

A Fleet Manager's  
Guide to Ecodriving

**energy**  
saving  
trust

# advising ecodriving techniques for your fleet

Department for  
**Transport**

## Introduction

---

Promoting an efficient driving style is perhaps considered outside the traditional remit of the fleet manager but the relentless pressure on fleet budgets makes the case for this important area to be addressed. Recent dramatic improvements in car and van official fuel consumption figures might suggest that vehicle technology is taking care of the issue but there is evidence of an increasing divergence between the official figures and real world results, which suggests that addressing driver behaviour is increasingly important.

Ecodriving is about adopting driving techniques that get the most out of modern vehicles and engines: the key advice is – at one level – pretty straightforward but there are subtleties in the approach and winning drivers’ hearts and minds is essential.

It’s worth emphasising at the start of the journey that it’s not all about sacrificing

performance and enjoyment for the sake of doing the right thing; it’s about a more professional approach and becoming a better driver. Experience shows that driving more efficiently doesn’t necessarily increase journey times and when drivers are convinced, their conversations change from how quickly they completed a journey to what MPG they achieved, and that has to be good for all concerned.

---

## Winning drivers’ hearts and minds is essential

## Ecodriving techniques

---

The core tips apply to most drivers most of the time and have a significant effect on fuel consumption.

### Core tips

#### 1. Drive smoothly

- ✔ Anticipate situations and other road users as far ahead as possible to avoid unnecessary braking and acceleration.
  - ✔ Maintain a greater distance from the vehicle in front so that you can regulate your speed when necessary without using the brakes.
- 

#### 2. Step off the accelerator

- ✔ When slowing down or driving downhill, remain in gear but take your foot off the accelerator as early as possible. In most situations and for most vehicles this will activate the fuel cut-off switch, reducing fuel flow to virtually zero.
- 

#### 3. Shift up early

- ✔ When accelerating shift to a higher gear early, usually by around 2,000-2,500 RPM
  - ✔ Skip gears e.g. 3rd to 5th or 4th to 6th when appropriate.
- 

#### 4. Avoid excessive speed

- ✔ High speeds greatly increase fuel consumption.

### Other tips

#### 5. Keep tyres correctly inflated

- ✔ Underinflated tyres are not only dangerous but also increase fuel consumption.
- 

#### 6. Use air conditioning sparingly

- ✔ All ancillary loads, but particularly air conditioning, add to fuel consumption.
- 

#### 7. Turn off

- ✔ Turn off your engine if you expect to be stationary for more than a minute or so.
- 

#### 8. Reduce drag

- ✔ Remove racks, roof boxes and bike carriers when not in use as they significantly increase air resistance and fuel consumption at higher speeds.
  - ✔ Keep windows shut at high speed.
- 

#### 9. Lose weight

- ✔ Avoid carrying dead weight as anything that adds to the weight of a vehicle will increase fuel consumption.

## **The principles & the evidence behind the techniques**

---

In urban driving, greater anticipation to avoid unnecessary acceleration and braking is probably the single most important technique. This is no surprise if you consider the basic physics behind the motion of a vehicle.

Energy is required for two main reasons: to accelerate the vehicle and to overcome air resistance. Much smaller amounts are also required to overcome friction, gain height when driving uphill and run the ancillary loads, but the vast majority of fuel is used to provide acceleration and overcome air resistance. Air resistance is fairly negligible at low speeds which means in typical urban driving the vast majority of fuel is used for acceleration. So even at low speeds a vehicle that's constantly accelerating and braking will use a lot of fuel whereas the vehicle with the driver that's anticipating well, has perhaps dropped back slightly from the vehicle in front and is managing to smooth out much of the stop-go will use a lot less fuel.

When driving downhill or slowing down, for example approaching a junction or a red light, a modern vehicle will usually use less

fuel if you remain in gear but take your foot off the accelerator, than if you 'coast' in neutral. This is because it recognises that the momentum of the vehicle is driving the engine, rather than the normal situation when the reverse is true. The response is for the fuel cut-off switch to operate, stopping the flow of fuel to the injectors. In contrast the vehicle coasting in neutral would still be burning some fuel to keep the engine ticking over. This doesn't hold at low revs when the fuel cut-off switch no longer operates and most engines will instead inject enough fuel to prevent a stall even if the accelerator is not depressed. For this reason many European organisations involved with ecodriving advocate rolling or coasting in neutral at low speeds when the fuel cut-off would have ceased to operate, but this is contrary to the Highway Code in the UK and so cannot be advocated.

