope.

Alam, S. and McNabola, A. (2014) A critical review and assessment of Eco-Driving policy & technology: Benefits & limitations. Transport Policy Volume 35.

Auto Express (2014) Does in-car Black Box telematics really work? Retrieved 29.09.2015: http://www.autoexpress.co.uk/car-news/consumer-news/88077/does-in-car-black-box-telematics-really-work

Barclaycard (2015) Eco-unfriendly driving costs UK motorists £700 million a year. Retrieved 15.09.2015: http://www.home.barclaycard/news/fuel-plus.html.

Barkenbus, J. N. (2010) Eco-driving: An overlooked climate change initiative. Energy Policy Volume 38 (2).

Beusen, B. and Denys, T. (VITO) (2010) FLEAT_WP5_Final Report: D5.3 Report on monitoring pilot actions. Intelligent Energy Europe.

Campbell-Hall, V. and Dalziel, D. (2011) Eco-driving: Factors that determine take-up of post-test training research. Department for Transport and Driving Standards Agency.

CICEA (2007) Eco-driving in driver training and testing.

Cristea, M., Paran, F. and Delhomme, P. (2012) The role of motivations for eco-driving and social norms on behavioural intentions regarding speed limits and time headway. International Scholarly and Scientific Research & Innovation 6(6).

Delhomme, P., Cristea, M. and Paran, F. (2013) Self-reported frequency and perceived difficulty of adopting eco-friendly driving behavior according to gender, age, and environmental concern. Transportation Research Part D: Transport and Environment, 20.

Department for Transport (2004) Survey of Privately Owned Vans.

Department for Transport (2006) The activity of GB-registered vans in Great Britain: 2003 to 2005.

Department for Transport (2012) Public attitudes to climate change and the impact of transport in 2011.

Department for Transport (2014) Table ENV0201 Greenhouse gas emissions by transport mode: United Kingdom, 2000-2012

Department for Transport (2015a) Vehicle Licencing Statistics Table VEH0202 Cars licensed by keepership (private and company), Great Britain, annually: 1994 to 2014

Department for Transport (2015b) Vehicle Licencing Statistics Table VEH0402 Licensed light goods licensed by keepership, Great Britain, annually: 1994 to 2014

Department for Transport (2015c) National Travel Survey Table NTS0901 Annual mileage of 4-wheeled cars by ownership and trip purpose: England, 2002 to 2014.

Department for Transport (2015d) Road Traffic Estimates: Great Britain 2014.

Department for Transport (2015e) National Travel Survey Table VEH0402 Licensed light goods licensed by keepership, Great Britain, annually: 1994 to 2014.

ecoDrive (2008) ECODRIVEN Campaign Catalogue for European Ecodriving & Traffic Safety Campaigns. Intelligent Energy Europe.

Ecowill (2011) WP2 Investigation and Preparations: D2.2 & D2.3 Identification of potential benefits for relevant target groups & Recommendations how to influence target groups behavioural change in order to enhance ecodriving activity. Intelligent Energy Europe.

Energy Saving Trust (2014) Smarter Driving Field Trials: Final Report. Department for Transport.

Ertico (2015) Study of Intelligent Transport Systems for reducing CO2 emissions for passenger cars

Fiat (2010) Eco-driving Uncovered: the benefits and challenges of eco-driving, based on the first study using real journey data.

GE Capital (2014) The State of Car Policies in Europe and Key Fleet Challenges: 2013-2014 Edition.

Gonder, J., Earleywine, M. and Sparks, W. (2011) Final Report on the Fuel Saving Effectiveness of Various Driver Feedback Approaches. National Renewable Energy Laboratory.

Graves, G., Jeffreys, I. and Roth, M. (2012) RACQ EcoDrive Research Study: Final Report. RACQ and the Queensland Government.

HMRC (2015) Taxable benefits in kind and expenses payments statistics.

Hof, T., Conde, L., Garcia, E., Iviglia, A., Jamson, S., Jopson, A., Lai, F., Merat, N., Nyberg, J., Rios, S., Sanchez, D., Schneider, S., Seewald, P., van der Weerdt, C., Wijn, R. and Zlocki, A. (2014) WP11 Envisioning new systems: D11.1: A state of the art review and users' expectations. ecoDriver.

