February 2010

ECO-DRIVING UNCOVERED

The benefits and challenges of eco-driving, based on the first study using real journey data.

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AN INTRODUCTION FROM FIAT

A heritage of environmental responsibility

Since Fiat was founded over a century ago, our mission has been to provide vehicles that enhance people's quality of life, making driving fun and affordable, while making as little impact as possible on the world around. Throughout our history we have led the way in developing new technology that can make driving even more accessible and economical. By their very nature, our designs have always been environmentally aware - our cars are made to fit into their environment and not to impose on it, providing solutions to people's mobility needs in the most efficient way possible.

Today we are still recognised as the leading manufacturer of small, practical and efficient cars. And our heritage as an environmentally-aware manufacturer of affordable and fuel-efficient cars continues to shape our approach to innovation and design. We focus on creating ever-more efficient vehicles, and are proud to have, in Europe[1], the lowest average CO_2 emissions of any vehicle manufacturer group. We are constantly exploring new ways to improve the efficiency of our vehicles, from our Start&Stop technology, available in our 7 newest models and 31 versions; to our MultiAir engines that reduce fuel consumption and CO_2 emissions by up to 10% while improving performance. The newest expression of MultiAir technology is the two cylinder TwinAir engine, a fun-to-drive engine with 85HP and only 92 g/km CO_2 emissions on 500 with Dualogic gearbox.

We are also committed to expanding the use of alternative fuels. We are leader in the European market of CNG vehicles with our bi-fuel Natural Power range covering every mobility need from city cars to professional vehicles.

Changing driver behaviour with eco:Drive

But a car manufacturer's responsibility towards the environment doesn't stop at technological advances that reduce the CO_2 emissions of its vehicles. This area has for a long time been the focus of the car industry in its response to the challenges of climate change, and rightly so – we have a responsibility to innovate to produce low emission cars if we are to remain relevant in the future. However, at Fiat we feel strongly that there are opportunities to further reduce the emissions associated with cars by looking beyond the model itself, and thinking about the role of the driver.

We don't believe that a manufacturer's responsibility towards the environment ends when a customer drives the car away from the showroom – we must be concerned not just with what people drive but with how they drive it, too.

[1] JATO Dynamics, Volume-weighted average CO2 emissions 2009 (g/km)
http://www.jato.com/PressReleases/Small%20Cars%20Driving%20Down%20European%20CO2%20Emissions.pdf

That's why we developed eco:Drive. We knew that by making simple changes to the way you drive, you can significantly reduce your CO_2 emissions. With eco:Drive, we wanted to show drivers exactly how they can drive more efficiently and what effect that has on their fuel consumption and CO_2 emissions. eco:Drive is an interactive, personalised tool that makes use of Fiat's in-car Blue&Me infotainment system. Plugging a USB key into the Blue&Me port on the dashboard allows eco:Drive to record information about your driving style. You then just plug this USB into your computer to see how you performed, how you can improve, and track the fuel and CO_2 savings you manage to make.

eco:Drive has provided us with a bank of data about how people drive their cars – over 9,000,000 journeys have been uploaded by 42,000 drivers. For the first time, we are able to see exactly how efficiently people drive and how they respond to learning about eco-driving. In the past, knowledge about eco-driving's effectiveness has been based on individual experiences comparing one's fuel consumption from one day to the next, having been explained the techniques. The eco:Drive data tells us about the effectiveness of eco-driving for a large number of people, over an extended period of time, in a range of road and traffic conditions. This is the closest anyone has come to understanding the 'real-life' impacts of eco-driving.

Lower emissions, better drivers

What have we learnt? We have seen that eco-driving works – on average, eco:Drivers reduced their fuel consumption and emissions by 6%; the best 10% of drivers managed to improve by at least 16%. We have seen that the changes from eco-driving are not, in most cases, temporary – it is possible to achieve real behaviour change that lasts over an extended period of time. We have seen that eco-drivers are better drivers, learning to anticipate changes in traffic flow so that they stop and start less frequently and drive at a more consistent speed. We have also seen that there are big variations between the improvements experienced by different people and in different places, which shows that the effectiveness of eco-driving is heavily dependent on traffic conditions, road systems and personal commitment.

Next steps for Fiat

The findings from eco:Drive to date provide some important lessons for Fiat and for all those involved in the car world.

As a carmaker, we believe we have a responsibility to explain to drivers just how they can save on fuel and emissions by driving more efficiently, and make it as easy as possible for them to do so. Changing driving behaviour isn't easy. We think eco:Drive's interactive, personalised approach helped drivers by allowing them to see what they are achieving. But we think we can do more to remind drivers regularly of what to improve on, so that eco-driving becomes true habit. That's why we are developing a new version of eco:Drive for 2011, eco:Drive Live, which provides regular feedback on driving style, and tips for improvement, through portable devices (such as satnav or smartphones).

The success of eco-driving in reducing emissions depends on carmakers working together with a range of stakeholders to unlock the potential of eco-driving. For example, we all need to encourage and educate drivers to try to change their behaviour. We also need to make our roads more eco-driving-friendly. Legislators and town planners have a role to play here – the eco:Drive data shows just how important traffic fluidity is to CO_2 emissions, which increase sharply when average speeds are lower. This applies particularly to cities where traffic systems require regular stopping and starting.

The car industry faces huge challenges to reduce the emissions associated with driving – it's essential for the future of the planet, and it's essential if we are to remain competitive and relevant in the future. Big achievements have been made to date through technological innovations, but we think there is more that can be done, today, by engaging drivers in the journey to reduce emissions. With eco-driving, we have an approach that can save up to 16% and more of emissions – today. We have an opportunity to re-shape the environmental impact of mobility now, and we believe it is our collective responsibility to promote eco-driving and to make it as easy as possible for people to become more efficient drivers.

EXECUTIVE SUMMARY

As an industry, car manufacturers are experiencing difficult times. With climate change providing one of the biggest challenges of our time, individuals and institutions everywhere are under pressure to reduce CO_2 emissions. The car industry is responding well. Through huge investment in a range of technological innovations, emissions from new cars are steadily declining.

However, reducing the emissions from driving isn't just about making a more efficient vehicle; nor is it solely the responsibility of car manufacturers. To date, the industry has focused on technological solutions to environmental challenges, but CO_2 emission reductions can also be achieved by thinking about driver behaviour - not just by looking at the vehicles that people drive, but also at how they drive them. This is the focus of eco-driving – techniques to reduce fuel consumption and emissions, which can be used by any driver in any car.

A range of activity in recent years – activity from governments, companies, and NGOs – has raised awareness of eco-driving. Such activities have also shown that eco-driving can deliver significant reductions in fuel consumption and emissions; over 20% in some cases. However, understanding of the 'real-life' effectiveness of eco-driving is limited. Whilst eco-driving can be powerful it faces challenges to its successful implementation, such as how to motivate people to start eco-driving and stick to it, and how to change behaviour in the long-run. Communications campaigns are not enough – drivers must be engaged on a personal level and shown how they can improve and then maintain these improvements.

Fiat's eco:Drive was developed with this in mind, as a tool to involve drivers in a process of understanding, reviewing and improving their driving performance over time. This is the first ever qualitative measurement of driving efficiency; which we believe is the only way to really change behaviour. Quantitative measures, such as fuel consumption counters, don't go far enough in helping drivers to understand their behaviour, understand what the numbers mean, and what they should do to improve.

With eco:Drive, drivers use a USB stick to record information from their car's inboard computer whilst driving, which is then analysed on through the eco:Drive computer programme. Through this process, Fiat has acquired extensive data about how people drive which shows that eco-driving, approached in this way, does indeed create real change – a 6% reduction in fuel consumption on average across all users and a reduction of at least 16% for the top 10% of improvers – and that this change does last over time. However, the data also suggests that various factors that can limit eco-driving's effectiveness, from road and traffic conditions, to the individual's own commitment.

To get the most out of eco-driving, and achieve the emissions reductions that it promises, a multi-actor approach is essential. This includes developing efficient cars, helping people to understand how to drive them to get the most out of their efficiency, and making it easier for them to do so – by manufacturers providing in-car ways to see and understand driving efficiency, and by governments both promoting eco-driving and factoring it into decisions about road and traffic planning.

This report uses insights from interviews with a range of stakeholders involved in eco-driving activity in Europe and, more generally, in the transport and environment sectors, along with an analysis of data gathered by eco:Drive, to further understanding of eco-driving – including its effectiveness, the challenges it faces, and how it can play a more powerful role in reducing emission from driving.

1. CARS AND THE ENVIRONMENT

1.1 Climate change and the automotive industry

Climate change is one of the biggest challenges of our time. Governments, the private sector, non-governmental sector and individuals around the world are engaged in finding ways to reduce CO_2 emissions and limit the damage caused to people and the planet due to changes in global climate patterns.

According to European Commission figures, passenger cars contribute approximately 12% of manmade CO_2 emissions in Europe. As climate change has risen up the agenda, manufacturers have come under increasing pressure from consumers, NGOs and governments to do more to reduce the environmental impacts of their products

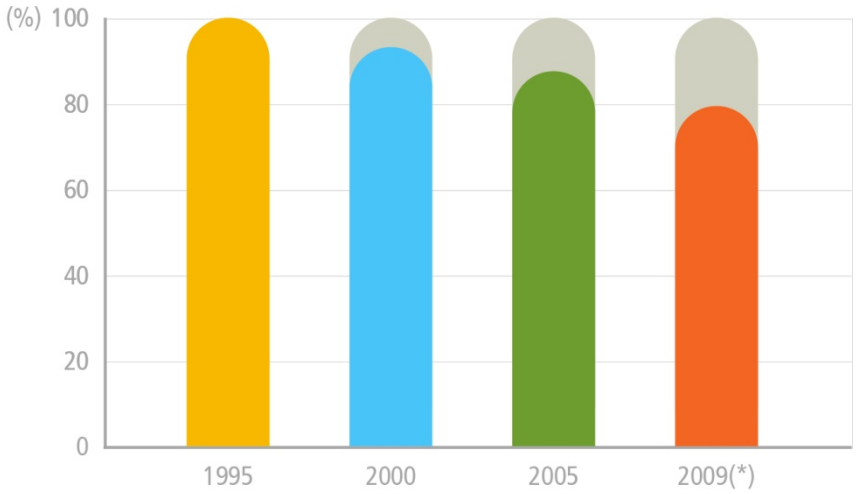
In 1998 the first voluntary targets were set by the European Commission, with manufacturers agreeing to work towards average emissions of 140g/km by 2008 and 120 g/km for all new passenger cars by 2012. As a result of this agreement, CO_2 emissions levels for new cars sold in 2008 were 18% lower than for 1995[2]. In December 2008 European Commission introduced mandatory emission standards, setting an overall target of reducing the average CO_2 emissions from new passenger cars to 120 g/km by 2015 (130 g/km by means of improvement in vehicle motor technology and a reduction of 10 g/km by additional measures) and to 95g/km by 2020 (although these targets vary for different manufacturers, according to the average weight of their car fleets).

1.2 Approaches to reducing emissions

Car manufacturers' responses to these pressures have largely been in the form of a **technological approach.** Thanks to ongoing research and innovation, vehicle emissions are gradually and steadily being reduced – although more rapidly in some segments and by some manufacturers than others. The range of technological approaches is broad – from improving existing technology through greater engine efficiency and structural efficiency (e.g. reducing body weight), to developing new powertrains based on hybrid and electric technology, to building cars to use alternative fuels such as CNG.

