

Towards an effective EU framework for road transport and GHG emissions

Christian Egenhofer, Andrei Marcu, Vasileios Rizos, Arno Behrens, Jorge Núñez-Ferrer, Arndt Hassel and Milan Elkerbout

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Abstract

The adoption of the Paris Agreement at the end of 2015 and the EU's intended nationally determined contribution (INDC) have confirmed the EU's commitment to achieve decarbonisation by 2050. Transport accounts for about a quarter of EU greenhouse gas (GHG) emissions, representing the second-largest source of GHG emissions in Europe after the energy sector. The transport sector will play a significant role in the EU's efforts to decarbonise its economy in line with its international commitments.

The purpose of this report is to examine different EU policy options to address transport emissions, with a special emphasis on passenger cars. It 'thinks through' the options that are currently assessed in the EU and considers how they could be put together in a comprehensive framework. The report concludes with a number of measures to lead EU transport decarbonisation policy. A distinction is made between i) no-regret options and ii) measures for consideration.



The report is based on research conducted by CEPS and on discussions that took place during three stakeholder workshops, at which a wide range of representatives from industry, NGOs and research institutes provided input. CEPS is responsible for the content of this report.

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1. Introduction

In the course of 2016, the European Commission will publish a Communication on the decarbonisation of transport, which will be followed by specific legislation. This Communication will indicate how the transport sector will contribute to achieving the 30% CO₂ emissions reduction objective set for non-ETS sectors until 2030 (compared to 2005) (European Commission, 2014a).

This will require a comprehensive strategy involving numerous European Commission Directorate Generals. The European Commission has indicated that the Communication will focus on three elements: i) improvements in the efficiency of vehicles, including through emissions standards for cars and vans and the review of the test cycles; ii) better management of road transport activity, including modal shift, charging systems and intelligent transport systems; and iii) decarbonisation of fuels, including electrification and alternative fuels.

Currently, transport is in the non-ETS sectors, although elements of transport activities are partially covered by the ETS; namely EU aviation, and rail via the power sector or refining of fuels. There is the option, recognised in the 2014 EU Council Conclusions and part of the EU ETS Directive, of integrating transport into the main pillar of EU climate change policy, the EU ETS.

The transport sector accounts for around one-quarter of EU greenhouse gas (GHG) emissions. Two-thirds of transport-related GHG emissions stem from road transport (European Commission, 2016a). According to rough estimates by the European Commission (2014b), heavy duty vehicles (HDVs),¹ are responsible for about a quarter of EU CO₂ emissions from road transport,² and around 6% of total EU CO₂ emissions. Cars and vans make up the rest, i.e. three-quarters, and around 15% of total EU CO₂ emissions (European Commission, 2016b).

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¹ This refers to trucks, buses and coaches.

² According to ACEA (2016a) HDVs account for about 75% of all land-based freight in Europe.

Emissions from HDVs increased by 36%³ between 1990 and 2010, but those from LDVs have been stabilising. Emissions from urban mobility are estimated to be around 40% of CO₂ emissions from road transport; the remainder stems from long-distance transport (European Commission, 2012).

There are many reasons to make the decarbonisation of passenger transport, i.e. cars and vans, a priority. Cars and vans are responsible for some 15% of EU CO₂ emissions. At the same time, the EU Regulation on passenger cars will need to be revised in line with the 2030 energy and climate framework. The appearance of new electric cars by Tesla, among others, and the expected reduction of battery costs have heightened interest in electrical vehicles. Other technological solutions such as synthetic fuels and natural gas produced by carbon-free electricity, hydrogen or sustainable biofuels are increasingly being examined. The controversy about the performance of the diesel engine and the discrepancy between real-life and test cycle emissions have triggered a debate on the future role of diesel engines.

Heavy-duty vehicles (HDVs) are not subject to the same regulatory framework based on mandatory CO₂ emissions standards. According to the European Commission (2014b), emissions from HDVs have been increasing, mainly due to increased EU freight volumes.⁴ A study by Transport & Mobility Leuven (2014) suggests that trucks have the potential to reduce their CO₂ emissions by around 20% by 2020 as long as all actors contribute to create optimal conditions. In view of the increasing emissions from HDVs, in May 2014 the Commission put forward a strategy to measure and monitor their CO₂ emissions and to improve transparency in the market. Whether this strategy will be enough to drive significant CO₂ emissions reductions from HDVs is uncertain at present, however.

While the regulatory issues regarding cars and vans are different, the two are still linked through fuels and their associated infrastructure. There is a finite number of low-carbon transport technologies at the disposal of the sector. Technological solutions are likely to be different but both freight and passenger technologies may rely on the same infrastructure. This will change the relative costs of technologies and the ease with which they can be deployed.

The 2050 objectives of reducing 80-95% of GHG emissions compared to 1990 will require a comprehensive strategy, broadly supported by stakeholders. In particular, it will require proactive government policy to provide incentives for technology development and deployment in a competitive way, and to guarantee the enabling conditions, notably infrastructure and the internal market. Given the uncertainties of technological developments, the strategy, while comprehensive, will require flexibility to incentivise and capture the benefits of different

³ These should be considered as very rough estimates due to the limited availability of official historical data for CO₂ emissions from HDVs (European Commission, 2014b).

⁴ ICCT (2015) indicates that the efficiency of HDVs in the EU has not improved in more than a decade.

technologies. A crucial question will be how emissions standards will interact with other instruments to drive cost-effective decarbonisation and technological change.⁵

The purpose of this report is to examine different EU policy options to address transport emissions, with a special emphasis on passenger cars. It ‘thinks through’ the options that are currently discussed and discusses how they could possibly be put together in a comprehensive framework. It makes a twofold distinction:

- no-regret options,
- measures for consideration.

The report is guided by the principle that any EU policy will need to achieve the necessary emissions reductions to meet EU medium and long-term targets, and achieve this in a cost-effective way. It should also ensure that the EU industry will be able to maintain or strengthen its competitiveness.

2. Decarbonising transport after the Paris Agreement

This global agreement on climate change in Paris in late 2015 has given new impetus to the decarbonisation agenda. In parallel, technology advances open up new policy options. Low-carbon transport may also provide important co-benefits in terms of local pollution, health or economic benefits.

Low carbon transport after the Paris Agreement

The adoption of the Paris Agreement at the end of 2015 and the EU’s intended nationally determined contribution (INDC) have confirmed the EU’s commitment to a reduction in domestic greenhouse gas emissions of at least 40% by 2030 and by 80 to 95% by 2050, compared with 1990 levels. The Paris Agreement also includes an obligation to review its INDC every five years, with the intention to globally increase the ambition level. The EU’s objective will be achieved collectively on the basis of shared responsibility between the EU and its member states.

The European Council in October 2014 has given guidance by inviting the European Commission to examine a “comprehensive and technology neutral approach” while making reference to renewables, electric transport and fossil fuel dependence. It reiterates the possibility offered by the existing legal framework to opt transport in to the ETS. There are ample references throughout the European Council conclusions of where cost-effectiveness, fairness and flexibility are mentioned.

With a few exceptions road transport is currently included in the Effort-Sharing Decision (ESD). This leaves member states free to choose the sectors of the economy that will have to reduce their GHG emissions. This flexibility finds its limits when it comes to cross-border effects, however, notably related to the internal market. Emissions standards, labelling, fuel quality and infrastructure require at least a coordinated approach. In its pre-Paris

⁵ This question has been analysed in a CEPS Task Force Report named “Pathways to Low Carbon Transport in the EU” (Bleijenberg et al., 2013).

communication, the European Commission (2015a) has suggested making use of international allowances, should additional efforts be needed, and avoiding additional commitments for sectors not covered by the ETS.

In previous documents, the European Commission (2011) has suggested that emissions from transport could be reduced to more than 60% below 1990 levels by 2050.

Technology developments

In the short term, progress can still be made through improving the efficiency of the internal combustion engine (ICE), hybridisation, advanced biofuels, weight reduction, reduced resistance (surface and air), intelligent transport systems (ITS) including eco-routing and eco-driving. But this will require a closing of the gap between real-life emissions and those measured in the test cycle. Otherwise emissions reductions will remain statistical, largely unrelated to existing real-life conditions.

In the medium to long-term, hybrid, plug-in hybrid and electric cars could allow for steeper emissions reductions. Current barriers to the deployment of electric vehicles are cost, low range, and lack of infrastructure and consumer acceptance. A key element will be the development costs of batteries, but, as shown in section 4, there is evidence that these costs have been falling rapidly.