---

When driving downhill or slowing down a modern vehicle will usually use less fuel if you remain in gear but take your foot off the accelerator, than if you 'coast' in neutral.

Some of the clearest research into the effect of the use of gears on fuel consumption comes from TNO in the Netherlands in a paper published in 2006. TNO assessed various models of petrol and diesel cars under three different acceleration strategies:

- Shifting up at high revs (3000 rpm for a diesel and 3500 rpm for a petrol) with a moderate accelerator position of 50%.
- Shifting up at low revs (2000 rpm for a diesel and 2500 rpm for a petrol) with a moderate accelerator position of 50%.
- Shifting up at low revs (2000 rpm for a diesel and 2500 rpm for a petrol) with a deep accelerator position of 90%.

For both petrol and diesel cars the second strategy – shifting up at low rpm and 50% accelerator position - resulted in the lowest fuel consumption.

The TNO paper did not look at shifting up below 2000 rpm for a petrol and 2500 rpm for a diesel but anecdotal reports from the fleet trainers that work on Energy Saving Trust's Smarter Driving programme indicate that shifting up even earlier might be more efficient still. However TNO reported that for diesel cars the combination of moderate or deep accelerator position and shifting up before 2000 rpm led to an increase in NOx emissions.

Air resistance or drag increases by the square of a vehicle's speed, so whenever speed is doubled air resistance increases by a factor of four. At motorway speeds most of the fuel burned by a vehicle is used to overcome drag. The relationship between

drag and speed ensures that relatively small increases in speed add significantly to fuel consumption.

Data on the effects of speed on fuel consumption for different vehicle types is available from the UK's Department for Transport (DfT), based on work carried out by the Transport Research Laboratory in 2009. The table overleaf gives extracts of the DfT data and shows that for a typical modern car, fuel consumption increases by around 11% between 60 and 70mph and 18% between 60 and 75mph.

For a typical large van (>1760kg) the increases in fuel consumption are even more marked: 23% between 60 and 70mph and 37% between 60 and 75mph. It is perhaps unsurprising that an increasing number of vans are being fitted with speed limiters.

**Fuel consumption data from TRL 2009 <sup>3</sup>**

	<b>60mph</b>	<b>70mph</b>	<b>75mph</b>
<b>Petrol car<sup>4</sup></b> fuel consumption (l/100km)	5.50 (51 MPG)	5.99 (47 MPG)	6.30 (45 MPG)
Percentage increase 60-70mph & 70-75mph		8.8%	5.2%
Percentage increase 60-75mph			14.5%
<b>Diesel car<sup>5</sup></b> fuel consumption (l/100km)	3.98 (71 MPG)	4.49 (63 MPG)	4.84 (58 MPG)
Percentage increase 60-70mph & 70-75mph		13.0%	7.8%
Percentage increase 60-75mph			21.8%
<b>Car</b> (simple un-weighted average of petrol & diesel car figures) fuel consumption (l/100km)	4.74 (60 MPG)	5.24 (54 MPG)	5.57 (51 MPG)
Percentage increase 60-70mph & 70-75mph		10.9%	6.5%
Percentage increase 60-75mph			18.2%
<b>Large diesel van<sup>6</sup></b> fuel consumption (l/100km)	10.01 (28 MPG)	12.28 (23 MPG)	13.74 (21 MPG)
Percentage increase 60-70mph & 70-75mph		22.7%	11.8%
Percentage increase 60-75mph			37.2%

As any cyclist knows, it is harder to move a vehicle with under-inflated tyres. Tyres are flexible and flatten at the bottom where they are in contact with the road. This means the shape of a tyre is constantly changing as it rotates and a different section comes into contact with the road. This process, which is exacerbated in an underinflated tyre, creates friction and heat and increases rolling resistance. The EU TREATISE project<sup>7</sup> quotes research from SenterNovem in the Netherlands states that four tyres underinflated by 25% will add approximately 10% to rolling resistance and about 2% to fuel consumption.

