Ricardo Energy & Environment

Study on national policies reported in the transport sector under Article 7 of the Energy Efficiency Directive and energy savings potential for the period 2021-2030

Report for the Coalition for Energy Savings

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Contact:

Anna-Liisa Kaar

Ricardo Energy & Environment

Gemini Building, Harwell, Didcot, OX11 0QR, United Kingdom

t: +44 (0) 1235 75 3341
e: anna-liisa.kaar@ricardo.com

Ricardo-AEA Ltd is certificated to ISO9001 and ISO14001

Authors:

Anna-Liisa Kaar, Daniel Forster, Felix Kirsch

Approved By:

Sujith Kollamthodi

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1 Introduction

Directive 2012/27/EU (Energy Efficiency Directive (EED)) was designed to address one of the three key pillars identified in the EU 20-20-20 Strategy – the 20% energy efficiency target. Within the EED, Article 7 is one of the most important components, not least because it is expected to deliver more than half of the energy efficiency target by the 2020.

At the end of 2016 the European Commission proposed an update to the EED, including a new binding 30% energy efficiency target by 2030. The Commission's proposal extends Article 7 for the new period 2021-2030, with the expectation that the article will deliver around half of the energy savings required to meet the 30% target (European Commission, 2016).

As with Article 7 currently, the Commission's proposal targets energy savings associated with final energy consumption. It therefore concerns energy consumption – and energy savings – in the major end-use sectors, such as buildings, industry, and transport.

The results of previous studies on the implementation of Article 7 to date (Ricardo et al, 2016) indicate that transport sector may be under-represented in terms of the relative share of the energy savings that are expected to be delivered by the sector. This may suggest a certain level of untapped potential in this sector.[1]

The objective of this project is to develop an enhanced understanding of (1) the specific policies that have been used by Member States to date under Article 7 of the EED to achieve energy savings in the transport sector, and (2) the potential contribution that national policy measures targeting energy consumption in transport could make in the new period 2021-2030.

2 How is transport reflected under Article 7?

Article 7 of the EED requires Member States to achieve new energy savings each year over the 2014-2020 period, amounting to 1.5% of the baseline annual energy sales to final customers. The proposal for the revised Article 7 retains the 1.5% new energy savings requirement for the new period 2021-2030.

Member States' energy saving targets are therefore determined by the baseline level of energy sales that is used in the target calculation. For the current Article 7, the baseline and energy savings target calculations used annual energy sales over the period 2010 to 2013; the new proposal is that the baseline for the 2021-2030 period will be based on energy sales over the period 2016 to 2018.

However, Article 7 also allows certain flexibilities as part of the target calculation. In particular, Member States may partially or fully exclude energy sales in the transport sector from the baseline calculations. Excluding these sales reduces the baseline volume of energy sales, and therefore the associated energy savings target. In the current obligation period, all Member States (except Sweden) make use of this flexibility and fully exclude transport energy sales when calculating their baseline (Ricardo et al, 2016)[2].

In order to meet the 1.5% savings requirement, Member States need to establish either energy efficiency obligation schemes (EEOS) or alternative policy measures. Alternative policy measures include, but are not limited to, energy and CO_2 taxes, financing schemes and fiscal incentives, regulations or voluntary agreements, standards or norms, energy labelling schemes, training and education instruments, and an energy efficiency national fund.

[1] Also a study commissioned by the European Commission (DG Energy) on policy options to realising energy efficiency savings potential until 2020 and beyond indicated additional energy savings potential under different policy options until 2030 (Fraunhofer et al, 2014).

[2] Member States may also make use of certain exemptions, which further reduce the level of their energy savings target. Collectively, these exemptions must not amount to more than up to 25% of the baseline level of energy sales. In the current obligation period, all Member States (except Denmark, Portugal and Sweden) make full use of the exemptions, Denmark and Sweden use it to less than 25% level (Ricardo et al, 2016).

The policy measures implemented by Member States are required to trigger end-use energy savings i.e. savings associated with final consumption. There are no limitations in which sectors the energy saving actions can be delivered. Therefore, Member States can use policy measures which deliver energy savings in the transport sector to deliver their target, even if energy sales in the transport sector were excluded from the baseline when setting the initial target.

These energy savings from national policy measures need to be sufficient to deliver the Member States' energy saving target, over the compliance period. The energy savings also need to be additional to existing EU legislation. In the case of the transport sector, this means that Member States need to demonstrate that the energy savings are additional to existing EU legislation, and savings that are the direct result of the existing EU legislation cannot be counted. This includes energy savings arising from:

- For new passenger cars and light commercial vehicles – CO_2 emissions performance standards provided in Regulation (EC) 443/2009 and Regulation (EC) 510/2011
- Energy and CO_2 taxes – minimum levels of taxation applicable under Directive 2003/96/EC and 2006/112/EC

As the CO_2 emissions standards have been set as average emissions for all new car fleets (rather than for every individual vehicle), the impact of these CO_2 emissions standards may therefore vary between the Member States, both in response to consumer preferences, but also any national policies that incentivise more or less efficient vehicles.

3 What has been the use of transport policies under Article 7 to date?

The EU Member States had to notify to the European Commission, by 5 December 2013, of the policy measures that they intend to use to reach their 1.5% energy savings target over the 2014-2020 period.

Previous analysis of these notifications concluded that the energy savings that can be clearly associated with the transport sector represent only 6% of the total cumulative energy savings (Ricardo et al, 2016). This contribution is low in comparison to the current around 30% share of the final energy consumption in the EU that is associated with the transport sector.

While only 6% of the energy savings can be clearly associated with the transport sector, a much greater share of the energy savings was associated with policies targeting more than one sector (cross-cutting measures), including transport and/ or industry (such as taxes, EEOS and financial incentives applying to multiple sectors). In many cases the energy savings that were notified by Member States in relation to these policies were not disaggregated by end-use sector. This means the actual level of energy savings in the transport sector was under-represented in the previous analysis.

To explore this issue further, a more detailed assessment of the cross-cutting policies with the potential for transport-related energy savings was performed. Following an initial screening, the cross-cutting policies that were expected to have the greatest impact on energy savings in the transport sector were (1) energy and CO_2 taxes and (2) EEOS. Therefore, these policies notified by Member States that fell within these policy types were analysed further.

3.1 Energy and CO_2 taxes

Six Member States (Austria, Estonia, Germany, Spain, Sweden[3] and United Kingdom) have taxes in place that cover more than one end-use sector. Based on the total energy savings for the measure (Ricardo et al, 2016) and additional information on the share of transport, from the Member States' Article 7 notifications as well as other national literature, the potential energy savings from cross-cutting tax measures in the transport sector were estimated.

The analysis identified that, where information was available, there could be considerable savings derived from these measures in the transport sector. For example, in Estonia 35% of energy savings

[3] Transport energy savings from Swedish energy and CO_2 taxes were already counted within previously identified 6% transport savings.

are delivered through taxation on transport fuels, while in Germany the share is estimated to be around 50%.[4]

Appendix 1 provides an overview of the national tax measures, their coverage and the estimated share of savings that are expected to arise in the transport sector.

3.2 Energy efficiency obligation schemes

EEOS have either been implemented, or are planned to be implemented, in 15 Member States: Austria, Bulgaria, Croatia, Denmark, Greece[5], France, Ireland, Italy, Latvia, Luxembourg, Malta, Poland, Slovenia, Spain and United Kingdom. However, the EEOS in Denmark, Malta and United Kingdom do not cover energy savings in the transport sector (also there is no information on target sectors of EEOS in Greece). Appendix 2 provides an overview of the different EEOS and the estimated share of the energy savings that are expected to arise in the transport sector.