The range of hybrid technologies spans from low-level hybridisation (non-plug-in) to plug-in hybrids. They provide significant potential for reducing GHG emissions, while not facing some barriers (range and infrastructure) of EVs. The lower level of hybridisation (non-plug-in) achieves comparable life-cycle emission reductions to both plug-in hybrids and EVs, because of emissions related to the current power generation mix and higher vehicle weight of the latter (Hawkins et al., 2012; Onat et al., 2015). With a number of studies concluding that the total cost of ownership (TCO) is already similar to or lower than ICE vehicles (e.g. Bubeck et al., 2016), one of the remaining challenges for mild hybrid vehicles is customer acceptance.

Another medium-term option is biofuels with a positive effect on GHG emissions, including ILUC.⁶ This is generally associated with advanced bio-fuels.⁷ Biofuels may be an option for aviation and road haulage, as not all heavy duty vehicles are expected to fully run on electricity, at least in the short term (European Commission, 2015b). Regarding costs, it seems that several technologies, such as some advanced biofuels, would be competitive on the basis of full life-cycle accounting. This would require the accounting of full costs for all types of energy used in the transport system, including fossil fuels, however. A major issue is scale and most studies put the potential contribution of biofuels far below 10% of EU fuels demand. According to some industry estimates, industry would struggle to produce more than 5% of

⁶ This refers to indirect land-use change.

⁷ The European Industrial Bioenergy Initiative (2014, p. 2) created under the Strategic Energy Technology (SET) Plan describes advanced biofuels as “biofuels typically produced from non-food/feed feedstocks such as woody biomass, wastes and residues (i.e. wood, wheat straw, municipal waste), non-food crops (i.e. grasses, miscanthus) or algae”. In addition, they have low CO₂ emission or reduce GHG emissions and reach zero or low ILUC impact.

EU demand if one takes the need to ramp up production facilities to large-scale industrial production.

Another option could be natural gas vehicles, which constitute an option for heavy duty vehicles. Passenger cars fuelled by natural gas have been around for a long time but have not managed to penetrate the European market without tax breaks. In light of the long-term reduction targets, natural gas can only be a transition fuel, unless it is produced carbon free, e.g. by substitute natural gas produced from a power-to-gas (P2G) process (see Annex II).

In the longer run, i.e. beyond 2030, hydrogen fuel cells vehicles could become an option.

It is very unlikely that there will be one single winning technology, not even in the long term. The decarbonisation of different modes such as passenger or freight, but also of urban and long-distance transport, will likely rely on a variety of technologies and fuels. This will mean that the policy framework will need to be technology-neutral, yet reward low-carbon solutions. It will also require flexibility to support all low-carbon solutions while accounting for technological change. Policy should also account for societal co-benefits of technologies, such as reduction of noise and air pollution health impacts, balance of payment impacts.

A report commissioned by the European Commission (DG Move) finds that Europe is lagging behind in most of the alternative fuels such as electricity, CNG, LNG, ethanol or hydrogen (Ecofys & PWC, 2016).

Reductions will also occur through a better transport system and alternative mobile solutions. Existing ones are rapid transit systems, cycling and walking, urban planning, ICT, efficient modality, green logistics or by getting the transport prices right. There might be new potential in the digitalisation of transport and energy, e.g. by the sharing economy of connected cars.

Reducing imported oil

The total cost of ownership can be discussed in relation to the positive impacts of reducing oil demand for transport, which would mean reducing dependence on exporting countries and generating economic returns from the 'savings', e.g. in the White Paper on transport by the European Commission (2011). Often, the benefits of reducing oil dependency are presented as a financial saving. At face value this is quite impressive. In 2012, the EU 28 imported €295 billion in oil products and exported only €5.6 bn (Eurostat, 2016). This is a considerable share of the total value of imports in goods (€1,700 bn).⁸

While the reduced imports from fuels may be a direct financial saving, what matters is the return in investment of the money saved in alternative uses. Fossil fuels are used to generate goods worth a multiple of the cost. If the alternatives are less efficient, benefits may be forgone. The overall impact may be difficult to estimate, as factors such as the impact of externalities (if any), and positive impacts on health, need to be factored in.

⁸ This information is available on the database of DG Trade: <http://tinyurl.com/hqokpkv>.

3. Lessons learnt from the previous policy cycle

Standards can deliver tangible results

Passenger cars have been subject to mandatory CO₂ emissions standards since 2009. The EU Regulation on passenger cars (Regulation (EC) No 443/2009) set a 2015 target for average CO₂ emissions from new passenger cars at 130 grammes of CO₂ per kilometre (g/km), phased in from 2012. The Regulation on passenger cars was revised in 2014 and amended with a tightened average target of 95 g/km to be achieved by 2021, phased in from 2020. Actual emissions levels – according to the measurement of the actual test cycle – seem to suggest that these standards work effectively. The 2015 target had already been achieved in 2013 and average CO₂ emissions of new passenger cars decreased to 123.4 g/km in 2014. Since the start of monitoring in 2010 under the current legislation, average CO₂ emissions have decreased by 17 g/km or 12%.

Target achievement has been facilitated by several flexibility mechanisms introduced in the EU regulation on passenger cars. These include phase-in periods, an emissions factor for heavier vehicles, super credits for low-emissions vehicles, credits for innovative technologies, targets for smaller manufacturers, the possibility for manufacturers to act jointly in groups to meet the target, and an excess emissions premium of up to €95 per g/km if the target is not met. This penalty would represent a carbon price of several hundred euros per tonne of CO₂.

An increasing gap between real-world and official CO₂ emissions

Despite the notable successes of the progressive tightening of EU CO₂ emissions standards, evidence suggests that in reality the magnitude of the achieved emission reductions is not as high as indicated by official statistics. In particular, the CO₂ and pollutants levels of cars are determined through the type approval test procedure, which measures emissions under laboratory conditions using a legislative driving cycle i.e. the New European Driving Cycle (NEDC). The targets for cars for 2015 and for 2021 rely on the results obtained through the NEDC. However, in recent years a number of studies question whether the results of the laboratory test can be translated into real driving emissions. For example,⁹ in assessing data for 600,000 vehicles across the EU, ICCT et al. (2015) estimated that the gap between test results and real-world performance has been increasing steadily and reached 40% in 2014. This growing gap might undermine the EU's efforts to reduce the CO₂ emissions of passenger cars.

A number of reasons have been put forward to explain the deviations between real world CO₂ emissions performance and values obtained in the laboratory. The NEDC was originally designed as a means to assess pollutant emissions rather than a system to accurately measure fuel consumption¹⁰ and CO₂ emissions in real-life driving conditions (ICCT et al., 2013). As such, the test cycle includes some flexibility that can be utilised to achieve lower CO₂ values in

⁹ See also: Fontaras & Dilara (2012); ICCT (2012); ICCT et al. (2013).

¹⁰ The NEDC also provided some basic figures for fuel consumption but mainly for consumer information reasons.

the laboratory (Kadijk et al., 2012). One example is road load¹¹ determination, which provides flexibility for adapting several key parameters such as types of tyres, tyre pressure and ambient test conditions (e.g. humidity, air temperature and pressure). In addition, there is a tendency for some specific technologies with an increasing market share, including stop-start systems¹² and hybrids, to exhibit lower emissions under the NEDC than on the road (ICCT et al., 2015; ICCT et al., 2013). Finally, external factors such as air conditioning systems and vehicle accessories are not fully considered in the test cycle (Fontaras & Dilara, 2012).

Standards only work if embedded in a comprehensive and robust framework

Emissions standards have worked to date for CO as well as for NO_x and particles, although these air pollutants are *technically* different from CO₂. The difference is that NO_x and particles from combustion¹³ can be removed by end-of-pipe technologies. CO₂ is a necessary result of the combustion in the internal combustion engine fuelled by fossil fuels. The functioning from a regulatory perspective is similar, however. The tightening of standards will incentivise all reduction options; first combustion efficiency and then, gradually speed up the deployment of new low-carbon technologies and fuels, such as vehicles running on low-carbon electricity, hydrogen, compressed natural gas or sustainable biofuels. A pre-condition is that standards are realistically achievable and that they respect the principle of technology neutrality.

Standards have also proven to overcome barriers in investing in fuel economy that would be profitable from a societal and a consumer perspective, e.g. by avoiding wasteful fuel use. Setting standards for vehicle efficiency and fuels allows car manufacturers to anticipate the direction of future standards and thereby creates regulatory certainty for product developers and manufacturers. Pro-active deployment policies can help to bring costs down, as we have seen with renewable technologies, making them competitive with existing technologies, i.e. wind and solar.

The risk is that standards – if they go beyond the technological frontier – can push deployment of immature and inefficient technologies or that the market does not take up the technologies, e.g. either because they are too costly or (EU and global) customers do not see sufficient benefit in buying it.

In the case where standards push alternative technologies, the policy can only work if the accompanying measures, notably on infrastructure and a full-functioning barrier-free internal market for low-carbon power trains or R&D, are put in place, e.g. sufficient charging stations, compatibility of cross-border infrastructure, aligned incentives etc. This requires pro-active

¹¹ The road load refers to the total resistance to vehicle movement. In order to calculate this value, a series of tests is performed in an outside truck to determine the vehicle's aerodynamic and rolling resistance (ICCT et al., 2015; ICCT, 2013).

