



**Next phase of the European Climate Change
Programme: Analysis of Member States
actions to implement the Effort Sharing
Decision and options for further community-
wide measures**

A report for DG Climate Action

Transport sector – Policy case studies report

Restricted - Commercial

ED46903

Issue Number: 4

June 2012

Title	Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures Transport sector – Policy case studies report
Customer	European Commission
Customer reference	DG ENV C.5/SER/2009/0037
Confidentiality, copyright and reproduction	This report is submitted by AEA under the contract DG ENV C.5/SER/2009/0037. It may not be used for any other purposes, reproduced in whole or in part, nor passed to any organisation or person without the specific permission of the European Commission/DG CLIMA.
File reference	ED46903 – Next phase of the ECCP
Reference number	ED46903

Dan Forster
The Gemini Building
Fermi Avenue
Harwell International Business Centre
Didcot
OX11 0QR

Tel: 0870 190 6474
Fax: 0870 190 6318

AEA Technology plc
AEA is certificated to ISO9001 and ISO14001

Authors	Name	Matthew Morris, Gena Gibson, Daniel Forster
Approved by	Name	Daniel Forster
	Date	15 th June 2012
	Signature	

Executive Summary

This report has been prepared by AEA as the part of the study *Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures*. The project has been funded by DG Climate Action of the European Commission (EC) with the aim of assisting the EC in the identification of policies and measures that enable the Member States to fulfil their national commitments under the Effort Sharing Decision (ESD).

The emissions from transport falling under the ESD arise almost exclusively from road transport. Although evidence suggests that vehicles have become more efficient, these improvements have been outweighed by increases in demand for passenger and freight transport. Consequently, in the absence of further mitigation efforts it is likely that emissions from the transport sector, in a number of Member States, will not be limited¹ to the extent required for the ESD as a whole. This means that either further policy action in the transport sector is needed, or that other sectors will need to deliver a greater proportion of emission limiting efforts.

Within road transport, policy effort to reduce emissions at the European level has largely focused on improving vehicle efficiency (e.g. improved vehicle design, propulsion system and energy system) and reducing the GHG intensity of fuels (e.g. through the Fuel Quality Directive). These existing EU policies are likely to take up a large proportion of the low cost technical abatement measures in the sector. Therefore, delivery of additional savings by 2020 may require the take up of more expensive technical measures, or the further application of non-technical measures.

This report provides a detailed examination of four policy case studies that could deliver additional GHG abatement in the transport sector, over and above existing EU wide policies. An assessment is provided of the strengths and weaknesses of different options, including the synergies and co-benefits. Where possible, evidence has been gathered from ex-post studies of real-world examples, in order to suggest how Member States could maximise the benefits and mitigate unwanted side effects.

The four case studies relate to uptake of electric vehicles and behavioural change measures. Electric vehicles are currently the preferred ultra-low (direct) emission solution for the passenger car market worldwide, in terms of market penetration and planned vehicle releases. Whilst they are not anticipated to play a significant role in reducing emissions from road transport until beyond 2020, there is a need to provide clear, long-term policy signals to stimulate development of the technology and to incentivise uptake in order to develop the market. Policy that aims to impact on transport user behaviour has the potential to be very effective. It could also have a very low mitigation cost, i.e. could reduce emissions whilst also saving consumers and governments money. Bearing these points in mind, the four case studies are:

1. Financial incentive schemes to stimulate uptake of electric vehicles;
2. Electric vehicle recharging infrastructure development schemes ;
3. Speed management measures; and
4. Eco-driving programmes.

Financial incentive schemes have been introduced by many Member States in order to stimulate the early market for electric vehicles. The price premium of electric vehicle purchases is one of the most important barriers to uptake. Evidence suggests that consumers may be more responsive to upfront monetary incentives as opposed to those which offer savings post-purchase, even if the total savings are the same.

It is likely that inadequate charging infrastructure will delay a widespread shift to electric vehicles. Public charging infrastructure is an important means of counteracting “range anxiety”, which is the fear of being stranded due to insufficient battery capacity. Deploying charging points in highly visible, busy public areas provides maximum benefit in terms of psychological reassurance and usefulness to consumers. In general, slow-charging schemes have been found to be cheaper but less effective at

¹ We refer to emissions limits against a business-as-usual scenario; for many Member States this could mean absolute increases in emissions, but on a reduced scale compared with the likely increase in the absence of policy intervention.

stimulating uptake of electric vehicles. A mix of fast- and slow- charging points therefore strikes a balance between cost and effectiveness.

Most European countries impose maximum speed limits on all their roads for a variety of reasons, including safety, traffic management and fuel consumption. However, they are not usually optimised for the latter: a typical passenger car is most fuel efficient at around 80 km/h, but European motorway speed limits are typically 120-130 km/h. At high speeds, when air resistance dominates vehicle resistive force, power demand increases with the cube of speed – so a reduction in speed leads to a significant reduction in fuel consumption. Proper enforcement is necessary to achieve results.

Eco-driving involves training drivers to modify their driving style in a way that reduces fuel consumption and emissions. This may involve actions such as timely gear changes, smooth deceleration and anticipation of traffic flows – all of which can reduce fuel consumption by up to 25% directly after training. Other elements may include reducing use of air conditioning, minimising idling and regular servicing. Uptake can be promoted through awareness campaigns, subsidised schemes or mandatory training. It is most effective when incorporated into novice driver training, and this is also one of the cheapest options.

Thus, the case studies provide a review and analysis of policies that could be implemented by Member States to address transport emissions. They provide a synthesis of existing information, with further analysis of policy relevant issues. The outputs provide a useful evidence base for national policy makers, which takes into consideration the strengths and weaknesses of each option.

Table of contents

1	Introduction	1
1.1	Background.....	1
1.2	Characteristics of the transport sector	1
1.3	Emissions, policy gaps and abatement potential.....	2
1.4	The need for policy intervention.....	3
1.5	Policy options.....	3
1.6	EU policy landscape	5
1.7	National policies.....	5
1.8	Selection of case study policies.....	6
2	Policies to stimulate the uptake of electric vehicles and electric vehicle charging infrastructure	8
2.1	Background.....	8
2.2	Barriers to uptake	9
2.3	Policy options to support the uptake of electric vehicles	9
2.4	Case Study 1: Monetary incentives	11
2.5	Case study 2: Infrastructure investment	18
3	Policies that aim to achieve behavioural change leading to more efficient use of the transport system.....	24
3.1	Background.....	24
3.2	Case study 1: Speed management measures in road transport.....	27
3.3	Case study 2: Eco-driving programmes	33
4	References.....	42
4.1	Electric vehicles	42
4.2	Behavioural change	43

Annex

Annex 1: Policies in European countries to stimulate uptake of electric vehicles

1 Introduction

1.1 Background

This report has been prepared by AEA as the part of the study *Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures*. The project has been funded by DG Climate Action of the European Commission (EC) with the aim of assisting the EC in the identification of policies and measures that enable the Member States to fulfil their national commitments under the Effort Sharing Decision (ESD).

In earlier phases of the project an assessment was made of the projected emissions of greenhouse gases to 2020 in each of the main ESD sectors, the potential gap between the projected emissions and the ESD target, and the abatement measures that could be implemented to reduce the emissions gap. In addition, a high level review was provided of the policies and measures in place at Member State level. Further information on the ESD, on Member State's targets under the ESD, and analysis described above can be found in the report *Greenhouse gas emissions projections, emissions limits and abatement potential in ESD sectors* report (AEA, Alterra, Ecofys and Fraunhofer ISI (2012)).

Building upon the earlier work, this report provides a more detailed examination of the policy options that could be implemented at a national or EU wide basis in order to deliver additional emissions reductions. The focus of the analysis is on additional policies that could be implemented to support and complement existing EU-wide policies.

This report is focused on policies within the **transport sector**. A series of case studies have been prepared to illustrate examples of existing policies that could be replicated to deliver additional abatement. In each case an assessment has been provided of the relative strengths and weaknesses of the different policies, including the synergies and co-benefits.

The case study policies selected are not intended to be exhaustive. Other policies have been, and could be, implemented to deliver similar objectives. This report therefore presents a sample of the policy available to decision makers looking to mitigate greenhouse gas emissions from the industry sector.

1.2 Characteristics of the transport sector

Transport participates in the EU economy by facilitating the mobility of goods, services and individuals. Modes of transport can be categorised into three types:

- Land transport: Road, rail, unpowered (cycling & walking);
- Waterborne transport: Inland navigation, maritime shipping; and
- Air transport: Domestic and international aviation.

Transport volume is driven by demand for passenger and freight transport; energy use is linked to volume and efficiency. Transport can become more energy efficient either by making vehicles more efficient, by transporting more goods or people with the same vehicle movement, or by reducing the need to transport goods or people through system efficiency. Evidence suggests that transport is becoming more energy efficient; however volumes are also increasing, which means that overall energy consumption will not necessarily reduce in the future without further policy intervention.

1.3 Emissions, policy gaps and abatement potential

1.3.1 Projected emissions

Transport is responsible for a significant, and growing, proportion of GHG emissions in the EU, the majority of which is CO₂. The projected emissions from the sector were examined in AEA et al (2012). It was found that the transport sector was predicted to show an overall increase in annual GHG emissions between 1990 and 2030 under the PRIMES baseline². Transport has the single largest contribution of any sector to emissions within the scope of the Effort Sharing Decision.

Emissions from inter-EU transport fall under the scope of the ESD, where they occur from direct fuel use (i.e. electricity consumption is not included – this is covered by the EU ETS). The exception is aviation (both inter-EU and international), which is covered under the EU ETS from 2012. International maritime shipping is currently not regulated under EU law and is not covered by the ESD. In practice, this means that the main transport modes that cause emissions covered under the ESD are road transport, non-electrified rail transport, and inland navigation.

Of the transport modes outlined above that are covered under the ESD, road transport is by far the largest constituent in terms of emissions. The PRIMES baseline for the EU27 shows road transport contributing over 97% of the CO₂ emissions from the transport sector that would be covered under the ESD in 2005. Under the PRIMES baseline projection this proportion stays roughly constant to 2030.

For the EU as a whole, emissions from road transport in 2020 are projected to differ by less than 1% from the level of emission seen in 2005 under the PRIMES baseline.

The 2011 transport white paper (“Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”) sets a 2050 target of a 60% reduction from all transport against the year 1990. The interim target for 2030 is an 8% increase in emissions against 1990 levels (which translates to a 20% reduction on 2008 emissions). The PRIMES baseline scenario, for transport modes that fall under the scope of the ESD, projects that there would be an increase of 25% on 1990 emission levels by 2020. This would indicate that without further policy intervention, transport activities covered under the ESD would not achieve an emissions reduction commensurate with the overall target.

1.3.2 Abatement potential

Previous analysis conducted as part of this project, based on the updated SERPEC³ analysis, indicates that the road transport sector has an estimated technical abatement potential of 100 MtCO₂ eq available in 2020. This is additional to any emissions reductions captured in the PRIMES/GAINS baseline, and also allows for the take up of certain measures by the proposed policy to limit CO₂ emissions from vans and light vehicles. It does not, however, take into account the additional abatement that may be possible from demand-side measures, or the potential for rebound effects.

Much of the remaining abatement potential in 2020 appears to be comparatively expensive in transport, relative to other sectors within the scope of the ESD. This in part reflects the fact that existing EU policies, in particular regulations on emissions from cars and vans, are expected to drive the take up for the most cost-effective measures in the sector⁴. Indeed, these EU wide regulations are the principle driver of technological improvements in the CO₂ emissions performance of vehicles, and this is likely to remain the case up until 2020.

Therefore, in meeting their targets under the ESD, Member States may choose to implement relatively few national policies in transport and instead focus on other sectors where more cost-effective abatement remains.

² EU energy trends to 2030: 2009 update, European Commission DG ENER, http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm

³ http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=9642548

⁴ http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/study_car_2011_en.pdf,
http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/report_effect_2011_en.pdf

However, it is also important to look beyond 2020 to longer term targets, where emissions abatement in transport will be required (along with the take up of more expensive measures). There is therefore a case to implement policies in the short and medium term to achieve long term reductions in emissions.

1.4 The need for policy intervention

A number of abatement measures have been identified that have the potential to delivery reductions in GHG emissions in sectors within the scope of the ESD. Some of these measures will be taken up without the need for any further policy intervention, both in response to existing policies and other financial drivers.

Policy intervention can be justified where the market is unlikely to deliver the optimal level of abatement without reform. There are a number of reasons why the market may not deliver the socially optimal level of abatement. These can be described in terms of so called 'market failures'. Examples of market failures that apply to the road transport sector can be described as follows.

- Private transport in general is subject to irrational purchase decisions by individuals. Even if a mitigation measure is also economic, individuals may not make the decision because they do not appreciate that savings due to reduced energy / fuel consumption outweigh initial higher capital costs. Alternatively, private individuals may perceive the cost of capital to be too high or instinctively apply a very high discount rate to investment decisions because they value present-day cash very highly.
- Transport decisions made by private individuals are often perceived to reflect status. This may lead to individuals choosing more energy intensive modes of transport, or more energy intensive options within a mode, because of the perceived image.
- Market prices do not reflect the full social cost of environmental impacts. Therefore, businesses and consumers are not currently required to pay for the full external costs of the environmental pollution (e.g. greenhouse gases) they produce. This means that certain measure which have a net societal benefit may not appear cost-effective from a private operators perspective.
- Some abatement, even if cost-effective, may not be taken up because of the structure of the market. For example, road freight logistics may not be optimal because communication and co-operation between the large group of stakeholders (freight operators and their customers) is very difficult. Another example of co-ordination barriers is effective intermodality, both for passenger and freight transport.
- Information failures also present a barrier. Private individuals may not find the information they need to make rational decisions on transport readily available (for example, information on the full costs of different transport options).

There may also be political barriers to changes in the policy landscape. For example, in European countries a large amount of fiscal revenue is generated through taxation on transport (particularly transport fuels). Therefore, policies that seek to reduce fuel consumption or shift it to different fuels may result in a budgetary deficit for national governments. Therefore policies would either need to be designed in order that revenues did not reduce as a result of intervention, or revenue take would need to be increased elsewhere to compensate. This is an important consideration for policymakers, particularly in road transport.