[2] European Commission communications, COM(2009)713

Figure 1: Trend in CO_2 emissions reduction for new passenger cars in the European Union



Sources: European Commission communications, COM(2009); 2009 Jato Dynamics forecast

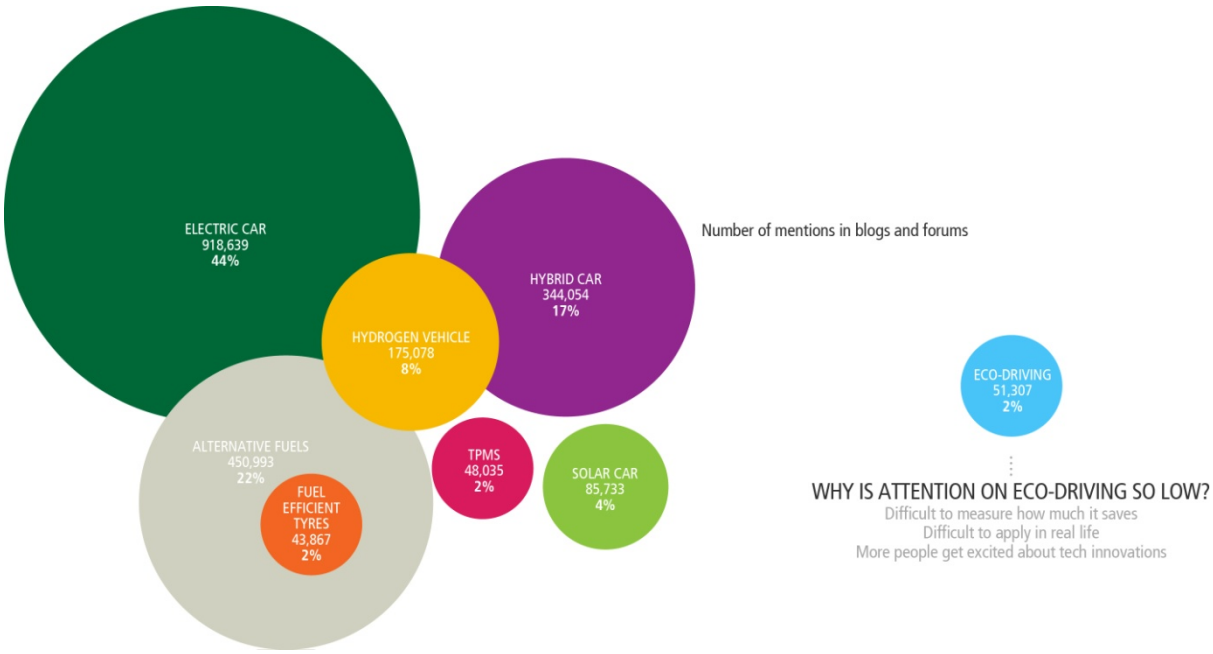
*Provisional data

This approach is complemented by efforts to look at the entire vehicle life cycle to find ways to reduce environmental impacts. For example, this includes reducing emissions from production processes and meeting environment management standards, as well as paying attention to the level of recyclability and recoverability of vehicles.

But reducing the emissions associated with driving is not just about the vehicles themselves – there's also the question of how people make choices about driving and the impact this has on emissions. This can include purchasing decisions – encouraging people to buy more environmentally-friendly models – the frequency with which people drive, as well as the way in which they drive. We can consider this **behavioural change approach** category to sit alongside the technological approach that dominates the environmental transport landscape.

To date, far more attention has been paid to technological responses to climate change in the car industry, with manufacturers investing large amounts in more efficient technologies and new, lower-emission engines. The level of attention paid to the two approaches in online discussion also demonstrates the imbalance, as shown below, with discussion of low emission technologies far outweighing consideration of behavioural change approaches – namely, eco-driving.

Figure 2: Debate around technological and behavioural change approaches to reducing emissions



To clarify the distinction, and the way in which these two approaches rely on each other, we can draw parallels with the broad climate change movement, beyond the car sector. For example, the technological innovations in low energy light bulbs, combined with behavioural changes around electricity use in the home and switching lights off. To reduce CO_2 emissions, we need a combination of technological advancement, alongside changes in people's behaviour – the greatest successes are yielded when both work together.

2. ECO-DRIVING

2.1 Eco-driving and its role in carbon emissions reduction

Eco-driving can be seen as one example of a behavioural change approach to reducing emissions. It is the practice of reducing emissions by adopting a more efficient manner of driving, irrespective of the vehicle being driven. It usually centres on driving style principles, including slow and steady acceleration, early gear changes, maintaining a moderate and consistent speed as much as possible, and slow and steady deceleration.

The concept has risen considerably in popularity in recent years, as the impetus to look for ways to reduce emissions from personal transport has increased. Eco-driving courses, events and studies have produced evidence of the potential for eco-driving to reduce people's fuel consumption and emissions by anything from 5 to more than 20%. In general, it is widely estimated and accepted that reductions of 5 to 10% should be achievable by the ordinary driver using eco-driving techniques. These are considerable reductions.

Given that this is a low-cost change to implement, many in the transport and policy worlds feel strongly that eco-driving has an important role to play in efforts to reduce transport emissions. The EU's preferred route is an 'integrated approach,' involving manufacturers' technological advances, as well as the role of the fuel sector, policy makers and drivers. Eco-driving sits very comfortably in such a broad vision. Jack Short, Secretary-General of the International Transport Forum (ITF) suggests, "it's one of the things that is relatively cheap and can be done relatively easily, so it should be part of the package. There's no silver bullet, and anything that brings 5-10% reductions should be grasped."

eco:Tips

- **Aggressive driving:** sharp braking and accelerating burn fuel and cause engine wear
- **Changing gear:** change up through the gears early as high revs burn more fuel
- **Keep a steady speed:** a moderate and steady speed is the most efficient way to drive
- **Planning ahead:** take the shortest route, avoid peak times and combine errands into one journey
- **Correct tyre pressures:** under-inflated tyres increase resistance
- **Overloading your car:** extra weight makes the engine work harder
- **Good maintenance:** keeps engine and parts working to maximum efficiency
- **Driving in the wet:** water on the road causes rolling resistance
- **Keeping windows up:** open windows above 30mph cause drag
- **Your car's electrics:** air-conditioning and other devices increase fuel consumption
- **Using the trip computer:** keep an eye on your fuel consumption

2.2 The eco-driving landscape

Eco-driving has become more visible in a wide variety of ways in recent years, from government-led campaigns, to competitive events to demonstrate the potential of efficient driving, to eco-driving courses to improve people's driving style, and even the inclusion of eco-driving techniques into learner driver syllabuses.

2.3 Eco-driving as an approach to emissions reduction

Eco-driving undoubtedly has considerable strengths as an approach to emissions reduction – as the activities already outlined demonstrate, it can provide considerable savings in emissions in a low cost way, and is increasingly recognised by governments and other institutions as an important component of an 'integrated approach' to reducing emissions from driving.

But eco-driving has its challenges, too. As a 'behavioural approach' it raises the question of how effectively the different ways of communicating or teaching eco-driving can be said to truly change behaviour, to what extent, and for how long. Moreover, our understanding of its effectiveness

– when applied in 'real-life' circumstances, away from test centres and eco-driving courses – is limited. There are several factors that may limit its effectiveness in reality, including the difficulty of changing driving behaviour in the long run, and the role of road conditions such as traffic, other drivers, and signals. There are also practical obstacles to its widespread implementation and effectiveness, including securing funding and legislative support, and creating the right mechanisms to encourage people to adopt eco-driving techniques.

This section considers existing knowledge and questions over the effectiveness of eco-driving, before outlining some of its broader strengths and weaknesses as an approach to reducing emission from driving.

2.3.1 Do we know how effective eco-driving can be?

There is a good range of existing information about how eco-driving can reduce fuel consumption and emissions. We know from many people's experiences of have data on the short-term effectiveness of learning eco-driving techniques on the spot – e.g. through one-day eco-driving courses and events on dedicated tracks – that eco-driving can be very effective in the short term, in these favourable conditions (e.g. a test track) removed from real-life driving. We also have data on how eco-driving can produce short-term benefits even on real roads – such as the FIA EcoTour – when drivers are fully focused on trying to do so. Some drivers achieved results below the manufacturer-stated mpg on their vehicles over this seven-day event – the purpose of which was to drive as efficiently as possible throughout. However, Olivier Lenz concedes that "of course you can't achieve those results in a real, everyday situation – you will never be 100% focused on it in this way."

Estimated data on 'real-life' savings is also available – such as the Dutch Government-sponsored 2006 study by Dutch research institute TNO which measures the effect of driving techniques on tailpipe emissions. To evaluate the impacts of eco-driving, TNO created two reference cycles (urban and non-urban) representative of moderate driving in average Dutch traffic conditions – much closer to realistic driving conditions than the standard legislation European testing cycle. The study found that applying eco-driving tips correctly under

these average traffic conditions led to a significant decrease of the CO_2 emissions and fuel consumption – on average 7% with petrol engines, and 8-10% with diesel.

All of these experiences leave no doubt that eco-driving reduces fuel consumption and emissions, and can do so by a substantial amount. However, what is lacking is an understanding of its effects on a wide range of people during their day to day driving. Eco-driving training courses are based on an individual concentrating intensely on eco-driving on a single day. We have no way of knowing if the techniques drivers can learn on a one-day course will be maintained in their driving style after the event. It demonstrates that drivers are very receptive to changing their driving style during a single day event, but gives no indication of whether they are receptive to changing their behaviour in the long run. The Dutch study, although based on normal road conditions, assumes that people are committed and focused enough to apply eco-driving techniques consistently over time. However, this is not necessarily a realistic assumption. To really understand the benefits of eco-driving – particularly in a public policy context – we need to know for certain what effects it has on ordinary people once they have learnt and understood the techniques. Are they successful at reducing their emissions? Do their results improve or worsen over time? Do they stick to it? Do they return to their bad habits?

What we have lacked is a full study of how people really improve – or otherwise – over a substantial period of time when using eco-driving techniques, and to what extent these improvements are sustainable. This sort of information will give us the true real world view – taking into account the vagaries in how well and consistently people apply the techniques, whether they really change their behaviour after being taught eco-driving tips (i.e. beyond just the day after reading some tips or the day of attending a course), how much they reduce emissions in normal traffic and everyday conditions.

This is about not the potential of eco-driving – we know that it can help drivers save over 20% if it is done it with full concentration in the right conditions – but about what effect it really has in practice when people try to apply it. **For the first time, we now have this data, thanks to Fiat's eco:Drive system.**

2.3.2 Strengths and weaknesses

Strengths of eco-driving

1. Eco-driving is accessible and universal

Importantly, it is something that can be applied by any individual in any vehicle at any time helping to bring down emissions from driving immediately.. Eco-driving requires drivers to understand and adopt driving techniques –there is no cost, no equipment, no extra time, no inconvenience necessary. This means that eco-driving can have universal reach, and immediate effect. Whilst technological innovations are essential in the move towards reducing emissions from driving, they represent a more long-term approach that presently reaches only a very small proportion of cars on the road.