The information on the split of savings delivered by EEOS per target sectors is limited, therefore stakeholders in some Member States (Austria, Ireland, Italy and Poland) were contacted for further information.

The analysis indicated that where measures targeting transport energy consumption were included in the scope of an obligation scheme, the overall share of energy savings was generally low in comparison to savings in the other target sectors. For example, in 2016 Italy's EEOS delivered only 1.2% of savings in the transport sector[6]; in 2016 Ireland's EEOS delivered around 1% of savings in the transport sector[7]; in 2014 the French EEOS delivered 2.9% of savings from standardised measures in the transport sector, however this fell to 1% in 2015; in 2014-2015 Austria's EEOS delivered approximately 9% of savings[8].

In Italy, for example, the low share of savings in the transport sector can be attributed to the low attractiveness of the available transport project options, also the difficulties associated with the measurement of savings in the sector[9]. In France it has been reported that the poor performance is due to the short lifetimes of several transport measures, smaller financial benefits available for consumers as compared to other measures, such as domestic insulation measures, and as in case of Italy, the measurement can be more difficult to address (Lees, 2014).

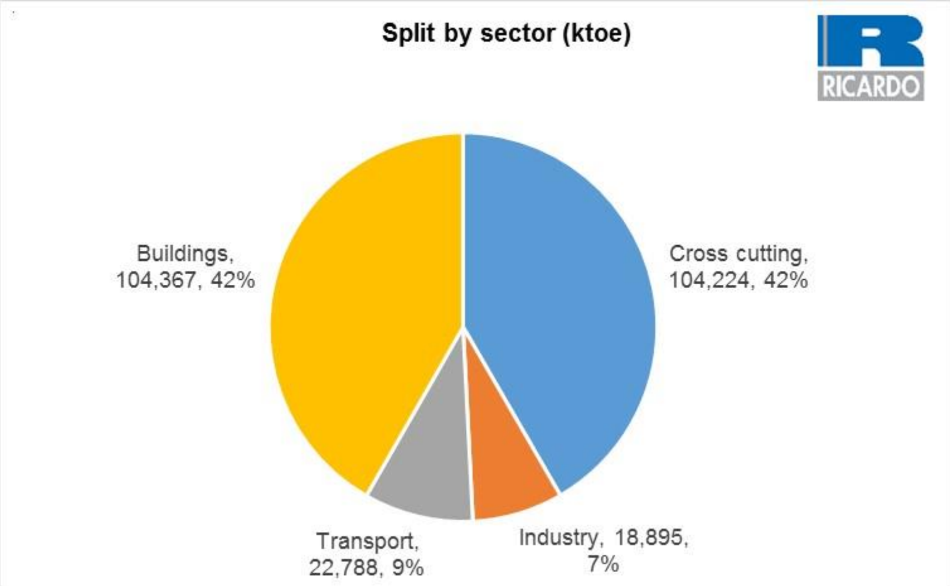
3.3 Updated assessment of the share of energy savings in the transport sector

Following the additional exploration of the energy savings associated with cross-cutting measures, the relative share of energy savings associated with the transport sector is estimated to represent nearly 23 Mtoe (that is 9%) of the total cumulative savings in the period 2014-2020. Thus, the inclusion of energy savings from the most relevant cross-cutting measures increases the proportion of savings that can be clearly associated with the transport sector by 50% on the previous estimate. However, the overall share of savings is still low in comparison to the relative contribution of the sector to current consumption.

An updated breakdown of energy savings delivered through national policy measures under Article 7 per target sectors is provided Figure 1.

[4] Savings were estimated based on the datasets provided by Germany along with their NEEAP 2014. However, assumptions had to be used by the study team, therefore the transport percentage is a best estimate based on available data.
[5] Greece notified introduction of EEOS in their Annual Report 2016.
[6] Based on communications with experts in FIRE (Federazione Italiana per l'uso Razionale dell'Energia)
[7] Based on communications with experts in Sustainable Energy Authority of Ireland (SEAI)
[8] Based on communications with experts in Austrian Energy Agency
[9] Based on communications with experts in FIRE (Federazione Italiana per l'uso Razionale dell'Energia)

Figure 1 Breakdown of energy savings (ktoe) through national measures under Article 7 EED per target sectors in the period 2014 to 2020



The policy measures implemented by Member States under Article 7 of the EED are estimated to deliver nearly 23 Mtoe of cumulative energy savings in the transport sector from 2014 to 2020 (9% of the total cumulative savings) or 0.8 Mtoe of new savings per year (assuming an equal distribution of new savings over the period).

This contribution is rather small given that the transport sector currently represents approximately 30% of final energy consumption in the EU.

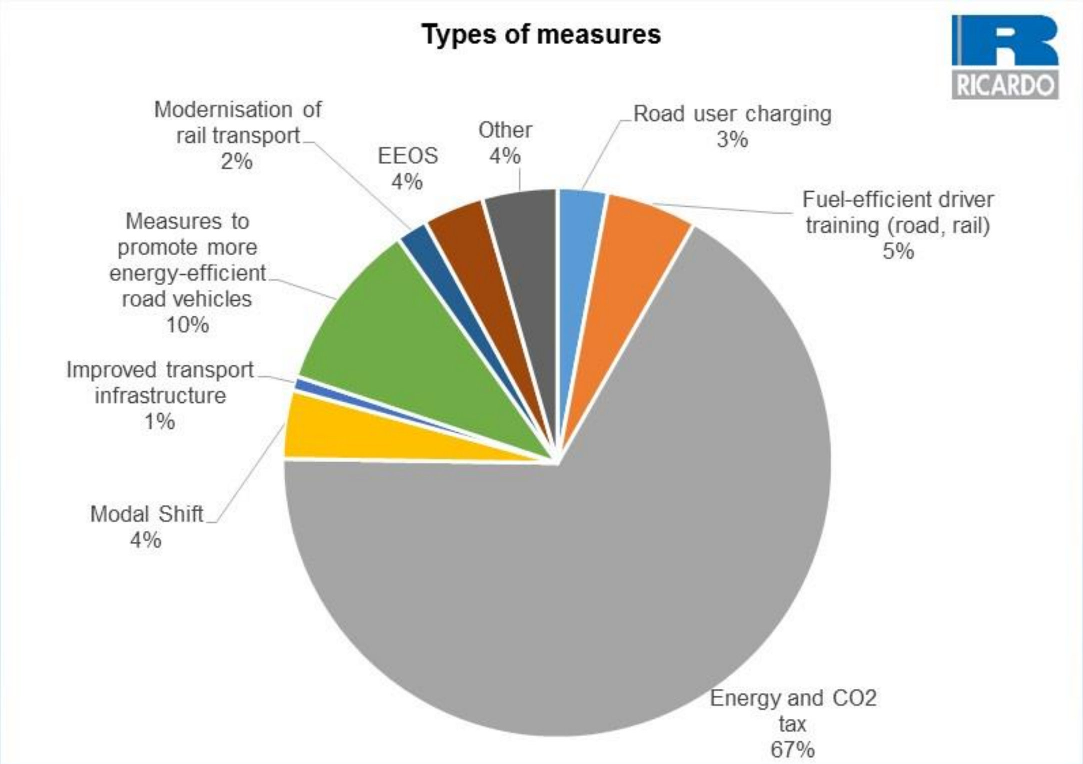
3.4 What types of policies?