1.5 Policy options

Transport is a diverse sector, and as such the range of policy options available to the EU and member states to promote low-carbon transport is varied.

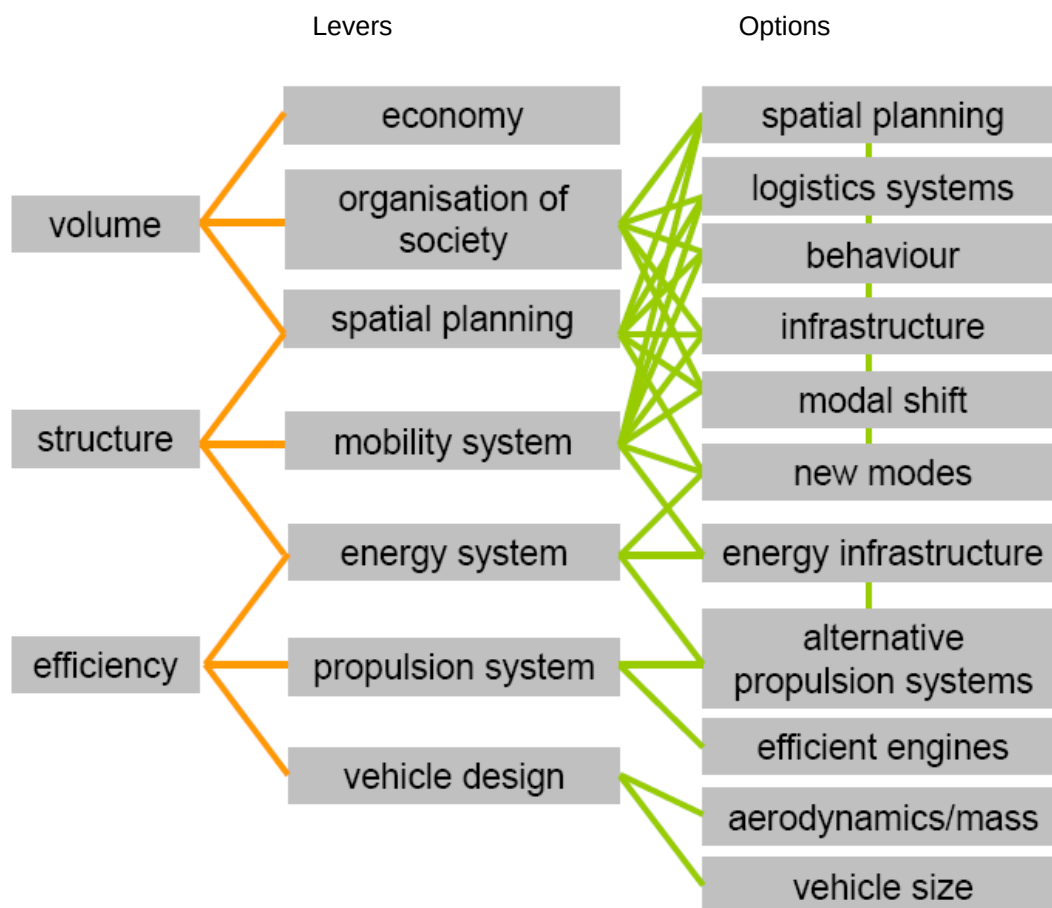
Figure 1-1 below illustrates the range of levers and options available. Whilst much of the discussion surrounding transport policy focuses on passenger cars, these options are generic to all modes, passenger or freight. They can broadly be grouped into options that:

- reduce demand volume (i.e. avoid travel taking place),

- change the structure of the transport system (usually, shifting travel to more carbon-efficient modes),
- improve efficiency of vehicles (i.e. there are less GHG emissions for the same amount of vehicle travel)
- reduce the carbon intensity of fuels (i.e. increased use of low carbon energy sources)

Some of these options come with important second order or 'rebound' effects which must be managed. For example, increasing the fuel-efficiency of transport is likely to decrease its cost, and as transport demand is often price-sensitive this can lead to an increase in demand for travel. This increased demand would act to compensate for the emissions avoided by increasing fuel efficiency.

Figure 1-1: Levers and options for reducing greenhouse gas emissions from the transport sector



Source: TNO (2010)

Policy instruments to stimulate uptake of these options can be categorised into five groups: planning, regulatory, economic, information, and technological. Examples of policy instruments are given in Figure 1-2.

Figure 1-2: Policy instruments for reducing GHG emissions from the transport sector

	Description	Examples
Planning	All measures concerning planning infrastructure of all transport modes.	Integrated public transport, car-free zones, improved linking of rail and maritime freight.

	Description	Examples
Regulatory	Measures that influence transport demand, vehicle or fuel carbon efficiency, by regulation.	Vehicle restricted zones or lanes, mandatory vehicle emissions standards, fuel quality standards, speed limit enforcement.
Economic	Charges, taxes or incentives to internalise the cost of emitting GHGs or promote uptake of a desired option.	Fuel or vehicle taxes, emission trading, congestion charging, subsidies for alternative fuels \ vehicles \ modes.
Information	Measures to raise public awareness concerning an area of transport in order to stimulate change.	Awareness campaigns, public transport information, travel planning, eco-driving schemes.
Technological	Measures that advance or promote a change in fuel or vehicle technology to reduce GHG emissions, or promote alternatives to travel.	Support for: vehicle efficiency improvements, alternative fuel vehicles, low carbon fuels, remote working \ teleconferencing.

1.6 EU policy landscape

Existing EU policies go some way to address the market failures described in section 1.4 above. The existing EU policy landscape (policies that are in place or soon to be implemented) targets energy performance of vehicles across most modes, and also the carbon intensity of energy used in the transport sector. This includes regulation to improve the energy efficiency of passenger cars and vans; preliminary work has been undertaken to examine policy options to reduce emissions from heavy duty vehicles. In addition, there is legislation to reduce the GHG intensity of road transport fuels.

Whilst the stringency of these measures could be increased (at greater cost) the policies (or those under consideration) already cover the major transport emission sources within the scope of the ESD. However, it is clear that looking beyond 2020, further policies will be needed in Europe in order to meet 2050 targets for reducing emissions from transport. This is illustrated by the analysis supporting the 2011 Transport White Paper⁵, which outlines a reference scenario for transport in which emissions in 2050 rise to 35% above 1990 levels, compared with the Commission target of a 60% reduction on 1990 levels over the same period. The same analysis sets out a range of policy areas where action is envisaged at a European level, including further action to reduce the CO₂ intensity of passenger cars, modal shift from road freight to other modes, and internalisation of external costs in line with the “polluter pays” principle.

1.7 National policies

As describe above, recently implemented or planned legislation aims to stimulate the take-up of technical options to make road transport more energy efficient, and to reduce the GHG intensity of existing road transport fuels. There is a compelling argument for setting these policies at a European level, as it will help to reinforce a unified European market for vehicles / fuels that makes it easier for the organisations involved to respond to the policy signals in a cost effective manner. Analysis on cost-effective abatement potential in transport conducted earlier in this project suggests that existing EU policies will result in take-up of much of the cost-effective abatement potential in transport covered by the ESD. However, national policies can still deliver important emissions reductions, including targeting areas not currently addressed strongly by EU regulations

There are a number of areas where it may be advantageous to implement policy at a Member State level. This can be for a number of reasons:

- It may be easier to implement new policies at a national level.

⁵ SEC(2011) 391 final, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:0391:FIN:EN:PDF>

- Member State policy making can be designed to address country-specific issues, or reduce emissions in a way that is most efficient at a regional or local level and responds to local socio-economic needs;
- Some areas of transport policy (particularly those that are perceived to constrain mobility) may be contentious at a European level, but in some cases acceptable in specific Member States;
- If there is no issue of market fragmentation, it may be sensible to allow Member States to decide the mechanisms for achieving specific policy goals in a way that suits their transport system;
- It may be more effective for Member States to design policies aiming to achieve behavioural change that address behavioural issues specific to their country / culture.
- Fiscal policy in transport is in many Member States a major source of tax revenue, and setting their own fiscal policy in transport allows Member States to have proper budgetary control.

The policy case studies examine policies and measures in areas where individual Member States have taken action at a national level which may provide insight for other Member States on areas or structures that could be successful for them.

1.8 Selection of case study policies

As previously outlined, road transport is by far the most significant constituent of transport-related emissions that fall under the ESD. In addition, the dominance of road transport is common to all member states, unlike rail and inland waterways where there is considerable variance in activity levels within Europe. Therefore, the transport case study policies focus on road transport on the basis that most Member States will require additional policies to address emissions from this area, and hence sharing of best practice between Member States is likely to be most productive.

Within road transport, policy effort to reduce emissions at the European level has largely focused on improving vehicle efficiency (e.g. improved vehicle design, propulsion system and energy system) and reducing the GHG intensity of fuels (e.g. through the Fuel Quality Directive). As examined in the analysis of the abatement potential within the road transport sector, existing EU policies are likely to take up a large proportion of the low cost technical measures. Therefore, delivery of additional savings by 2020 may require the take up of more expensive technical measures than those required under existing policy, or the further application of non-technical measures.

There are a number of policy options available to policy makers at a national level that could be used to deliver this additional abatement, and some options that would complement those already in place to assure or enhance their success:

- Much of current European policy focuses on policies that impact on energy and GHG efficiency from the supply-side (the vehicle and fuel providers). Another group of policy options exist that aim to improve efficiency of both the vehicles and transport system from the demand side (i.e. encouraging transport consumers to act in a more efficient way). This could include incentivising more efficient driving, encouraging a shift of demand to more efficient modes of transport or changing mobility patterns to reduce transport volume. Policies in this area must be carefully designed to avoid constraining mobility in a way that damages economic or social development.
- Some emerging technologies that are anticipated to play a significant role in reducing road transport emissions to a level compatible with 2050 targets require early action to overcome technology development and market penetration challenges. This particularly applies to alternative energy system vehicles (e.g. electric and hydrogen powertrains). There is therefore a need for policies to be introduced prior to 2020 that stimulate demand and development for these vehicles, even though the emission reduction benefits may not be realised until much later and these policies are very unlikely to result in cost-effective abatement by 2020.
- A shift to an alternative energy system (e.g. electricity, hydrogen, or biofuels) will also require a supporting infrastructure for energy distribution and supply to vehicles. Therefore there is a need for accompanying policy to stimulate infrastructure to facilitate the introduction of alternative fuelled vehicles.

Bearing this in mind, we have selected the following focus areas for case study examples:

- Electric vehicles are currently the dominant ultra-low (direct) emission solution for the passenger car market worldwide, in terms of current market share and planned future vehicle releases. Whilst they are not anticipated to play a significant role in reducing emissions from road transport until beyond 2020 – and are an expensive abatement option in the short term, there is a need to provide clear, long-term policy signals to stimulate development of the technology and to incentivise uptake in order to develop the market beyond 2020. **Therefore we will examine case studies of policies to stimulate development and uptake of electric vehicles and electric vehicle charging infrastructure. This case study would also consider wider policy issues e.g. life cycle emissions, market development etc.** Examples of policies we will consider:
 - Financial incentive schemes including grant programmes such as the UK's Plug-in Car Grant scheme, Luxembourg's PRIME CAR-e scheme, and Spain and Portugal's grant schemes; and electric vehicle-specific tax incentives offered by many Member States, including Germany, Italy and the Netherlands.
 - Infrastructure development schemes in Member States / regions that have installed significant numbers of charging points (e.g. Amsterdam, Berlin, London).
- Some Member States have begun to implement policy that aims to impact on transport user behaviour. Policy in this area has the potential to be very effective, in that changing inefficient behaviour could have a very low or even negative mitigation cost in some situations, i.e. could reduce emissions whilst also saving consumers and governments money. However, policies in this area can be very contentious and the potential economic and social side-effects are numerous and difficult to measure. This makes behavioural change policy a very interesting area for case studies. **Therefore we will examine case studies of policies that aim to achieve behavioural change leading to more efficient use of the transport system.** Examples of policies we will consider:
 - **Speed management measures in road transport** which aim to reduce fuel consumption by reducing the average speed of vehicles on the road.
 - Policies to encourage more energy-efficient driving of passenger cars, including speed limiting in Spain and the Netherlands.

Thus the case studies provide a review and analysis of policies that could be implemented at Member State in these areas. They provide a synthesis of existing information, with further analysis of policy relevant issues. The outputs are therefore a useful evidence base for national policy makers, on the strengths and weaknesses of the policy options and also inform thinking at EU level.

2 Policies to stimulate the uptake of electric vehicles and electric vehicle charging infrastructure

2.1 Background

Electric vehicles represent an opportunity to radically reduce the emissions from road transport, if powered by low-carbon electricity. Many independent research studies foresee a major role for electric vehicles in the long-term decarbonisation of the road transport sector, particularly in the passenger car segment. In the long term (i.e. to 2050), the need to significantly reduce emissions from the transport sector means that alternatives to gasoline or diesel powered vehicles will need to be found, and electric vehicles are a very promising option for passenger cars.

The focus of the Effort Sharing Decision is on emissions to 2020; however, electric vehicles are unlikely to play a significant role before 2030 due to their current low market share, which is unlikely to change significantly in the short term. Furthermore, it is important to note from earlier cost-effectiveness analysis conducted in this project that electric vehicles are **unlikely to represent a cost-effective way for Member States to achieve their target emissions trajectories under the ESD**; there are likely to be more cost-effective measures in transport, and in other sectors, that will enable Member States to achieve their targets. Therefore, when looking at policies to *achieve ESD targets* it is recommended that Member States consider the most cost-effective options across all sectors covered under the Decision.

However, this does not mean that policy action on electric vehicles can wait until 2020. In order that electric vehicles are able to contribute to long-term emissions targets, action is needed to stimulate the market in the short term. This is due to a number of reasons. Firstly, there is a significant time needed to develop and commercialise the technology, overcome hurdles and learn lessons from trial deployments. Secondly, vehicle lifetimes and subsequent fleet turnover rates mean that there is a substantial delay between a new vehicle technology gaining share in the sales of new vehicles and gaining share in the overall vehicle fleet. Finally, early policy action will send signals to the market actors to prevent investment lock-in to more carbon-intensive technologies – and potentially improve Europe's competitive position in the automotive supply industry in the future.