¹² This refers to a technology that automatically turns off the engine when the vehicle is at a standstill (e.g. in a traffic light). Under the NEDC this technology accounts for considerable CO₂ emission reductions since the testing system assumes a high frequency of idling (around 25%) which is not the case for the average driver and especially for those who travel on highways (ICCT et al., 2013).

¹³ This is, however, not valid for non-exhaust particulate emissions (from breaks, tyres etc.), which appear to almost equally contribute to total particulate matter emissions (JRC, 2014).

policies as well as an integrated and comprehensive strategy at EU, member state and regional and local level.

We have also seen that the role to incentivise technological change has been weakened by a test-cycle where real emissions continued to deviate from the measured and quoted emissions.

Current biofuels policy may have increased emissions

Supported since 2003, under the current framework biofuels are affected by two binding targets for 2020: a share of 10% of renewable energy in the final energy consumption of the transport sector and a reduction of 6% in the life cycle GHG emissions of transport fuels. These policies drove biofuels to a share of 5.9 % of final energy consumption in transport in 2014. According to legal requirements, only biofuels and bioliquids that meet sustainability criteria can be counted towards these targets.

The recent ‘Globiom’ study (Ecofys et al., 2015) suggests that indirect land-use change (ILUC) emissions tied to EU biofuel policy are higher than previously thought. It claims first generation biofuels’ ILUC emissions to be in the order of magnitude of conventional fuels’ well-to-wheel emissions with bioethanol performing better than biodiesel. As a consequence, most of the biofuel currently in the market would fail to meet binding EU sustainability requirements, a large portion even having a negative effect on net emissions. Advanced (or second generation) biofuels produced from wastes, residues and alternative crops can deliver the effect of GHG reduction that first generations fuels reportedly lack. A study by ECF et al. (2014) assessed a theoretical waste and residues potential for biofuels (without advanced crops) of 16%, albeit indicating the economic potential to be much lower.

The EU sustainability criteria demand that biofuels save at least 35% of GHG emissions¹⁴ as compared to fossil fuel. The methodology for the calculation of lifecycle emissions¹⁵ considers, among other sources of emission, indirect land-use change emissions, i.e. net emissions resulting from an altered ground-atmosphere metabolism after a change in land-use to fuel crop cultivation. These were estimated to be significant by the 2011 ‘Mirage’ study (IFPRI, 2011), which led to an amendment of biofuels legislation in 2015 limiting the contribution of biofuels to the transport target to 7%. The more recent ‘Globiom’ study claims ILUC emissions of first-generation biofuels consumed in the EU to be more than twice as high as the ‘Mirage’ study suggests. Specifically, biodiesel crops were exceeding well-to-wheel emissions of conventional diesel by 35%. Bioethanol ILUC emissions were amounting to 22% of well-to-wheel emissions of gasoline from fossil fuel.

Transport & Environment (2016) calculates that, if direct emissions occurring during the biofuels lifespan (during cultivation, processing, transport, distribution) are added to the new values for ILUC emissions, all of the first-generation biodiesel and some of the bioethanol currently in the system do not meet the sustainability requirement of 35% GHG savings. Biodiesel from virgin vegetable oil, which currently takes 70% of the EU biofuels market,

¹⁴ 50% in 2017, 60% in 2018.

¹⁵ Both Fuel Quality Directive (2009) and Renewable Energy Directive (2009).

would even lead to 80% higher emissions than conventional diesel. According to Transport & Environment, the average bioethanol achieves a GHG benefit over gasoline of 30%, which is also lower than the sustainability criteria requirement. Since biodiesel both holds the largest share in the biofuels market and emits considerably more GHG than diesel of fossil origin in the named studies, current biofuels policy may be increasing emissions, instead of lowering them.

Fuels quality policy

The carbon content of fuels has been addressed by the Fuels Quality Directive. This directive requires fuel suppliers to reduce the life-cycle GHG emissions of fuels per unit of energy they put on the market.¹⁶ The fuel suppliers are free to choose how to achieve these targets, e.g. to use more biofuels or alternative fuels, or to decrease their emissions by reducing flaring and venting at production sites (upstream) outside Europe. Following controversy over the question of whether differentiated values for the carbon-intensity of different (imported) crudes can and should be accounted for, legislation was amended whereby differentiated values for crudes were replaced with a default value. This means that the upstream emissions, i.e. from production, are not addressed. The Fuels Quality Directive in its current form incentivises measures within the EU once the crude has been imported, however. This could be strengthened by better linking incentives for vehicle and fuels decarbonisation, as described in chapter 5.

4. Transport in the 2030 framework and beyond

On the basis of the EU's intended nationally determined contribution (INDC) and the European Council Conclusions of October 2014, there is little doubt that the principle objective of EU transport policy is to reduce GHG emissions in line with EU short- and long-term targets. EU policy will have to ensure that the envisaged emission reductions required to meet the EU 2030 targets will be achieved. The current approach whereby the specific (carbon) efficiency of engines is regulated while transport volume is not will therefore have to give way to an approach whereby absolute emissions are controlled.

In discussing the post-2021 framework, all options should be on the table and considered on merit. Some will be discarded, as they present significant implementation challenges, or are faced with political realities.

One option, according to the European Commission, is that the EU transport strategy will focus on the efficiency of vehicles, decarbonisation of fuels and better management of road transport activity. Efficiency standards for vehicles will continue to play a major role. Inclusion in the EU ETS is another option, currently in the EU ETS Directive, and recalled in the EU Council Conclusions of Oct 2014. However, the challenges of this option, while changing, are

¹⁶ This will require a (mandatory) reduction of at least 6% compared to the EU-average level of GHG emissions in 2010, with interim targets for 2014 and 2017.

also formidable and cannot be ignored. The third option would be a combination of both options.

Reduction requirements and potentials

The Impact Assessment accompanying the 2030 framework proposal analyses a number of different scenarios to assess the impact of different options for setting headline targets. According to the Reference scenario, a full implementation of policies adopted by late spring 2012, including the 2020 targets for cars and vans,¹⁷ would result in an estimated reduction in emissions from transport of 9% between 2010 and 2030.¹⁸ Thereafter, emissions would remain virtually constant. However, in other assessed scenarios, more ambitious EU policies¹⁹ that could help Europe meet the 40% GHG reduction objective in 2030 could bring down emissions from transport by about 20% by 2030 and by around 65% by 2050 (European Commission, 2014c). A previous CEPS multi-stakeholder Task Force (Bleijenberg et al., 2013) has concluded that this would require a comprehensive policy strategy to provide confidence for product developers and manufacturers and other stakeholders.

Should the policy work, the principle elements of such a comprehensive strategy are the following, which would need to be implemented as a package:

- Emissions standards to drive the efficiency of existing and the deployment of new technologies;
- A realistic and robust test-cycle that reflects actual emissions, based on the real carbon footprint of fuels, and reduces the possibility for ‘creative accounting’;
- A comprehensive strategy at EU and member state level to build the required infrastructure for low-carbon alternative power trains;
- An evidence-based biofuels policy;
- A technology policy that is neutral in principle, with deviations only if justified to address network effects or if investments for private investors are too risky
- An optimised transport system to allow new transport solutions to develop.

According to a literature review conducted by CEPS for this paper,²⁰ there seems to be no single winning technology in the short term. This means that it is likely that different technologies may coexist warranting a technology neutral policy approach to decarbonisation of EU transport. The development of technologies will follow a different and (to a varying degree) uncertain timeline.

¹⁷ This scenario assumes that standards remain constant beyond 2020.

¹⁸ A study by Roland Berger (2016) estimates that maintaining the existing vehicle efficiency and fuels regulations to 2030 can achieve emissions reductions of 29%. Notably, this study assumes a significant contribution by biofuels.

¹⁹ In these scenarios standards could reach 70gCO₂/km in 2030 and between 25 and 17 gCO₂/km in 2050.

²⁰ See Annex I for the list of reviewed studies.

The total cost of ownership (TCO)²¹ of new technologies is one of the factors affecting consumer vehicle choice²² and thus plays an important role in the large-scale adoption of new vehicle technologies (Amsterdam Roundtables Foundation & McKinsey & Company, 2014). Recent studies suggest that the battery costs, which are an important component of the TCO, have been declining in recent years. For example,²³ using data from the US Department of Energy and other sources, IEA (2016a) estimates that the battery costs of PHEVs²⁴ decreased from \$1,000/kWh in 2008 to \$268/kWh in 2015, representing a decrease of 73%.²⁵ Technology learning, R&D and mass production were the main reasons for this estimated decrease in battery costs. It should be noted, however, that electric vehicles currently receive significant policy support in Europe in the form of purchase incentives and tax exemptions, among others.