2. Eco-driving can be used in any vehicle

Any vehicle can be driven with eco-driving techniques. From the most polluting vehicle to the newest hybrid to an electric car – eco-driving provides a way to reduce energy consumption, which is important regardless of the fuel or its emissions factor. Olivier Lenz agrees: "whatever is the energy source you are using, however polluting, you're still using energy and that's a problem that remains. Eco-driving is addressing that." Nonetheless, some might question whether a focus on eco-driving is worthwhile when vehicles are becoming technologically more and more economical. However, experts argue that eco-driving is of even greater importance in more efficient vehicles. Peter Wilbers says that the improvements in efficiency demonstrated in the test cycle by new, cleaner vehicles are not necessarily translated onto the road, when driven by ordinary drivers. Whilst this is a well-known fact for all vehicles, he argues that the cleaner models actually see even great gaps than is usual – "with the cleaner cars it's more and more important to drive in the proper way. In recent years the engine tech and performances of passenger cars have improved rapidly, while most drivers have not adapted their style. Eco-driving is an adapted driving style which best fits modern engine technology"

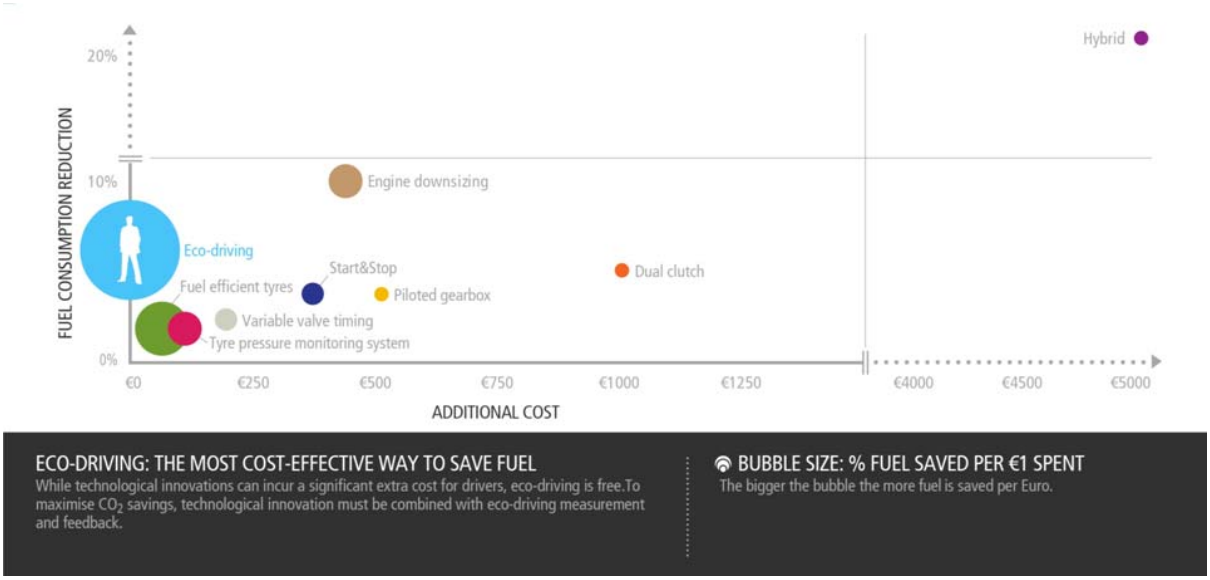
3. Eco-driving is low cost

For the individual driver, eco-driving is often free – learning the techniques through freely available 'eco-tips,' through government-supported eco-training courses, or through on-board devices such as eco:Drive or gear shift indicators, costs nothing, and brings financial savings.

What about the costs to the institution promoting eco-driving, be that a manufacturer, a government, or an NGO? Eco-driving is relatively low-cost for an institution to implement (e.g. through campaigns, incentives, courses). A 2006 study by Dutch research institute TNO evaluated the costs and benefits of the New Driving programme, and estimated the overall costs to be 9€ per avoided ton of CO_2. Peter Wilbers argues that "compared to other technical measures, eco-driving is very profitable."

The chart below shows the cost (to consumers) per % CO_2 saved, and reveals eco-driving to be the most cost-effective approach to emission reduction on this basis.

Figure 3: Cost-effectiveness of eco-driving



4. Eco-driving is pragmatic

Eco-driving offers a pragmatic step forward in lowering emissions. Not only because it is free and easy for drivers to apply, but also because it doesn't demand any mobility compromises on the part of drivers. If we recognise that many – if not most – people are not motivated to stop using their cars or reduce the amount that they drive for environmental reasons, then it is clear that eco-driving offers a way to reduce emissions without relying on drivers willingness to move away from relying on private cars. Paul Everett, Chief Executive of the Society for Motor Manufacturers and Traders (SMMT), feels that adopting eco-driving is "one of the ways in which we can sustain mobility whilst looking for reduced emissions, without having to make a stark lifestyle choice and giving up driving." It also appeals to a range of driver motivations, not just those based on environmental concerns, as Olivier Lenz argues: "If you drive in an eco-efficient way you also use less petrol and save money. The motorist, the environment and society all win." For these reasons, eco-driving has the potential to be a more engaging tool for reducing emissions from driving compared with changing purchasing behaviour or car use.

5. Eco-driving complements other efforts to reduce emissions

Eco-driving alone is, of course, not the solution to reducing driving emissions. But it can serve as an approach that is complementary to other efforts – namely, technological improvements in engine efficiency. A low-emission vehicle, driven badly, ceases to be a low-emission vehicle. Eco-driving techniques are therefore of crucial importance if people are to get the best out of the ongoing improvements in vehicle efficiency. Used in conjunction with low-emission vehicles, eco-driving offers even greater gains – Paul Everett talks of the "potential advantage of having highly efficient vehicles combined with highly efficient driving to deliver bigger reductions."

Eco-driving is about encouraging drivers to take responsibility for reducing emissions, alongside manufacturers; asking them to be engaged and pro-active. The ability of manufacturers and governments to reduce emissions from driving will be limited if we don't harness drivers' intelligence so they can play their part. This means not only encouraging them to make better choices about the cars they buy and how much they use them, but also about *how* they drive them.

6. Eco-driving brings positive side-effects

Eco-driving's primary positive side effect is an improvement in road safety. The principles behind eco-driving – planning ahead, preparing early for junctions, traffic lights and so on, maintaining a consistent and steady speed – are all measures that make people safer drivers. They encourage drivers to be highly aware of their surroundings and to drive smoothly. The techniques taught in eco-driving training courses are similar to those taught in advanced driving courses aimed specifically at making people better, more aware, safer drivers.

Eco-driving can also improve the flow of traffic, particularly in urban areas, by encouraging people to drive smoothly and stop and start less often.

Challenges for eco-driving

1. External road conditions

It is common sense to assume that the ability of a driver to reduce fuel consumption will be different on an empty testing track compared with a busy urban setting. 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.

A further external condition that might affect people's ability to eco-drive is the behaviour of other drivers. Some of the experts we spoke to raised the idea that the more people around you are using eco-driving techniques, the easier you will find it to do so yourself – and so an individual's improvements might be proportionally greater when more of his or her fellow drivers are also eco-driving. Paul Everett believes that "the benefit comes from more people driving in this way. The more of us who operate in this way, the more likely it is that we'll see big improvements."

2. Government support and funding

All of the experts that we spoke to agree that eco-driving is an area that is worthy of more support, due to its capacity to meet environmental and safety objectives, its accessibility to all drivers, and its ability to yield immediate impacts on emissions from driving. There is general support for eco-driving at this level – Jack Short says that all of the FIA's transport ministry members now include eco-driving to some degree in their transport and environment policies. But Paul Everett argues that "one of the reasons there isn't public money for training, or a bigger appetite to embed eco-driving into test mechanisms, is that people don't know what it can

do. We can see the benefits on an individual basis on a course, but how does it sustain?" Proving the effectiveness of eco-driving – over the long term – seems key to garnering more support and investment at a governmental level, and pushing it higher up the emissions-reduction agenda. In the Netherlands, Peter Wilbers argues that research carried out by his agency NL Agency around the cost-effectiveness of the 'New Driving' initiative (their 2008 analysis valued the cost of the programme at €9 per avoided ton of CO_2 emissions), was key in helping them to secure significant and sustained government funding.

2.3.2 What we need from eco-driving

Understanding more about the strengths of eco-driving as an approach, and the challenges that it faces, helps to clarify the areas that are important if an eco-driving initiative is to be effective and have lasting effects. These include:

- Making it easy – and cheap – to get started on eco-driving
- Showing drivers what they can and are saving
- Engaging drivers over time to maintain the changes, beyond their initial exposure to eco-driving tips or training
- Working in conjunction with efficient cars – a complementary technique to technological advances

The emphasis, then, needs to be on practical, personal approaches to eco-driving – reminding drivers how they are driving and how to improve, without requiring them to make significant time or financial commitments to do so.

Several manufacturers have made efforts to provide this sort of support – for example, gear shift indicators in cars so drivers know when the optimal time is to change gears for efficient fuel consumption, or onboard fuel economy indicators so drivers can see how efficiently they are driving and quantify their improvements. These methods, however, do have their limitations, as they provide only quantitative feedback. Gear-shift indicators tackle only one aspect of efficient driving and their effectiveness – and how far they go in trying to improve efficiency – depends on the way in which each car manufacturer has implemented the technology. Some gear shift indicators may be more demanding, and some less so. Fuel economy indicators are undoubtedly useful for drivers but only in conjunction with qualitative advice – that is, what these figures mean in terms of eco-driving and how they can improve their driving styles.

Fiat has tried to go further by engaging drivers on a very personal level, and providing them with thorough eco-driving education, in the most convenient way possible, that is rooted in an understanding of how that individual drives. eco:Drive keeps drivers engaged over time by showing how much they are improving, what this means in terms of fuel and CO_2 emissions, and what more they can do.

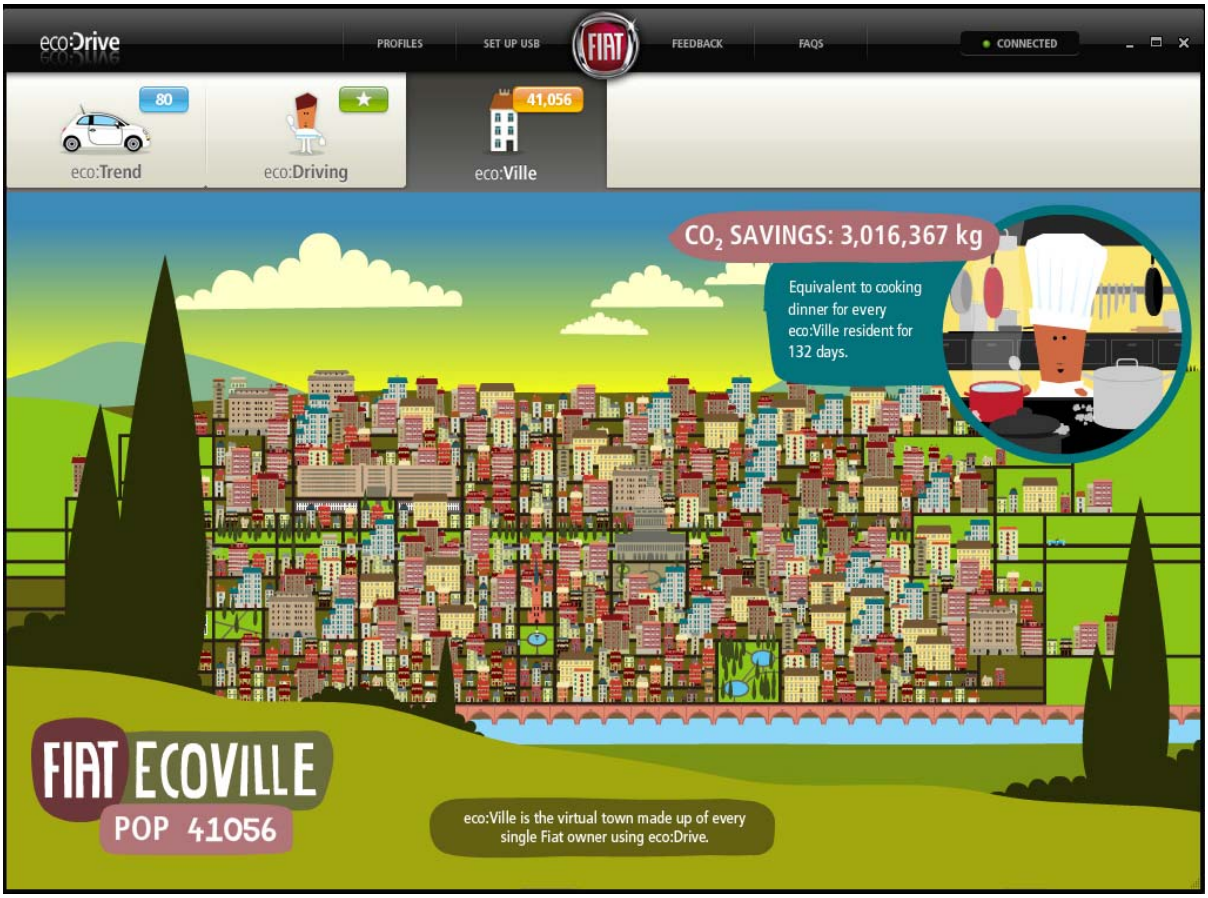
2.4 Fiat and eco:Drive

eco:Drive was launched in October 2008 as a software application that is free to download at Fiat's website (www.fiat.com/ecodrive). It works by asking drivers to plug a USB stick into their Blue&Me™ 'infotainment' port (present in all new Fiat models), where it records telemetric data from the car's network. Plugging the USB into a computer then allows the Fiat servers to analyse the journey data, on an anonymous basis. Algorithms measure driving efficiency based on four parameters: steady acceleration, steady deceleration, early gear changes and moderate and consistent speed. Drivers receive a star rating (out of 5) for each of these indicators, and their performance overall on the four indicators is used to calculate an eco:Index score out of 100 – a higher score means more efficient driving. Drivers receive tailored advice on how to improve their performance on each indicator, and thus their overall eco:Index. They can track improvements over time, set targets, and see how much CO_2 they are saving, through their computer.