Electric vehicles are also seen as an important option to meet several other policy objectives, including reducing dependence on fossil fuels and meeting local air quality targets (although again, today they may not be the most cost-effective way of meeting these policy goals). It is believed that without government support, electric vehicles will not gain significant market share unless oil prices dramatically increase (CE Delft, 2011).

For these reasons, case study policies to stimulate the uptake of electric vehicles and corresponding infrastructure are included in this report.

Box 2-1 : Definition of electric vehicles

The term “electric vehicles” may encompass several different types of configuration including:

- Battery electric vehicles (BEV): run on the battery alone, and have no auxiliary on-board power.
- Extended-range electric vehicles (EREV): the battery is the main energy source, but a combustion engine driven range-extender running on hydrocarbons is used to sustain the battery where distances exceed the electric range.
- Plug-in hybrid electric vehicles (PHEV): the battery is the main energy source, but a combustion engine running on hydrocarbons is used after batteries are depleted.

Conventional hybrid electric vehicles (HEVs), where the drive comes from the internal combustion engine as opposed to the electric motor, are not considered to be electric vehicles, but may still be included in the scope of some policies.

2.2 Barriers to uptake

The electric vehicle market is still in the early stages, and significant market penetration may not occur until after 2030. For battery electric vehicles, a market share in new car sales of 1 to 2% is forecast in 2020, rising to 11 to 30% in 2030. For plug-in hybrid vehicles a share of 2% is forecast in 2020, increasing to 5 to 20% by 2030 (EC, 2010). According to the European Automobile Manufacturer's Association, mass-market introduction of electric cars will start in 2011 and 2012 (ACEA, 2010).

The most significant barriers to consumer uptake, based on a survey of European respondents, is summarised in Table 2-1.

Table 2-1: Barriers to EV ownership (Source: adapted from Element Energy, 2009)

Barriers	Consumer type		Household		Commercial	
	Owner	Considerer	Owner	Considerer	Owner	Considerer
High price	High	High	High	High	High	High
Limited range	Medium	Medium	High	Medium	High	Medium
Time to charge	Low	Low	High	Low	High	Low
Inconvenient charging	Low	Low	Medium	Low	Medium	Low
No charging points	Medium	Medium	High	Medium	High	Medium
Lack of power or performance	Low	Low	Medium	Low	Medium	Low
Unfamiliarity	Low	Low	Low	N/A	Low	N/A
Lack of choice	Medium	Medium	High	Low	High	Low

This evidence is broadly supported by other studies (see e.g. ARUP, 2008 and FIA, 2011), and the most significant barriers relate to:

- **High upfront cost:** Currently, the price premium is around €15,000 to €40,000, with the potential to decrease to around €5,000 in the longer term (ETC, 2009);
- **Issues relating to charging:** “Range anxiety” is the fear of being stranded due to insufficient battery capacity, even though EVs will usually meet the daily needs to most drivers. Typical home charging points take 7-8 hours to charge a battery, which can be inconvenient for users.

Therefore, the case studies in this section will look at policies which address these two main barriers.

2.3 Policy options to support the uptake of electric vehicles

In its Communication ‘A European strategy on clean and energy efficient vehicles’ (EC, 2010), the European Commission announced some specific actions to support electric vehicles:

- **Placement on the market** – proposing electric safety requirements and reviewing crash safety requirements;
- **Standardisation** – development of a standard charging infrastructure to ensure interoperability and connectivity;
- **Infrastructure** – supporting Member States on charging infrastructure deployment. Funding will be made available for electric vehicles infrastructure through the European Investment Bank
- **Power generation and distribution** – comparing lifecycle emissions and evaluating the impact of the increase in overall electricity demand.

Actions have also been taken on the national and local scale. It is expected that many policies will be temporary measures to stimulate the early market, and can be withdrawn once production volumes increase sufficiently and consumer acceptance is achieved. Table 2-2 summarises the policy options available to address the barriers to consumer uptake. An overview of policy instruments employed by European countries is provided in Annex 1 of this case study report.

Table 2-2: Policy options to address barriers to uptake

Policy option	Barriers addressed	Policy sub-types
Research and /spending programmes to support new technologies	High price Limited range Time to charge Inconvenient charging No charging points Lack of power or performance Unfamiliarity	• Research and demonstration programmes • Infrastructure investment • National stock targets • Public procurement
Information provision, education and public engagement	Unfamiliarity	• Information campaigns • Car test driving schemes
Voluntary or incentivised negotiated agreements	Unfamiliarity Lack of choice	• Agreements have been secured at a more general level with respect to reducing car CO₂ emissions.
Market-based (economic or fiscal) instruments	High price	• Taxation incentives • Direct subsidies • Exemptions from congestion charging or road charging
Direct regulations	High price Lack of power or performance Unfamiliarity	• Standardisation of charging infrastructure • Safety standards • Public procurement (Clean and Energy Efficient Vehicle Directive) • CO₂ regulations – allows manufacturers to gain supercredits for sales of EVs • Energy taxation (Directive 2003/96/EC) fixes higher minimum tax rates for transport fuels than for electricity

The specific policy instruments selected for more detailed examination as part of a case study are:

- **Case study 1: Monetary incentives** which aim to address the first major barrier to uptake of upfront costs, and are a popular measure in many European countries

- **Case study 2: Infrastructure investments** which aim to alleviate problems relating to limited range, inconvenient charging and lack of charging infrastructure.

2.4 Case Study 1: Monetary incentives

2.4.1 Objective of the measure

Monetary incentive programmes to reduce the upfront cost of electric vehicles are widespread in Europe. The price premium of electric vehicle purchases is one of the most important barriers to uptake. The cost of charging an electric car is lower than the cost of refuelling a petrol vehicle; however, there is extensive evidence that consumers are more influenced by purchase prices and do not take into account savings over the lifetime of the vehicle (Ecolane, 2011).

2.4.2 Application of the measure in the EU Member States

Many countries have introduced monetary incentives for the purchase of electric vehicles. In 2010, 18 European countries had implemented some form of monetary incentive for electric vehicles and/or low carbon vehicles (see Annex 1). Taxes on the general car fleet which are based on emissions of CO₂ also favour electric vehicles, as their zero tailpipe emissions mean they satisfy the most stringent limits.

2.4.3 Main features of the measure

The range and magnitude of incentives is particularly wide and may consist of reductions in taxes, exemptions from taxes, or grants. Some countries use a combination of different measures; for example Portugal awards a premium for purchased of electric vehicles, as well as exempting them from circulation and registration taxes. A selection of the most popular policies is detailed here to highlight the different ways in which a monetary incentive scheme can be implemented, namely:

1. Reductions in car registration tax;
2. Reductions in annual circulation tax;
3. Grants at the point of purchase.

Table 2-3: Main features of monetary incentives

	Overview	Examples
Reductions in car registration tax	Reductions or exemptions in car registration tax can provide a significant monetary incentive for consumers. Examples from Member States include various scheme designs, including restrictions on the weight or type of vehicle that can qualify or caps on the maximum relief per vehicle.	Ireland has chosen to apply reductions in registration tax for a limited period (until the end of 2012) and have placed a cap on the maximum qualifying amount of €5,000 for electric vehicles and €2,500 for plug-in hybrids. Denmark excludes hybrid vehicles from its scheme, but electric vehicles weighing less than 2,000kg are completely exempt from registration tax.

	Overview	Examples
Reductions in annual circulation tax	There are many different methods of calculating annual circulation tax in the Member States, which means the maximum potential incentive differs between countries. Many countries have reformed circulation taxes to link with fuel efficiency or CO ₂ emissions, so that electric vehicles are implicitly subsidised, but some countries have chosen to explicitly favour electric vehicles.	In Italy, new electric vehicles are exempt from the annual circulation tax for the first 5 years after registration. After this period, they qualify for a 75% reduction of the tax rate compared to the equivalent petrol vehicle. In Portugal, electric vehicles are exempt from the circulation tax, whereas hybrid vehicles benefit from a 50% reduction. In Belgium, electric vehicles pay the lowest rate of circulation tax (€71.28).
Grants at the point of purchase	Grants for the purchase of electric vehicles have received much attention in Europe. Grants at the point of purchase refer to bonuses or reductions in price when a vehicle is bought, as opposed to other measures where the consumers claim a rebate back later e.g. through reductions in personal income tax.	In the UK, the maximum level of subsidy is £5,000 (€ 5,720) or 25% of the vehicle purchase price. The total budget is £43 million (€49.2 million), which would support the sales of 8,600 vehicles assuming each EV purchaser receives the maximum subsidy of £5,000. Luxembourg offers up to €3,000 per vehicle, provided the purchaser agrees to buy electricity from renewable energy sources. In Portugal, purchasers of the first 5,000 electric vehicles can receive a premium of €5,000, and could qualify for an additional €1,500 if they simultaneously scrap their old car.

Other types of monetary incentive are possible, including reductions in personal income tax and reductions in company car tax. The European Commission recognises the potential for these incentives and is currently preparing guidelines for their design and implementation. In addition, the Commission encourages solutions at a national or regional level based on traffic management and planning powers, such as free parking, access to restricted zones, use of restricted lanes and exemptions from local charging schemes (Jean, 2011). A full summary of programmes in Europe is provided in Annex 1 of this case study.

2.4.4 Evaluation of the measure: monetary incentives for EVs

This section evaluates the impacts of the policy in terms of Economic, Environmental and Social factors, indicating if the impacts are positive, neutral or negative and if the impact is High or Low.

- (++) High Positive Impact
- (+) Low Positive Impact
- (n) Neutral
- (-) Low Negative Impact
- (- -) High Negative Impact

Monetary incentives to support the uptake of electric vehicles are a relatively recent policy, so evidence on the effectiveness of existing schemes is more limited than for certain other policies. However, some preliminary assessment is possible on the effectiveness of the instrument.

Economic impacts

What was the cost to deliver the outcome, was it value for money?

- (+) Marginal cost to administer is relatively low for tax-based schemes, as the arrangements are already in place.
- (n) Costs can be limited by setting limits for: the number of eligible vehicles; the time period for the scheme; the total subsidy funding available; the maximum subsidy per vehicle.
- (-) Greater than expected response can be costly if suitable limits are not put in place. The cost of monetary incentives is low if the number of electric vehicles is small, but clearly increases in line with uptake.
- (-) Loss of revenue from taxes (fuel, circulation tax, registration tax) can extend over the lifetime of the vehicle

What wider economic impacts does the policy have?

- (++) Stimulates the early market for electric vehicles; may give a competitive advantage to EV manufacturers
- (+) Potential savings for consumers are significant. Depending on the scheme, these savings could be on upfront costs or over the lifetime of the vehicle.
- (+) Additional benefit to consumers in terms of reduced fuel costs for electric vehicles – although use of public infrastructure will increase fuel costs for consumers compared to charging at home.
- (n) Increased uptake of EVs can stop once the incentive is taken away. It can be expected that monetary incentives will be phased out in the medium or long term. Ideally, manufacturers would have been able to achieve cost reductions so that the reduction in incentives will not affect market uptake
- (-) Loss of revenue from taxes (fuel, circulation tax, registration tax) can extend over the lifetime of the vehicle
- (-) Resources may be more cost-effectively spent on other mitigation measures, particularly for the delivery of short term emissions targets.
- (--) Indiscriminate payment of incentives may subsidize sales for non-European OEMs, meaning the economic benefits of stimulating the market (from the supply side) are not realised in Europe..

Environmental impacts

Did the policy deliver the desired outcome?

- (++) If an electric vehicle replaces a conventional fossil-fuelled vehicle that would have been purchased otherwise, CO₂ savings can be significant. For example, in the UK, average well-to wheel (WTW) emissions for an EV are 75gCO₂/km, which is lower than any fossil fuelled car in production today. In France, an EV would emit just 12gCO₂/km, whereas in Greece it would be 118 gCO₂/km (Ecometrica, 2011). This variation reflects the carbon intensity of the assumed mix of electricity generation technologies in each country. If the maximum of 8,600 EVs were subsidised in the UK, the CO₂ savings would be at least 7,483 tCO₂ each year, assuming that the EVs replaced a mix of the most efficient diesel and petrol cars on sale (at 99gCO₂/km and 159gCO₂/km respectively). The average UK car emits 208gCO₂/km.
- (++) Potential environmental benefits would increase over time as the average electricity grid decarbonises. UK government projections for the grid average carbon intensity mean that emissions from EVs would fall to 3gCO₂/km in 2050 based on current vehicles (Ecometrica, 2011).
- (-) Potential rebound effect if lower costs per mile driven leads to increases in overall mileage

What other impacts has the policy had?

- (++) Improvements in local air quality are guaranteed if EVs displace conventional vehicles, as EVs have zero tailpipe emissions. This is particularly important for human health in urban areas.
- (-) Incentives could lead to purchase of cars that would not otherwise have been bought. Emissions could increase if this leads to modal shift from cleaner modes (e.g. walking, cycling).

Are there impacts on emissions from other sectors?

- (+) Reductions in overall pollutant emissions (including upstream emissions at the power station) will increase over time as the grid mix changes to include more renewable technologies and/or higher deployment of scrubbers.
- (n) While tailpipe emissions are eliminated, EVs do produce pollutants indirectly at the power station. Depending on the grid mix, this can actually increase overall emissions of NO_x, SO₂ and PM – particularly if coal is the generating fuel. However, these pollutants are far less damaging when released at power stations, which are unlikely to be located in densely populated areas.

Social impacts

Was the policy well received, were there issues in gaining

- (++) Instruments that are not revenue-generating tend to be more acceptable to the public. The literature suggests that registration tax incentives are “well accepted by consumers” (Ecolane, 2011)

acceptability, what did they relate to?

- (-) Very high differentials (e.g. on circulation taxes) could be politically unacceptable.

What are the distributional impacts?

- (-) EVs with limited range and/or small size could lead to a loss of consumer satisfaction
- (-) Even with subsidy the incentive are still likely to be taken up by the more wealthy consumers
- (-) Users with special needs (e.g. disabled, large families) may not be able to find a qualifying vehicle.
- (-) EVs may not be suitable for users in rural areas, or those who must travel longer distances.

Cross-Cutting

Are there interactions with policies in other sectors?