King, P. (2011) AA Member eco-driver survey. AA Research Foundation.

Kurani, K., Sanguinetti, A. and Park, H. (2015) “Actual Results May Vary”: A Behavioral Review of Eco-Driving for Policy Makers. National Center for Sustainable Transportation.

Kurani, K., Stillwater, T., Jones, M. and Caperello, N. (2013) Ecodrive I-80: A Large Sample Fuel Economy Feedback Field Test. Institute of Transportation Studies, University of California, Davis.

Lawson, K., Michaelis, C. and Waldron, D. (Databuild) (2007a) Freight Best Practice Impact Assessment. Department for Transport.

Lawson, K., Michaelis, C. and Waldron, D. (Databuild) (2007b) SAFED Impact Assessment. Department for Transport.

Lex Autolease (2014) The 2014 Lex Autolease report on company motoring.

Lex Autolease (2015) Where Next For Company Cars?

Luther, R. and Baas, P. (2011) Eco-Driving Scoping Study. AA Research Foundation and the Energy Efficiency and Conservation Authority.

Pandazis, J-C. and Winder, A. (2015) Study of Intelligent Transport Systems for reducing CO2 emissions for passenger cars. ERTICO - ITS Europe.

RAC (2015) Company car owners save more fuel in efficiency drive. Retrieved 15.09.2015: http://www.rac.co.uk/press-centre/press-releases/company-car-owners-save-more-fuel-in-efficiency-dr.

ROSPA (2013) Road Safety and In-Vehicle Monitoring (Black Box) Technology.

Schroten, A. (CE Delft) (2012) Behavioural Climate Change Mitigation Options: Domain Report Transport.

Seewald, P., Ahlström, C., Aleksic, M., Fors, C., García, E., Hibberd, D., Iviglia, A., Jamson, S., Jamson, H., Josten, J., Kircher, K., Kroon, L., Masala, A., Nogueira, A., Saint Pierre, G. and Santoro, G. (2013) SP1: Supporting Drivers in eco-driving WP13: Evaluation of Feedback Solutions. ecoDriver.

Shaheen, S., Martin, E. W. and Finson, R. S. (2012) Ecodriving and Carbon Footprinting: Understanding How Public Education Can Reduce Greenhouse Gas Emissions and Fuel Use. Mineta Transportation Institute Publications.

SMMT (2015) New Car CO2 Report 2015.

Strömberg, H. K. and Karlsson, I. C. MA. (2014) Eco-driving in a public transport context: Experiences from a field trial. Transport Research Arena 5th Conference: Transport Solutions from Research to Deployment.

Thornton, A. (2009) Public attitudes and behaviours towards the environment - tracker survey. Defra.

Thornton, A., Bunt, K., Dalziel, D. and Simon, A. (2010) Climate Change and Transport Choices Segmentation Study – Interim Report. Department for Transport.

TomTom (2013) Eyes on the road…Market research: an exploration of business driver behaviour.

Trommer, S., Höltl, A., Schießl, C. and Fricke, N. (2012) WP6.2 Study of driver motivation and behavioural change: D6.1 Requirements and motivators for private and commercial drivers. eCoMove.

Tulusan, J., Soi, L., Paefgen, J., Brogle, M. and Staake, T. (2011) Eco-efficient feedback technologies: Which eco-feedback types prefer drivers most? World of Wireless, Mobile and Multimedia Networks, 2011 IEEE International Symposium.

Unfallkassen und Berufsgenossenschaften and Deutscher Verkehrssicherheitsrat (2009) To the point 3: Studies on “Drive like a pro – safe driving, both in a professional and a private context”.

van den Hoed, R., Harmelink, M. and Joosen, S. (2006) Evaluation of the Dutch Ecodrive Programme. Intelligent Energy Europe.

Wengraf, I. (2012) Easy on the Gas: The effectiveness of eco-driving. RAC.

Annex 1 Mileage Estimates Methodology

Chapter 2 includes some estimates for vehicle mileage in instances where robust up to date data was not currently available. The methodology adopted in these instances, including any assumptions made, is set out here:

- Firstly, data is not currently published on the mileage of company owned cars that are not company cars. In order to estimate this data, the mileage of privately owned cars and company cars (DfT, 2015c) was subtracted from the total mileage for all cars in the UK (DfT, 2015d).