Figure 4: Illustration of an eco:Index report

Fiat has also developed an online community – 'ecoVille' – which shows the latest number of drivers using eco:Drive, and the total CO2 emissions that eco:Drivers have saved to date. As of September 2010, 45,000 eco:Drivers had saved a total of more than 3,300 tons of CO_2 by driving more efficiently.

Figure 5: Screenshot of eco:Ville



The eco:Drive technology is an automotive industry first, linking drivers with in-car diagnostics and giving them tailored advice based on how they drive. eco:Drive represents a unique, personalised way of harnessing technology to generate long-term changes in behaviour. Luis Cilimingras, Director of Digital Innovation at Fiat Group, describes eco:Drive as representing "a significant advance in automotive technology - this is the first application which links drivers with in-car diagnostics. Most importantly, what eco:Drive does is to make sense of the car's data for the driver, making it useful to them so that they can do something with it – namely, improve the way they drive their cars. "

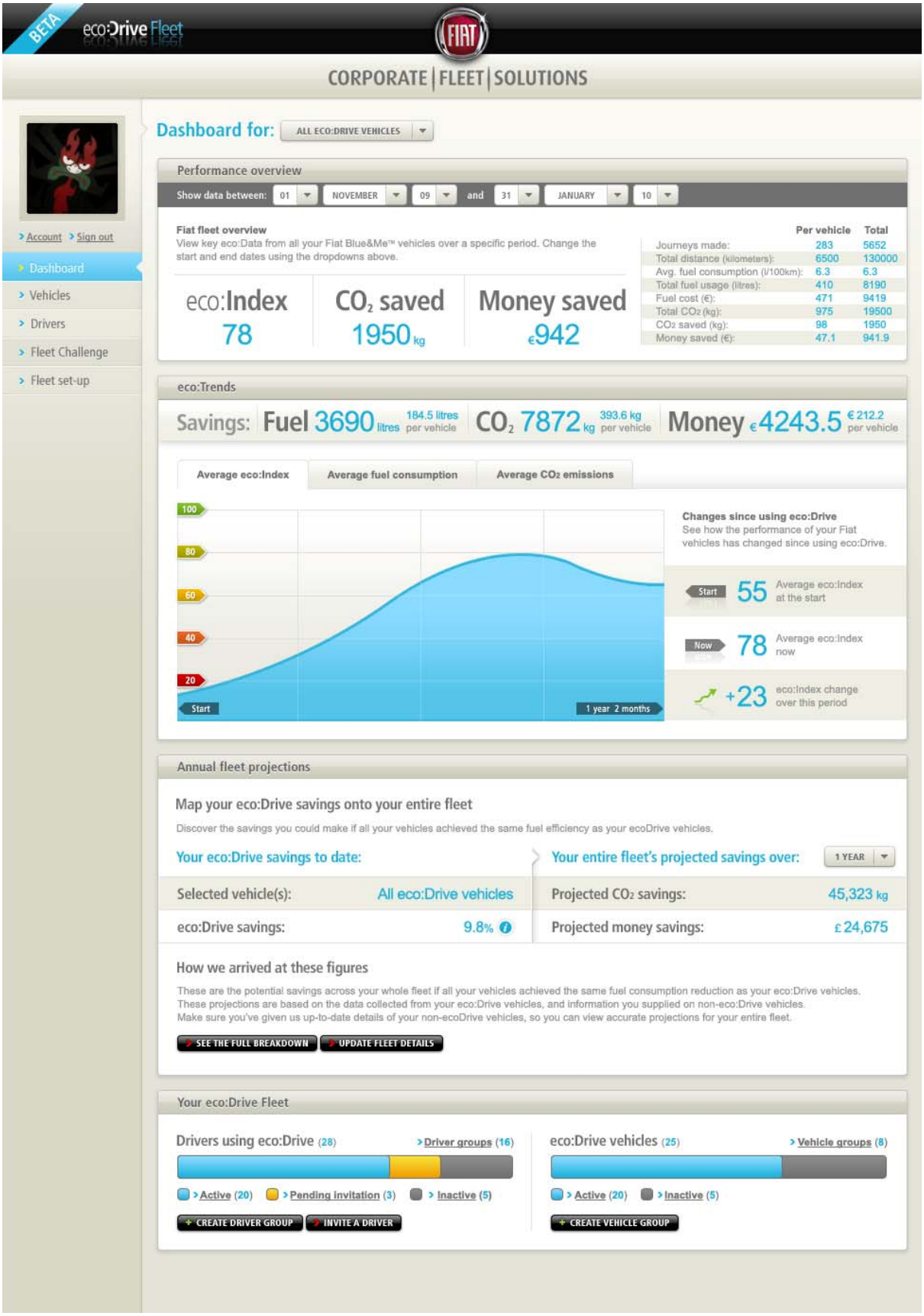
Whilst the eco:Drive system is only available to drivers of Fiat cars, the eco:Drive website includes a range of tips accessible to all drivers.

Figure 6: Sample eco:Driving tips

Further developments of eco:Drive will make the information more immediate. An in-car version– eco:Drive Live – will be launched in 2011 and will provide live updates on how efficiently people are driving, and reminders on how to improve. It will work in much the same way as eco:Drive, taking telemetric data from the car's network and turning this into qualitative advice to drivers. The difference is that this will be take place in real time. The eco:Drive Live feedback can be communicated to drivers through a range of mediums, including in car displays, satnav systems and smart phones .

In February 2010, Fiat also launched a version of eco:Drive for fleets, that allows fleet managers and corporations to manage CO_2 emissions and save costs.

Figure 7: eco:Drive Fleet 'Dashboard'



Fiat is working to reduce the environmental impact of its cars - its fleet has the lowest average CO_2 emissions of any car manufacturer in Europe[3] and was the first manufacturer to meet the EU's 2008 voluntary target for new car emissions. With eco:Drive, Fiat wanted to think not just about what people drive, but how they drive, and encourage drivers to play their part in reducing the emissions from driving.

2.5 The eco:Drive data: understanding eco-driving

This research seeks to use data gathered by eco:Drive to answer a range of key questions, raised in the preceding section, for the first time. These include:

- How effective is eco-driving in 'real-life'? Can its benefits be quantified?
- Does it last – does it create real and sustained behavioural change? What broader lesson can it teach us about how to create behavioural change?
- What are the limiting factors that influence its effectiveness? We have evaluated assumptions and opinions about the challenges to eco-driving's effectiveness; in reality how important can we say these factors are?

[3] JATO Dynamics, Volume-weighted average CO2 emissions 2009 (g/km)
http://www.jato.com/PressReleases/Small%20Cars%20Driving%20Down%20European%20CO2%20Emissions.pdf

3. ECO:DRIVE FINDINGS

3.1 The data

The data analysed comprises 428,000 journeys made by 5,697 drivers in 5 countries over 150 days. In most instances (unless stated otherwise) a comparison is made between drivers' performance at the beginning of using eco:Drive (before implementing its tips) with their average performance at the end of a 30-day period. The 30-day period was chosen as it represents the mean length of time that drivers remain committed to the system. This is as expected: once drivers have spent what is a reasonable amount of time in a process of learning and improving, and feel they fully understand how to drive more efficiently, they have less of a reason to return regularly to eco:Drive.

More information about the how the data was gathered and analysed can be found in the Appendix.

This section explores how efficiently people drive before and after using eco:Drive, which aspects of driving show greater and lesser improvements, and what these changes mean in terms of fuel consumption, CO_2 and cost savings. It also evaluates the trends in behavioural change over time, finding improvements to be steadily maintained, and observes the impacts of eco-driving on journey characteristics such as speed and stopping time. The key findings are summarised below.

3.2 Summary of findings

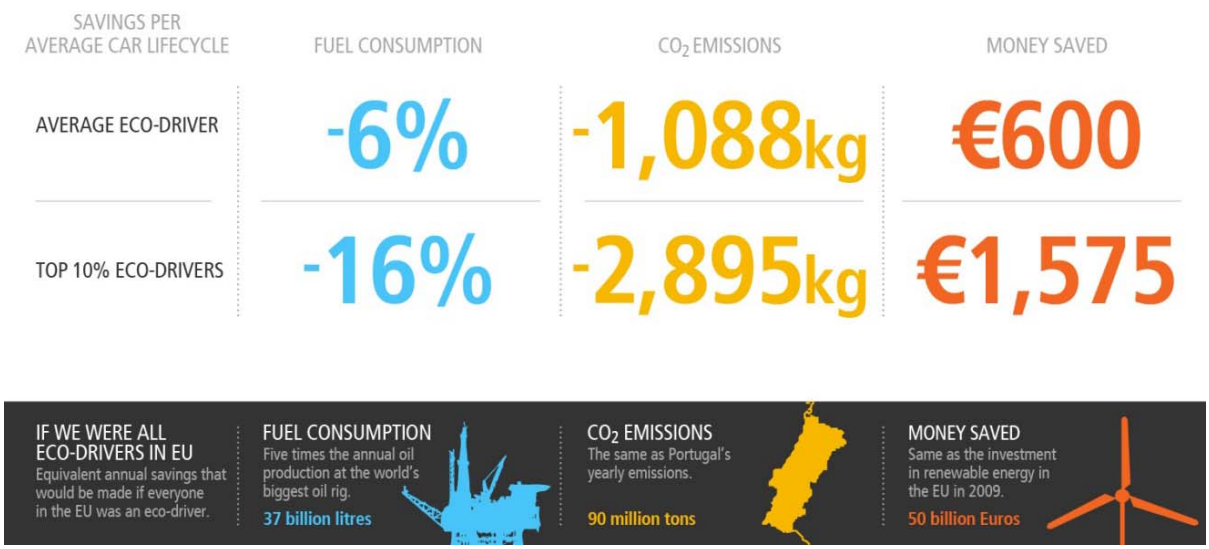
3.2.1 Significant savings

- Eco-driving brings significant savings in fuel, CO2 and money. The average reduction in fuel consumption over a 30 day period of using eco:Drive is 6% (using an exponential trend model), and the reduction for the best 10% of eco:Drive users is as high as 16%). Drivers improve most noticeably during the first 15 days of use, but continue to improve steadily beyond this point, suggesting sustained, gradual improvements.
- On average, eco-driving with eco:Drive over a year saves 133kg of CO_2, and 80euros of fuel.[4] For the best 10% of eco-drivers, these savings are as much as 354kg of CO_2 and 211 Euros of fuel.
- Over the whole lifecycle of the car, eco:Drive saves on average 1,088kg of CO2 and Euro 600 of fuel. This rises to 2,895kg of CO2 and Euro 1,575 for the top 10% of eco-drivers.
- What could be achieved if everyone in Europe was eco-driving? The fuel we could save would equate to almost twice the annual oil production at the world's biggest oil rig[5]; the CO_2 emissions avoided would be the same as 50% of Portugal's annual carbon footprint[6]; and the money we'd save adds up to 40% of the

[4] Average fuel cost calculated using *AA Fuel Report,* March 2010
[5] Newfoundland Labrador Department of Finance, Economic Research and Analysis Division, *Oil and Gas,* 2010
[6] United Nations Statistics Division, *Millenium Goal Indicators*, 2009

total investment in European renewable energy in 2009.[7] These savings are even more impressive for the top 10% of eco-drivers: 37 billion litres of fuel, 90 million tons of CO2 and Euro 50 billion. Of course, this is a utopia, but it provides a flavour of the power of eco-driving if it were to become the ordinary way of driving.