- (n) Increased uptake of EVs could lead to additional pressure on the electricity sector. However, the impact of EVs on the absolute increase in electricity demand is expected to be small - complete electrification of the European fleet would result in an additional demand of about 10-15% (CE Delft, 2011).
- (-) Increased uptake of EVs could lead to issues with material recycling, due to the difficulty in recovering battery materials. The impacts are magnified because the batteries tend to have shorter lifecycles than the vehicles themselves.
- (--) Member States with weak electricity infrastructure may find it challenging to deal with uncontrolled EV charging, which could lead to local power outages.

Timeframe – is there anything to note about the timing of policy implementation and expected impacts?

- (++) Electric vehicles are unlikely to play a significant role in meeting GHG reduction targets before 2030 due to their low market share. They have been included in the case study section because they could contribute to longer term objectives, but action is needed **now** in order to develop the market and reduce lock-in to more carbon-intensive technologies.
- (n) Current electricity infrastructure should be capable of handling additional demand due to charging, as market penetration is low. However, renewable energy sources such as wind and solar are already difficult to coordinate and EVs could increase the challenge. Controlled/smart charging would help to alleviate this problem; such technologies are being rapidly developed.

- 
- (-) Subsidies should only be employed when the market is ready to accommodate additional uptake of electric vehicles. If incentives are given too early, it could create additional costs and negative effects, e.g. with respect to inadequate infrastructure capacity (FIA, 2011). Therefore, it may be important to combine monetary incentives with infrastructure investment, as detailed in case study 2
 - (-) Significant advances in battery technology are likely to be made over the coming years with respect to range, longevity and weight. It is not clear which battery technology will be most successful in the long term.

2.4.5 Maximising desired impacts/reducing unwanted impacts

This section looks at how the positive impacts could be maximised to ensure the policy delivers its full potential. We have compiled the lessons learned from schemes that have already been introduced, as well as using evidence from the broader literature to suggest how implementation could be improved. Strategies to mitigate the negative impacts are also suggested.

Maximising the benefits

Upfront incentives e.g. grants may be more effective

Evidence suggests that the form of the incentive is just as important as the total subsidy amount. Previous studies (e.g. see Ecolane, 2011 and Diamond, 2009) indicate that consumers are highly sensitive to upfront costs, and less influenced by total cost of ownership, which may explain why schemes which deliver up-front incentives tend to be more effective than those which offer savings post-purchase. In addition, the incentive amount is usually a clear fixed amount, which avoids having to make calculations such as percentage reductions in tax. For the UK grant scheme, between the start of the grant on 1 January 2011 and 30 June 2011, 680 cars were ordered through the scheme. This is a significant increase over previous levels, where only around 270 ultra low emission vehicles were registered in the whole of 2010 (Department for Transport statistics, 2011).

Tax-based schemes should be based on registration tax

For tax-based schemes, incentives based on registration tax may be more effective instrument than circulation tax. The literature suggests that registration tax incentives “seem to have a great impact on vehicle purchase decisions”. Historical analysis of European data comparing the level of registration taxes and fuel economy improvements for conventional cars between 1970 and 1998 found that countries which favoured smaller cars through purchase tax incentives tended to have more fuel-efficient fleets (Ecolane, 2011). However, a review of current incentives offered through circulation taxes suggests that they are not sufficient to promote a switch to new vehicle technologies, as the band differentials are not large enough to affect purchasing behaviour (Ecolane, 2011). They may, however, have a symbolic value.

Consumers are attracted to things that are “free”

Further consumer research indicates that consumers are much more attracted to things that are “free” (e.g. tax-free) compared to things which have low cost (e.g. a small rate of tax).

Incentives could be framed as exemptions from cost penalties

It is well-accepted in behavioural economics that people tend to dislike losses more than they like gains, suggesting that an additional cost penalty for non-electric vehicles would have more of an impact than offering incentives for the purchase of electric vehicles (PSI, 2006).

Mitigation measures

Set clear limitations to ensure costs are predictable and manageable

In order to limit costs, many governments have placed a cap on the number of eligible vehicles or total funding allocation, and it can be expected that monetary incentives will be phased out in the medium or long term. Ideally, manufacturers would have been able to achieve cost reductions so that the reduction in incentives will not affect market uptake

Ensure charging and electric infrastructure is ready to accommodate more EVs

Subsidies should only be employed when the market is ready to accommodate additional uptake of electric vehicles. Therefore, it may be important to combine monetary incentives with infrastructure investment, as detailed in case study 2. At current penetration rates, electricity infrastructure should be sufficient to handle the changes in demand due to vehicle charging. However, in the future, high uptake could exacerbate existing challenges with load balancing.

2.5 Case study 2: Infrastructure investment

2.5.1 Objective of the measure

It is likely that inadequate charging infrastructure will delay a widespread shift to electric vehicles. Public charging infrastructure is an important means of counteracting “range anxiety”, which is the fear of being stranded due to insufficient battery capacity. Although most trips can easily be accommodated by modern electric cars, consumers prefer to buy cars that are capable of much longer distances. For instance, over 80% of car journeys are below 20km, and most Europeans drive less than 40km per day (EEA, 2009).

2.5.2 Application of the measure in the EU Member States

Many countries have introduced support for electric vehicle infrastructure. The schemes usually focus on development of charging networks in major cities, as uptake of electric vehicles is likely to be higher compared to rural areas. These regions also serve as demonstration projects to gather data on consumer behaviour which can be used to improve subsequent projects. City authorities may partner with a private firm in order to ensure consistency and compatibility across all charging points. In many cases, access is controlled by cards which enable users to be billed on a subscription or pay-per-use basis.

2.5.3 Main features of the measure

Standardisation is a particular concern in terms of battery layouts and plug design, as a harmonised standard will likely need to be in place before significant rollout. The European Standardisation Organisation has been mandated to develop a common charging system, which should help address this. A further issue is related to the use of a common billing system in order to ensure interoperability between different areas.

Table 2-4: Main features of electric vehicle infrastructure investments

	Overview	Examples
Slow charging	Slow charging is typically associated with overnight charging. - Charging time is typically 7-8 hours. - Cost per station is US\$ 500-2,500	In Switzerland, the basic Park & Charge network are standard slow chargers. Electric vehicle owners in Switzerland reportedly make use of Park & Charge spaces at least once a week for around two hours, although some owners use the reserved parking spaces without recharging their vehicles (Element Energy, 2009). Around 200 standard charging points were built in Paris in the 1990s. Access is controlled by chip-cards. Evidence suggests that the public provision of slow charging stations in Paris has had limited impact on electric vehicle adoption (Element Energy, 2009).

	Overview	Examples
Fast/rapid charging	Fast charging would be useful for consumers using public infrastructure, where it may not be possible to park for extended periods. • Charging time is 3-4 hours • Cost per station is US\$ 2,000-8,000 Rapid charging is a relatively recent technology • Charging time is 30 minutes • Cost per station is US\$ 40,000 – 75,000	Two test cases have started in Berlin, with a view to better understanding user requirements. One was initiated by RWE (a major utility) in partnership with Daimler and the other by Vattenfall (a Swedish utility) in partnership with BMW. The car manufacturers have developed battery powered cars while the utilities are installing charging infrastructure. The city of Berlin has mandated the interoperability of the two networks, which are based on semi-fast infrastructure with the option of upgrading to rapid charge. Supporting multiple providers has the advantages of fostering competition and avoiding early lock-in. In 2010, 70 spots had been installed by RWE and 30 by Vattenfall.
Battery-swapping	At battery-swapping stations, drivers are able to exchange depleted batteries for ones that are fully recharged. This offers an experience which is much closer to conventional liquid refuelling. • Charging time is several minutes • Cost per station is US\$ 1,500,000+	In Denmark, project Better Place is planning to build a nationwide grid of battery switching stations. Potential customers must buy a Renault Nissan Fluence Z.E. vehicles (205.000 DKK or €27.496) and choose a subscription option with monthly charges ranging from 1.495 DKK (€199) to 2.995 DKK (€399). The subscription includes unlimited charging from Better Place public charging spots and battery swapping stations

Source: Charging times and cost per station sourced from CCI (2010)

2.5.1 Evaluation of the measure: infrastructure investment

This section evaluates the impacts of the policy in terms of Economic, Environmental and Social factors, indicating if the impacts are positive, neutral or negative and if the impact is High or Low.

- (++) High Positive Impact
- (+) Low Positive Impact
- (n) Neutral
- (-) Low Negative Impact
- (- -) High Negative Impact

As with financial support mechanism for electric vehicles, measures to support EV infrastructure are still in the early stage of development. On the basis of this early experience some preliminary conclusions can be drawn.

Economic impacts

What was the cost to deliver the outcome, was it value for money?

- (+) Revenues can be generated by charging users for use of electricity at charging points. Rates tend to be higher for fast-charging stations, which are also more expensive to install.
- (n) Costs can be limited by partnering with a private company
- (- -) Charging points involve significant capital outlay, particularly for fast-charging types and battery-swap stations. Slow charging points are the cheapest option.
- (-) Loss of revenue from fossil fuel taxes over the lifetime of the EV

What wider economic impacts does the policy have?

- (++) Stimulates the early market for electric vehicles by helping to overcome range anxiety; this may give a competitive advantage to EV and charging points manufacturers
- (-) Resources may be more cost-effectively spent on other mitigation measures, particularly for the delivery of short term emissions targets.
- (+) Potential fuel savings for consumers are significant over the lifetime of the vehicle, although fuel costs are increased for consumers who use public infrastructure

Environmental impacts

Did the policy deliver the desired outcome?

- (++) If an electric vehicle replaces a conventional fossil-fuelled vehicle that would have been purchased otherwise, CO₂ savings can be significant. For example, in the UK, average well-to-wheel emissions for an EV are 75gCO₂/km, which is lower than any fossil fuelled car in production today. The average UK car emits 208gCO₂/km. In France, an EV would emit just 12gCO₂/km, whereas in Greece it would be 118 gCO₂/km (Ecometrica, 2011). This variation reflects the carbon intensity of the assumed mix of electricity generation technologies in each country.
- (++) Potential environmental benefits would increase over time as the average electricity grid decarbonises. UK government projections for the grid average carbon intensity mean that emissions from EVs would fall to 3gCO₂/km in 2050 based on current vehicles (Ecometrica, 2011).
- (-) Potential rebound effect if lower costs per mile driven leads to increases in overall mileage

What other impacts has the policy had?

- (++) Improvements in local air quality are guaranteed if EVs displace conventional vehicles, as EVs have zero tailpipe emissions. This is particularly important for human health in urban areas.
- (-) Would lead to purchase of cars that would not otherwise have been bought. Emissions could increase if this leads to modal shift from cleaner modes (e.g. walking, cycling).

Are there impacts on emissions from other sectors?

- (+) Reductions in overall pollutant emissions (including upstream emissions at the power station) will increase over time as the grid mix changes to include more renewable technologies and/or higher deployment of scrubbers.
- (n) While tailpipe emissions are eliminated, EVs do produce pollutants indirectly at the power station. Depending on the grid mix, this can actually increase overall emissions of NO_x, SO₂ and PM – particularly if coal is the generating fuel. However, these pollutants are far less damaging when released at power stations, which are unlikely to be located in densely populated areas.

Social impacts

Was the policy well received, were there issues in gaining acceptability, what did they relate to?

- (++) The policy is generally well-received. Highly visible charging points may play a crucial role in overcoming range anxiety

What are the distributional impacts?

- (-) Charging points may not be accessible for users in rural areas, or those who must travel longer distances outside of the network area.

Cross-Cutting

Are there interactions with policies in other sectors?

- (n) Increased uptake of EVs could lead to additional pressure on the electricity sector. However, the impact of EVs on the absolute increase in electricity demand is expected to be small - complete electrification of the European fleet would result in an additional demand of about 10-15% (CE Delft, 2011).
- (-) Increased uptake of EVs could lead to issues with material recycling, due to the difficulty in recovering battery materials. The impacts are magnified because the batteries tend to have shorter lifecycles than the vehicles themselves.
- (--) Member States with weak electricity infrastructure may find it challenging to deal with uncontrolled EV charging, which could lead to local power outages.

Timeframe – is there anything to note about the timing of policy implementation and expected impacts?

- (++) Electric vehicles are unlikely to play a significant role in meeting GHG reduction targets before 2030 due to their low market share. They have been included in the case study section because they could contribute to longer term objectives, but action is needed **now** in order to develop the market and reduce lock-in to more carbon-intensive technologies.
- (n) Current electricity infrastructure should be capable of handling additional demand due to charging, as market penetration is low. However, renewable energy sources such as wind and solar are already difficult to coordinate and EVs could increase the challenge. Controlled/smart charging would help to alleviate this problem; such technologies are being rapidly developed.
- (--) Potential for lock-in to obsolete charging technologies, if industry agrees on a standard configuration which is incompatible. Charging point technology is evolving quickly and it is likely that advancements will be made in the near future.

2.5.1 Maximising desired impacts/reducing unwanted impacts

This section looks at how the positive impacts could be maximised to ensure the policy delivers its full potential. We have compiled the lessons learned from schemes that have already been introduced, as well as using evidence from the broader literature to suggest how implementation could be improved. Strategies to mitigate the negative impacts are also suggested.

Maximising the benefits

Deploy a mixture of fast- and slow-charging stations

In general, provision of public slow charging infrastructure on its own has not successfully stimulated uptake of electric vehicles. However, fast-charging stations are significantly more expensive. A balance between cost and effectiveness has been achieved by several countries who have deployed a mixture of fast- and slow- charging stations.

Install charging stations in highly visible, busy locations

It is likely that the bulk of recharging will take place at home or at work, which suggests that a key role of public charging infrastructure is to provide peace of mind. Initial results from trials in Berlin suggest that users mostly rely on home charging, and public charging is mainly used in spots close to their place of work, major shopping areas, or transportation hubs (e.g. airports). This implies that public infrastructure would be most useful if provided in these areas (CCI, 2010).

Benefits can be higher for users without access to private parking

For cities with lower levels of private off-street parking, public charging infrastructure may be more important. For example, in the UK, less than 40% of urban households have off-street parking availability (CCI, 2010).