As described in Section 2, Article 7 lists a number of different types of policies that may be used by Member States to meet their energy saving targets. However, the policy types used in Article 7 are rather broad. This section provides some further characterisation of existing transport policy measures notified by Member States.

Overall, there is a large number of different transport policy measures implemented by Member States. The types of policy measures used by Member States include: (1) Energy and CO_2 taxes; (2) Measures to promote more energy-efficient road vehicles, including financial incentives; (3) Fuel-efficient driver training; (4) Modal shift; (5) Road user charging (tolls for trucks); (6) Modernisation of rail transport; (7) Improved transport infrastructure; and (8) Other individual measures or measures that could not be categorised. A full list of transport policy measures notified by Member States has been provided in Appendix 4.

The analysis of Member States' policy measures shows that energy and CO_2 taxes are the only policy measures that are expected to result in significant energy reductions in the transport sector (by delivering 67% of the total cumulative savings in the transport sector) in the period 2014-2020 under Article 7 of the EED. All other measures combined deliver only 33% of savings; these include measures to promote more energy-efficient road vehicles (10%), fuel-efficient driver training (5%) and measures encouraging a modal shift (4%). A breakdown of savings per policy measure types has been provided in Figure 2.

Figure 2 Breakdown of savings per transport policy measure types under Article 7 EED



The analysis is based on the policies that Member States expect to use to deliver their targets. However, as Member States progress with the implementation of Article 7, there might be some changes to the policy measures implemented and the savings delivered. For example, Spain has notified a new measure called "PIMA Land (Tractors)" in their Annual Report 2016, the savings that are expected from the measure are however unknown.

Under Article 7 of the EED to date, the transport related energy savings are dominated by energy and CO_2 taxes – this policy measure accounts for 67% of the transport savings in the period 2014-2020.

4 What is the energy savings potential in the transport sector from 2021 to 2030?

This section provides an assessment of the potential energy savings which could be delivered in the transport sector from national policy measures in the period 2021- 2030, the results are then compared to the energy savings requirements for the new compliance period 2021-2030 under Article 7 of the EED.

The assessment of the potential energy savings draws upon the results from previous analysis of climate change policies in the transport sector that was prepared by Ricardo Energy & Environment for the European Climate Foundation (Ricardo, 2016). The analysis makes use of the SULTAN modelling tool to scope scenarios for emissions reductions in transport for 2030, and to explore how these might contribute to meeting the emissions reductions foreseen under the EU's climate and energy policy framework. The scenarios have been developed based on a literature review of individual policy instruments, and represent the potential impacts of "scaling up" these individual policy impacts across all of the EU Member States. The scenarios therefore make assumptions about the energy savings potential in each of the EU Member States. The scenarios exclude energy savings from aviation and international shipping; any savings from measures in these sub-sectors would be additional to those reported below.

In practice, and as described in previous section, some Member States may already have in place policies which will deliver some of the potential identified in the scenarios. However, the scenarios that are presented in this section cannot be compared directly to the savings from policies notified under Article 7 by Member States over the period 2014-2020, as described in the previous section. This is because the savings notified under Article 7 to date have been calculated by Member States, using their own assumptions and modelling approaches. The results presented in this section are instead based on a harmonised set of modelling assumptions for each of the Member States, modelled using the SULTAN tool. The scenarios are therefore illustrative of the total potential savings for representative policy types.

This also means that some of the policy types that were identified in the previous section, and have been notified by Member States under Article 7 to date, are not considered in the SULTAN scenarios. The savings from these policies can therefore be considered additional to the savings below.

4.1 Energy savings potential of transport policies identified in SULTAN scenarios

The analysis includes six Member State level transport policy packages, as well as a package where all policies are combined. The latter takes into account interactions between individual policy types, so the savings can be added together. A description of the baseline, as well as a brief summary of the six packages, is provided below. The final energy consumption trajectories (split by transport mode) for each of the six scenarios, as well as further detail on input assumptions for these have been provided in Appendix 5.

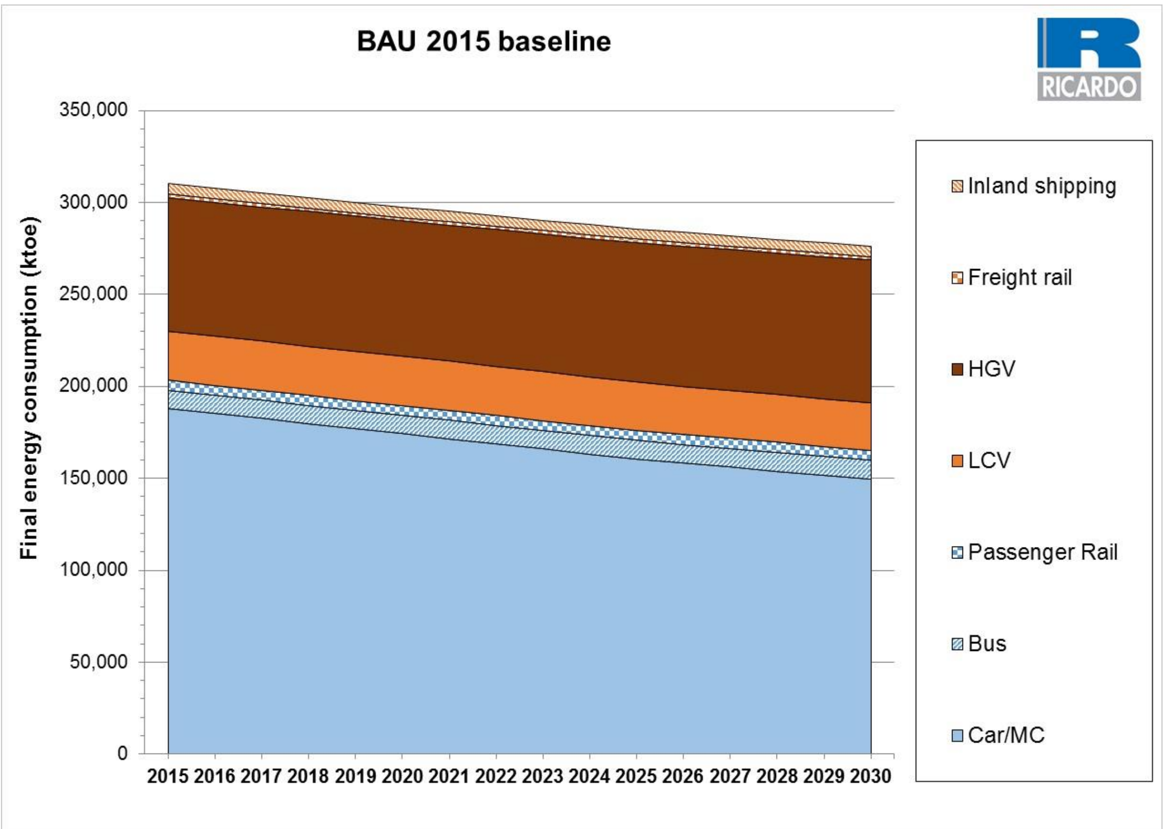
4.1.1 2015 Business as usual (BAU) baseline

Energy savings potential is established by comparing the policy packages against the 2015 BAU baseline which takes account of current EU policies and extrapolates trends into the future. The baseline therefore describes the expected outturn in the absence of any Member State or further EU-level policies. For example, the baseline does not include possible new EU CO_2 emission standards for cars and vans post-2021 which the European Commission is currently developing.