Low-carbon technologies, such as electric vehicles, provide benefits to society beyond avoided fuel costs, e.g. reduced costs of climate change, noise and air pollution etc. As such, it seems advisable to compare costs of low-carbon technologies across the multiple societal co-benefits that go beyond CO₂ abatement.

Even if total costs of ownership are reduced and become competitive with the internal combustion engines, consumer uptake of EVs and plug-in hybrids might still be limited. Reasons given are performance, range and lack of adequate infrastructure. EVs tend to be second cars or part of company fleets. A lower hanging fruit would be non-plug-in hybrid vehicles, which achieve similar emission reductions and do not face range or infrastructure barriers.

To date, it appears that EVs and plug-in hybrid vehicles are most attractive in urban areas. This is in contrast to the fact that most emissions occur in long-distance transport, where electrification is not necessarily the solution. Focus on electrification should also not undermine the development of new urban mobility solutions.

Another technology would be advanced biofuels with full life-cycle accounting. However, the scale for advanced biofuels is limited, and is generally estimated to be below 10% of total EU fuels demand. Some studies put it as low as around 5%.

A third low-carbon technology could be what is called power-to-gas (P2G) (see Annex II for more details). Power-to-gas could provide hydrogen from renewable electricity for fuel cell vehicles or substitute conventional fossil fuels (gas or liquids) when a sustainable carbon

²¹ The TCO comprises the vehicle's purchase price, maintenance, fuel, and infrastructure costs over the lifespan of the vehicle (Amsterdam Roundtables Foundation & McKinsey & Company, 2014).

²² Some studies have suggested that the vehicle operating costs, which are part of the TCO, are not decisive in shaping consumer vehicle choice, see, for example, Hagman et al. (2016).

²³ See also: Nykvist & Nilsson (2015); Amsterdam Roundtables Foundation & McKinsey & Company (2014).

²⁴ This refers to plug-in hybrid electric vehicles.

²⁵ According to IEA (2016a), the stock of electric cars across the globe amounted to 1.26 million in 2014, almost doubling the number of cars in stock during the previous year. The majority (80%) of electric cars can be found in the US, China, Japan, the Netherlands and Norway.

source is provided. To date scale is limited, but theoretically it can be scaled to cover transport fuel demand.

Emissions standards

To date emissions standards are uncontroversial if they overcome barriers to investment in fuel economy, which is profitable both from a societal and a consumer perspective. This has been largely the case in the past where vehicle technology efficiency has improved due to regulation. This might change if standards incentivise a transition to new – low-carbon – technologies, such as electric or hydrogen vehicles. Demand driven by regulation represents the risk that consumers do not take up new technologies. Different low-carbon technologies also have different time lines; technological breakthroughs cannot be predicted, as we have seen in the case of renewable energy.

One way such uncertainty is typically addressed is via flexibility mechanisms. The current regulation on passenger cars envisages various flexibility mechanisms such as phase-in periods, an emissions factor for heavier vehicles, super credits for low-emissions vehicles and credits for innovative technologies. There might be a need for additional flexibility mechanisms, for example allowing for transfers of reductions in one technology to another. This would allow companies to pursue their preferred strategies. Inclusion into the EU ETS – analysed in chapter 5 – is one of the flexibility options.

Another option is penalties for car manufacturers in the event of temporary non-compliance with standards, as happens today. The disadvantage of today's penalty rate of €95 per gramme is that it might force cars onto the market, for which no demand exists. Unless governments provide incentives for purchase, car companies lose out. A penalty closer to the cost differences between the total cost of ownership of different technologies, as discussed in the previous section, would incentivise the accelerated deployment of technologies where the cost differences are lower. This reduces the level of government subsidies and thereby reduces the societal costs of deploying low-carbon technologies. The penalty rate could also be linked to (a multiple of) the EU Allowance price under the ETS.

Such a system could be combined with the possibility of a choice between deploying low-carbon vehicles, paying the penalty or investing in low-carbon infrastructure. Car manufacturers would have the choice to offset the non-compliance by investing in low-carbon infrastructure such as EV charging stations, hydrogen or natural gas fuelling stations.

Finally, as car manufacturers choose different technology strategies, they could be allowed to offset the emissions in one technology by achieving tighter emissions reductions in another, for example calculated on the basis of a conversion factor.

Irrespective of the above, emissions standards only work if they are associated with a robust test cycle.

A new test procedure in the 2030 framework

A significant body of evidence points to a growing gap between official test results obtained through the NEDC test procedure and real world emissions. The European Commission is

therefore planning²⁶ to introduce²⁷ a new test procedure, named ‘Worldwide harmonized Light vehicles Test Procedure’ (WLTP), which has been developed in the framework of the United Nations Economic Commission for Europe. This new testing system is expected to better reflect real-world driving. Compared to the NEDC, the WLTP includes a more precise definition of the key physical parameters²⁸ determining the road load of a vehicle, enhanced methods and new algorithms to correct the measurement results for parameters influencing fuel consumption and CO₂ emissions, improved testing technologies and new methods for calculating the CO₂ emissions from electric vehicles and hybrids (ICCT, 2013; ICCT, 2014a). ICCT et al. (2015) estimate that the introduction of the WLTP can decrease the divergence between the values obtained through the test procedure and real-world emissions to 23% by 2020. By contrast, under the NEDC this divergence would further increase and would reach around 49% in 2020. Hence, there would still be a gap between real-world emissions and those measured through the test procedure.

From this analysis, it seems that a robust monitoring system of the gap between real emissions and those measured under the test-cycle is warranted.

A real EU infrastructure policy creating a barrier-free internal market

A precondition for the deployment of low-carbon vehicles is the availability of infrastructure for low-carbon technologies. This would require the construction of infrastructure for plug-in hybrid and electric vehicles but also gas for passenger cars and trucks, should the potential for P2G be confirmed, and hydrogen. The cost of necessary infrastructure would vary for each of the technologies.²⁹

The 2014 directive on alternative fuels holds limited binding commitment for member states other than ensuring the development of common technical specifications for recharging and refuelling stations. The directive envisages that member states adopt a national policy framework for the development of alternative fuels infrastructure, including national targets and objectives. This leaves the responsibility to develop the required infrastructure to member states; at this moment it is uncertain whether this framework will be able to overcome the gap of adequate infrastructure for alternative fuels. Countries in other parts of the world seem to be making more progress than Europe. In January 2015, Bloomberg (2015) reported that Japan

²⁶ The introduction of a new test procedure is requested by Regulation (EU) No 333/2014 amending Regulation (EC) No 443/2009 to define the modalities for reaching the 2020 target to reduce CO₂ emissions from new passenger cars.

²⁷ On 14 June 2016, the technical regulatory committee gathering member states representatives (Technical Committee of Motor Vehicles) voted in favour of the Commission's draft Regulation to introduce the WLTP in the EU. If the European Parliament and the Council do not object to the current text, the new WLTP test will be mandatory for all new vehicle types from September 2017 and for all new vehicles from September 2018.

²⁸ This refers to mass, aerodynamic drag, and rolling resistance.

²⁹ Infrastructure costs could be lower for substitute natural gas (SNG) from P2G, than for hydrogen and EVs, utilising the existing gas grid and compressor/tank-assemblies retrofitted to gas stations.

has more chargers for electrical cars than for petrol and diesel, which however seems to include also private chargers.

The alternative fuels directive also addresses the internal market issues, i.e. the barrier-free cross-border market for all forms of low-carbon fuels. Such a strategy will require a significant improvement in the number of charging and refuelling stations. Experience with the current directive seems to suggest that a more proactive EU-wide approach is required.

Member states could accelerate this by committing to the creation of cross-border corridors (e.g. Derdevet, 2015), as for example proposed by the French-Spanish-Portuguese initiative launched in November 2015 in Madrid (ERDF, 2015). These corridors could then be linked up to speed up the development of a pan-European low-carbon network.

The deployment of EV charging stations, hydrogen or natural gas stations could be accelerated if car manufactures could off-set the non-compliance with investment in infrastructure.

An evidence-based biofuels strategy

Advanced biofuels, i.e. biofuels that are not food-based, perform better than first generation biofuels, with low or even negative ILUC emissions (see for instance the Globiom Study by Ecofys et al., 2015). According to Transport & Environment (2016), when direct emissions are added, the lowest scoring advanced biofuel crop assessed has over 60% benefit over fossil fuel and the average emission of the assessed advanced crops is negative. A relevant and complementary study by ECF et al. (2014) estimates benefit values of around 80% for lifecycle emissions of advanced biofuels from wastes and residues, which exploit the effect of neutralising otherwise emitted methane, a GHG more harmful to the atmosphere than carbon dioxide. Reportedly, (sustainably sourced) wastes and residues could technically cover up to 16% of road transport fuels by 2030, not including the cultivation of advanced crops. This number would, however, decrease under aspects of economic feasibility, due to high costs and competitive uses. A share of 2% covered by second generation from wastes and residues by 2020 was seen in the study by ECF et al. (2014, p.26) as “less challenging”. To exceed the limitation of scale of wastes and residues, the deployment of advanced fuels from advanced (low-ILUC) crops would be necessary.