Figure 8: Summary of annual savings from eco-driving



3.2.2 Different driving styles

Drivers tend to perform best, initially, on speed level and deceleration, and worse on acceleration and gear shift. Variations in initial efficiency of driving between different countries suggest that there are differences in drivers' attitudes, styles and behaviour in different regions. Looking at the components of driving style, the greatest improvements are seen coming from changes to gear shift and acceleration behaviours, which showed weaker performances initially.

3.2.3 Better drivers

Using eco:Drive over a 30-day period produces an upwards trend in the average speed of journeys and a considerable downward trend in the amount of time drivers spent stopped during their journeys. This indicates that using eco-driving techniques can cause a real shift in behaviour, so that the characteristics of people's journeys change over time, as well as the way they drive during those journeys. Eco-drivers driver more fluently, with fewer stops, and reach their destinations quicker.

[7] Rutherford, Max, *Green Energy in 2009,* 2010

Figure 9: Changes in driving behaviour

3.3 How efficiently people drive

3.3.1 Initial eco:Drive performance

eco:Drive calculates drivers' performance on four indicators – gear shift, speed, acceleration and deceleration – and uses this to produce an eco:Index figure for each journey taken. This is the figure that drivers see improving – ideally – over time. We have found that the overall mean starting eco:Index for all drivers is 59.2, out of a possible 100. This is the level drivers achieve when they first start to use the eco:Drive programme, and before receiving any personalised eco:Drive tips and starting to improve. Thus we can take this to be broadly representative of the way the general public drives ordinarily, without trying to implement eco-driving techniques. This starting index varies considerably across different countries, from 61.8 in the UK to 56.6 in Spain. This suggests that there may be differences in drivers' attitudes, styles and behavioural norms in different places – 'cultural' differences.

3.3.2 Breakdown

As the eco:Index is a composite of drivers' scores on four different indicators, it is possible to look at drivers' relative performance across these indicators. The eco:Index is calculated by measuring four different elements of driving style, each of which drivers are given a star rating of 1 to 5:

- Acceleration: The harder the acceleration pedal is pushed, the harder the engine has to work and the more fuel is burned. Accelerating gently and less often reduces fuel consumption.
- Deceleration: The harder a driver decelerates, the more fuel has to be burned to accelerate again. Anticipating reductions in speed, and reducing speed earlier and more gradually, burns less fuel.
- Gear shift: To keep the engine running at its most efficient operating conditions, drivers should shift up a gear as soon as possible, avoiding the car losing momentum.

- Speed level: Maintaining a steady and moderate speed allows vehicles to operate at their most fuel efficient level.

The data shows that drivers initially perform best, on average, on speed level and deceleration, achieving an average score of 3.5 and 3.7 out of 5 respectively. In both cases, the scores are relatively consistent across drivers of different countries, although Italian drivers perform worst in both cases. These differences are maintained across all car models and across trips with the same average speed. This suggests, as with the overall eco:Index scores, that poorer performance of drivers in some markets – notably Italy, and to a lesser extent Spain, is linked to driver behaviour.

Acceleration and gear shift see slightly worse performances, with average scores of 3.2 and 3.3 respectively. In both cases, there are significant variations between performance in different countries – from 2.87 in Spain for gear shift performance to 3.52 for the UK, for example.

The eco:Index is most useful as a tool for comparisons, providing a quantifiable way for drivers to see how they improve over time. Looking at drivers' initial fuel consumption figures – also possible to obtain from the eco:Drive data – gives us a more readily understandable way of looking at driving efficiency.

3.4 The effects of eco-driving

3.4.1 Average improvements in driving efficiency

Now we have established an understanding of how efficiently people drive ordinarily, before employing eco-driving techniques, we can make comparisons with the levels of efficiency achieved over time through using eco:Drive.

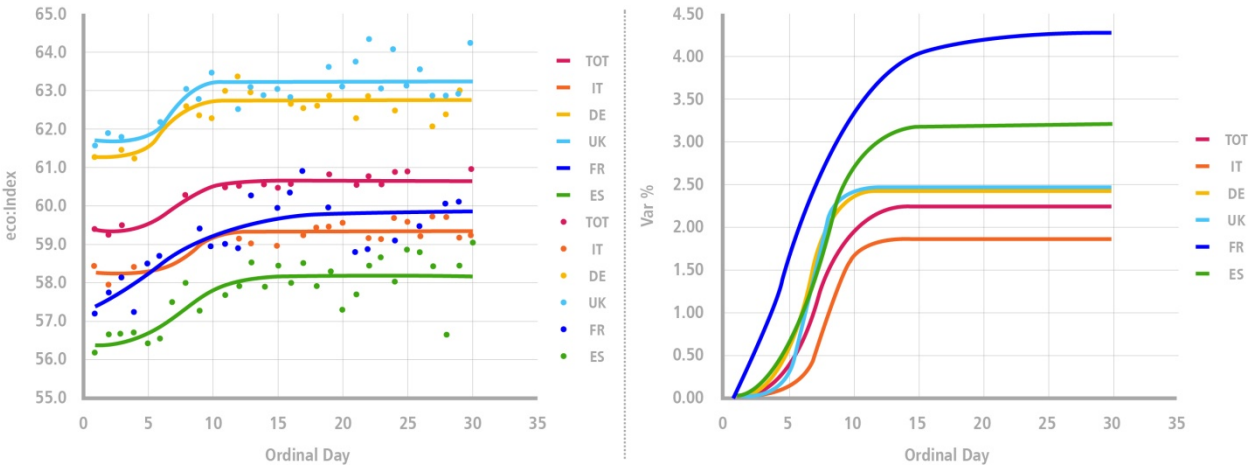
We analysed drivers' improvements over a 30-day period. This was the average length of time to remain active within the eco:Drive system. Many drivers do continue to use eco:Drive beyond 30 days, and continue to improve, but the numbers are smaller and thus less statistically reliable.

3.4.1.1 Average improvement in eco:Index

The average improvement in drivers' eco:Index (from their second day of driving with eco:Drive – before employing eco-driving techniques – to their thirtieth day of use. The second day was used because the first day can provide anomalous results, due to people only using eco:Drive for part of their normal day's driving) is 2.25%. The biggest improvements were seen in France (5.25%) and Spain (3.20%). Italian drivers showed the smallest improvement (1.85%).

The graph shows the pattern of average improvement in drivers' eco:Index scores over a 30-day period (using a sigmovid model). Almost all the improvement occurs in the first 12-15 days – 2.25% - and the improvement is maintained or does continue, at a slower rate, towards the 30th day.

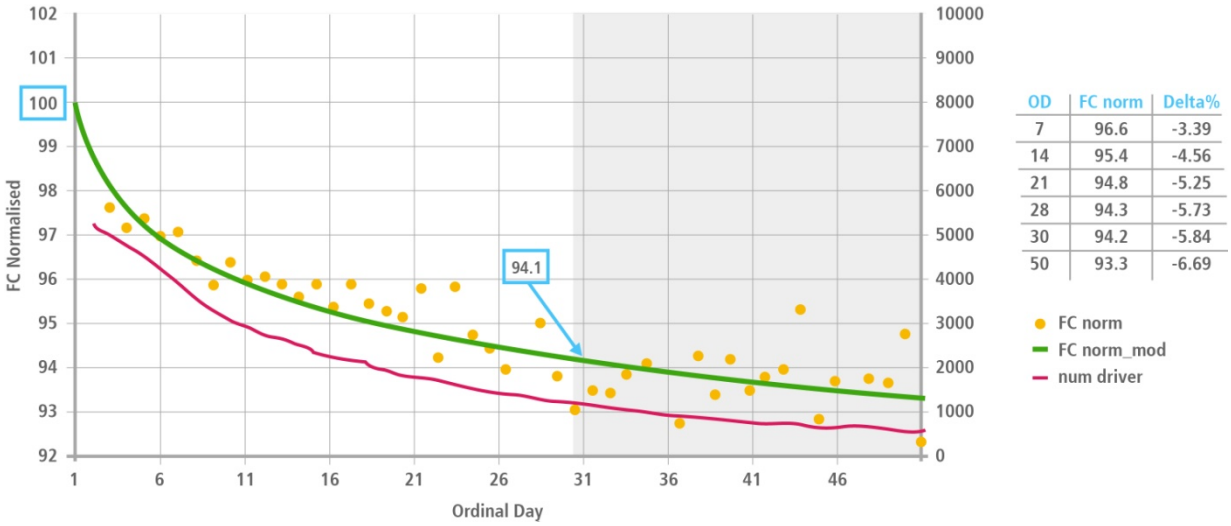
Figure 10: Improvement in eco:Index over 30 days



3.4.1.2 Average improvement in fuel consumption

What does this improvement in the eco:Index mean in terms of fuel consumption? The average reduction in drivers' fuel consumption over 30 days of using eco:Drive was 5.84%. The biggest improvements were seen in Spain (6.01%) and the UK (5.71%). Italy showed the smallest improvement (2.63%).

Figure 11: Improvement in fuel consumption over 30 days



The graph above shows the overall pattern of improvement in drivers' fuel consumption over a 30-day period – the improvement after 14 days is 4.56%, and after 30 days it is 28% higher – 5.84%. This suggests that eco-

driving doesn't simply yield instant results that are not sustained over time. Instead, it helps drivers to improve gradually as they adjust to the methods over a period of time.

3.4.2 Breakdown of average improvement by eco:Index indicator

We have seen that drivers improve considerably in their fuel consumption and eco:Index through using eco:Drive, and thus save CO_2 emissions and fuel costs. We can also look in to a breakdown of drivers' improvements, to understand which elements of driving seem to be easier to improve upon, and yield the greater improvements in efficiency.

Looking at the four component indicators (computed using an exponential model) that are used to calculate the eco:Index, we see that drivers achieve the greatest improvement in the efficiency of their gear shift behaviour. Improvements of 5.0% are seen in the scores in this category, followed by improvements of 4.1% in acceleration. Speed level and deceleration showed less significant improvements, of 1.2% and 1.5% respectively. This suggests that the areas that drivers find easiest to change their behaviour in, and that therefore yield greater efficiency savings, are the way the change gears and the way they accelerate. The relative weight (importance) that each component has for the overall eco:Index has also been evaluated. Gear shift and Acceleration together account for over 60% (31% and 29% respectively) of the improvement, while speed only 15% and deceleration 25%.

Figure 12: Average improvement by eco:Index indicator

Drivers of different nationalities showed considerable variations in improvements. On gear shift, for example, French eco:Drivers improved by 10.6%, whereas in the UK drivers only improved by 3.9%. In all other

categories, Italian drivers demonstrated the smallest improvements. These variations suggest that driver behaviour and attitudes might affect how readily people can improve their driving style.

The graphs below model the improvements on the four eco:Index indicators over a 30-day period of eco:Drive use. It is clear that the steepest improvements are found in gear shift and acceleration.