The 2015 BAU used in the ECF study is an updated version of the 2012 SULTAN baseline scenario (AEA, 2012), which was based on the European Commission's PRIMES-TREMOVE reference scenario of 2011. The 2015 update excludes aviation and international shipping, and includes updates to growth forecasts, affecting passenger and freight transport activity, as well as updates to biofuel shares and real-world versus test-cycle vehicle energy consumption uplift factors (Ricardo, 2016). Between 2015 and 2030, annual transport energy consumption is expected to decrease slightly, despite the absence of any new transport policies affecting energy use (Figure 3).

The baseline does not explicitly take into account national policies, although the influence of certain national policies may already be factored into the underlying trends that underpin the scenarios in SULTAN.

Figure 3 BAU 2015 baseline trajectory



4.1.2 Public transport, cycling and walking improvement measures

In this scenario, it is assumed that improvements to public transport, walking and cycling lead to 8% of urban passenger activity and 3% of non-urban/motorway passenger activity travelled by car shifting to public transport and walking/cycling by 2030. As a result, overall car energy use falls by around 4%, and total transport energy use by 1.5%.

4.1.3 Improved freight intermodality

In this scenario, it is assumed that 6% of heavy truck tonne-kilometres (tkm) are shifted to inland shipping and rail by 2030 (and consequently heavy truck energy consumption falls by 6%). These assumptions are in line with current studies on freight modal shift potential (CE Delft, 2011). By 2030, rail freight activity increases by 70% over 2015 levels, while inland shipping increases by 30%. Overall transport energy demand in 2030 is reduced by 0.7%.

4.1.4 Speed related measures for road vehicles

This scenario includes (a) improved speed enforcement and (b) reduction of average motorway speeds. It is assumed that the combination of these measures has the following impacts on average speeds.

Table 1 Changes to average speeds through policy

	Motorway		Urban		Non-urban	
	Light duty vehicles (≤3.5t max. weight) (LDVs)	Heavy duty vehicles (>3.5t max. weight) (HDVs)	LDVs	HDVs	LDVs	HDVs

Current Average Speed Limit (km/h):	123	82	49	49	95	70
Reduced Av. Speed (km/h):	105	78	45	47	88	67
Speed Enforcement %Change:	-15.2%	-4.8%	-8.0%	-4.0%	-8.0%	-4.0%

The reduction in average speeds is presumed to have impacts on both distance-specific vehicle energy consumption (i.e. l/100km), as well as distances driven (i.e. km per year). Elasticity of speed change to change in distance driven is assumed to be 1 for passenger modes and 0.25 for freight modes. By 2030, the above measures for reducing average speeds are presumed to be 60% implemented, reducing distance-specific fuel consumption by 2% for cars and 5% for light commercial vehicles (LCVs). In addition, given an average reduction in car speeds by 5.5%, car demand is also presumed to fall by 5.5%. LCV demand is presumed to fall by only 1.4% (given the elasticity of 0.25 for freight modes). Overall, the measure reduces energy consumed by cars by around 7.5%, and energy consumed by LCVs by 6.5%. The overall transport energy reduction is around 5% over baseline in 2030.

Arguably, the assumption that, in addition to reduced distance-specific fuel consumption, demand for car travel is reduced by 5% as a result of reduced speed limits and enhanced enforcement should be viewed as optimistic. Without the demand response (focussing solely on reduced distance-specific fuel consumption), total energy savings over baseline in 2030 would be limited to around 2%.

4.1.5 Fuel efficient driver training

Drivers trained in fuel efficient driving are presumed to decrease their energy consumption by around 3% on average in 2030. Under this scenario, it is assumed that 75% of goods vehicle, bus and train drivers, and 30% of car and motorcycle drivers have undertaken such training. Consequently, transport energy consumption in 2030 is around 1.5% lower than under baseline. The effectiveness of driver training is presumed to weaken over time (by 2% per year) given the introduction of new vehicle technologies which make energy consumption less sensitive to driving habits (e.g. regenerative breaking on electric vehicles).

4.1.6 Reform of company car tax

This scenario was defined to investigate the potential GHG impacts of reforming company car tax to eliminate subsidies that encourage increased activity, vehicle numbers, and larger/less efficient vehicles. The main assumptions were based predominantly upon information from TI (2009), including:

- Proportion of EU fleet that is company cars = 15%
- Proportion of new EU cars that are purchased by businesses = 50%
- Additional km driven by company cars = 1,200 km per year
- 6% higher fuel consumption by company cars on average vs equivalents
- 5% increase in the total fleet of vehicles due to current incentives

The current scenario results in a reduction of overall car energy use of 1.2% by 2030, driven by a reduction in passenger car demand (annual mileage reduction). A revised version of this scenario (Ricardo, forthcoming) results in an overall reduction in car energy consumption of 3.6%, taking into account both a reduction in demand and an improvement in distance-specific fuel consumption. Therefore, the savings presented for this policy in the current scenarios are considered conservative.

4.1.7 Environmental taxes

In this scenario, energy consumption for all transport modes decreases as energy prices are increased as a result of adding environmental taxes on top of existing energy taxes and duties. The environmental taxes added reflect external costs for CO_2, NO_x and PM emissions and are drawn from the IMPACT study handbook (Ricardo-AEA, 2014), based on a literature review of external cost estimates. The effect is a 27% increase on the pump price of diesel and an 18% increase on the pump price of petrol (both inclusive of duties and VAT). The elasticities used to estimate the impact of the energy cost increases on transport energy consumption are provided in Table 2. By 2030, energy savings for road vehicles are around 4-5% over baseline, and slightly less for rail and inland waterways.

Arguably, the fuel price increases presumed as part of this scenario are high, and would require strong political intent for implementation. Consequently, the impacts of the policy are relatively large. However, as described further below, since the savings in the scenarios are based on the additional levels of taxation over current prices, it will underestimate the saving that can be counted under Article 7.

Table 2 Fuel price elasticities used in the definition of illustrative scenarios modelled in SULTAN

Mode	Elasticity
Car	-0.54
Bus	-0.38
Passenger Rail	-0.24
Motorcycle	-0.41
LCV	-0.30
Medium Truck	-0.30
Heavy Truck	-0.30
Inland Shipping	-0.18
Freight Rail	-0.24

Source: UK MARKAL ED model (AEA, 2008)