According to the latest IEA (2016b) report on energy technologies, advanced biofuel technology is at a pivotal stage of development. Worldwide, ten commercial plants have been deployed. Reportedly, the most cost-efficient advanced biofuel production technologies would become competitive at an oil price in the range of \$100-130 bbl, without subsidy. Research and development, and further support, especially for biofuels from low-ILUC crops, are necessary to bring costs down and increase scale.

A truly technology-neutral policy

There is consensus that government incentives such as standards, tax incentives or labels should be technology-neutral to enable the market to identify the most efficient technology. Governments are generally wary, with good reason, about engaging in technology-specific support by ‘picking winners’, because, among other problems, the record of such policies is generally considered to be poor.

An exception for research & development (R&D), demonstration and in some – well-defined – cases, early deployment is generally accepted, as long as they keep all promising routes open. However, some (low-carbon) transport technologies have network effects, i.e. require dedicated infrastructure³⁰ or investment in technologies that can be too risky for private investors because of time horizons (e.g. hydrogen). Technology-specific public intervention may also be justified to reap the scale effects of new technologies (e.g. battery costs), if indeed scale effects are physically and economically within reach.

The reality in the EU is different, however. Diesel enjoys a tax break, for example compared to petrol. According to Transport & Environment (2015), this tax break amounts to €27 bn per annum. In some member states, natural gas enjoys tax breaks. Similarly, first-generation biofuels where the environmental benefit has not been proved enjoyed technology-specific support. Super-credits, although abolished now, have credited low-carbon vehicles more than once. Weight-based CO₂ standards – although justifiable as a flexibility tool for a transition period, have benefited larger cars to the detriment of smaller ones.

Technology-specific measures should therefore be abolished.

Optimising the transport system

There have been continuous attempts to reduce transport growth by better management and measures such as the increase of vehicle load factors or attempts to shift the modal split. Generally speaking, they have had limited effect. In practice, policy has struggled to change trends that are rooted in economics and consumer preferences. Effective policy measures that would change trends are difficult, if not impossible, to adopt because of political opposition (Bleijenberg et al., 2013).

Nevertheless, a number of measures such as ICT and eco-driving support systems, efficient co-modality, especially if designed at European scale, green logistics, transport taxation, or optimisation of infrastructure construction, management and operation can bring reductions.³¹ Still, without low-carbon technologies (vehicles and fuels), they will be largely insufficient to address the challenge (ibid.).

Leveraging standards by member states and local governments

Of particular importance for this optimisation will be the role of member states, regional and local governments. Their action will be essential to reinforce the incentives by member state, regional and local strategies. This optimisation will also require that incentives are aligned with carbon efficiency, among others doing away with environmentally harmful subsidies.

Incentives from emissions standards can be leveraged by member state and local governments, on condition that the *structure* of incentives – not the level – is aligned across the EU, i.e. that vehicles are defined, e.g. by labelling across Europe in a harmonised way according to carbon-

³⁰ Examples are charging stations for EVs, hubs and loading stations for co-modality of systems for seamless transfer.

³¹ See, for example, Bleijenberg et al. (2013); ACEA (2016b).

efficiency, or whatever metric is chosen. Incentives should be consistent with EU objectives on low-carbon transport (i.e. technologies and fuels) in a non-discriminatory manner (i.e. technology-neutral).

- Fiscal or financial incentives such as taxation are powerful complementary tools in the hands of member states, regional or local governments to accelerate the market penetration of vehicles and components with higher efficiency and a lower carbon footprint, adapted to local preferences and circumstances. The best examples are taxes on vehicles. Only recently have such taxes been differentiated according to vehicle fuel economy or CO₂ emissions.
- Another powerful instrument is CO₂ differentiation of the fiscal treatment for company cars. Company cars in Europe are a huge market. Each year, European companies buy about 50% of all new cars sold in the EU, including cars used in the course of business, such as hire cars or taxis, and pooled cars that are not available for employees' private use, i.e. fleet management. This would have a spill-over on the second-hand market, which largely consists of ex-company cars.
- Consumer information, including labelling, is meant to influence the car-purchasing decisions of consumers selecting a fuel-efficient vehicle, even if fuel costs are only a very small part of the full-life costs of ownership. A precondition is that European rating systems do not provide contradictory information about the emission performance of the same vehicles, according to member states.

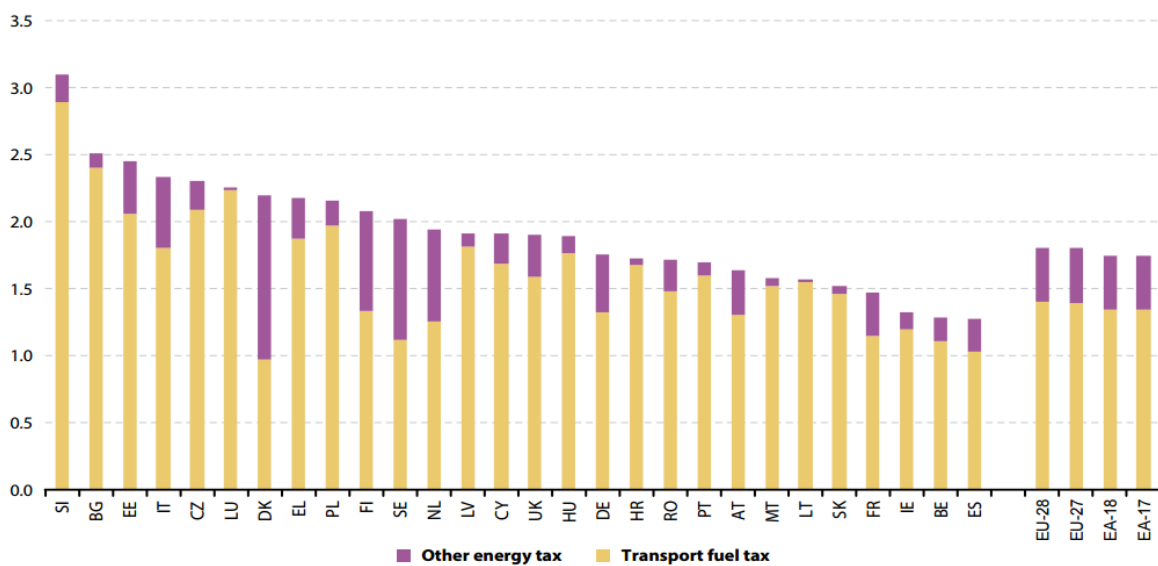
Addressing government revenues from fuels taxation

The other particularly important field is fuel taxation. Fuel taxes provide incentives to shift to more fuel-efficient vehicles, at least over time, although purchase, ownership or circulation taxes are generally considered to be more effective in providing incentives for a shift to more fuel-efficient vehicles (see for an overview Bleijenberg et al., 2013).

Increasing vehicle efficiency will reduce fuel tax revenues for governments in absolute terms and this risks a gradual weakening of the incentives stemming from fuel taxation. Maintaining the fuel tax related incentive for more fuel-efficient vehicles will therefore require adapting the level of fuel taxes. Additionally, in conjunction with adapting fuel taxation, the gradual application of road pricing could also offset the potential revenue losses due to more efficient vehicles, and maintain the purchasing power of the consumer. This approach would affect all vehicles in the same way and would be in line with the EU objective of all sectors paying the full marginal cost. While this is a policy option, at least in theory, it is not clear whether such a policy is politically feasible.

Figure 1 shows the revenues from transport fuel tax and other energy taxes as a percentage of GDP by member state. Although their importance as a share in GDP is not great, the share of transport fuel tax as a percentage of tax revenue reaches 8.6% in Bulgaria compared to 2% in Denmark (the weighted average of the EU 28 is 3.6%) (Eurostat, 2014).

Figure 1. Energy tax revenues by member state, 2012 (% of GDP)



Source: Eurostat (2014).

Including transport in the ETS?

Most transport sectors, including road transport, are currently included in the residual Non-ETS climate policy framework, covered by the Effort-Sharing Decision (ESD). Another way to look at this is that Road Transport (as well as all other transport, except domestic aviation) is *not* included in what is politically advertised as the EU's central pillar of its climate policy; the EU ETS. Nevertheless, as discussed below, over the years there have been frequent discussions on whether (road) transport should become part of the EU's 'flagship' climate policy.