Mitigation measures

Costs can be recovered through user charging – subscription models are the most effective

The overall costs of the measure depend on several factors, including the type of infrastructure and the charge out rate. For a single charging point to break even, mark-ups of 50 to 125% would be needed depending on the type of infrastructure (CCI, 2010). However, these high mark-ups should translate into a relatively low monthly cost of between US\$11 to US\$ 192 depending on the station type. Annual maintenance for charging stations is estimated to be around 10% of the original instalment cost, and estimated lifespans are 10 to 15 years (CCI, 2010). Revenue can be generated through pay-per-use or subscription models, although subscription models tend to be more popular as it is easier to frame the high mark-up per kWh in terms of a low additional cost per year.

Opting for battery-swapping is risky

The concept of battery exchange has problems due to its high cost, the increased number of batteries needed per car. In addition, car manufacturers appear reluctant to engage with the idea, partially due to the design limitations with respect to where they can place the battery in the car (CCI, 2010). It appears that despite initial enthusiasm, the future of battery swapping is uncertain (CCI, 2010)

3 Policies that aim to achieve behavioural change leading to more efficient use of the transport system

3.1 Background

The category 'behavioural change' could be used to refer to a very wide range of policy options in transport, depending on its definition. In some sense, every policy seeks to change the behaviour of actors in the transport system. This section is restricted however to **policy options that seek to change the behaviour of end users of the transport system with the aim of reducing emissions, without the need for a change in the technologies used in transport**. This section therefore deliberately excludes policy options that aim to increase the uptake of low-carbon technologies in the transport sector.

Behavioural change policy options have a number of potential advantages:

- In many cases, successful implementation translates immediately to emissions reductions. This is in contrast to many technical measures, e.g. more energy efficient vehicles, where there is a significant lag-time associated with take-up of the technology until it has achieved significant penetration in the vehicle fleet. This is particularly relevant to action under the Effort Sharing Decision, because of the relatively short time left to achieve emissions reduction targets.
- They are believed to be cost-neutral or even cost-negative to the transport user, and relatively inexpensive to governments. In transport, in particular, analysis of the costs of technical options shows that they are often expensive in comparison.
- Non-technical measures can reinforce the benefits of technical measures, by ensuring low-carbon technologies achieve market penetration or high utilisation.

However, there are also a number of risks and disadvantages associated with this type of policy option:

- European and national governments are rightly unwilling to compromise on the freedoms of their citizens, especially in the area of mobility. Therefore behavioural change policies need to be carefully designed to avoid placing restrictions on users of the transport system that could compromise their quality of life. Furthermore, policies which are *perceived* by the public to be restrictive often face stiff opposition, even if objective analysis indicates they deliver societal benefits.
- It is very difficult to predict the impacts of behavioural change policy options, or retrospectively measure these impacts. This is due to challenges in isolating the effects of a single policy from numerous other drivers of behaviour. As a result, there is little quantitative information on the effectiveness of these policies.

Behavioural objectives to reduce transport emissions

Optimise energy efficiency of vehicles (in terms of energy use per km travelled)

The behaviour of the drivers of manually driven vehicles can have a large impact on the energy efficiency of travel. This is particularly relevant to road transport modes the driver has a large degree of control over speed and driving style, as well as other decisions such as gear selection which impact on vehicle efficiency. Policy options include giving drivers the skills to drive more efficiently through training, incentivising efficient driving through information campaigns or price signals, and mandating more efficient driving through speed limits.

Optimise the choice of mode for a particular journey or journey section	Where viable alternatives exist, shifting transport demand to more efficient modes can be an effective way of reducing emissions. There is scope in particular in passenger transport to influence behaviour to shift demand from private cars to public transport or non-motorised modes. Policies can help to provide viable public transport alternatives through infrastructure investment and spatial planning, and incentivise modal shift through price signals and provision of information. A variation of this objective is to shift transport demand to more efficient option within a given mode (e.g. shift demand from less to more efficient passenger cars).
Optimise the utilisation of transport vehicles (loading or occupancy)	Emissions per unit of service demand can be reduced by ensuring that vehicles are operating as close to their capacity as possible. Policies can support higher utilisation by providing infrastructure that facilitates increased loading (e.g. freight consolidation centres) or by prioritising highly loaded vehicles (e.g. high occupancy car lanes). Price signals would also be expected to increase loading, particularly in the freight sector where response to price signals is expected to be stronger.
Optimise the use of transport systems (whether / where to travel)	Behavioural change can lead to a reduction in the requirement for transport. In passenger transport, individuals can change their behaviour to consolidate trips, or choose alternatives that avoid trips entirely. Policy can support this through long-term spatial planning to reduce the need for transport, supporting alternatives to transport (e.g. teleconferencing and telecommuting) and providing price signals to give a disincentive towards unnecessary travel.

The behavioural objectives outlined above can be influenced by policy through a number of levers. Levers to influence behaviour include:

- Planning (spatial planning to reduce the need for transport or to incentivise sustainable options)
- Information, education and public engagement
- Influencing the price of transport options
- Direct regulation
- Infrastructure investment (ensuring there is appropriate infrastructure for preferred travel options and restricting allowances of infrastructure for unsustainable options).

The table below shows policies available to Member States in each of these policy areas, and their behavioural objectives.

Behavioural change policies may not always be universally applicable across Europe. Whilst some behavioural trends in transport are common across Europe, others vary widely between or within Member States. Behavioural change policies would be expected to mirror this diversity in transport systems and culture.

The specific policy instruments selected for more detailed examination as part of a case study are:

- **Case study 1: Speed management measures in road transport** which aim to reduce fuel consumption by reducing the average speed of vehicles on the road.
- **Case study 2: Eco-driving programmes** which aim to inform, educate and encourage drivers on the use of energy efficient driving techniques.

Table 3-1 Behavioural change policy options

	Optimise energy efficiency of vehicles (in terms of energy use per km travelled)	Optimise the choice of mode for a particular journey or journey section	Optimise the utilisation of transport vehicles (loading or occupancy)	Optimise the use of transport systems (whether / where to travel)
Information, education, public engagement	• Eco-driving schemes • CO₂ information campaigns	• Public transport / travel choices information campaigns	• Car sharing information campaigns	• Travel choice information campaigns • Teleworking campaigns • Improved public transport information
Direct regulation	• Enforced / reduced speed limits • Mandate eco-driving (e.g. in driving test, professional driver training)			
Infrastructure investment / restriction	• Optimise infrastructure for smooth traffic flow • Dedicated infrastructure for public transport (e.g. bus rapid transit)	• Investment in public transport / walk & cycle infrastructure • Improved intermodal links (passenger and freight) • Parking restrictions • Bus lanes	• High occupancy car lanes • Freight consolidation centres • Parking restrictions	• Communications infrastructure to reduce the need for travel to communicate (e.g. commuting, business meetings)
Spatial planning		• Improved spatial access to public transport • Amenities accessible by walking & cycling • Improved intermodal links		• Spatial planning to reduce travel needs (e.g. mixed use developments)
Pricing	• Increased fuel price	• Increased fuel price • Subsidised public transport • Congestion charging • Vehicle pricing	• Increased fuel price • Congestion charging	• Increased fuel price • Congestion charging

3.2 Case study 1: Speed management measures in road transport

3.2.1 Objective of the measure

Most European countries impose maximum speed limits on all their roads, and many also impose different speed limits for different classes of vehicle. These are in place for a variety of reasons, including safety, traffic management and fuel consumption. However, they are not usually optimised for the latter: a typical passenger car is most fuel efficient at around 80 km/h, but European motorway speed limits are typically 120-130 km/h. At high speeds, when air resistance dominates vehicle resistive force, power demand increases with the cube of speed – so a reduction in speed leads to a significant reduction in fuel consumption. Even on slower roads, more uniform, slower speeds can lead to energy consumption reduction through reducing braking and acceleration (though the case here is perhaps less clear cut).

3.2.2 Application of the measures in EU Member States

Speed limits to reduce fuel consumption have historical precedent in Europe and the US, when post-war and oil shock-induced constraints on fuel supply motivated the introduction of fuel-saving measures. However, attempts to reduce speed limits more recently have been met with stiff public resistance.

Box 3-1: Focus on Spain – reduced motorway speed limit

Between March and July 2011, the Spanish Government cut the speed limit on its motorways from 120km/h to 110km/h. Its motivation for doing so was not ostensibly environmental – Spain imports most of its transport fuel, and high oil prices combined with a challenging economic climate within Spain triggered this move in an attempt to reduce the nation's fuel bill. This would in theory lead to a reduction in money leaving Spain to pay foreign oil companies, with resulting economic benefits. The Spanish Ministry of Industry, Tourism and Commerce (2010) announced after the first month of the policy that seasonally adjusted fuel consumption had decreased 8.4% over the same month the previous year, compared with a 1.2% rise in January and a 1.6% decline in February. They estimated that this equated to a saving of 177,000 tonnes of transport fuel, and avoided €94 million of oil imports. Elsewhere in the media it was reported that speeding fines also dropped by 35% in March⁶, and that over the four months of the reduced speed limit traffic accidents have reduced by 15% on the same period in the previous year⁷, though it is not clear how much of this reduction is from motorways. In July, the higher speed limit was reinstated. The policy was always intended to be temporary, and was highly controversial amongst many Spanish stakeholder groups

3.2.3 Main features of the measure

There is a range of potential approaches to speed management, which are summarised in the table below.

⁶ <http://www.endseurope.com/26170>

⁷ <http://www.ecologistasenaccion.org/article20931.html>

Table 3-2: Main features of speed management measures

	Overview	Examples
Specific roads / areas only	Speed management policies for GHG emissions reductions often target specific road types with the highest speeds, usually motorways. However, specific roads or areas can also be targeted where there are significant potential co-benefits, such as noise reduction or congestion relief.	Several studies have been carried out to assess the impact of reducing motorway speed limits. A 2010 CE Delft study concluded that a strictly enforced uniform speed of 80 km/h would lead to fuel consumption reductions of 30% on Dutch motorways, which equates to 12% of all passenger car emissions and overall CO ₂ reductions of 3Mt. Less drastic speed reductions were found to reduce passenger car emissions in the Netherlands by between 3 and 9%. A study by the European Environment Agency (2011) found that reducing the motorway speed limit from 120km/h to 110km/h would deliver fuel (and emissions) savings of 12-18% in an idealised case, but they cut their estimate to a 2-3% saving in a more realistic scenario (taking into account levels of compliance and less smooth driving).
Specific vehicle classes only	Speed limits can be imposed on heavy duty vehicles or vans only, rather than for all motor vehicles. However, this is difficult to enforce without technology such as speed limiting devices. This is already the case for certain heavy vehicle classes, which are covered by a European Directive mandating the use of speed limiters with defined maximum speeds.	A 2002 trial in the Netherlands fitted 177 vans and 30 light trucks with speed limiters for one year, and found on average fuel savings of 5% resulted from setting the limiters to 110km/h.
Increased enforcement of existing limits	The average speed of traffic on roads can be reduced without changing the speed limit simply by increasing efforts to enforce the current limit. This is particularly relevant to motorways.	An example of this approach has been seen in France, where the 2004 'Plan Climat' estimated that improved compliance with speed limits could produce CO ₂ savings of 3Mt

	Overview	Examples
Infrastructure that reduces ability to travel at speed	Roads can be designed to promote smoother, slower driving – for example by inhibiting overtaking. Traffic calming measures include humps, chicanes and junction tables. They have traditionally been used to reduce speed in urban areas for safety reasons. In some cases they can reduce emissions in the areas in which they are used; however, there are often increases in traffic and pollution on the alternative routes.	TNO (2004) have measured the effect of local traffic measures on emissions. Speed ramps were found to increase CO ₂ by 45-55% because of the need for drivers to decelerate before the ramp, and their tendency to accelerate between ramps. Limiting speed to 30km/h was found to reduce CO ₂ emissions by 10%, mainly because traffic flow is improved.

3.2.4 Evaluation of the policy

This section evaluates the impacts of the policy in terms of Economic, Environmental and Social factors, indicating if the impacts are positive, neutral or negative and if the impact is High or Low.

- (++) High Positive Impact
- (+) Low Positive Impact
- (n) Neutral
- (-) Low Negative Impact
- (--) High Negative Impact

	Economic impacts
What was the cost to deliver the outcome, was it value for money?	(+) Speed limits closer to the optimum driving speed for fuel efficiency would reduce vehicle operator's fuel bills for a given distance travelled (although the cost of extra journey time may negate this). (+) Where congestion impedes traffic flow, speed management can smooth the flow of traffic, reducing congestion⁸. This can result in benefits including reduced journey times, improved vehicle efficiency and increased carrying capacity of infrastructure. However there are also important rebound effects from reducing congestion, including increasing the attractiveness, and hence volume, of travel. (n) For governments, enforcement is the main cost. Legislation is unlikely to result in speed reductions if it is not enforced. This can be very expensive, but the cost is usually met in part by revenue raised through penalty fines

⁸ This outcome is not applicable in all circumstances, and is also affected by local circumstances. For instance, introducing 80-kilometre zones in the Dutch agglomeration Randstad induced an increase in congestion in some places and a decrease in others (CE Delft, 2010)

	(-)	Speed limits relying on infrastructure that reduces the ability to travel at speed requires additional investment in infrastructure and could disrupt traffic flow through the area
What wider economic impacts does the policy have?	(+)	In theory, vehicle manufacturers could react to a change in policy on speed limits by changing the design of vehicles to optimise their performance at lower speeds. This could further increase road transport energy efficiency.
	(+)	Improved energy security if reduced fuel consumption results in a reduction in fuel imports
	(-)	If speed management results in increased travel times, costs may be incurred in both passenger and freight transport due to lost time or reduced mobility in a given time budget.