For a car, 25% under-inflation might for example be 24 PSI instead of 32 PSI. An alarmingly high proportion of vehicles fall into this category. According to Michelin research from 2011, 39% of British motorists were driving with tyres  $\geq$  8 PSI under-inflated<sup>8</sup>.

Establishing processes and checks to ensure tyres are correctly maintained is, of course, about more than fuel consumption and is primarily a safety issue. For more information see [www.bettertyres.org.uk](http://www.bettertyres.org.uk).

3 Downloaded from <http://www2.dft.gov.uk/pgr/roads/environment/emissions/viewer.xls>  
 4 Petrol car, 1400-2000cc, Euro 5  
 5 Diesel car, 1400-2000cc, Euro 5  
 6 Diesel Light Commercial Vehicle, Category N1 (III) i.e. >1760 tonnes, all emissions standards  
 7 "Ecodriving: Smart, Efficient Driving Techniques", IEE TREATISE Project, 2005  
 8 Michelin 2011 "Fill Up with Air" campaign press release

**Air conditioning** systems, like fridges and freezers, use heat pumps to pump a fluid around a circuit where it continuously evaporates and condenses. With vehicle air conditioning, the fluid evaporates at a point that removes heat from the vehicle and condenses at a point where the heat released is dissipated outside of the vehicle. The compressor that drives the movement of this fluid takes its power from the vehicle engine, increasing fuel consumption. The effects can be surprisingly high. A paper from ADEME 9, France, reports research into the effects of air conditioning on fuel consumption for 10 models of diesel and 10 models of petrol cars over the standard New European Drive Cycle (NEDC) with the ambient temperature maintained at 30C. Each car drove the NEDC once with its air conditioning off and again with its air conditioning working at maximum capacity. The results showed an average 23% increase in fuel consumption for the petrol cars and an average 27% increase for the diesel cars.

These results appear high and one caveat is that at just under 20 minutes the NEDC cycle is relatively short and it might be surmised that for longer journeys, once the internal temperature has been reduced, an air conditioning system works less hard to maintain the lower temperature. The same ADEME study also estimated that in practice – presumably based on a typical French climate throughout the year - cars with air conditioning will use approximately 5% more fuel than equivalent models without air conditioning.

The advice to ‘use air conditioning sparingly’ is a pragmatic recognition that most drivers would not be prepared to stop using their air conditioning completely, but many could reduce the use of their air conditioning with little or no sacrifice to comfort, for example by setting the climate control a degree or two higher.

The 2006 TNO report<sup>10</sup> discussed above also considered idling versus turning an engine off with respect to fuel consumption and emissions. The paper’s clear conclusion was that for both petrol and diesel cars the CO2 emissions (and therefore fuel consumption) from idling were “substantial and so high compared to the restart emissions that stopping the engine almost directly (after no more than 10-20 seconds) leads to a benefit”. For diesel cars the same was true for NOx and PM, the most concerning air quality emissions. The benefits of turning off when stationary in order to cut out idling emissions almost immediately outweighed the small re-start emissions penalty.

---

The benefits of turning off when stationary in order to cut out idling emissions almost immediately outweighed the small re-start emissions penalty.

9 “Automobile Air-Conditioning, its Energy & Environmental Impact”, S Barbusse and L Gagnepain, ADEME, 2003  
10 The Effects of a Range of Measures to reduce tailpipe emissions &/or the fuel consumption of modern passenger cars on petrol and diesel”, R.J. Vermeulen, TNO, 2006.

The advice to “turn off if you expect to be stationary for more than a minute or so” again seeks to take a pragmatic line by recognising that most drivers would find it impractical or irritating to turn their engines off every time they expected to be stationary for 10-20 seconds. Of course simplified advice like this is just a guideline and in one-to-one training a good ecodriving instructor will take account of many factors. For example, an anxious driver first at the red light of an unfamiliar junction would probably be encouraged to leave the engine running whereas a confident driver several cars back with a good view of the queue might be advised to turn off. While the science from TNO is clear, the practical application requires interpretation.