5. Transport and the ETS

Most transport sectors, including road transport, are currently included in the residual Non-ETS climate policy framework, covered by the Effort-Sharing Decision (ESD), except aviation.³² Road Transport (as well as all other means of transport, except domestic aviation) is *not* included in what is the EU's central pillar of its climate policy: the EU ETS.

According to the European Commission EU transport strategy will continue to focus on efficiency of vehicles, decarbonisation of fuels and better management of road transport activity. Efficiency standards for vehicles will continue to play a major role. Inclusion in the EU ETS is another option, currently in the EU ETS Directive, and reminded in the EU Council Conclusions of Oct 2014. However, the challenges, while changing, are also formidable and cannot be ignored. The third option would be a combination of both options.

Over the years, there have been frequent discussions on whether (road) transport should become part of the EU's 'flagship' climate policy. The European Council in October 2014 reiterated in its Conclusions that member states may at their own discretion opt in their

³² Exceptions are: EU aviation, rail via the power sector or refining of fuels.

domestic transport sector. Indeed, Art 24 of the EU ETS Directive allows for the inclusion of any Non-ETS sector into the ETS if a Member State so chooses. There are a number of examples of inclusion of the ETS in other countries.

In China, which runs a number of ETS pilots in major urban areas, there is also experimentation with transport inclusion. In California, fuel distributors are included in the ETS, which constitutes an upstream point of compliance. Yet California also makes use of other direct regulatory measures affecting road transport emissions: so-called 'complementary policies'.

Is road transport inclusion in the ETS desirable?

EU decarbonisation efforts should be achieved in the most economically efficient way and the EU ETS Directive refers to that. However, it needs to be recognised that there will always be trade-offs between economic efficiency, and the political realities of other objectives. Both the EU ETS, and EU climate and energy policies in general, in fact, are frequently marked by such trade-offs. The discussion regarding the inclusion of transport in the EU ETS should be seen in that light.

As the EU is framing its new road transport decarbonisation policy the essential question that first needs to be answered is: Why ETS inclusion?

Arguably, part of the answer lies in the framing of the EU ETS as the central pillar and main instrument in EU climate change policy. With an ETS, the inclusion of any sector at all seems attractive at first sight. An ETS introduces a cap, and with that comes long-term scarcity. This in turn leads to price discovery and transparency of costs faced. Moreover, an ETS is in principle inherently technology neutral. GHG emission reductions will take place wherever they are cheapest, thus minimising the overall costs of mitigation to society.

The choice to include any one sector should bear in mind the overall economy-wide effort that is required. Extending the scope of an ETS and allowing for broader coverage may boost the cost-efficiency of the ETS as a whole, provided exposed sectors receive appropriate protection against impacts to competitiveness.

Marginal abatement costs in the road transport sector are generally seen far above allowance prices observed in the EU ETS at any time since its inception, but also above those faced by other sectors included in the EU's carbon market. With marginal abatement costs in the road transport sector being so much higher than in others, inclusion in the EU ETS would do little to spur actual abatement in this sector.

Even in the absence of high marginal abatement costs, low elasticity of demand in fuel prices may prevent the ETS price signal from triggering changes in consumer purchasing behaviour or mobility patterns.³³

³³ With EUA prices at €5, an average vehicle owner would face only about €10 a year in ETS costs (ICCT, 2014b).

At the same time, adding Road Transport to the EU ETS would also increase demand for allowances as a result of adding a new sector in the EU ETS, which would purchase allowances as an option, instead of abating their emissions.

This extra demand is likely to lead to higher EUA prices, which would put additional demands on sectors under the ETS, which are more responsive to changes in the ETS price signal.

With EUA prices at current (and even at multiples of) levels, ETS inclusion would only lead to a few cents being added to the price of fuel. Due to the very low levels of demand elasticity to fuel prices, this hinders behavioural change.

Yet there may still be economic and political arguments for ensuring that all sectors consistently contribute to the long-term abatement effort. This is an issue of static versus dynamic efficiency, where it may well be cost-efficient in the short run if emission reductions take place in other sectors where they are cheaper, but not so in the long run. Longer term, to 2050 and beyond, the EU's international commitments under the Paris Agreement make it imperative that all sectors will need to decarbonise.

At the same time, other instruments that target road transport GHG emissions may also have other objectives or co-benefits, such as improving air quality. Thus, a mix of policies is always desirable.

The case for the direct or indirect inclusion of road transport in the EU ETS does not have to entail a choice/competition with other instruments (e.g. car emissions standards), but as in other cases, different policies can coexist. Emission reduction standards for vehicles therefore unequivocally can and should continue to be used, irrespective of the role of the EU ETS in the policy mix.

In the California ETS in fact, emission trading is a residual element (together with standards) in the policy mix, more intended to ensure a cap is in place, and to 'catch' emissions which are not well targeted by the 'complementary measures' (which are in reality, and expressly, the main driver of emissions reductions).

Options

Point of compliance: upstream or downstream?

Whether the point of compliance is upstream or downstream will determine if it is fuel distributors that ensure compliance with the ETS, or if this falls to end-users. Upstream compliance would be a different point of compliance from other sectors in the ETS, yet it may be easier to administer than involving consumers directly.

Road transport silo, or part of regular EU ETS?

While the default option may be to consider road transport as just another sector to be included in the EU ETS, it could be envisaged to keep the sector in a separate 'silo'. This would be similar to what takes place with domestic aviation in the EU, for which a de facto separate ETS has been created, with its own class of allowances. As such, in a silo-ETS, trading of allowances would only take place between participants in that sector, and not between those in other sectors of the ETS.

Direct or indirect inclusion

Road transport in ETS could involve a car emission standards with two levels: a ‘necessary ambition’ level, and a stricter ‘high ambition’ level. The necessary ambition level would always be met through car emission standards. However, for the ‘very ambitious’ level, some flexibility could be available, by connecting this extra achievement (the delta between the two levels) to the EU ETS.

A car-maker would thus have two options at its disposal: either meet the high ambition level, or pay a multiple of the EUA price (at a level to be politically decided) for the difference between the high level, and the actual efficiency level at which the car performs, calculated over the expected lifetime of the vehicle. This would be equivalent to a penalty.

The mechanics require further consideration, but the principle of having both standards and a link to ETS must be retained.

Unilateral inclusion by member states via Art. 24 ETS Directive

Art. 24 of the EU ETS Directive allows for the inclusion of any non-ETS sector into the ETS if a member state so chooses.

6. The way forward

This chapter identifies a number of measures to lead EU transport decarbonisation policy. They are based on the experiences of the previous policy cycle and the analysis in chapters 4 and 5. The report makes a distinction between:

- no-regret options, and
- measures for consideration.

No-regret options

No-regret policies should focus on supporting existing low-carbon technologies, including the efficiency of the internal combustion engine. The main elements are:

- 1) Tightening of technology neutral emissions standards³⁴ with adequate flexibility provisions to account for the technological uncertainty.
- 2) Flexibility provisions could be a i) penalty rate in line with the costs of low-carbon technologies and which avoids the deployment of very high cost technologies, ii) a choice for car manufacturers to offset the non-compliance by investment in low-carbon infrastructure such as EV charging stations, hydrogen or natural gas fuelling stations, or iii) offsetting the achievement of tighter emissions reductions in one technology with those from other, for example calculated on the basis of a conversion factor. A crediting mechanism could be applied.

³⁴ Standards would also need to be realistically achievable.

- 3) A precondition for emissions standards to work is a robust and credible monitoring system to assess the gap between emissions measured under the test cycle and real emissions.
- 4) Support for those biofuels that increase GHG emissions should not be continued while respecting existing legal commitments.
- 5) Successful transition to low-carbon transport system will require a more pro-active infrastructure policy for alternative fuels, notably charging or fuelling stations. The EU or groups of member states should think about developing cross-border corridors for EV charging and fuelling stations. This might require reviewing the alternative fuel infrastructure directive.
- 6) A crucial element will be creating an internal market free of barriers for EV, P2G and hydrogen. Member states could accelerate this by committing to the creation of cross-border corridors, as for example proposed by the French-Spanish-Portuguese initiative. These corridors could then be linked to speed up the development of a pan-European low-carbon network.
- 7) Technology-neutrality should be reinforced by doing away with tax breaks, for example for diesel or natural gas.
- 8) The impact of emissions standards can further be enhanced if incentives are reinforced by member state, regional and local strategies. This optimisation will also require that incentives are aligned with carbon efficiency, requiring an end to environmentally harmful subsidies.
- 9) R&D support for all low-carbon technologies should be continued and where possible, strengthened.
- 10) Another priority should be the optimisation of the transport system such as via ICT and eco-driving support systems, efficient co-modality, especially if designed at European scale, green logistics, transport taxation, or optimisation of infrastructure construction, management and operation can bring reductions. Priority should also be given to nurturing new and alternative mobility solutions.