Environmental impacts

Did the policy deliver the desired outcome?	(++)	Emission savings are realised as soon as a speed management policy is implemented and enforced. This contrasts to technology measures that have a lag-time due to the need for technology to achieve market penetration, and is particularly pertinent given the proximity of Effort Sharing Decision target year (2020).
What other impacts has the policy had?	(++)	Potential co-benefits could include: • <i>Reduced congestion</i> due to smoother, more uniform traffic flow, which will further increase energy efficiency and may result in shorter journey times than with higher speed limits (but may lead to rebound effects); • <i>Increased safety</i> and the congestion benefits of fewer traffic accidents; • <i>Reduced noise</i>, which may lead to health benefits in populated areas; • <i>Improved air quality</i> due to more efficient engine operation, which has significant health benefits in built up areas.
	(+)	An additional potential knock-on effect is a reduction in overall transport, as less passenger transport can be achieved in the same time budget, and freight transport becomes more expensive (due to driver costs). This in turn could lead to modal shift where other modes become competitive with road modes in both passenger and freight transport. For example, passenger car journeys may shift to public transport

	(-) Not all speed reduction will improve efficiency – clearly if speeds are reduced below the most efficient for vehicles, then overall energy consumption will increase (unless slower speeds result in reduced congestion or smoother driving). (--) Potential rebound effects could include: • <i>Increased traffic</i> is a potential consequence of improved traffic flow: if congestion is eased, journey times decrease and the carrying capacity of the road becomes greater which can lead to more overall travel occurring, and therefore greater emissions. • <i>Increased vehicle use</i> can also occur as vehicle owner's fuel bills reduce due to more efficient travel, so they are able to afford more vehicle use with the same budget.
Are there impacts on emissions from other sectors?	(+) If greater fuel efficiency per mile leads to less fuel use overall, then emissions of all pollutants will be reduced during the upstream fuel production phase.

Social impacts

Was the policy well received, were there issues in gaining acceptability, what did they relate to?	(+) In theory, people support lower speeds. In a recent poll, about two thirds of EU citizens said they were willing to compromise a car's speed in order to reduce emissions (EEA, 2011). (--) Recent attempts to reduce speed limits, particularly on motorways, have met with stiff public resistance. A key challenge to reducing speed limits is to win the support of drivers.
What are the distributional impacts?	(n) Gains from speed changes for one group often mean losses to some other group. For example, pedestrians would benefit from lower speeds, as they would enjoy increased safety and better air quality. Conversely, drivers would usually prefer higher speeds to reduce the time cost of travelling.

Cross-Cutting

Are there interactions with policies in other sectors?

N/A

Timeframe – is there anything to note about the timing of policy implementation and expected impacts?

(n) Emission savings are realised as soon as a speed management policy is implemented and enforced. Other impacts relating to changes in traffic flow and/or modal shift may take longer to appear

3.2.1 Maximising desired impacts/reducing unwanted impacts

This section looks at how the positive impacts could be maximised to ensure the policy delivers its full potential. We have compiled the lessons learned from schemes that have already been introduced, as well as using evidence from the broader literature to suggest how implementation could be improved. Strategies to mitigate the negative impacts are also suggested.

Maximising the benefits

Good enforcement is essential	Around 40–50 % of drivers (up to 80 % depending on the country and type of roads) drive above legal speed limits (EEA, 2011). Therefore, enforcement is essential to achieve concrete results.
Focus on roads where speed reduction increases efficiency	Current vehicles peak in fuel efficiency around 80km/h ⁹ . Therefore, the greatest improvements in fuel economy through speed management occur when reducing speed limits on faster roads (usually motorways).
Focus on roads where co-benefits are greatest	The additional benefits of lower speed limits, including increased safety, reduced noise and air pollution, and improved traffic flow can significantly improve the case for action. Therefore, lowering speed limits on roads where these co-benefits have a positive impact (typically roads in urban and suburban areas) results in an improved benefit:cost ratio. Where heavy goods vehicles make up a large proportion of traffic, reductions in emissions may be limited as these vehicles are often already restricted to lower speeds.

Mitigation measures

Enforcement costs can be recovered through penalty fines	The enforcement technology represents a high investment cost, as well as an annual operating cost. Automatic fines for drivers will remove the need for manual monitoring. Although this technology will aid the recovery of fines, it will be expensive to install and operate (EEA, 2008)
---	---

⁹ CE Delft, Why slower is better: Pilot study on the climate gains of motorway speed reduction, 2010, Figure 4

Speed restrictions on a wider scale and on longer lengths of road could be more effective

Speed restrictions in smaller areas or on shorter lengths of road could be less successful, because of the increased emissions caused by acceleration and deceleration at either end of the restricted area (EEA, 2008).

Assess alternative routes

The surrounding area should be checked to ensure that traffic is not displaced from the regulated area in an attempt to evade the speed limit.

3.3 Case study 2: Eco-driving programmes

3.3.1 Overview of the measure

Eco-driving involves training drivers to modify their driving style in a way that reduces fuel consumption and emissions. This may involve actions such as timely gear changes, smooth deceleration and anticipation of traffic flows. Other elements may include reducing use of air conditioning, minimising idling and regular servicing. Uptake can be promoted through awareness campaigns, subsidised schemes or mandatory training.

Drivers may reduce their fuel consumption by up to 25% directly after training, with an average saving of 5 – 10% (TNO, 2006). While many studies confirm the initial benefits, the long-term effects are less well-documented and are likely to be smaller. Longevity may be increased by follow-up measures; fuel savings over the medium term (<3 years) are reported to be around 5% where there were no follow up measures, or 10% where continuous feedback was available (IEA, 2009).

3.3.2 Barriers to uptake

The main barriers to increased uptake of eco-driving technique include:

- Drivers have low skill;
- Drivers are unwilling to adapt;
- Lack of awareness of eco-driving techniques;
- Lack of awareness of the benefits of eco-driving;
- Eco-driving training is unavailable; and
- Cost of training

A range of policy options are available to encourage more fuel-efficient driving.

Policy option	Barriers addressed	Policy sub-types
Research and /spending programmes to support new technologies	Lack of awareness of eco-driving techniques Lack of awareness of the benefits of eco-driving	• Eco-driving demonstration programs
Information provision, education and public engagement	Drivers are unwilling to adapt Lack of awareness of eco-driving techniques Lack of awareness of the benefits of eco-driving	• Mass information campaigns • Targeted campaigns (e.g. driving schools, fleet managers) • Training of driving instructors • Competitions

Policy option	Barriers addressed	Policy sub-types
Voluntary or incentivised negotiated agreements	Lack of awareness of eco-driving techniques Lack of awareness of the benefits of eco-driving Eco-driving training is unavailable	• Voluntary agreements with companies to apply eco-driving programmes (e.g. leasing companies) • Voluntary agreement with car manufacturers or dealers to provide a voucher for an eco-driving course to customers
Market-based (economic or fiscal) instruments	Drivers have low skill Lack of awareness of eco-driving techniques Lack of awareness of the benefits of eco-driving Eco-driving training is unavailable Cost of training	• Subsidized courses • Subsidized tools which assist more fuel-efficient driving styles • Fuel taxes (indirect)
Direct regulations	Drivers have low skill Lack of awareness of eco-driving techniques Lack of awareness of the benefits of eco-driving Eco-driving training is unavailable	• Mandatory inclusion of eco-driving in driving lessons • Mandatory inclusion of ICT that facilitates eco-driving techniques (e.g. EC 661/2009 which mandates the fitment of gear shift indicators)

Source: Adapted from CE Delft (2011)

Looking to the future, motor vehicles will need to meet increasingly stringent CO₂ emission standards. Driving style is expected to continue to have a direct impact on fuel consumption; however the potential for improvements will be less as vehicles become optimised for fuel efficiency. However, there will be a significant time lag before new technologies penetrate the market. One of the great advantages of an eco-driving scheme is that its benefits can be realised after a few hours of training, and could extend to the entire fleet, including older cars.

3.3.1 Application of the measures in EU Member States

Ecodriving has enjoyed wide support in Europe. The majority of countries provide some sort of direct training, but other types of policy include competitions, information campaigns, voluntary certification schemes or demonstration projects. Many countries aim policies at drivers of passenger cars, since this tends to be the largest group of road users; 87% of the EU fleet are cars (ACEA, 2010). Potential savings in the rail sector are also significant, with average reductions in CO₂ emissions of 5% under a German scheme (IEA, 2007). The potential for inland waterways is estimated to be even higher, at 10 – 15% (IEA, 2007). However, the focus of this case study will be on cars, as data is most readily available for these schemes.

In addition, several Europe-wide initiatives have been introduced, with great success. For example, between 2006 and 2008, a synchronised campaign ran in 9 European countries under the ECODRIVEN project. It aimed at licensed drivers of passenger cars, delivery vans, lorries and buses. Over 20 million licensed drivers were reached, and 1Mton CO₂ was avoided between 2006 and 2010. EcoWILL is a large pan-European project running from May 2010 until April 2013, coordinated by the Austrian Energy Agency. Programmes are aimed at both licensed and learner drivers in 13 European countries. It aims to train at least 500 driving instructors, 10,000,000 learner and novice drivers, 10,500 licensed drivers. The expected results are fuel savings of 5 – 10%, avoiding 8Mtons of CO₂ until 2015. Table 3-3 summarises the policies employed by individual European countries.

Table 3-3: Eco-driving policies in European countries

Country	Policy type	Details	Source
Austria	Subsidized courses	Subsidy paid for participants of one-day driving courses	IEE (2010)
	Competitions	Eco-triathlon competition, where competitors had to travel through Austria in two days with the lowest CO ₂ emissions possible.	Anable & Bristow (2007)
	Competitions	Sprintspar Initiative includes an annual ecodriving competition, certification of ecodriving trainers, and training provision. By 2008, 2,800 bus drivers, nearly 2000 truck drivers and 1.500 car drivers have been trained. Typical fuel savings after training are 5-15%.	ECODRIVEN (2008)
Belgium	Information campaign	Tyre pressure campaign between September 2007 and June 2008 with a budget of €5,000. In total, 600 cars were checked and the campaign received considerable media attention. In September 2007 62% of cars tested had dangerously underinflated tyres (defined as 0,5 bar or more below recommended pressure) but in June 2008 the figure was only 35%.	ECODRIVEN (2008)
	Training	In 2008, Ecodriving training was provided for existing driving instructors and examiners. The campaign trained 400 instructors and 200 examiners. These instructors will in turn have taught ecodriving to 60 000 learner drivers during year 1.	ECODRIVEN (2008)
Czech Republic	Voluntary certification	A voluntary certification programme for hauliers was introduced. Applicants were tested in over 15 criteria. 13 haulier companies enrolled and the 8 best companies qualified for an A-class haulier certificate. The certificate is valid for one year and companies are allowed to use it as a marketing tool.	ECODRIVEN (2008)
	Training	Over 1000 drivers participated (either receiving short-duration training or practicing ecodriving in standard traffic) between 2007 and 2008, with a budget of €45,000	ECODRIVEN (2008)
Croatia	Mandatory inclusion of eco-driving in lessons	Eco-driving has been included in learner driver education since 2008. All candidates must pass the ecodriving training for at least 2 hours on the theoretical part and 2 hours on the practical part.	IEE (2010)
Finland	Training	An eco-driving program was introduced in 1995 and is expected to cut average fuel consumption by 10-16 %. Training was planned for 1,000 bus and truck drivers and 15,000 car drivers in 2005-06. 200,000 driving school students, as well as over 3,500 drivers who already have a driving licence, received training during 2003-05	Anable & Bristow (2007)
	Training	In 1997 1,000 instructors were trained to deliver eco-driving lessons to novice drivers. Between 1998 and 2008, over half a million new drivers have been taught, with typical fuel reductions of 10-15%	ECODRIVEN (2008)
France	Competition	13,000 bus drivers were involved in a competition between different lines with the goal of reducing fuel consumption by 5%. The staff from the winning line were invited to a celebratory prize-giving evening.	ECODRIVEN (2008)

Country	Policy type	Details	Source
Germany	Training	More than 4000 driving instructors and 650 examiners of driving instructors have been educated in the safe and economic driving behaviour by DVR and were trained to convey these skills to learner drivers from their first lesson on.	(IEE, 2010)
	Information campaign	Under the Spiritsparwochen platform, ecodriving events are announced and promoted, and training vouchers are raffled. Visitors of the website can calculate their personal saving potentials, find training facilities and give feedback on their training.	IEE (2010)
Greece	Information campaign	Between 2007 and 2008, a campaign was launched to promote ecodriving in Greece. This involved media interviews, engagement with large transport companies and training for drivers and instructors.	ECODRIVEN (2008)
	Mandatory inclusion of eco-driving in lessons	Integration of ecodriving in new driver training and examination from 2009.	ECODRIVEN (2008)
	Competition	Several competitions are in place, including the Mega Test Drive, “lean about ecodriving”, the ecodriving marathon, eco-cars @ the Mall Athens, Drive Me @ Golden Hall, and the Ecorally	IEE (2010)
Italy	Information campaign	The “annual guide on fuel savings and on CO ₂ emissions of cars” published by the Ministry of Economic Development includes eco-driving tips	IEE (2010)
Netherlands	Training; Information campaign;	‘Het Nieuwe Rijden’ concerns a long-term strategy for the period 1999 until 2011. It includes: 1. Driving school curriculums 2. Re-educating licensed drivers 3. Fuel saving in-car devices 4. Tyre pressures 5. Purchasing behaviour The results of the 2007 evaluation show that one third of the Dutch licensed drivers apply the main ecodriving driving style tips and 80% of licensed drivers are familiar with the tips. In 2007 the programme resulted in at least 0.3 Mton CO ₂ emission avoidance	ECODRIVEN (2008)
	Mandatory inclusion of eco-driving in lessons	Training techniques have been incorporated into normal driving lessons since 2001, with training and support provided to help instructors. Learners who received training drove 4% more efficiently compared to other new drivers. More recent figures suggest this figure has now risen to 10%.	Anable & Bristow (2007)
	Information campaign	Mass media campaign targeted at private car drivers commenced in 2004, which aimed to stimulate eco-friendly driver behaviour. This programme has been estimated to have saved around 0.6 MtC per year (population 6m)	Anable & Bristow (2007)
	Information campaign	For five weeks in September and October 2007 various activities took place to promote ecodriving at Shell fuel stations and adjacent parking lots alongside	ECODRIVEN (2008)

Country	Policy type	Details	Source
		highways. At least 25,000 drivers were reached directed, and an estimated 3 million through media coverage	
Poland	Training	Fleet driver training. KAPE began the Polish ECODRIVEN campaign with Lease Plan Poland as a partner and sponsor. This cooperation with a well-known car fleet management company afforded credibility to the project and helped to give fleet managers confidence in the subject. 380 fleet managers were targeted.	ECODRIVEN (2008)
	Training	Train-the-trainer sessions were organised to train 45 instructors.	ECODRIVEN (2008)
Spain	Information campaign	The Activation Plan (2008-2012) is a project to raise awareness of citizens. Actions include: Laying down an administrative regulation to allow for the inclusion of ecodriving in the car driving license training system in a maximum term of 2 years; Training of staff at the provincial traffic police headquarters (through the Autonomous Regions). Carried out in 2008 – 2010; Training of examiners and training coordinators in 2010; Drawing-up of additional theory questions. Made in 2009; Setting-up of an assessment procedure for ecodriving.	IEE (2010)
UK	Demonstration project	EST-Ford initiative to demonstrate the effectiveness of short-duration training courses. A competition was held over 13 days in 2007 for a total of £20,000 Energy Saving Recommended products provided by Ford	EST (2008)
	Training	The Energy Saving Trust's Smarter Driving Training programme is funded by the Department for Transport (DfT) and provides short-duration ecodriving training for companies' employees. The programme has been running since December 2008 and has so far trained just over 15,000 drivers. Organisations pay £15 plus VAT (sales tax) per person, which is approximately half the true cost of the training. Training lasts just 50 minutes per person.	IEE (2010)
	Training	The aim of the project for Safe and Fuel Efficient Driving (SAFED) is to develop a standard so that accreditation of trainers follows best practice for fuel economy driving. SAFED is aimed at drivers of vans, heavy goods vehicles and buses. The government subsidised courses for over 20,000 drivers of vans and HGVs between 2002 and 2009 with a typical fuel saving of 10%. Funding ended in 2010, but training is still available at full price.	AEA (2009)
	Information campaign	From 2007 until early 2010 DfT ran a national media campaign aimed at private individuals called "Act on CO2". This campaign encompassed a wide variety of environmental messages but included a strong emphasis on ecodriving, including ecodriving adverts on TV, billboard and national newspapers.	IEE (2010)

3.3.2 Evaluation of eco-driving schemes

This section evaluates the impacts of the policy in terms of Economic, Environmental and Social factors, indicating if the impacts are positive, neutral or negative and if the impact is High or Low.