Figure 13: Gear shift trend over 30 days

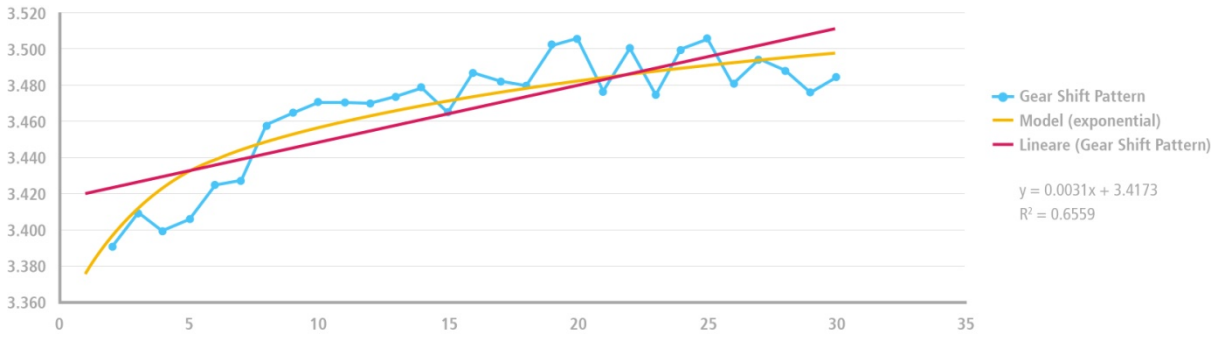


Figure 14: Acceleration trend over 30 days

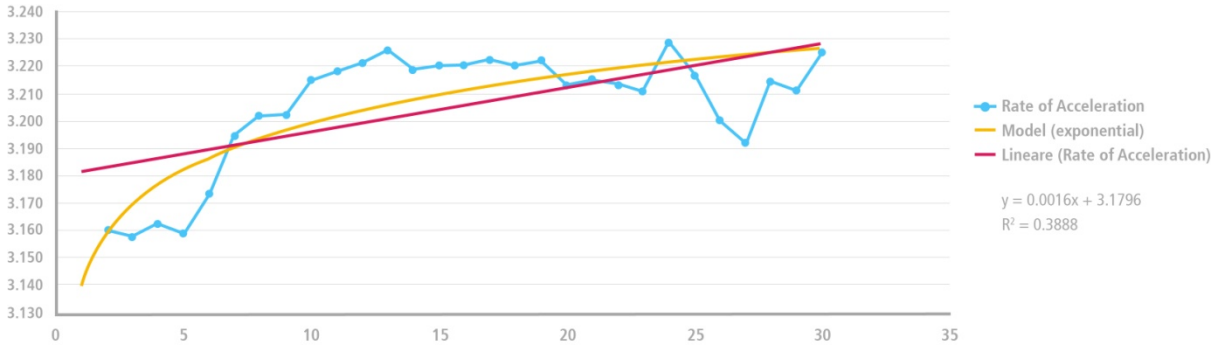


Figure 15: Deceleration trend over 30 days

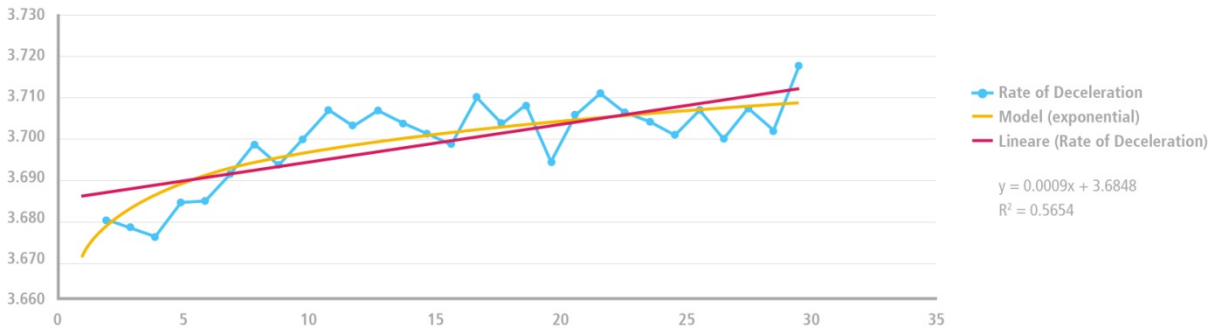
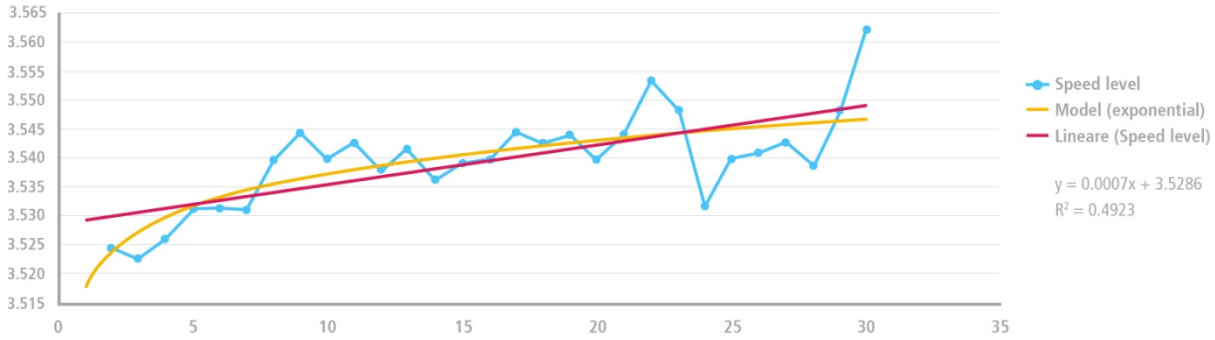


Figure 16: Speed level over 30 days



3.4.3 The potential of eco-driving

The results we have seen so far are for the average eco:Drive user. By looking at the improvements of the top 10% of users, we can build a picture of the range of the real potential of eco-driving and the possible improvements that it can bring. Analysing those drivers who made more or less the same type of trips at the beginning of its experience with eco:Drive and at the end (up to 30 days) we found that around 10% of drivers improve fuel consumption by more than 16%.

3.5 How people use their cars

So far, we've looked at how drivers perform on the four elements that make up the eco:Index – gear shift, acceleration, deceleration and speed. We've also looked at the sorts of improvements they managed to make on these elements by eco-driving, and the impacts this has on their fuel consumption, emissions and fuel costs

But eco:Drive doesn't only help us to understand how well people accelerate, decelerate, change gears and maintain their speed. It also tells us how people use their cars – how often they drive, how far they drive, how fast their journeys are and how much time they spend stationary. From this information we can draw some further conclusions about how the way people use their cars – and the road conditions they drive in – can affect their efficiency and fuel consumption. We now look at the characteristics of average journeys, and what this means for emissions, including:

- How often, how far and for how long people drive
- The average speed of journeys, and how this affects fuel consumption
- The average stop-time in journeys, and how this affects fuel consumption

Finally, and most importantly, we have seen the way that using eco:Drive has changed the way people drive in a broader sense – not just improvements in their ratings on acceleration and gear shift, for example, but real changes in the characteristics of their journeys, notable average speed and stopping time. This indicates that

using eco-driving techniques can cause a real shift in behaviour, so that the characteristics of people's journeys change.

1.2.1 Characteristics of journeys

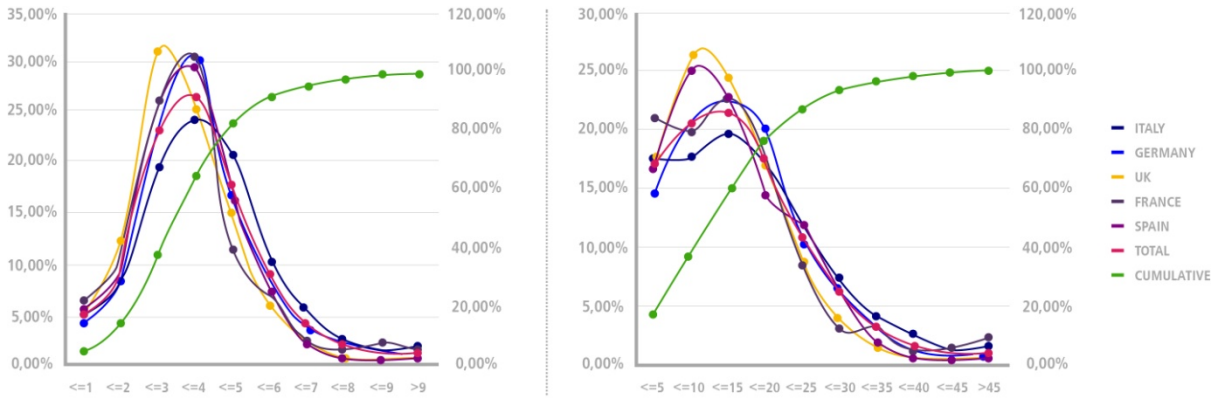
3.5.1.1 Frequency

The average eco:Drive user makes 2.72 trips per day over the course of the year (this includes travel and non-travel days). On days on which drivers travel, the average number of journeys is 4. A slight decrease is noticed in August, when an average of 2.45 journeys are made per day. The number of daily trips is also lower on a Sunday. The modal average is 4 journeys a day, and this is the case across nearly every country, regardless of car model.

Most drivers use their car between 10 and 15 times each week. 80% of people use their car up to 20 times a week, while 20% of people use their car less than 5 times a week.

The graphs below show the distribution of journey frequency on a daily and weekly basis:

Figure 17: Daily and weekly journey frequency



3.5.1.2 Speed

The average eco:Drive user travels at a speed of 32.5 km/h, with variations across different countries. The average speed in Germany (34.3), France (34) and the UK (33.9) is higher than in Italy (31.4) and Spain (30.9). In Germany it is notable that 80% of drivers drive at an average speed of 25 to 35 km/h – a higher proportion than in the other countries. The most likely explanation for these variations are the different traffic levels and road systems in each country.

3.5.1.3 Stop time

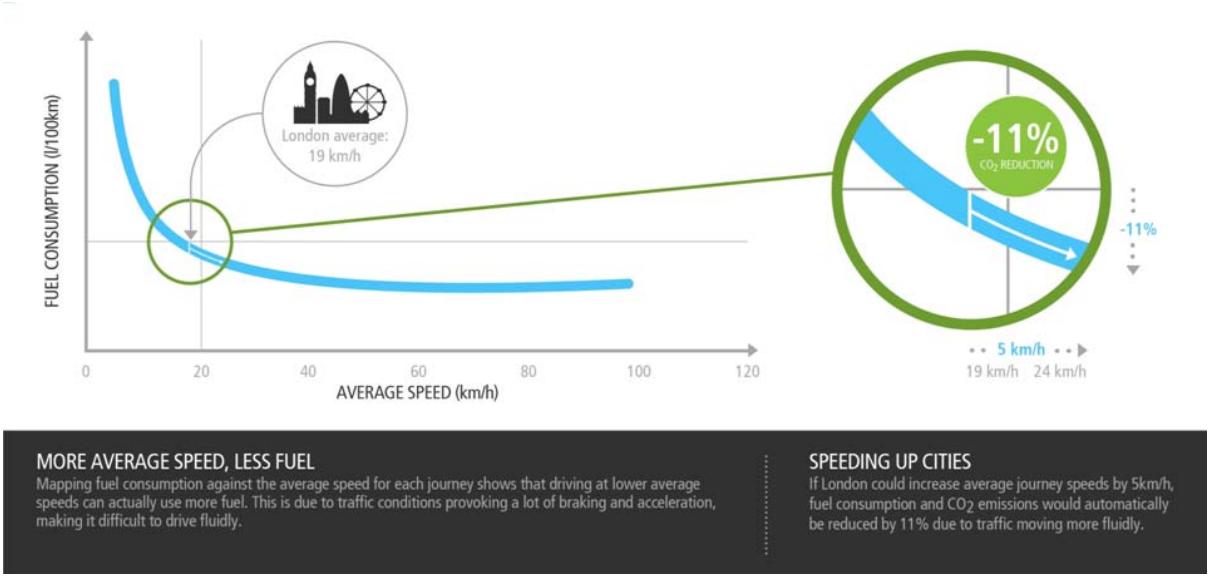
On average, drivers find themselves stationary for 16% of their journey time – averaging 2 minutes per journey. We see considerable differences in average stop time among the different markets. For example, the average driver in Germany spends less time stopped than in the other countries (1.5 minutes). In contrast, Italian drivers spend more time stopped, an average of 2.1 minutes, whilst Spanish drivers spend the most time stopped at 2.5 minutes per day. The variations in stop time are likely to reflect different road systems (e.g. frequency of traffic lights) and traffic volume; there are no notable differences between different models.