Measures for consideration

- 11) To date, the electrification of transport seems most attractive and advanced in urban areas. Most emissions occur in long-distance transport, where electrification is not necessarily the best solution. Focus on electrification should not undermine the development of new urban mobility solutions.
- 12) For power-to-gas to play a significant role in future low-carbon transport, further technological advances are needed. There could first be a facilitation of renewable hydrogen penetration in the market, where currently hydrogen from fossil fuels is being used (e.g. in refining, ammonia production). This could improve the lifecycle emissions of conventional fuel and biofuels, provide a further learning effect for the technology and give a basis for the direct application of low-carbon hydrogen or derived substitute fossil fuels as transport fuels.

- 13) The ETS could provide flexibility for car manufacturers. Road transport in ETS could involve car emission standards at two levels: a ‘necessary ambition’ level, and a stricter ‘high ambition’ level. The first ambition level would always be met through car emission standards, but for the ‘very ambitious’ level some flexibility is possible by connecting this extra achievement to the EU ETS. The car-maker could simply meet the high ambition level, or pay a multiple of the EUA price or, if not linked to the ETS, a penalty.
- 14) If member states offset emissions from transport with emissions from other sectors, this should not hinder the entry onto a road transport decarbonisation pathway, in line with EU long-term objectives. As this report points out, effective and efficient decarbonisation in the medium and long term requires policies that set decarbonisation in motion now. The inclusion of transport into the EU ETS could provide flexibility. At the same time, a precondition will be that there are incentives for the decarbonisation of vehicles and fuels in line with the long-term objectives.
- 15) In the absence of a specific fuel policy to incentivise fuel decarbonisation, bringing all transport fuels under the EU ETS could be an option.
- 16) Another option is for member states to agree and implement concrete and practical technology deployment targets, not only for cars but other modes too. In the case of EVs, such criteria could include a commitment from each member state to: i) a number of pilot projects in relation to its population and/or GDP, ii) a certain number of charging stations, iii) a certain number of hybrid plug-ins or other innovation solutions, iv) kms of smart grids, etc. Examples for other modes, e.g. for the rail freight sector could be i) reliable availability of rolling stock, ii) flexible train configurations, iii) availability of integrated mobility hubs, iv) availability of a tracking system to customers, etc. Such technology deployment targets would provide confidence to investors and developers because they are sufficiently concrete to be tracked.³⁵
- 17) While EVs and plug-in hybrids are still facing barriers regarding range, infrastructure and emissions from power generation, non-plug-in hybrid vehicles bypass these challenges while delivering similar emission reductions. Since their total cost of ownership can be lower than those of ICE vehicles, these mild hybrids could hold potential for short-term emission reductions, learning effects applicable to EVs and a platform for fostering consumer acceptance of road transport electrification.

7. Principal Recommendations

This Report makes the following recommendations:

1. Monitor the development gap between the test cycle and real emissions over time.
2. Establish technology-neutrality by doing away with existing distortions.
3. Implement no re-regret options.
4. Analyse the ‘measures for consideration’ above, including the role for the EU ETS.

³⁵ For details see: Egenhofer (2011).

References

- ACEA (2016a), “Reducing CO₂ Emissions from Heavy-Duty Vehicles – Empowering Customers, Strengthening Market Forces and Working in an Integrated Approach”, Position Paper.
- ACEA (2016b), “Joining Forces to Tackle the Road Transport CO₂ Challenge – A Multi-stakeholder initiative”, Brussels.
- Amsterdam Roundtables Foundation and McKinsey & Company (2014), “Electric vehicles in Europe: gearing up for a new phase?”.
- Bleijenberg, A., C. Egenhofer, A. Behrens, V. Rizos and M. Alessi (2013), “Pathways to low carbon transport in the EU – from possibility to reality, Climate Change”, CEPS Task Force Report, CEPS, Brussels.
- Bloomberg (2015), “Japan Has More Car Charges Than Gas Stations” (<http://tinyurl.com/o9myae6>).
- Bubeck, S., J. Tomaschek and U. Fahl (2016), “Perspectives of electric mobility: Total cost of ownership of electric vehicles in Germany”, *Transport Policy*, Vol. 50, pp. 63-77.
- Derdevet, M. (2015), “Energy, a networked Europe - Twelve proposals for a common energy infrastructure policy”, Report addressed to Francois Hollande, President of the French Republic.
- ECF et al. (2014), “Wasted – Europe’s Untapped Resource”, February.
- Ecofys et al. (2015), “The land use change impact of biofuels consumed in the EU”, August.
- Ecofys and PWC (2016), “Alternative fuels and infrastructure in seven non-EU member states”, Final Report, Study conducted for the European Commission – DG MOVE.
- Egenhofer, C. (2011), “The EU should not shy away from setting CO₂-related targets for transport”, CEPS Policy Brief No. 229, CEPS, Brussels, January.
- European Commission (2011), “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”, White Paper, COM(2011) 144 final of 28.03.2011.
- European Commission (2012), “Towards low carbon transport in Europe – Communicating transport research and innovation” (<http://tinyurl.com/hk35znd>).
- European Commission (2014a), “A policy framework for climate and energy in the period from 2020 to 2030”, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2014) 15 final (<http://tinyurl.com/hdohyw1>).
- European Commission (2014b), “Impact Assessment Accompanying the document Strategy for Reducing Heavy-Duty Vehicles Fuel Consumption and CO₂ Emissions”, Commission Staff Working Document, SWD(2014) 160 final (<http://tinyurl.com/js6o3ol>).

- European Commission (2014c), Impact Assessment accompanying the document “A policy framework for climate and energy in the period from 2020 up to 2030”, Commission Staff Working Document, SWD(2014) 15 final, 22 January (<http://tinyurl.com/jguumrd>).
- European Commission (2015a), “Energy Union Package - The Paris Protocol – A blueprint for tackling global climate change beyond 2020”, COM(2015) 81 final, 25.2.2015.
- European Commission (2015b), “State of the Art on Alternative Fuels Transport Systems in the European Union”, Final Report.
- European Commission (2016a), “Reducing emissions from transport” (<http://tinyurl.com/7ex6am3>).
- European Commission (2016b), “Road transport: reducing CO₂ emissions from vehicles” (<http://tinyurl.com/6gtlzcz>).
- European Industrial Bioenergy Initiative (2014), “Boosting the Contribution of Bioenergy to the EU Climate and Energy ambitions - Implementation Plan 2013 – 2017”, Version of 24 January (<http://tinyurl.com/zmfdpqm>).
- Eurostat (2014), “Taxation trends in the European Union - Data for the EU Member States, Iceland and Norway”, 2014 edition (<http://tinyurl.com/z5rl82z>).
- Eurostat (2016), “Trade in energy products - Statistical analysis of EU trade in energy products, with focus on trade with the Russian Federation” (<http://tinyurl.com/gvzof2p>).
- ERDF (2015), “Corridors de Mobilité Electrique – Initiative Franco Espagnol Portugaise”, Madrid, 23 November.
- Fontaras, G. and P. Dilara (2012), “The evolution of European passenger car characteristics 2000–2010 and its effects on real-world CO₂ emissions and CO₂ reduction policy”, *Energy Policy*, Vol. 49, pp. 719–730.
- Hagman, J., S. Ritzén, J.J. Stier and Y. Susilo (2016), “Total cost of ownership and its potential implications for battery electric vehicle diffusion”, *Research in Transportation Business & Management*, Vol. 18, pp. 11-17.
- Hawkins, T.R., O.M. Gausen and A.H. Stromman (2012), “Environmental impacts of hybrid and electric vehicles – a review”, *The International Journal of Life Cycle Assessment*, Vol. 17, pp. 997-1014.
- ICCT (2012), “Discrepancies between type approval and ‘real-world’ fuel consumption and CO₂ values - Assessment for 2001-2011 European passenger cars”, Working Paper No. 2012-02, International Council on Clean Transportation.
- ICCT (2013), “Worldwide Harmonized Light-duty Vehicles Test Procedure”, International Council on Clean Transportation, November.
- ICCT (2014a), “The WLTP: How a new test procedure for cars will affect fuel consumption values in the EU”, International Council on Clean Transportation.
- ICCT (2014b), “Road Transport in the EU Emissions Trading System: An Engineering Perspective”, International Council on Clean Transportation.