4.1.8 Combination of Member State level policies

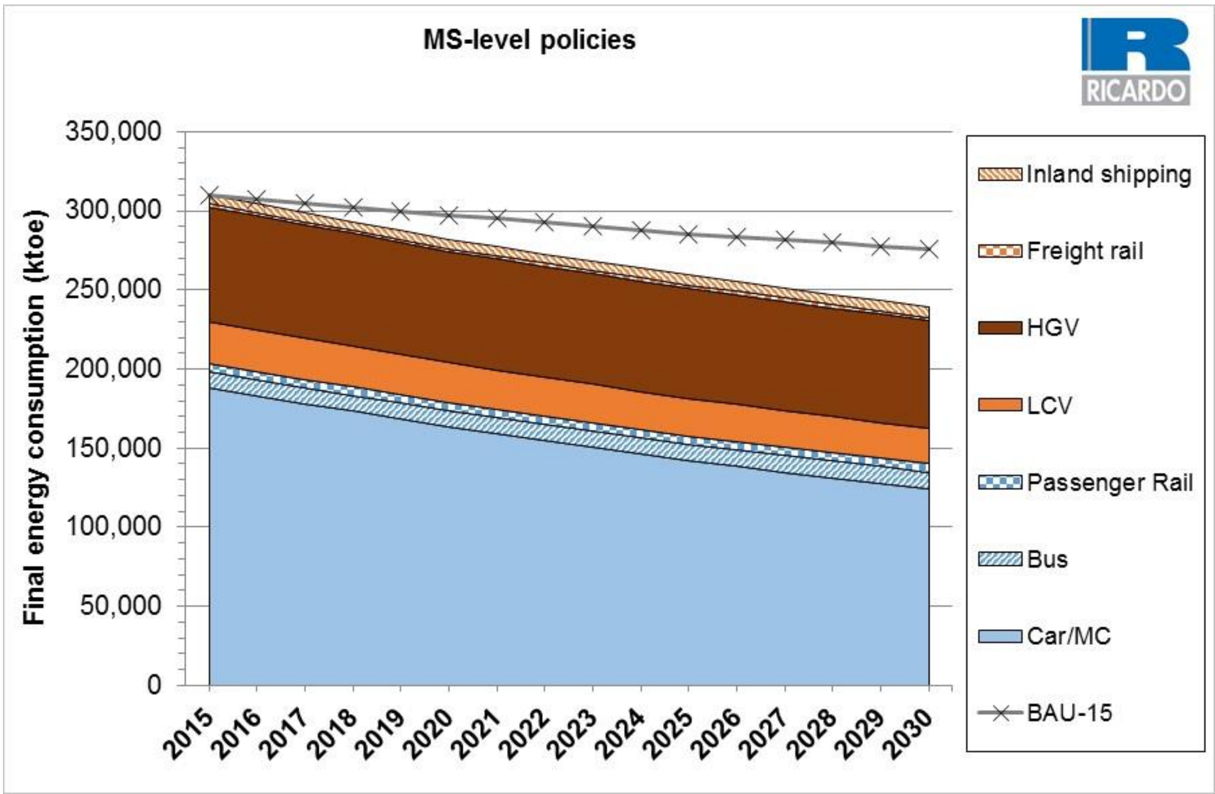
Table 3 summarises the overall energy savings achievable in the transport sector by 2030 under the SULTAN policy scenarios, as compared to the BAU 15 baseline. The final row represents the combined Member State policies scenario, which combines the policy measures of the previous six scenarios. Note that the impact of the individual measures is not additive, due to interactions between the policy measures. Therefore, the combined percentage reduction for the Member State policies scenario is slightly less than the sum of the individual policies' impacts.

Table 3 Overall final energy savings in years 2020, 2025 and 2030 over baseline by scenario (ktoe)

	2020	***2025***	***2030***
Public transport, cycling and walking	1,451	2,924	4,205
Freight intermodality improvement	291	911	1,894
Speed related measures	4,986	9,435	13,431
Fuel efficient driver training	1,844	3,268	4,353
Company car tax reform	412	1,169	1,729
Environmental taxes	6,896	9,663	13,409
Combination of MS-level policies	15,576	26,356	36,881

Overall, under the combined Member State policies scenario, passenger car energy consumption in 2030 is 17% lower than under baseline, light commercial vehicle energy consumption 15% lower and heavy goods vehicle energy consumption 12% lower. In contrast, energy consumption for buses, passenger and freight rail transport and inland waterways are slightly higher than under the baseline.

Figure 4 Transport final energy consumption trajectory for combined MS-level policies scenario



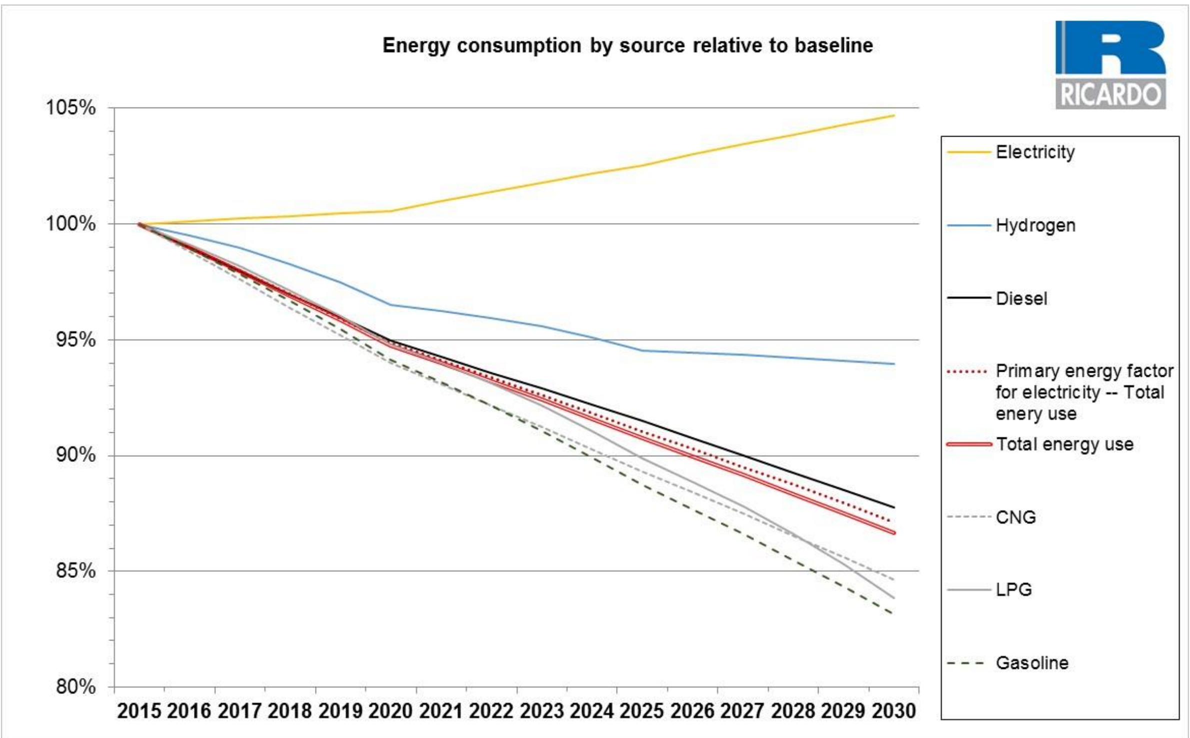
4.1.8.1 Impact on energy demand by energy carrier (fuel type)

Applying policies at Member State level also affects the composition of final energy consumption in the transport sector. Figure 5 illustrates the difference in the development of energy demand by fuel type between the combined Member State policies scenario and the baseline. It shows that demand for most fuels decreases, as expected. Overall, demand for gasoline drops most strongly. This is indicative of the fact that the Member State policies affect demand for passenger car use more than they affect road freight demand. Passenger cars use both gasoline and diesel, while vans and trucks almost entirely run on diesel, so demand for diesel is proportionately less affected by the policies.

Figure 5 also includes an illustration of the development of total energy use if a primary energy factor of 2.5 is applied to electricity consumption[10]. Given the low share of electricity in transport energy consumption overall, the overall trajectory is barely affected.

[10] In accordance with Annex IV of the EED.