3.5.2 Impact on efficiency

3.5.2.1 Fuel consumption and average speed

The average speed of journeys has a clear relationship with fuel consumption, as shown in extensive literature (e.g. the European Commissions' TREMOVE policy assessment model for transport and the environment[8]) and proven here by the eco:Drive data. The graph below shows this relationship (across all models and markets), and demonstrates that fuel consumption is highest during trips with very low average speeds, e.g. under 10 km/h, and that consumption improves sharply as speeds increase from 0 to 20 km/h. After 40 km/h, consumption is fairly stable, but starts to increase again somewhat after 90km/h.

Figure 18: Fuel consumption and average speed



The key causes of low average speeds are traffic conditions and road infrastructure, that cause drivers to start and stop frequently. The eco:Drive data clearly shows the importance of maintaining traffic fluidity and avoiding low average speeds in reducing overall emissions from driving. Moreover, these conditions make it very hard for people to eco:Drive successfully, as they are unable to follow the key principle of driving smoothly, by accelerating and decelerating as little as possible and maintain a constant speed.

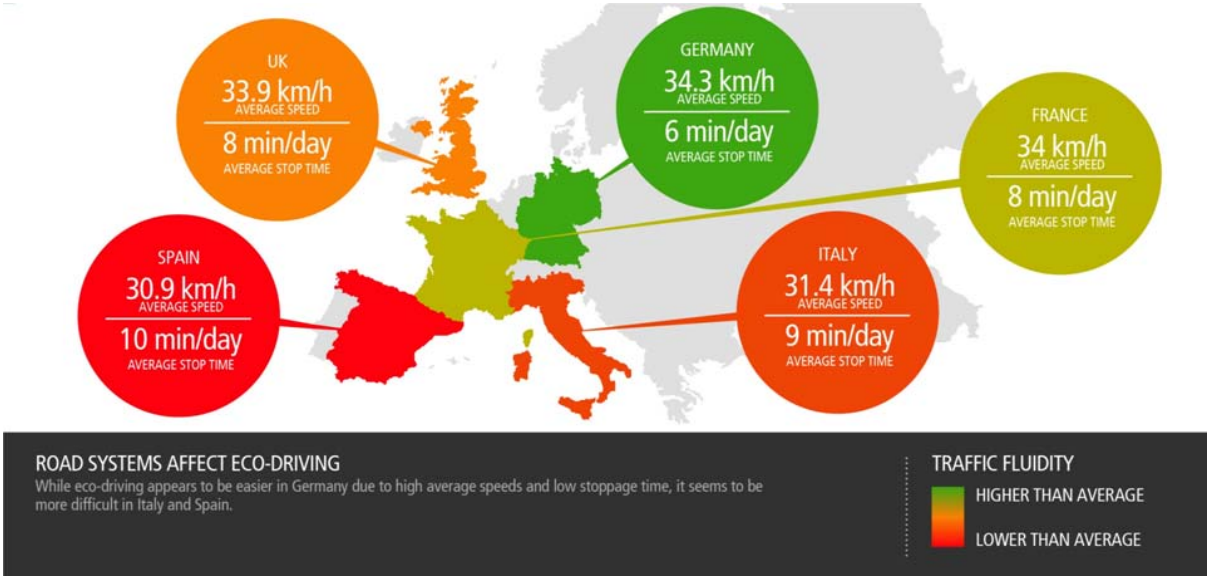
[8] http://ec.europa.eu/environment/air/pollutants/models/tremove.htm

3.5.2.2 Fuel consumption and stopping time

Fuel consumption is adversely affected when cars have to stop in traffic during their journeys, as we have seen. We can speculate that the impact of stop time on fuel consumption may in part explain why Italian drivers saw the lowest improvement in their fuel consumption after using eco:Drive. Italian drivers spend more time stopped during their journeys, on average, than those in other markets, suggesting that a combination of their driving conditions (traffic) and driving culture (tendency to accelerate and decelerate sharply, thus stopping more frequently) may be a limiting factor in their potential to improve fuel consumption and driving efficiency – and thus emissions.

The graph below shows how different levels of stop time affect how well eco:Drivers in different countries are able to improve their driving style.

Figure 19: Fuel consumption and stopping time



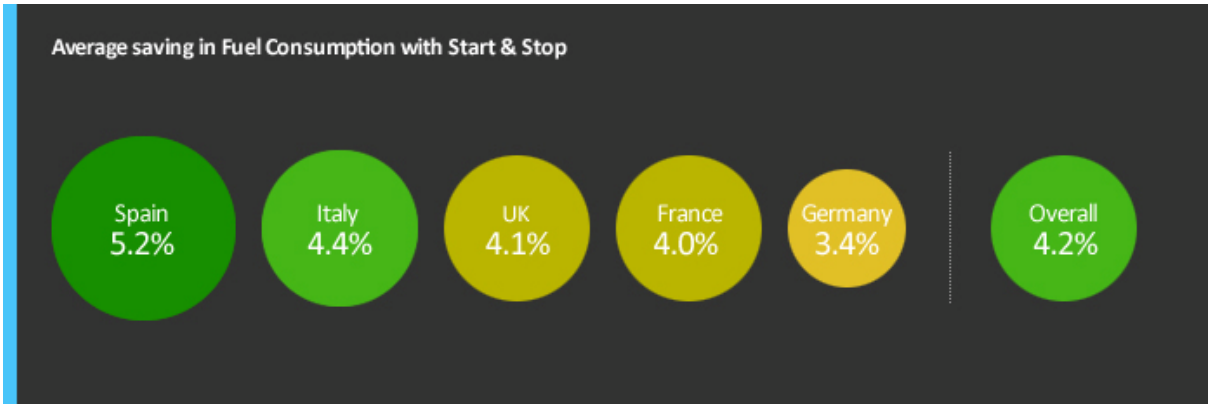
3.5.2.3 Start&Stop

Given what we have seen about the effect that stopping time can have on overall fuel consumption (and thus emissions), it is interesting to look at the difference between fuel consumption in Fiat Start & Stop models using eco:Drive, and those without Start&Stop.

From the information we have gathered about how people ordinarily drive (at the very start of using eco:Drive) we can calculate the improvement in fuel consumption that would take place if these drivers were using Start & Stop models. Theoretically, then, we can reasonably suppose that using eco:Drive in addition to driving a Start & Stop vehicle could deliver average savings of 6% (eco:Drive) plus 4.2% (Start & Stop) – over 10% in total. In particular, it could have a big impact in places where drivers struggle with efficiency due to the

poor fluidity of traffic. For example, Spain was shown earlier to have the highest stop times among eco:Drivers, and would therefore benefit from significant fuel consumption improvements with the use of Start & Stop technology – by 5.2%, as shown in the table below.

Figure 20: Fuel consumption with Start & Stop



3.5.2.4 Effects of eco:Drive

By measuring the different 'mobility indicators' that we have looked at already – average speed, stop-time, journey length etc – over a 30-day period of eco:Drive use, we can see the way that eco-driving has a real effect on the characteristics of people's journeys. These changes provide robust evidence that eco-driving can bring about real and sustained behavioural change.

3.5.2.5 Unchanged trip characteristics

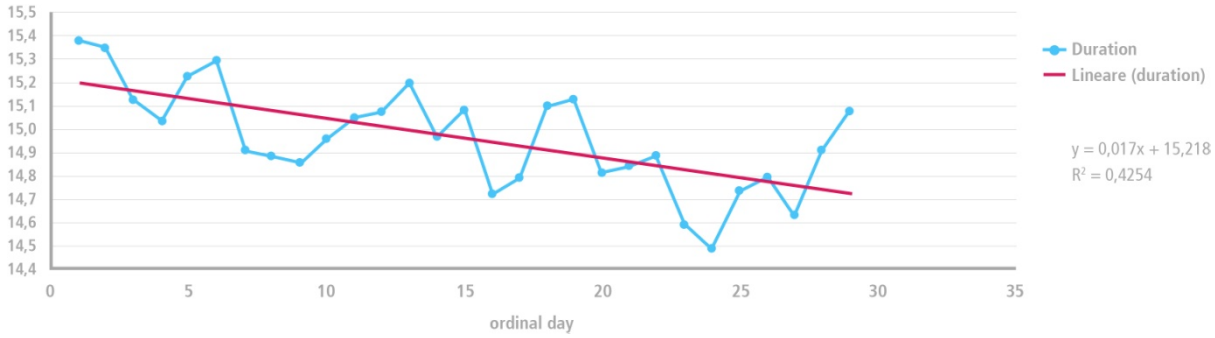
Overall, we find that there is stability in the number of trips, trip length, and daily distance travelled. This means that using eco:Drive is having no impact on the frequency with which people use their cars and the type and length of journeys they tend to make

3.5.2.6 Changed trip characteristics

In contrast, we do see significant changes in other characteristics of the journeys taken – their duration, speed and the time drivers spend stopped.

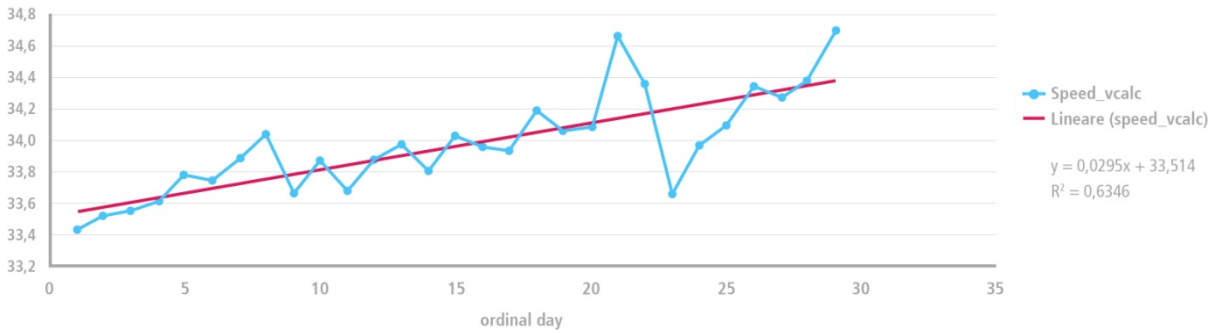
Firstly, there is a decreasing trend in trip duration over a 30 day period of using eco:Drive – a fall of approximately 3.3%, as shown below.

Figure 21: Trip duration trend over 30 days



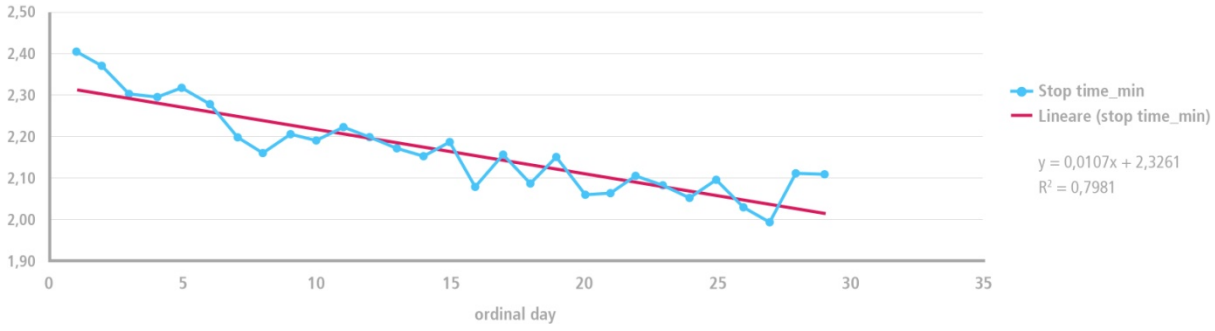
This decrease is closely related to the increase that we see in the average speed drivers travel at. If we consider the average speed of journeys, excluding time spent stopped, there is a 1% increase over 30 days. However, if we include stop time in our analysis, we see a more significant 2.4% increase over the period, as shown below.