- ICCT (2015), "Overview of the heavy-duty vehicle market and CO₂ emissions in the European Union", International Council on Clean Transportation.
- ICCT, TNO, Sidekick Project Support & IFEU (2013), "From laboratory to road - A comparison of official and 'real-world' fuel consumption and CO₂ values for cars in Europe and the United States".
- ICCT, TNO & IFEU (2015), "From Laboratory to Road - A 2015 update of official and 'real-world' fuel consumption and CO₂ values for passenger cars in Europe".
- IEA (International Energy Agency) (2016a), "Global EV Outlook 2016 - Beyond one million electric cars".
- IEA (International Energy Agency) (2016b), "Energy Technology Perspectives 2016", June.
- IFPRI (2011), "Assessing the Land Use Change Consequences of European Biofuel Policies", October.
- JRC (Joint Research Centre) (2014), "Non-exhaust traffic related emissions. Brake and tyre wear PM".
- Kadijk, G., M. Verbeek, R. Smokers, J. Spreen, A. Patuleia, M. van Ras, J. Norris, A. Johnson, S. O'Brien, S. Wrigley, J. Pagnac, M. Seban and D. Buttigieg (2012), "Supporting Analysis regarding Test Procedure Flexibilities and Technology Deployment for Review of the Light Duty Vehicle CO₂ Regulations", Study prepared for the European Commission - DG CLIMA.
- Mansilla, C., S. Avril, J. Imbach and A. Le Duigou (2012), "CO₂-free hydrogen as a substitute to fossil fuels: What are the targets? Prospective assessment of the hydrogen market attractiveness", February.
- Nykqvist, B. and M. Nilsson (2015), "Rapidly falling costs of battery packs for electric vehicles", *Nature Climate Change*, Vol. 5, pp. 329-332.
- Öko-Institut e.V. (2014), "Prüfung der klimapolitischen Konsistenz und der Kosten von Methanisierungsstrategien", February.
- Onat, N.C., M. Kucukvar and O. Tatari (2015), "Conventional, hybrid, plug-in hybrid or electric vehicles? State-based comparative carbon and energy footprint analysis in the United States", *Applied Energy*, Vol. 150, pp. 36-49.
- Roland Berger (2016), "Integrated Fuels and Vehicles Roadmap to 2030+".
- Schiebahn, S., T. Grube, M. Robinius, V. Tietze, B. Kumar and D. Stolten (2015), "Power to gas: Technological overview, systems analysis and economic assessment for a case study in Germany", *International Journal of Hydrogen Energy*, Volume 40, Issue 12, pp. 4285-4294.
- Transport & Environment (2015), "€27bn indirect subsidy to diesel cars in fuel taxation in 2014", November.
- Transport & Environment (2016), "Globiom: the basis for biofuel policy post-2020", April.
- Transport & Mobility Leuven (2014), "GHG reduction measures for the Road Freight Transport sector - An integrated approach to reducing CO₂ emissions from Heavy Goods Vehicles in Europe", Report prepared for ACEA.

Annex I: List of studies reviewed by CEPS

- ACEA (2016), "Joining Forces to Tackle the Road Transport CO₂ Challenge - A multi-stakeholder initiative", Brussels.
- C-ITS Platform (2016), "Final Report", January.
- Chan, C.C. (2007), "The State of the Art of Electric, Hybrid, and Fuel Cell Vehicles", *Proceedings of the IEEE*, Vol. 95, No. 4, April.
- Contestabile, M., G. Offer and R. North (2012), "Electric Vehicles: A Synthesis of the Current Literature with a Focus on Economic and Environmental Viability. Technical Paper", LCAworks.
- De Wilde, H.P.J. and P. Kroon (2013), "Policy options to reduce passenger cars CO₂ emissions after 2010", ECN.
- ECF et al. (2015a), "Fuelling Britain's Future", Cambridge Economics, Cambridge.
- ECF et al. (2015b), "Fuelling France", Cambridge Economics, Cambridge.
- ECF et al. (2014a), "Fuelling Europe's Future - How Auto Innovation Leads to EU Jobs", Brussels.
- ECF et al. (2014b), "Wasted - Europe's Untapped Resource", February.
- ERTICO (2015), "Study of Intelligent Transport Systems for reducing CO₂ emissions for passenger cars", September, Brussels.
- Grünig, M., M. Witte, D. Marcellino, J. Selig and H. van Essen (2011), "Impacts of Electric Vehicles - Deliverable 1. An overview of Electric Vehicles on the market and in development", Ecologic & CE Delft, Study prepared for the European Commission's Directorate General for Climate Action.
- ICCT (2015a), "Hybrid Vehicles - Technology Development and Cost Reduction", Technical Brief No. 1, International Council on Clean Transportation, July.
- ICCT (2015b), "Global climate change mitigation potential from a transition to electric vehicles", International Council on clean Transportation.
- ICCT (2013), "Reducing CO₂ and fuel consumption from new cars: Assessing the near-term technology potential in the EU", Briefing, International Council on Clean Transportation, January.
- ICCT (2012), "Calculating Electric Drive Vehicle Greenhouse Gas Emissions", International Council on Clean Transportation.
- IKA (Institut für Kraftfahrzeuge) (2014), "CO₂ Emission Reduction Potential for Passenger Cars and Light Commercial Vehicles Post 2020", Study Commissioned by the German Federal Ministry for Economic Affairs and Energy.
- JRC (Joint Research Centre) (2014a), "Well-to-Wheels analysis of future automotive fuels and powertrains in the European context - Overview of Results".

- JRC (Joint Research Centre) (2014b), "Well-to-Wheels Appendix 1 - Version 4.a. Summary of WTW Energy and GHG balances. Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context".
- Kieckhäfer et al. (2015), "Prospects for Regulating the CO₂ Emissions from Passenger Cars within the European Union after 2023", in *Zeitschrift für Umweltpolitik & Umweltrecht*, Vol. 4/2015, December, dfv Mediengruppe, Frankfurt am Main.
- OECD and IEA (2004), "Hydrogen & Fuel Cells - Review of National R&D Programs", OECD/IEA, Paris.
- Pengg, H. (2015), "Audi e-fuels: Decarbonisation of the mobility sector", PowerPoint presentation, Audi AG.
- US Department of Energy (2013), "Well-to-Wheels Greenhouse Gas Emissions and Petroleum Use for Mid-Size Light-Duty Vehicles".

Annex II: Power-to-gas (P2G)

Conceptually, P2G can be divided into two steps: electrolysis (producing hydrogen from electricity) and catalytic synthesis technologies (reacting hydrogen with carbon to form substitute fossil fuels), the latter including both production of SNG/LPG³⁶ and liquid fuels (substitute gasoline/diesel).

We can envisage two general technology paths for the decarbonisation of road transport with P2G:

- 1) **the replacement of fossil fuels:** sustainable SNG and/or liquid fuels from P2G could replace conventional fuels, and
- 2) **hydrogen-based transport:** a change of road transport from fossil fuels to hydrogen produced from renewable electricity, which is used by fuel-cell vehicles.

Compared to hydrogen-based transport, the replacement of fossil fuels would face lower technological challenges related to hydrogen and lower infrastructure investment: gas stations could remain and be augmented with CNG³⁷ compressors. Disadvantages would be lower energy efficiency and difficult sourcing of sustainable carbon (e.g. Schiebahn et al., 2015).

The use of carbon from CCS plants is possible and would constitute a decrease in emissions (carbon burned twice before emitted). More sustainable carbon could come from biomass, but would be more technologically challenging.

Past underestimations of emissions in the biofuels sector imply a need for the assessment of pathways for life-cycle emissions of the whole process chain (renewable electricity, carbon sourcing, P2G process and vehicles).

Electrolysis and catalytic synthesis of substitute natural gas (SNG) have both been applied commercially, albeit not in the transport sector and independently of each other (in refineries/ammonia plants and coal-to-gas plants, respectively). Yet P2G plants do exist on an industrial scale demonstration level.³⁸ More development on both pathways could reduce remaining uncertainties like sustainable carbon sourcing and full life-cycle emissions (for substitute natural gas/liquid fuel) and infrastructure issues (for hydrogen).

Öko-Institut e.V. (2014) claims that it is contradictory to expand synthesis of substitute fossil fuels from hydrogen, when most hydrogen used for industrial purposes today is produced from fossil fuels. The most logical first step would thus be to substitute these already-used hydrogen volumes with low-carbon hydrogen. Mansilla et al., (2012) point to the use of hydrogen to enhance the yield of advanced biofuels processes.

Both hydrogen and substitute natural gas could provide reductions in NO_x and particle emissions.

³⁶ SNG: substitute natural gas (methane); LPG: liquid petroleum gas (butane/propane).

³⁷ Compressed (substitute) natural gas.

³⁸ Audi e-gas plant in Germany producing SNG, Carbon Recycling International plant in Iceland producing methanol.

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ECH focuses its research on four workstreams:

- Climate Policy
- Energy Policy
- Finance
- Markets

In carrying out its activities, ECH is guided by a commitment to four essential principles:

- Complete independence
- Inclusiveness in soliciting participants, and therefore an openness to all stakeholders who have an interest in discussing these challenges
- Policy-relevance and (policy) demand-driven
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