- (++) High Positive Impact
- (+) Low Positive Impact
- (n) Neutral
- (-) Low Negative Impact
- (- -) High Negative Impact

Economic impacts

What was the cost to deliver the outcome, was it value for money?

- (++) Eco-driving can be a relatively cheap measure to implement. If eco-driving is integrated into standard driving lessons the cost is around €1 per driver (TNO, 2006). The training is likely to be more effective for novice drivers, as it establishes eco-driving as a normal way of driving instead of attempting to change habits.
- (-) Reaching experienced drivers requires higher investment costs in retraining courses, and drivers may be less receptive to adapting their techniques
- (-) Promotional campaigns launched alongside the training schemes may help to increase uptake, but this can greatly increase the cost of the programme.

What wider economic impacts does the policy have?

- (+) Reduced fuel costs for the driver, due to more efficient driving technique
- (+) Somewhat counter-intuitively, average speeds also slightly increased – this is a common outcome of eco-driving training, as drivers find they are better able to navigate roads and therefore reach higher average speeds (ECODRIVEN, 2008). This reduces the time cost of travel.

Environmental impacts

Did the policy deliver the desired outcome?

- (++) Emission savings are realised immediately and could potentially apply across the entire vehicle fleet (as opposed to new vehicles only). Drivers may reduce their fuel consumption by up to 25% directly after training, with an average saving of 5 – 10% (TNO, 2006).
- (+) Training is useful to extend the range of electric vehicles, and will therefore become more relevant if market penetration of EVs increases.

	(n) The composition of the national fleet may influence the potential CO₂ savings. For instance, eco-driving generally has a greater impact on CO₂ emissions from heavier vehicles; therefore a higher proportion of large vehicles could increase the potential fuel benefits (Smit, Rose & Symmons, 2010). (n) Benefits could reduce over time as vehicles become more efficient. However, there will still be improvements. (-) Potential rebound effect if lower costs per mile driven leads to increases in overall mileage (-) Long-term outcomes are less certain, but are likely to be smaller. Longevity may be increased by follow-up measures; fuel savings over the medium term (<3 years) are reported to be around 5% where there were no follow up measures, or 10% where continuous feedback was available (IEA, 2009).
What other impacts has the policy had?	(n) There is uncertainty as to whether eco-driving contributes towards a reduction in emissions of air pollutants. TNO (2004) found that eco-driving tips could reduce emissions of CO by up to 59%, HC by up to 39%, NO_x by up to 47% and PM by up to 27%. However more recent work by CE Delft (2008) found that the impact on air pollutant emissions is neutral - or even negative if eco-driving techniques are incorrectly implemented by drivers.
Are there impacts on emissions from other sectors?	(+) If greater fuel efficiency per mile leads to less fuel use overall, then emissions of all pollutants will be reduced during the upstream fuel production phase.

Social impacts

Was the policy well received, were there issues in gaining acceptability, what did they relate to?	(+) Acceptance is high if eco-driving is integrated into novice driving lessons. Acceptance can also be increased by using well-designed promotional materials and/or awareness raising events. (--) Implementation can be difficult as it requires buy-in from the individual drivers and a willingness to adapt their driving style. This can be particularly challenging with experienced drivers, who can be resistant to changing their habits. Partnering with commercial organizations can increase confidence in the campaign messages.
--	---

What are the distributional impacts?

- (+) Subsidized training can be provides for targeted social groups. The upfront costs of an eco-driving course are more visible than the long-term savings, which may deter some participants, particularly those with low incomes.

Cross-Cutting**Are there interactions with policies in other sectors?**

N/A

Timeframe – is there anything to note about the timing of policy implementation and expected impacts?

- (++) Reductions in fuel consumption are measurable immediately after training.
- (+) Training is also useful to extend the range of electric vehicles, and will therefore become more relevant if market penetration of EVs increases.

3.3.3 Maximising desired impacts/reducing unwanted impacts

This section looks at how the positive impacts could be maximised to ensure the policy delivers its full potential. We have compiled the lessons learned from schemes that have already been introduced, as well as using evidence from the broader literature to suggest how implementation could be improved. Strategies to mitigate the negative impacts are also suggested.

Maximising the benefits**Target novice drivers by integrating eco-driving into lessons**

The most cost-effective way of spreading eco-driving is to integrate it into standard driving lessons. TNO (2006) estimates the cost to be around €1 per driver. The training is likely to be more effective for novice drivers, as it establishes eco-driving as a normal way of driving instead of attempting to change habits.

Short-duration courses are most cost-effective for experienced drivers

In general, it has been found that half-day courses are very effective, but too expensive for the mass market, so they tend to be reserved for the worst-performing drivers only. Costs for a typical 4-hour course are around €50 – €100 (TNO, 2006). (ECODRIVEN, 2008). An alternative which has proven very effective is short-duration “snack” training. Evidence shows that lessons lasting an hour or less can result in substantial improvements – in the EST-Ford study, nearly 500 drivers managed to improve their fuel consumption by an average of 22.5% in lessons lasting 50 minutes (EST, 2008). Even cheaper still are eco-driving simulators, although they tend not to be as effective as on-road training. A pedal, steering wheel and CD ROM together cost around €80, and can be used to convey the key messages (ECODRIVEN, 2008).

Potential benefits per driver could be larger for commercial drivers	The average annual distance of travel is significantly larger for commercial vehicles than for passenger cars; accordingly, the potential benefits per driver could be larger for commercial vehicles. In Austria, more than 1,700 bus drivers were trained in 2007, resulting in an average reduction in fuel consumption of 10.5% (ECODRIVEN, 2008).
Quality standards are important to ensure confidence in the outcomes	Quality standards are also important to ensure confidence in the outcomes. Trainers can be certified after they have completed standard education and their performance should be monitored periodically. In Germany, the German Road Safety Board requires trainers to obtain a formal Driving Instructors Licence, a permission for Driving Intervention Courses, training courses on eco-driving, specific Train-the-Trainer Instructions and a certification according to DIN EN 45013 (Ecodriving Europe, 2004). The certificate must be renewed every four years on the basis of further training.
Communication strategies can be designed to suit any budget	In terms of promotional efforts, the costs vary depending on the measures used. Introducing eco-driving into standard tuition is a low-cost measure; a mass campaign to reach experienced drivers would be more expensive. In the Netherlands, a mass media campaign included a series of TV adverts that ran for many years. Approximately half of the total programme budget was required for setting up of the communication campaigns (EEA, 2008). A budget of €10 million was allocated for the first phase (1999-2005), rising to €15 million for the second phase. Experience suggests that communication campaigns, supported by information materials, can improve fuel efficiency by around 5% for people who follow the advice (IEA, 2007). For smaller campaigns, cheaper materials can be used such as posters and fliers, which can be scaled to suit any budget. Very often, they will direct people to a website where they can access more in-depth information.

Mitigation measures

Partnering with commercial organizations can help to win support	Ensuring co-operation with the training is a difficulty, particularly when attempting to change habits of experienced drivers. Outcomes from programmes in the Netherlands and Belgium suggests that partnering with commercial organisations helps with credibility, because the target groups take these organisations more seriously than governmental organizations (ECODRIVEN, 2008).
In-car equipment can help drivers to maintain the fuel savings after training is over.	Examples of equipment that can support eco-driving techniques include cruise control and fuel consumption gauges. However, few countries have introduced fiscal incentives to stimulate the uptake of instrumentation, as it can be an expensive option. The Netherlands is one example, where incentives achieved uptake of 75% of new cars – but the programme was so successful that it had to be ended because of the unexpectedly large shortfall in tax revenue (IEA, 2007). The scheme did result in long-term benefits, as car manufacturers continued to supply the equipment after the incentives were withdrawn in order to avoid falling behind competitors.

4 References

4.1 Electric vehicles

ACEA (2010) 'Electric vehicles: turning buzz into reality.' European Automobile Manufacturers' Association. http://www.acea.be/news/news_detail/electric_vehicles_turning_buzz_into_reality/

ARUP (2008) 'Investigation into the scope for the transport sector to switch to electric vehicles and plug-in hybrid vehicles' Department for Business Enterprise & Regulatory Reform & Department for Transport. <http://www.bis.gov.uk/files/file48653.pdf>

Better Place Denmark (2011) 'FAQ'. <http://danmark.betterplace.com/faq/klima-luftforurening-og-stoej/>

Business Green (2010) 'Amsterdam launches electric vehicle grant scheme'. <http://www.businessgreen.com/bg/news/1806110/amsterdam-launches-electric-vehicle-grant-scheme>

CE Delft (2011) 'Impacts of electric vehicles'. EC DG Clima. http://ec.europa.eu/clima/news/articles/news_2011051701_en.htm

CCI (2010) 'Policy options for electric vehicle charging infrastructure in C40 cities.' Clinton Climate Institute. <http://www.innovations.harvard.edu/cache/documents/11089/1108934.pdf>

EC (2010) 'A European strategy on clean and energy efficient vehicles'. European Commission COM(2010) 186 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0186:FIN:EN:PDF>

Ecometrica (2011) 'Technical Paper: Your new electric vehicle emits 75 gCO₂/km (at the power station)'. http://d3u3picknor73l.cloudfront.net/assets/media/pdf/electric_car_emits_75_gCO2_per_km.pdf

Diamond (2009) 'The impact of government incentives for hybrid –electric vehicles: Evidence from US states.' LMI Research Institute http://www.uns.ethz.ch/edu/teach/bachelor/energmob/Diamond_2009.pdf

DfT (2010) 'Green light to ultra low carbon car consumer incentive.' Department for Transport. <http://nds.coi.gov.uk/clientmicrosite/Content/Detail.aspx?ClientId=202&NewsAreaId=2&ReleaseId=414706&SubjectId=36>

Department for Transport Statistics (2011) 'Vehicle Licensing Statistics.' <http://www.dft.gov.uk/statistics/series/vehicle-licensing/>

Ecolane (2011) 'Ultra-low carbon vehicles in the UK.' RAC Foundation. http://design.open.ac.uk/documents/Market_delivery_of_ULCVs_in_the_UK-Ecolane.pdf

ETC (2009) 'Environmental impacts and impact on the electricity market of a large scale introduction of electric cars in Europe.' European Topic Centre on Air and Climate Change. <http://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22885/20110629ATT22885EN.pdf>

Element Energy (2009) 'Strategies for the uptake of electric vehicles and associated infrastructure implications.' Committee on Climate Change. http://hmccc.s3.amazonaws.com/Element_Energy_-_EV_infrastructure_report_for_CCC_2009_final.pdf

EP (2010) 'Challenges for a European market for electric vehicles.' European Parliament <http://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22885/20110629ATT22885EN.pdf>

EVUE (2010) 'Electric vehicles in urban Europe: Baseline report.' Electric Vehicles in Urban Europe. http://urbact.eu/fileadmin/Projects/EVUE/documents_media/2010-05-21_Final_EVUE_Baseline_study.pdf

FIA (2011) 'Towards e-mobility and the challenges ahead.' Federation Internationale de L'Automobile
http://www.lowcvp.org.uk/assets/reports/emobility_full_text_fia.pdf

IEA (2011) 'Clean energy progress report.' International Energy Agency.
http://www.iea.org/papers/2011/CEM_Progress_Report.pdf

Jean (2011) 'Electric vehicles – challenges of the new mobility. Speech by Mr Philippe Jean.'
Conference Sofia, Bulgaria, 11.02.2011
http://ec.europa.eu/enterprise/sectors/automotive/files/pagesbackground/competitiveness/speech-jean-sofia_en.pdf

PSI (2006) 'Designing policy to influence consumers.' Policy Studies Institute.
<http://ec.europa.eu/environment/enveco/pdf/RealWorldConsumerBehaviour.pdf>

Westminster (2009) 'Understanding existing electric vehicle recharging infrastructure, vehicles available on the market and use behaviour and profiles.' City of Westminster.
<http://www.westminster.gov.uk/workspace/assets/publications/Electric-charging-and-EV-vehicles-1247227333.pdf>

4.2 Behavioural change

AEA (2009) 'SAFED helping low carbon transition become reality.'
<http://www.aeat.co.uk/cms/assets/MediaRelease/PR110809.pdf>

ACEA (2009) 'Trend towards CO2-related car taxation continues', URL:
http://www.acea.be/index.php/news/news_detail/trend_towards_CO2_related_car_taxation_continues

ACEA (2010) 'European vehicle fleet.' European Automobile Manufacturers Association.
http://www.acea.be/images/uploads/files/20100520_european_vehicle_fleet.pdf

ACEA website (2010), URL: http://www.acea.be/index.php/news/news_detail/consistent_taxation/

Anable, J. And Bristow, A (2007) 'Transport and climate change: supporting document to the CfIT.'
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.113.8032&rep=rep1&type=pdf>

CE Delft (2010) 'Why slower is better.' http://www.ce.nl/publicatie/why_slower_is_better/948

CE Delft (2010) 'Limitation to order.'
http://www.cedelft.eu/publicatie/limitation_to_order%3A%3Cbr%3Eresults_of_trials_with_speed_limits_on_vans_and_light_trucks/269?PHPSESSID=ad8353cb75ccfd097561c2fc46a6f6a

EC (2005) Proposal for a Council Directive on passenger car related taxes {SEC(2005) 809} <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52005PC0261:EN:NOT>

Eco-driving Europe (2004) 'Eco-driving Europe.' http://www.aatas.com/files/eco_driving.pdf

ECODRIVEN (2008) 'ECODRIVEN Campaign Catalogue for European Ecodriving & Traffic Safety Campaigns.' Intelligent Energy Europe.
http://www.fiabrusseles.com/download/projects/ecodriven/ecodriven_d16_campaign_catalogue_march_2009.pdf

EEA (2008) 'Success stories within the road transport sector on reducing greenhouse gas emission and producing ancillary benefits.' EEA Technical report No 2/2008.
http://www.eea.europa.eu/publications/technical_report_2008_2

EEA (2011) 'Reducing speed limits on motorways: how good is it for the environment?.' European Environment Agency.