Figure 22: Average speed (including stop time) trend over 30 days



This indicates that a key effect of eco:Drive on drivers' behaviour is the ability to reduce the amount of time they spend stationary in each journey (and thus decrease the length of time spent in the car). This is verified by looking at the data specifically for stop-time – eco:Drivers achieved a consistent decrease in their stop time over 30 days, decreasing the time stopped by around 13% over this time.

Figure 23: Stop time (min) trend over 30 days



This means that drivers, using their cars in the same way (with the same frequency, over the same distances) are managing to travel at a slightly higher speed and stop for less time over their journeys.
Using eco-driving techniques is helping them to significantly – and consistently – improve their driving performance – especially in terms of how much time they spend stopped which, as we have seen, has a big impact on fuel consumption and emissions.

4. DRAWING CONCLUSIONS

4.1 What do we understand about eco-driving?

The potential effectiveness of eco-driving is not in doubt. Driving more efficiently can bring substantial savings in fuel consumption and CO_2 emissions, as well as positive side effects around road safety and traffic flow. From analysing the quantitative data gathered through eco:Drive – the first data of its kind – we now have a much clearer picture of how eco-driving affects people's behaviour over time, not just on the day they read eco-driving tips or on the weekend they attend an eco-training course. The results are encouraging – eco:Drive users managed to **reduce fuel consumption and CO_2 emissions by an average of 6%** over a 30-day period. Importantly, they also provide evidence that eco-driving behaviour is maintained over time, with improvements growing steadily.

This suggests that creating lasting change in drivers' behaviour is possible. eco:Drive relies on three important principles: providing drivers with personalised feedback on their own driving style on everyday journeys, rather than generic tips; showing drivers exactly how they are improving, and what this means in terms of fuel, CO_2 and money; and engaging drivers over an extended period of time so that eco-driving behaviour is reinforced and they remain involved in reviewing and improving their driving efficiency. eco:Drive is the first time a manufacturer has gone beyond providing just quantitative data to drivers about driving efficiency (e.g. fuel consumption) and developed qualitative feedback about driving style, that helps drivers make sense of their car's quantitative data and understand what this means and how they can improve.

Another important insight that we can draw from the data here is the difference between the average improvements drivers achieve over time with eco:Drive, and the improvements drivers have been shown to improve on one-off attempts, removed from everyday driving situations. This suggests that, in reality, it is difficult to implement eco-driving techniques, be this due to:

- The driver: the ingrained nature of driving behaviour; the challenge of concentrating of the techniques fully 100% of the time; culture and norms of driving style
- The external conditions: the behaviour of other road users; the weight of traffic
- The road systems: the frequency of traffic signals; speed limits; other obstructions to traffic flow

From our analysis, we can take away several two key points about eco-driving in practice:

- Changes in drivers' behaviour are possible if eco-driving tuition is undertaken in an engaging, personal and regular manner, with qualitative feedback that enables them to understand their performance and how to improve it.
- The effectiveness of eco-driving in everyday situations is limited by a driver's personal commitment, the prevailing driving culture in their area, and their interaction with external conditions and road systems.
- Some elements of driving style are easier to improve on, and bring 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%.
- Eco-driving brings benefits beyond reducing emissions – it also creates more fluid, more aware and safer drivers. By thinking ahead and avoiding sharp acceleration and deceleration, eco-drivers stop far less often (13% less often, on average), driving more fluidly overall.

4.2 Where do we go from here?

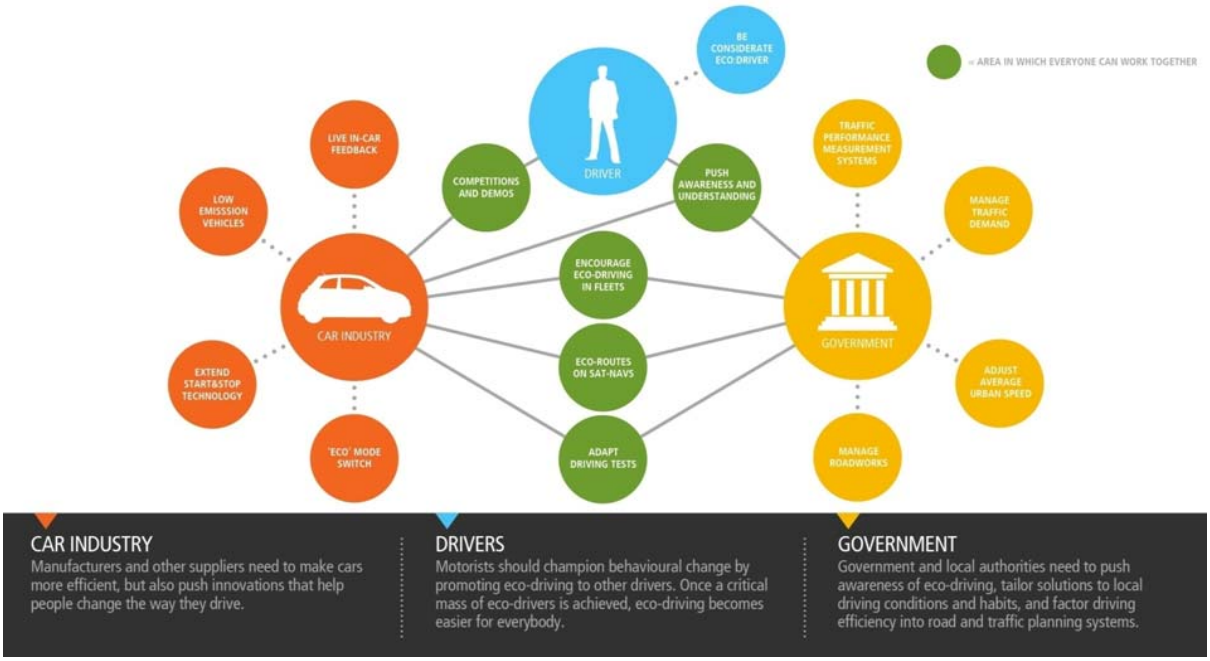
Understanding more about how drivers' behaviour changes through eco-driving, and the limitations of this change, provides an opportunity to recommend the steps that need to be taken to encourage European drivers to adopt eco-driving in the most effective way possible. It should be remembered that, just as eco-driving functions best as one component of an integrated approach to reducing emissions – alongside technological innovations and government commitments – so too does effective eco-driving implementation depend on a combined approach from a range of different actors.

- Manufacturers and other innovators need to help drivers to see and be reminded of their performance regularly. This can be done successfully out of the car, as eco:Drive has shown. In could also be very effective inside the car – instant, in-car reminders such as eco:Drive Live or green driving gauges (indicating whether driver is driving the car at its most efficient level) should help turn eco-driving into habitual driver behaviour.
- Governments need to factor driving efficiency into road and traffic planning decisions, as these systems can hinder drivers' abilities to drive efficiently with a consistent speed and minimal stopping.
- Related to this, given what we have learnt about the impact of traffic fluidity and stop time on fuel efficiency, cities should invest in reliable measurements of average speed of traffic. If this information can be recorded and made available to satnav systems to detect, they can calculate the quickest route for drivers, thus reducing emissions and boosting traffic flow further.

- All actors can continue to promote and encourage eco-driving to all drivers, so that progress can be made towards achieving a 'critical mass' of eco-drivers – the more people are driving efficiently, the easier it is for eco-driving to be effective.

Of course, eco-driving represents one small component of the action needed to create real reductions in CO_2 emissions from personal transport. Manufacturers have a responsibility to innovate, meet targets, and produce the lowest-emission models possible – and they are making big progress towards these ends. But that shouldn't be the end of the story. What this paper shows is there is still considerable scope for emissions to be reduced by drivers themselves. Moreover, efficient driving is essential to get the most out of newer vehicles and achieve the low emissions they are capable of. The integrated approach we need to see is about manufacturer responsibility and driver responsibility; vehicle improvement plus driver improvement; and the recommendations above provide preliminary guidance about how the latter can better be achieved.

Figure 24: What can we all do to encourage eco-driving?



1.3 Fiat's commitments

Fait is committed to continuing to work on both technological and behavioural change approaches to reducing emissions from driving. That means continually investing in lower-emission technology, to meet our objective of maintain our leadership in offering affordable, low carbon vehicles to drivers, whilst also finding ways to help drivers make the most efficient use of these vehicles, by encouraging eco-driving and make it as easy as possible for more drivers to eco-drive effectively.

Some of our specific eco-driving commitments include:

- Launch eco:Drive Live in 2011, using eco:Drive technology to provide live feedback to drivers on their driving style, through portable devices (e.g. satnav or smartphones)
- Use the insights from this eco:Drive research paper to feed into our Research and Development work, so that we can create cars that are as easy as possible to drive efficiently.
- Extend start and stop technology throughout our range of vehicles, helping drivers to save up to 15% in fuel and emissions

We are also committed to continuing to share the learnings of our experiences in reducing emissions from driving, since only by collaborating will it be possible to solve the challenges that climate change poses to the car industry. We regard this eco:Drive research paper as the start of a conversation between different actors, in the car industry, government and beyond – to explore how we can all make eco-driving easier and more effective, and thus achieve the goals of reducing emissions from driving.

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Interviewees

Jack Short, Secretary-General, International Transport Forum

Olivier Lenz, Director of Mobility, International Automobile Federation

Paul Everitt, Chief Executive, Society of Motor Manufacturers and Traders

Peter Wilbers, Senior Programme Manager at NL Agency

Rob Jong (Head of Transport, UN Environment Programme)

Vered Ehsani (Transport team, UN Environment Programme)

Andreas Knie (Social Science Research Centre, Berlin)

APPENDIX: METHODOLOGY

Outline of analysis

The analysis has been performed by considering the population of drivers and their journeys and car models over a defined period of observation. For each driver/car and for each day on which drivers use their cars, statistical parameters and frequency distributions of several mobility and performance indicators have been computed, accounting for the overall period of observation and the evolution over time, in order to try to identify commonalities and differences in driving behaviour among markets and models and to understand the way in which drivers use and benefit from the eco:Drive system.

The main mobility indicators analysed include:

- Number of trips per day
- Trip length
- Trip duration
- Trip speed (including and excluding stop time)
- Stop-time
- Stop-time percentage

The main performance indicators analysed include:

- Fuel consumption
- eco:Index
- eco:Index breakdown (acceleration deceleration, gear changes, speed)
- CO_2 emissions
- Fuel cost

In addition, statistical analysis on the total population of trips has been carried out to understand the average characteristics and statistical distribution of the main parameters of the trips, independent from the driver.

Finally, data on fuel consumption and average speed of each trip have been analysed to find the relationship between the two, checking against the TREMOVE model for coherence.

Subjects of the analysis

- 5,697 drivers, who made 428,048 trips, between 09/06/09 and 31/10/09.
- Drivers drawn from five major markets: UK, Italy, Spain, Germany and France.
- 3 car models were included in the analysis: Fiat Grande Punto (41.4%), Fiat Bravo (41.4%) and Fiat 500 (27.9%)
- Average number of trips made by drivers during the period was 75.1, with quite large differences between markets (from 57 in the UK to 83 in Italy)

Behaviour of the driver population

- 5,697 drivers were present (i.e. actively using the eco:Drive system) at the beginning of the 146 days of observation.
- 468 of the 5,697 drivers only stayed in the eco:Drive system for one day (8.2%). 39% stay for less than 10 days and 56% for less than 20 days.
- On average, drivers are present during the observation period for an average of 28 days.
- The average number of days on which drivers made trips during the average 28 day period of presence was 18 (average driver makes trips on roughly 2 days out of 3).
- 1/3 made trips on more than 90% of the days of presence, while 2.3 drove on more than 70% of days.
- In general, across the population of drivers, there is very high variability in the number of trips and in the distance travelled.