- Secondly, data is not currently published on mileages of privately owned vans in comparison to company owned vans, although the total mileage for all vans is available. In order to estimate this, data on the comparatively mileage of privately owned vans in comparison to company owned vans collected through older surveys (DfT, 2004; DfT, 2006) was examined. This suggested that company owned vans had a mileage 57% higher than privately owned vans. This percentage ratio was applied to the total mileage for all vans (DfT, 2014d) to estimate their current comparative mileages.

- Thirdly, data is not currently published on the split between personal travel and business travel for privately owned vans or company owned vans. Data on this had been collected through the older surveys (DfT, 2004; DfT, 2006) and this was used to estimate their current mileages for personal travel and business travel.

Annex 2 Case Study - The Dutch ecodrive programme: 'Het Nieuwe Rijden'

- Evaluated in 2006 [van den Hoed et al (2006)]

- The Dutch Ecodrive programme was introduced in 1999, and ran until 2010, as a part of an action plan to help the Netherlands meet the targets of the Kyoto Protocol.

- The overall objective of the programme was to promote efficient purchasing and driving behaviours amongst private drivers, professional drivers and fleet owners with the goal of reducing CO2 emissions by 0.8 Mton per year by 2010.

- In order to achieve these goals, the programme distinguished five objectives:

  1. Stimulating the uptake of an ecodriving style amongst existing and professional drivers. This involved training instructors, subsidising training for professional driver groups, the development of a driving simulator (used in workshops and conferences) and an extensive media campaign.

  2. Integrating ecodriving principles into the driving school curriculum. In order to reach new drivers, the programme facilitated the training of driving instructors in ecodriving principles.

  3. Training new drivers in ecodriving. This was achieved by the integration of ecodriving into the driving theory and practical tests.

  4. Stimulating the market for in-car devices. Ecodriving assistant devices were exempt from tax from 2000 to 2005. The programme also promoted the use of in-car devices with public campaigns and demonstrations.

  5. Facilitating the use of optimal tyre pressures. Highlighted the importance of tyre pressures on fuel economy with targeted marketing activities as well as organising and subsidising demonstrations and training for drivers on tyre pressure checks. The programme also aimed to integrate tyre pressure checks into regular car maintenance in car dealerships and garages.

- The programme also aimed to achieve 'complementary side effects' which included economic gains from reduced maintenance costs, increased road safety, and reduction of local emissions and noise.

- The budget to deliver these targets was set at €40 million between 1999 and 2010.

Outcomes

- The programme was successful in providing ecodriving training to driving instructors, and by 2004 74% of category B instructors (cars) and 93% of category CE instructors (vehicles and trailers which with combined maximum weight above 750 kg) had been trained. 92% of the trained instructors claimed that they planned to include ecodriving techniques in their training for new drivers. The programme estimated that 35% of new drivers would apply ecodriving in daily practice.