At motorway speeds most of an engine’s output is used to overcome air resistance. Given the lengths that manufacturers go to to ensure that even details such as door handles and badges don’t adversely affect a vehicle’s aerodynamics, it’s no surprise that a roof rack or box, set of ladders or even just roof bars will significantly increase air resistance and fuel consumption. Data on this subject is hard to find, perhaps because the effects will always depend on at least three variables – the vehicle, the rack/box/ equipment attached, and speed – but literature from the Spanish energy organisation IDEA (Instituto para la Diversificación y Ahorro de la Energía) shows that at 75mph roof bars will add around 7.5% to a car’s fuel consumption, a large rack will add around 16% and a roof box around 39%. The author has not been able to verify this data but the important point to remember is that

anything that affects a vehicle’s aerodynamics, even just an open window, will significantly increase fuel consumption at higher speeds.

At low speeds, however, aerodynamics has little effect. For most urban driving, perhaps up to around 30mph, it is usually more efficient to open the windows than use the air conditioning but at higher speeds the reverse is true.

Carrying unnecessary weight in a vehicle increases the power and therefore fuel required for acceleration. However this point can be overstated. In May 2010 a consortium led by AEA Technologies including Ricardo published a report into research that had measured fuel consumption over the NEDC test cycle for a series of vans at their Gross Vehicle Weight (i.e. fully laden) and their Reference Weight (i.e. unladen). The average increase in fuel consumption when fully laden was only 7.8% even though the load typically added around 50% to the total mass. It therefore seems reasonable to conclude that the amount of weight most drivers might realistically carry in their vehicles unnecessarily would usually have only a small effect on fuel consumption. One caveat to this point is that the NEDC cycle contains only gentle acceleration and in duty cycles with more stop-start and faster acceleration we would expect weight to have more effect on fuel consumption.

Nevertheless, compared to the previous point about aerodynamics, the fuel consumption penalty for driving with unnecessary weight is likely to be much smaller than the penalty for driving at medium to high speeds with a rack, ladder or box attached.

## The benefits of ecodriving

---

### Lower fuel consumption & Less CO<sub>2</sub>

By reducing fuel consumption ecodriving saves money and reduces CO<sub>2</sub> emissions. But how big are the savings likely to be? The answer to that question inevitably depends on details such as the vehicles you operate, the duties they perform, and most importantly how your drivers currently drive, but as a rule of thumb the techniques applied thoroughly and consistently might save an average of around 15%, and a realistic long term goal for a fleet might be around half of that figure i.e. a reduction in fuel consumption of 7 or 8%. These long term savings will depend on fleet policies and management and are discussed further under “Ensuring the Benefits Stick.”

Energy Saving Trust’s Smarter Driving programme<sup>12</sup> has trained more than 30,000 drivers with subsidised short-duration training since 2009 and has seen an average 14.9% reduction in fuel consumption immediately after training. This training focuses on urban driving so these benefits are achieved almost entirely through better anticipation, use of gears

and by releasing the accelerator early and remaining in gear when slowing down. The 14.9% figure doesn’t include any benefits from vehicle maintenance or preparation (tyres, racks, weight etc) nor the potentially big wins from slowing down at high speeds e.g. 37% saving for a van or 18% for a car by slowing down from 75mph to 60mph.

For a given fuel, CO<sub>2</sub> emissions are proportional to fuel consumption, so an X% reduction in fuel consumption will give a straightforward X% reduction in CO<sub>2</sub>. Whilst most organisations’ involvement with ecodriving stems primarily from a desire to reduce costs, many forward-thinking organisations are also interested in the environmental, CSR and PR benefits of shrinking their corporate carbon footprint.

### Financial benefits even with AFRs

For fleets using fuel cards or bunkered fuel the financial benefits from lower fuel consumption are clear. But fleets that pay AFRs or other fixed mileage rates can also benefit if ecodriving is promoted in conjunction with lower mileage rates – or at least used to resist calls for higher rates.

---

Techniques applied thoroughly and consistently might save an average of around 15%.