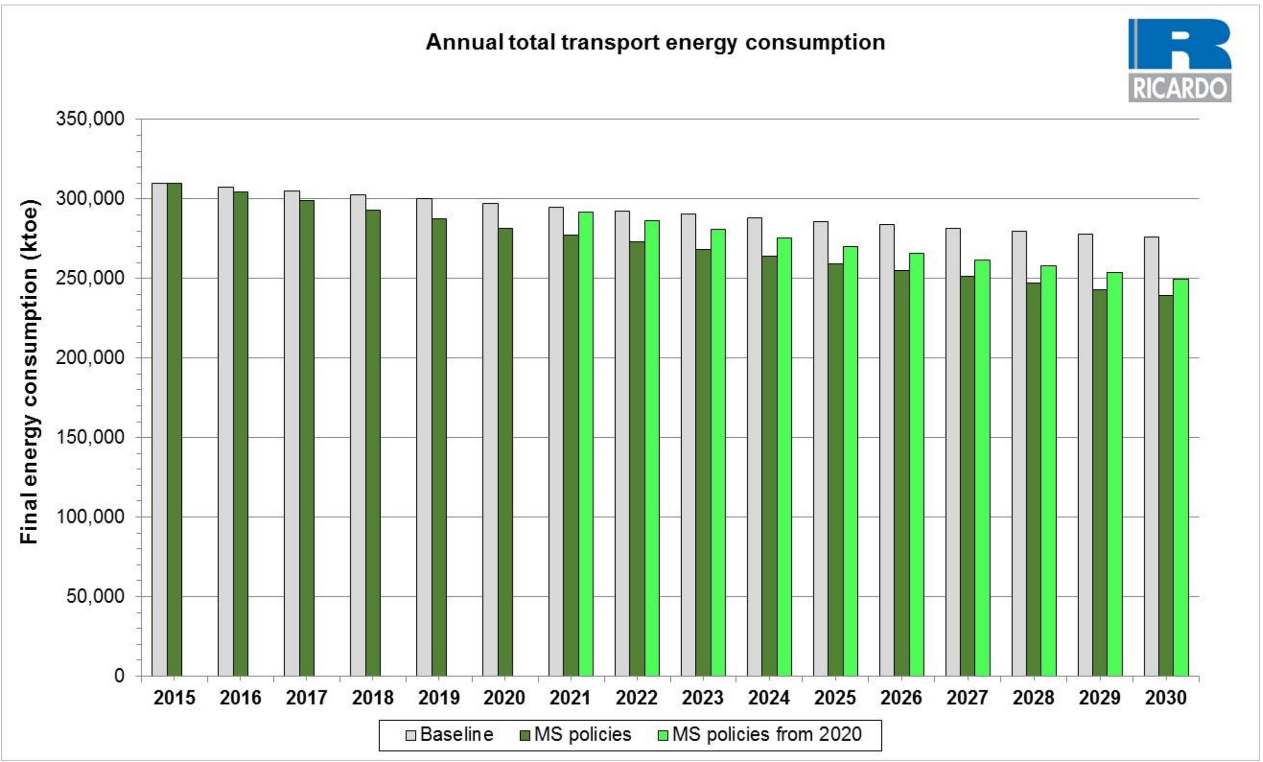
Figure 5 Index of energy consumption by source in combined MS policies scenario relative to baseline (2015=100)



4.2 Comparison of Member State transport energy savings with the requirements of Article 7 EED

As illustrated in the previous section, in the policy scenarios analysed in the ECF study, the relevant policies are introduced from 2016. However, given that to date, few of the measures covered in the scenarios are being implemented at scale throughout the EU28, and given that the objective of the present analysis is to identify additional savings in the period 2021 to 2030, it is assumed that implementation of the policies is moved back from 2016 to 2021. The revised energy consumption trajectory is provided in Figure 6.

Figure 6 Illustration of revised combined MS policies energy consumption trajectory, implemented from 2021



Effectively, under the revised trajectory, annual savings achieved are moved back by five years compared to the results from the ECF study. Table 4 revises the savings obtained from each of the scenarios accordingly, accounting for the 5-year delay in presumed implementation.

Table 4 Revised final energy savings over baseline by scenario, with policies launched in 2021 (in ktoe)

	2021	*2025*	*2030*
Public transport, cycling and walking	290	1,451	2,924
Freight intermodality improvement	58	291	911
Speed related measures	997	4,986	9,435
Fuel efficient driver training	369	1,844	3,268
Company car tax reform	82	412	1,169
Environmental taxes	1,379	6,896	9,663
Combination of MS-level policies	3,115	15,576	26,356

Following the revision, the Member State policies are expected to deliver estimated new savings of 3,115 ktoe per year over the period 2021-2025, after which they will fall to 2,156 ktoe per year over the period 2026-2030. On average this is 2,853 ktoe per year over the whole new obligation period 2021-2030.

However, when estimating the energy savings potential from Member State policies for the next Article 7 obligation period 2021-2030, two further elements should be taken into consideration. First, under Article 7 of the EED, the additionality of energy and CO_2 taxes is considered in relation to the EU minimum taxation requirements. Second, Member States widely use policies that incentivise the uptake of plug-in vehicles and/or other low-CO_2 vehicles.

These impacts have not been fully captured under the SULTAN policy scenarios, and therefore there may be further energy savings potential than illustrated in the scenarios. The potential impact of these additional savings is discussed in the sections below. The estimates developed would, however, need to be treated with caution as these are based on Member State best practices and assuming strong implementation of the policies from Member States' governments throughout the EU.

Under the SULTAN policy scenarios Member State policies are expected to deliver an estimated 3 Mtoe of new annual energy savings on average over the whole new obligation period 2021-2030 under Article 7.

4.2.1 Fuel taxation policies (fuel consumption avoided through existing policies)

Article 7 allows Member States to take into account credit for energy savings from taxation measures that exceed the minimum levels of taxation applicable to fuels as required in Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity or in Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax. The requirement has also been included in the Commission's proposal for a revised Article 7 (European Commission, 2016).

However, in the SULTAN policy scenarios, the relevant taxation policy package "Environmental taxes" only calculated savings associated with additional levels of taxation, over and above the current levels. This failed to take into account that Member States may already have in place taxes that go beyond the minimum levels required by EU legislation. Therefore, these savings are under-estimated in the policy scenarios, from an Article 7 perspective.

The level of under-estimate can be approximated based on the level of energy savings that were notified by Member States under Article 7 to date. As discussed in Section 3, about two-thirds of savings in the transport sector notified within the 2014-2020 period under Article 7 relate to energy and CO_2 taxes, adding up to an average of around 545 ktoe new savings per year. In practice, this estimate does not include energy savings from those energy and CO_2 taxes where it was not possible to allocate savings to the transport sector, or taxation policies which are known to be in place in Member States, but were not notified under Article 7. Still, this figure can provide a conservative indication of the potential impact of this option.

Energy and CO_2 taxes will deliver additional energy savings beyond those estimated in the SULTAN scenarios. Based on the savings estimated for these measures from Article 7 notifications over the 2014 -2020 period, these savings maybe of the order of 0.5 Mtoe per year.

4.2.2 Electric/ clean vehicle support policies at Member State level

Support policies for plug-in vehicles or other types of low emission vehicles are already in use by some Member States, and can have significant impacts on new vehicles' average emissions and energy consumption (ICCT, 2016). For example, the Netherlands levies a substantial CO_2-dependent vehicle registration tax on new vehicles, providing strong incentives for battery electric and plug-in hybrid vehicles, along with further electric vehicle support policies. In 2015, some 10% of vehicles registered in the Netherlands were electric (including plug-in hybrids) versus an EU average of 1.1%, and average new vehicle CO_2 emissions were 101g CO2/km, versus an EU average of 120gCO_2/km (EEA, 2016; Netherlands Enterprise Agency, 2016).