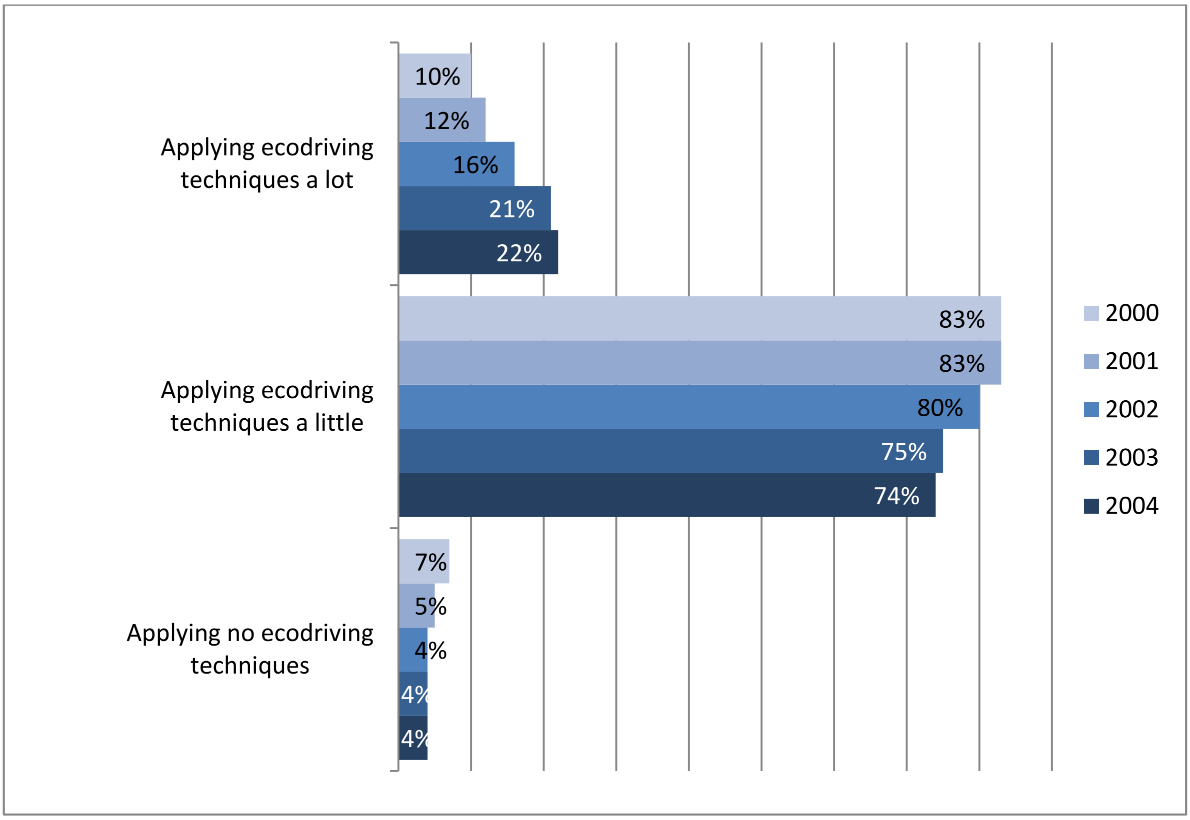
- From 2001 ecodriving was integrated into instruction books and theory exams, and thus became standard criteria for 100% of new drivers.

- At the time of this evaluation (2006), training structures and subsidised activities for existing drivers had been developed by a network of the programme partners. Between 2000 and 2004, more than 100 driver training projects had been undertaken, with a total reach in excess of 150,000 (approximately 1.5% of the total driver population of the Netherlands) existing drivers via training, simulators and the use of a multimedia game.

- An extensive communication campaign was set up with the objective achieving 60% programme recognition of all drivers in the Netherlands for the ecodriving programme. The campaign included television, newspapers, magazines, radio, and printed material. The Communications campaign accounted for 25 – 30% (€0.8 – 1 million per year) of the total budget for the programme. This high cost was justified by the effectiveness of the campaign, which increased spontaneous recognition amongst drivers partaking in a survey (n=1,100) from 18% in 1999 to 31% in 2004, and increased supported recognition from 36% to 50% over the same period. Television was found to be the most effective media channel, with 78% of respondents becoming aware of the programme through television. However, recognition of the programme name was found to be greater than recognition of the principals that it represents, with only 14% questioned drivers association the programme with early gear shifting, 9% with driving at a constant speed, and 7% with steady acceleration.

- There is evidence of a change to driver behaviours, and based on a survey of 1,100 drivers:

  - More than 90% of all respondents familiar with the Ecodrive programme had applied ‘some’ or a ‘lot’ of the ecodriving drive style suggestions. In 1999, before the start of the programme, 83% of drivers were applying ecodriving ‘a little’, and only 10% ‘a lot’. As of 2004, less than 7% of the respondents claim not to use any ecodriving techniques at all. Drivers who were familiar with the programme were more likely to practise ecodriving techniques.



- Although limited, there is some evidence to suggest that drivers who are familiar with the programme are more likely to regularly check tyre pressures.

- An increase in in-car device ownership was observed, from 13% in 2000 to 33% in 2004, and integration of in-car devices in new cars increased to over 70% in 2004. It is estimated that 45-60% of the in-car devices would not have been purchased without the tax exemption. An increase in the regular use of in-car devices was also observed, from 2% in 2000 to 14% in 2004, with drivers who are more aware of the ecodriving programme more likely to regularly use the device.