## Safety

Ecodriving brings safety benefits due to the focus on greater anticipation and avoidance of excessive speed. The link between the two is universally acknowledged throughout the driver training industry. A documented example of eco-driving training leading to lower accident rates is Arriva NW13, which put bus drivers through eco-driving training in 2007 and then in 2008 recorded a 29.6% reduction in 'at fault' collisions involving other vehicles and an 18.3% reduction in non-fault collisions. Another example is available from the German Road Safety Council (DVR) which reports that in the year after putting fleet drivers through short-duration eco-driving training Hamburger Wasserwerke recorded a 21.8% reduction in comprehensive insurance claims and a 34.8% reduction in third party liability claims.

## Service, maintenance & repair

Ecodriving's smooth driving style, with less acceleration and braking, reduces vehicle maintenance costs through less wear and tear on components including brakes, clutches and tyres. Vehicles with variable service intervals are likely to be able to travel greater distances between services.

Vehicles with diesel particulate filters (DPFs) that perform predominantly low speed light duties are sometimes reported to suffer from problems regenerating their DPFs. This can be exacerbated by eco-driving due to the emphasis on gear changes at low revs. However it only takes an occasional short run at higher engine speeds (not necessarily higher vehicle speeds) to generate the heat required for the regeneration. Where these vehicles are fitted with a warning light that DPF generation is taking place, drivers should comply with the instructions provided in the vehicle's handbook to minimise the possibility of damage resulting from blocked DPF filters.

## Options for promoting ecodriving

---

The most effective way to promote ecodriving is through on-the-road training with a suitably qualified and experienced trainer. Conventional driver training is usually a full day or half day and due to its cost (in time as well as money) tends to be reserved for a minority of drivers, perhaps those covering the highest mileage. Short-duration ecodriving training, usually around an hour per driver, is popular in much of Europe and is the basis of Government subsidised ecodriving programmes in England and Scotland.<sup>14</sup>

**In-car technologies**, especially those giving drivers instant feedback on their driving are also effective and variations on this theme are available from telematics companies, sat nav providers and in some cases from vehicle manufacturers themselves.

Driver training and in-car technologies naturally complement each other. The training provides drivers with a good understanding of ecodriving techniques, while the technologies provide on-going reminders and feedback encouraging drivers to use and further develop their ecodriving skills.

**Driving simulators** are sometimes used to promote ecodriving but their sophistication varies greatly. At the top end of the scale

are large machines with wrap-around screens and life-size weighted controls, mounted on hydraulics that move to give a genuine feeling of driving. At the other end of the scale small simulators might be little more than video games. They can be an effective way to promote awareness and interest in ecodriving but they are generally not a particularly effective way to teach the techniques.

Ecodriving Information - printed, electronic, or delivered verbally - is a useful way to remind drivers of what they have learned and can work as a stand-alone means of communicating the more objective information such as the effects of tyre pressures or speed. But it is no substitute for training when it comes to the key skills of anticipation and using gears efficiently.

## Ensuring the benefits stick

---

However ecodriving is promoted, what matters is ensuring the benefits last. If 15% is the typical reduction in fuel consumption that most fleet drivers could achieve, what they actually achieve will depend largely on associated policies and management.

One key factor is how drivers pay for their private fuel use. If company car drivers with fuel cards repay the cost of their private mileage as the appropriate proportion of their actual fuel costs, then they will have a personal financial incentive to drive efficiently for all their mileage, business and private. In contrast the more common system in which private mileage is repaid as a fixed 'pence per mile' provides no such incentive.

A well-managed fleet might also implement a range of other measures including:

- periodically providing drivers with reminder information;
- producing fuel consumption league tables to encourage competition between drivers;
- offering incentives for the most efficient drivers;
- additional help and advice for the least efficient.

Fuel consumption league tables are well-suited to fleets of identical vehicles and are often associated more with van than car fleets. League tables can also work for a mixed fleet of company cars as each driver's actual fuel consumption can be normalised against the car's official fuel consumption. The results are then ranked by percentage of the vehicle's official consumption.