However, the EU has set legally binding fleet average CO_2 emission targets for manufacturers of cars and vans for the period up to 2021 which manufacturers are required to achieve regardless of Member State policies. Further targets for the post-2021 period are currently under development (European Commission, 2016). As the CO_2 emissions standards have been set as average emissions for all new car fleets, Member State policies will support car manufacturers in meeting their CO_2 emissions standards. On the other hand, Member State policies stimulate the market for clean vehicle technologies, bringing down their cost and therefore providing a basis on which future ambitious CO_2 standards at EU level can be politically and economically justified. Member State policies incentivising electric vehicles can therefore to some extent be viewed as complementary policies to CO_2 emissions performance standards set at EU level. In this context, a particular methodological challenge is determining the extent to which the Member State measures deliver additional savings that go beyond what EU-level CO_2 standards provide. At the same time, it is important that Member States are appropriately incentivised for taking action which may lead to the least cost delivery of the CO_2 standards, for example, by ensuring these actions can be counted towards the Article 7 targets.

Assuming that these policies can be notified under Article 7, we can develop a rough estimate of the magnitude of savings achievable by following the aforementioned Dutch example:

- Current Dutch policy measures lead to new car emission ratings that are around 20 gCO_2/km less than the EU average (see above). This is broadly equivalent to fuel savings of around 0.75 litres of diesel per 100 km, or 7.5 kWh (the energy content per kg of CO_2 released for gasoline is almost identical).
- A large part of these savings is likely to be due to the registration of (plug-in) electric vehicles, which still consume energy in the form of electricity. Electric vehicles consume around a quarter to half the amount of final energy relative to conventional vehicles (Howey, et al., 2011). Therefore, we assume net energy savings per 100km are around 5kWh (at 7.5 kWh gross fuel savings).
- Average annual distance driven per car is around 15,000 km (Ricardo, 2015), thus annual savings per car are around 750kWh.
- Annual EU new car sales are ~15m (ACEA, 2017), thus the measure saves 11,250 GWh, equivalent to 967 ktoe.

Consequently, annual new savings from applying Dutch-style support policies for clean vehicles across the EU28 should roughly be in the order of 1 Mtoe[11]. Applying the Dutch example across the EU28 assumes that similarly strong policies are put in place throughout the EU Member States, that however requires strong political will by all governments.

The Member State policies covered in the SULTAN scenarios could be complemented by Member State clean vehicle policies. While there are methodological challenges in demonstrating the additionality of these policies to the EU level vehicle CO_2 emission standards, the savings deriving from Member State ambitious clean vehicle policies could amount to 1Mtoe of new savings per year.

4.2.3 Overall level of savings and comparison with the requirements of Article 7 EED

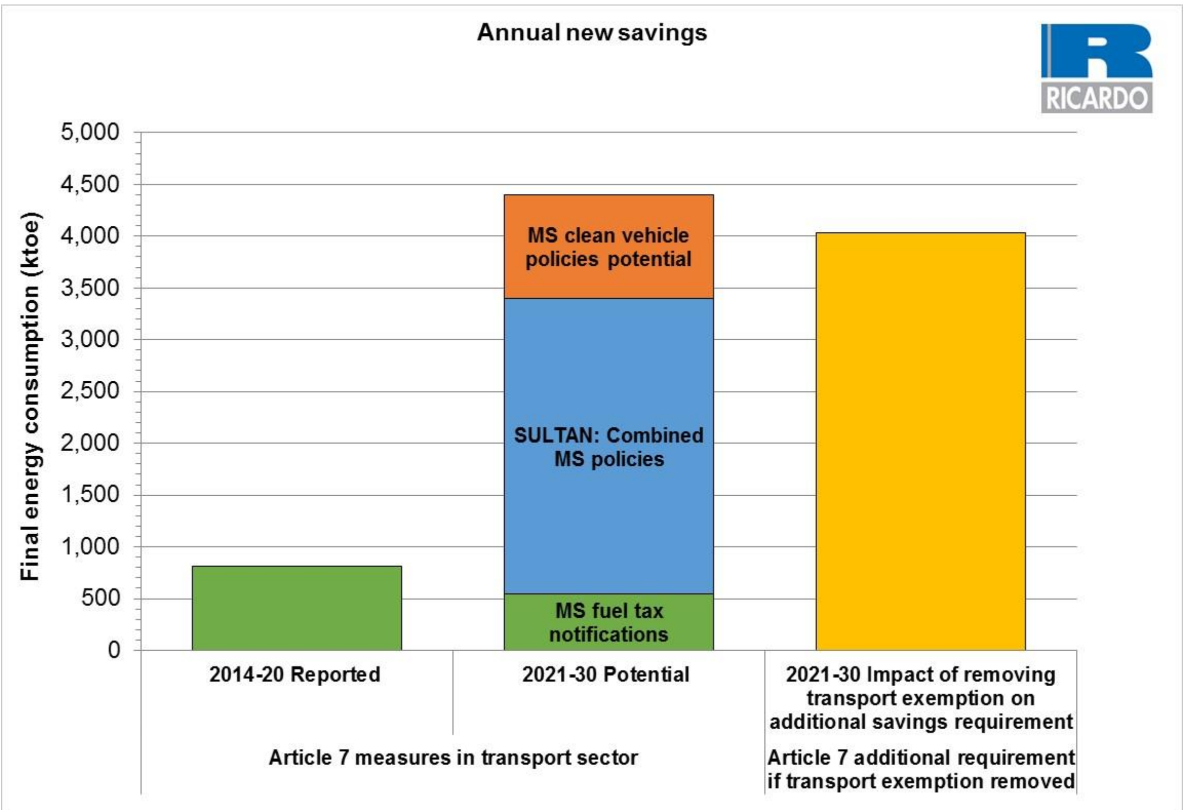
As established in Section 3, cumulative transport energy savings over the current Article 7 obligation period 2014-2020 amount to nearly 23 Mtoe. Assuming an equal distribution of new savings over the period, the new annual energy savings in any given year are 813 ktoe.

The analysis of SULTAN policy scenarios shows that the transport sector has the potential to deliver around three time greater levels of energy savings in the new period 2021-2030 compared to 2014-2020. This potential can be further complemented by clean vehicle support policies and additional savings from energy and CO_2 taxes that were not captured in the scenarios. According to outputs from the SULTAN tool, Member State policies could deliver on average of 2,853 ktoe of new energy savings per year over the whole new obligation period 2021-2030. Coupled with the potential impacts of clean vehicle support policies and full use of existing tax measures, Member States' savings could reach close to 4.5 Mtoe per year.

These potential energy savings for the new obligation period 2021-2030 under Article 7 are of a similar magnitude to the additional annual savings required if the transport exemption were removed from the Article 7 provisions (Figure 7).