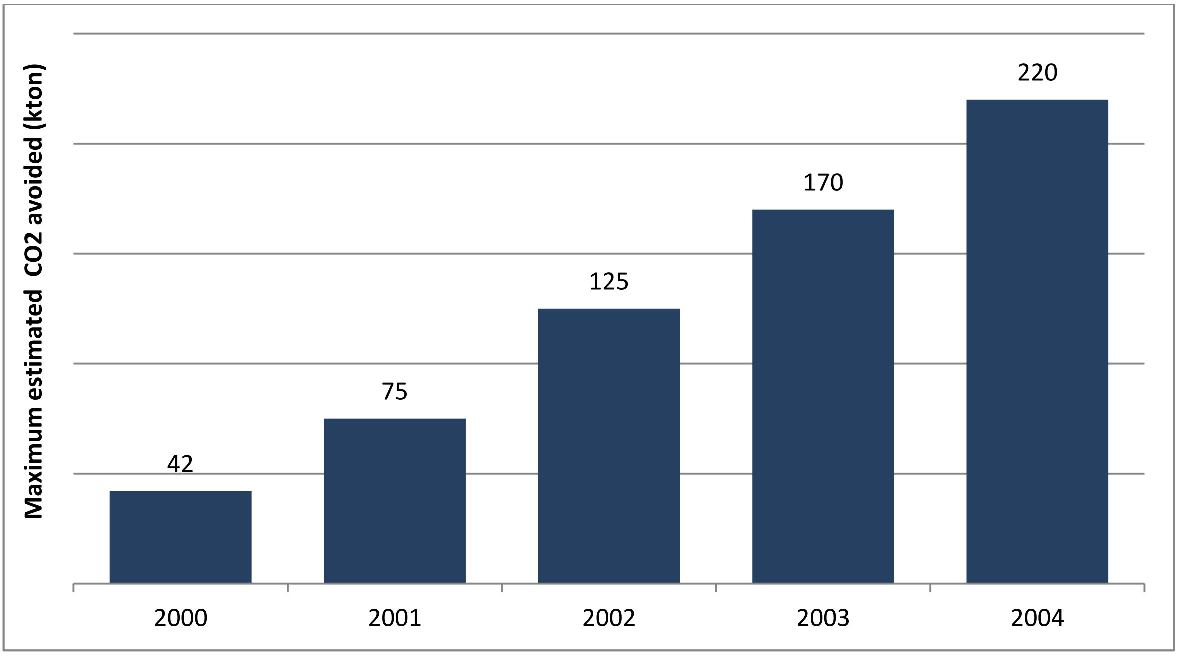
Impacts

- The total avoided CO2 emissions resulting from the ecodriving programme grew from 9-41 kton in 2000 (2000) to 97-222 kton in 2004.

  - CO2 emission reductions from in-car device increased between 2000 and 2004, up to 16-42kton in 2004, an estimated 80% of which was attributed to the tax-exemption. The importance of tax exemption for the sales of in-car devices is confirmed by several interviewees.

  - CO2 emission reduction as a result of targeting licence owners increased from 8-39kton in 2000 to 34-86kton in 2004. 40–75% of this was attributed to the communications campaign. Subsidised training activities were estimated to have accounted for 10-20% of total reductions.

- The integration of the ecodriving programme into the drive school curriculum led to a CO_2 emissions reduction of 47-94 kton in 2004. An estimated 40-60% of these reductions resulted from training of commercial drivers involved in goods transport.



- The cost effectiveness of this programme for the government was estimated at €9-20 per avoided ton CO_2 (excluding tax exemption costs) and 68-99€/ton in case tax exemption is included. Cost efficiency for consumers is estimated on -€210 to -€418 per avoided ton CO_2 emission (benefit as a result of lower fuel costs).

- The Netherlands ecodriving programme was deemed to be a success due to the high percentage of driving instructors trained in ecodriving and the integration of ecodriving principles into the driving test for new drivers. Also the broad range of communications activities provided high recognition of the programme amongst drivers. These successes yielded substantial reductions in emissions.

- Less successful was the low proportion of drivers across the Netherlands reached by the programme, at only 1.5%.