The likely results within a large fleet are that the best drivers will achieve close to their cars' official fuel consumption while the worst will achieve little more than 50 or 60% of the official figure.

Incentive schemes to identify and reward the most efficient drivers can be an inexpensive and effective way to promote ecodriving. Examples include awarding cash or vouchers to the most efficient drivers and funding monthly social events for the most efficient team.

Fleet managers should let the worst drivers know that they're using more fuel than their peers and ask them why. There may be mechanical problems or the higher fuel consumption could be explained by different duty cycles such as more stopping and starting or heavier loads. If not then the inefficient drivers might be offered additional help, advice or training. If the problems persist then ultimately - depending on circumstances and company culture – it might become appropriate to issue warnings with the potential for further disciplinary action. But in general carrots are more appropriate than sticks: help, advice and information and appealing to a driver's pride in his or her work is likely to be more effective than disciplinary action.

## **Smarter Driving an electric vehicle – conquering range anxiety**

---

Anticipation and maintaining momentum are skills that can be transferred to driving electric vehicles to help conserve energy and, therefore, increase range. Driving the latest electric cars and vans is similar to driving conventional automatic vehicles but there are key differences. Applying ecodriving techniques to an electric vehicle can help to increase range by 20%.

Electric vehicle road tests and reviews frequently highlight the challenge drivers face translating published range – achieved on the NEDC test cycle, the same gentle drive cycle used for conventional cars and light vans – into the reality of daily driving. This is where a fuller understanding of the technology pays dividends.

Research carried out by Cenex and Millbrook emphasised the importance of the correct use of regenerative braking and the impact this has on range. Regenerative braking as used by electric vehicles (and increasingly by efficient petrol and diesel cars to improve battery charging efficiency) converts the kinetic energy or momentum of the vehicle into electricity by using its electric motor as a generator, slowing the vehicle in the process. As well as improving range, this also reduces wear on the vehicles' conventional, friction brakes.

Energy Saving Trust developed research into a Smarter Driving programme for electric vehicles, and, funded by the Department for Transport, offered free training to recipients of the Plug-in Car Grant. Between February and May 2011, 67 drivers were trained and, on average, energy consumption, as measured by a data logger calibrated for the vehicle in question, was reduced by 16%. This translates into an increase in range of 20%. As is the case with conventional vehicles this demonstrates that some people are driving their electric vehicles inefficiently which means they are unlikely to achieve the promised range.

Training in an electric vehicle takes up to two hours per driver, most of it behind the wheel. The most important technique - greater anticipation of the road ahead to avoid unnecessary acceleration and braking - was imported from our main petrol and diesel Smarter Driving programme but was tailored to help drivers make the most of the regenerative braking. There are also other differences, for example we're all used to ancillary loads such as air conditioning increasing fuel consumption, but with an electric vehicle these have a disproportionately greater effect. And of course we're used to having a ready supply of surplus heat with a petrol or diesel engine under the bonnet whereas with an electric vehicle, using the heater will significantly increase energy consumption and therefore decrease range. Driver selectable drive modes may be provided, helping to conserve the electricity stored in the battery or adjust the regenerative braking to increase its effectiveness.

Some vehicles allow the car or van cabin to be heated or cooled using mains electricity while charging, reducing the battery capacity needed to reach the desired temperature on cold or hot days. Ensuring drivers are aware of and understand how these features work to improve range and comfort is all part of the training.

Following the pilot programme, Energy Saving Trust has delivered additional, client-funded training days in both cars and vans and feedback has been overwhelmingly positive. Drivers have been impressed with the training, and advised that their confidence in driving further has increased as a result. All of those surveyed would recommend the training to others. Easy and relaxing to drive, electric vehicles potentially offer a cost effective choice of transport for goods and personnel, particularly in an urban environment and Smarter Driving can help smooth the transition to electric drive.

**Energy Saving Trust**

21 Dartmouth Street

London, SW1H 9BP

Advice line: 0845 602 1425

Email: [transportadvice@est.org.uk](mailto:transportadvice@est.org.uk)

[energysavingtrust.org.uk/linkhere](http://energysavingtrust.org.uk/linkhere)

XXXX © Energy Saving Trust

Month 2012