EST (2008) 'Energy Saving Trust – Ford Ecodriving Challenge 2008.'. Energy Saving Trust
<http://www.mcrit.com/transvisions/documents/Technology%20projects/Ecodriving%20Challenge.pdf>

French Development Durable (2010), Une évaluation du bonus malus automobile écologique
Commissariat Général Au Développement Durable URL: <http://www.developpement-durable.gouv.fr/Politiques-et-mesures.html>

IEA (2007) 'Workshop on ecodriving.' International Energy Agency.
http://www.iea.org/work/2007/ecodriving/ecodrivingworkshopfindings_en.pdf

IEE (2010) 'Overview on the status of ecodriving integration in the driver education and testing.'
Intelligent Energy Europe.
http://www.ecodrive.org/download/downloads/d2_1_ecodriving_education_for_licensed_driversecowill_wp2_final.pdf

MITYC (2011) 'Primeros resultados del plan extraordinario de ahorro energetico.' Ministerio de Industria, Turismo y Comercio. <http://www.mityc.es/es-es/gabineteprensa/notasprensa/documents/pptruedaprensaahorroenergetiCO280411.pdf>

Smit, R; Rose, G & Symmons, M. 'Assessing the impacts of eco-driving on fuel consumption and emissions for the Australian situation.' Australasian Transport Research Forum
http://www.patrec.org/web_docs/atrf/papers/2010/1925_020%20-%20Smit%20Rose%20Symmons.pdf

TNO (2004) Driving style and traffic measures – influence on vehicle emissions and fuel consumption

TNO (2006) 'Review and analysis of the reduction potential and costs of technological and other measures to reduce CO₂-emissions from passenger cars.'
http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report_co2_reduction_en.pdf

TNO (2010) 'Policy framework for reducing GHG emissions by decarbonising transport fuels and improving vehicle efficiency', Richard Smokers, TNO (presentation slides), EU Transport GHG 2050 project, final stakeholder conference, March 2010
<http://www.eea.europa.eu/themes/transport/speed-limits>

UKERC (2009). 'Ecodriving including in-car information systems'
<http://www.ukerc.ac.uk/Downloads/PDF/09/0904TransEcoDriveTable.pdf>

Annex 1: Policies in European countries to stimulate uptake of electric vehicles

Summary of policies in Europe to stimulate uptake of electric vehicles

Country	Policy type	Details	Source
Austria	Monetary incentive	Fuel consumption tax is CO ₂ based – cars <120g/km receive a maximum of €300. alternative fuelled vehicles receive a €500 bonus until 31 August 2012	ACEA (2010)
		Exemption from fuel consumption tax and monthly vehicle tax	ACEA (2010)
		Some pilot projects include access to the mobility card, car leasing and maintenance and free charging.	EP (2010)
Belgium	Monetary incentive	Private persons who purchase a passenger car that is powered exclusively by an electric motor receive a personal income tax reduction of 30% of the purchase price (with a maximum of € 9,190).	ACEA (2010)
		Vehicles that do not qualify for the 30% income tax reduction can receive 15% reduction of purchase price up to €4,540 for cars <105 g/km; 3% reduction of purchase price up to €850 for cars between 105 and 115 g/km	ACEA (2010)
		Electric vehicles pay the lowest rate of tax under the registration tax (€ 61.50) and under the annual circulation tax (€ 71.28)	ACEA (2010)
		Wallonia: Eco-bonus up to €600 bonus for cars <99 g/km with a maximum price of €30,000	ACEA (2010)
		The deductibility rate for expenses related to the purchase and use of company cars is 120% for zero emissions vehicles and 100% for vehicles emitting between 1 and 60 g/km of CO ₂ . Above 60 g/km, the deductibility rate decreases gradually from 90% to 50	ACEA (2010)
		The benefit in kind for the private use of a zero-emissions vehicle as a company car is taxed at the lowest rate (€ 500 – 750).	ACEA (2010)
	Public procurement	Wallonia: up to €2 million to buy electric vehicles	EP (2010)
Cyprus	Monetary incentive	30% reduction in registration tax for cars < 120g/km	ETC (2009)
		15% reduction in annual circulation tax for cars <150 g/km	ETC (2009)
		Discount of €683 for purchase of new electric cars	ETC (2009)
Czech Republic	Monetary incentive	Electric, hybrid and other alternative fuel vehicles are exempt from the road tax (this tax applies to cars used for business purposes only)	ACEA (2010)
Denmark	Monetary incentive	Exemption of tax clean cars – compared with up to registration tax of 180% and VAT of 25%	IEA (2011)
		Free parking for electric cars	ETC (2009)
	Infrastructure	Investment of €100 million in collaboration with DONG and Better Place	
	Research	€4 million EV fleet trial programme	ETC (2009)
		€5.6 million R&D - International consortium carries out the EDISON R&D project on intelligent integration of EVs and their optimal interaction with wind power	CE Delft (2009)
France	Monetary incentive	Tax bonus up to €5,000 for cars <60 g/km for the first 100,000 low cars vehicles purchased with a total budget of €400,000	IEA (2011)
		Electric and hybrid vehicles are exempt from the company car tax	ACEA (2010)

		Free parking spaces for EVs	ETC (2009)
	Public procurement	Mass order of 5,000 hybrid and electric cars	
		Public-private procurement programme, intended to procure 10,000 EVs by 2012	ETC (2009)
	Standardisation	National charging network set-up	EP (2010)
	Research	€400 million fund for low carbon R&D and demonstration projects, including €90 million research fund for battery and vehicle technology, and €107 fund for demonstration projects	ETC (2009)
	Stock target	2 million PHEVs/EVs by 2020	IEA (2011)
Germany	Research	€500 million to support pilot projects, research and development of battery technology and vehicles	EP (2010)
		€60 million to support development of battery technology	ETC (2009)
		€20 billion investment in R&D of which a high share will be dedicated to efficient drive technologies and EVs	Westminster (2009)
	Monetary incentive	Exemptions for EVs from annual circulation tax for the first five years from the date of their first registration	ACEA (2010)
		Free inner circle parking	ETC (2009)
	Infrastructure	Berlin: 500 charging stations	ETC (2009)
	Standardisation	Common standard for plugs	ETC (2009)
	Stock target	1 million by 2020	EVUE (2010)
Greece	Monetary incentive	Exemptions from special consumption tax and yearly circulation taxes	EP (2010)
	Non-monetary incentive	Exclusion of circulation restriction in metropolitan areas	EP (2010)
Ireland	Monetary incentive	Exemption of vehicle registration tax until 30 April 2011. From 1 May, they will benefit from VRT relief of maximum € 5,000. Plug-in hybrids benefit from VRT relief of maximum € 2,500 until 31 December 2012. Conventional hybrid vehicles and other flexible fuel vehicles benefit from VRT relief of maximum € 1,500 until 31 December 2012	ACEA (2010)
	Public procurement	10% of national fleet to be electric cars by 2020	ETC (2009)
	Infrastructure	Agreement for ESB to develop a nationwide charging infrastructure	EP (2010)
	Research	€1 million project to research, develop and demonstrate EVs	Westminster (2009)
Italy	Monetary incentive	Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of their first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to equivalent petrol vehicles	ACEA (2010)
	Infrastructure	Lombardy: installation of 270 charging points	CE Delft (2011)
		Enel will set up over 400 charging points as part of the project e-mobility Italy.	CE Delft (2011)
Luxembourg	Monetary incentive	Purchasers of electric vehicles (or other vehicles emitting 60 g/km or less of CO ₂) receive a premium of € 3,000 (PRIME CAR-e) until 31 December 2011. The purchaser must have concluded an agreement to buy electricity from renewable energy sources in order to obtain the premium	ACEA (2010)

Netherlands	Research	Dutch companies will be financially incentivised to invest	CE Delft (2011)
		€10 million of grants for practical testing	CE Delft (2011)
	Public procurement	National and local governments will aim to electrify their fleets as soon as possible	CE Delft (2011)
	Infrastructure	Grid operators have agreed to build 10,000 charging points by 2012	CE Delft (2011)
		Amsterdam: the installation of 45 charging stations, rising to 200 charge points by 2012	Business Green (2010)
	Monetary incentive	Amsterdam: Grants of between €15,000 and €45,000 per vehicle will be made available to cover up to 50 per cent of the additional costs of buying electric vehicles compared with conventional alternatives. Grants of up to €250,000 will be on offer to businesses that commit to buying fleets of 20 electric vehicles or more. Reduced parking charges, reserved parking spaces and priority for residents parking permits.	Business Green (2010)
		Electric vehicles are exempt from the registration tax BPM and from the annual circulation tax. Other vehicles including hybrid vehicles are also exempt from these taxes if they emit less than 95 g/km (diesel) or less than 110 g/km (petrol) respectively	ACEA (2010)
Norway	Monetary incentive	Exemption from car registration tax, VAT or annual car tax	ETC (2009)
		Free parking and exemption from combustion charge	EP (2010)
		Free use of ferryboats and bus lanes	CE Delft (2011)
Portugal	Monetary incentive	Electric vehicles are exempt from circulation tax and registration tax. Hybrid vehicles benefit from a 50% reduction of the registration tax.	ACEA (2010)
		Purchasers of electric vehicles receive a premium of € 5,000 (limited to 5,000 vehicles). They receive an additional incentive of € 1,500 if they have their old car scrapped simultaneously	ACEA (2010)
	Infrastructure	320 charging points by 2010 and 1,300 by 2011	EP (2010)
Romania	Monetary incentive	Electric and hybrid vehicles are exempt from the special pollution tax (registration tax).	ACEA (2010)
Spain	Monetary incentive	Incentives outlined are up 25% of EV cost, with an upper limit of €6000 per vehicle. €72 million are allocated in 2011 and €160 million in 2012	IEA (2011)
		Various regional governments (Aragon, Asturias, Baleares, Madrid, Navarra, Valencia, Castilla la Mancha, Murcia, Castilla y León, Cantabria, Catalunya, Galicia, Pais Vasco, Extremadura) grant incentives of € 2,000 to € 7,000 for the purchase of electric, hybrid, fuel cell, CNG and LPG vehicles. In Andalucia, the incentive is maximum 70% of the investment.	ACEA (2010)
	Stock target	250 000 by 2014 and 2.5 million by 2020.	IEA (2011)
Sweden	Monetary incentive	Rebate of SEK10,000 for EV purchases	EP (2010)
		CO ₂ -based tax system (SEK 10- SEK 15 per gram of CO ₂ emitted above 100g/km)	EP (2010)
		Electric vehicles with an energy consumption of 37 kWh per 100 km or less and hybrid vehicles with CO ₂ emissions of 120 g/km or less are exempt from the annual circulation tax for a period of five years from the date of their first registration.	ACEA (2010)
		For electric and hybrid vehicles, the taxable value of the car for the purposes of calculating the benefit in kind of a company car under personal income tax is reduced by 40% compared with the	ACEA (2010)

UK		corresponding or comparable petrol or diesel car. The maximum reduction of the taxable value is SEK 16,000 per year	
		Exemption from congestion charge in Stockholm	ETC (2009)
		€20 million worth of incentives through 2014 with the aim of reaching 600,000 vehicles by 2020	IEA (2011)
		Infrastructure	EP (2010)
		€1.5 million investment in charging infrastructure	
	Infrastructure	500 charging points by the end of 2010	
		Stock target	IEA (2011)
	Monetary incentive	600,000 by 2020	
		No annual circulation tax <100 g/km	ACEA (2010)
		Purchasers of electric vehicles and plug-in hybrid vehicles with CO ₂ emissions below 75 g/km receive a premium of £ 5,0000 (maximum) or 25% of the value of the vehicle provided they meet a series of eligibility criteria (for example, minimum range 70 miles for electric vehicles, 10 miles electric range for plug-in hybrid vehicles)	ACEA (2010)
		Electric cars are exempt from company car tax for a period of five years from the date of their first registration. Electric vans are exempt from the van benefit charge for a period of five years	ACEA (2010)
		London: Exemption from London parking fees and congestion charge	ETC (2009)
	Public procurement	£20 million procurement programme	EP (2010)
	Infrastructure	London: 25,000 charging points in London with an estimated cost of €60 million	EP (2010)
		London: Dedicated bays for car club EVs in London	ETC (2009)
	Research	£400 million for research and demonstration	EP (2010)
	Stock target	No firm target, but 800,000 has been mentioned in reports	IEA (2011)

AEA group
329 Harwell
Didcot
Oxfordshire
OX11 0QJ

Tel: 0870 190 1900
Fax: 0870 190 6318