[11] Given typical vehicle lifetimes of 15 years, the overall annual impact of this measure is likely to stop growing after around 15 years and flatten out at less than 15 Mtoe

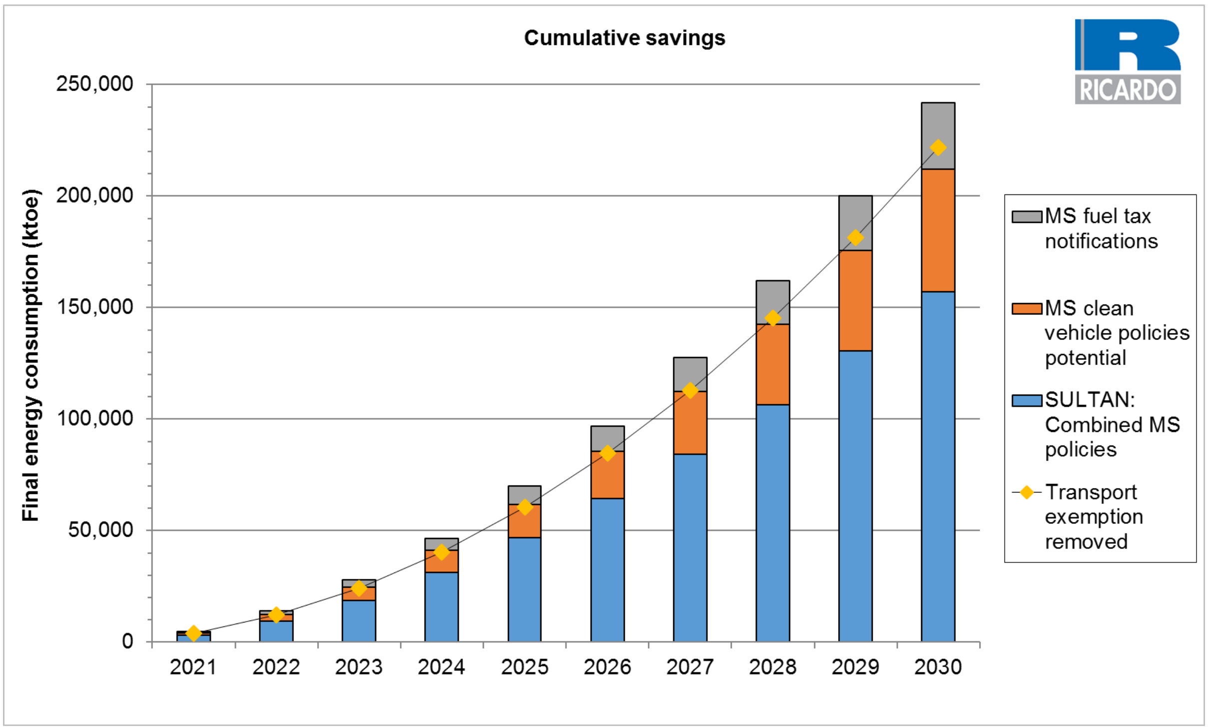
Figure 7 Annual new savings in the transport sector (ktoe): reported for 2014-2020, potential from Member State policies in 2021-2030 period, impact in 2021-2030 period if transport exemption removed



Notes: The new savings required if the transport exemption was removed has been calculated based on 1.5% of total transport final energy consumption for EU28 for the year 2015, as transport energy consumption data for years 2016-2018 is not yet available. The value for 1.5% of 2015 transport energy consumption is then reduced by 25% in order to take account of the 25% exemption allowable to Member States under Article 7. Note also that the total on which this value is based includes aviation and international shipping, areas which have not been considered as part of the ECF study, and for which further savings as a result of Member State policies could be conceivable.

Figure 8 presents the potentials achievable as cumulative savings over the new period 2021-2030. Cumulative savings potential from Member State transport policies notifiable under Article 7 is almost 250 Mtoe.

Figure 8 Cumulative energy savings over baseline of combined MS policies versus Article 7 EED requirement applied to the transport sector



The potential savings from Member State policies over the new Article 7 obligation period 2021-2030, coupled with clean vehicles policies and continued use of energy and CO_2 taxes, could deliver sufficient energy savings to cover the level of savings associated with the removal of the transport exemption from Article 7 in the new obligation period.

5 Conclusions

This study has provided an analysis of the specific policies that have been used by Member States to date under Article 7 of the EED to achieve energy savings in the transport sector. It has then assessed the potential contribution that national policy measures targeting energy consumption in transport could make in the new period 2021-2030.

The headline conclusions from the study are as follows:

- The policy measures implemented by Member States under Article 7 of the EED are estimated to deliver nearly 23 Mtoe of cumulative energy savings in the transport sector from 2014 to 2020 (9% of the total cumulative savings) or 0.8 Mtoe of new savings per year (assuming an equal distribution of new savings over the period).
- This contribution is rather small given that the transport sector currently represents approximately 30% of final energy consumption in the EU.
- Under Article 7 of the EED to date, the transport-related energy savings are dominated by energy and CO_2 taxes – this policy measure accounts for 67% of the transport savings in the period 2014-2020.
- Under the combined SULTAN Member State policy scenario, which combines a variety of policy measures, Member State policies are expected to deliver an estimated 3 Mtoe new annual energy savings on average over the whole new obligation period 2021-2030 under Article 7. The list of policy measures under this scenario is, however, not exhaustive – further Member State policy actions to reduce transport energy consumption are conceivable.

- Energy and CO_2 taxes will deliver additional energy savings beyond those estimated in the SULTAN scenarios. Based on the savings estimated for these measures from Article 7 notifications over the 2014 -2020 period, these savings maybe of the order of 0.5 Mtoe per year.
- The Member State policies covered in the SULTAN scenarios could be complemented by Member State clean vehicle policies. While there are methodological challenges in demonstrating the additionality of these policies to the EU-level vehicle CO_2 emission standards, the savings deriving from Member State ambitious clean vehicle policies could amount to 1Mtoe of new savings per year.
- The potential savings from Member State policies over the new Article 7 obligation period 2021-2030, coupled with clean vehicles policies and continued use of energy and CO_2 taxes, could deliver sufficient energy savings to cover the level of savings associated with the removal of the transport exemption from Article 7 in the new obligation period.

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Appendices

Appendix 1 – Savings delivered in transport sector by energy and CO_2 taxes

Member State	Type/Name of tax	Cumulative energy savings (ktoe)	Energy carriers covered	Transport share of energy savings	Comments
Austria	Energy taxes	1,789	Electricity, natural gas and mineral oil/ petrol	?	Insufficient information available to determine the share of savings expected in the transport sector.
Estonia	Energy and CO_2 taxes	435	Electricity, natural gas, petrol, light fuel oil, diesel and district heating	36%	Calculations provided in Estonian notification show that 36% of the energy savings derive from transport fuel taxation. Note: Estonia has recently updated its energy savings estimates, but the transport share is assumed to remain the same.
Finland	Transport fuel taxes	1,979	Transport fuel taxation/ road traffic	100%	Only taxation of transport fuels included in Finland's notification.
Germany	Energy tax	13,184	Electricity, fuel oil, petrol, diesel and natural gas	50%	Approach to calculate energy savings from energy taxes in Germany is described in Prognos, 2013[12]. The overall share of savings in the transport sector is not reported. However, based on the information reported on elasticities, and the expected change in fuel prices, we estimate that approximately 50% of the savings are likely to arise in the transport sector.
Netherlands	Duty on diesel and LPG	114	Diesel and LPG	100%	This instrument is only concerned with transport fuels.
Spain	Tax measures	1,328	Electricity, natural gas and coal	0%	This instrument does not cover transport fuels.
Sweden	Energy and CO2 tax	11,513	Electricity, fossil fuels in industry and transport fuels	60%	The share of transport is calculated based on the cumulative energy savings in the transport sector until 2020. Sweden only intends to use energy and CO_2 taxes to deliver its target – so all energy savings arise from taxation measures.

[12] Available at: https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/endenergieeinsparziel-abschaetzung-der-durch-politische-massnahmen-erreichbaren-energieeinsparungen.pdf?__blob=publicationFile&v=3

Member State	Type/Name of tax	Cumulative energy savings (ktoe)	Energy carriers covered	Transport share of energy savings	Comments
United Kingdom	Climate Change Levy	3,912	Coal, gas and non-renewable electricity	0%	This instrument does not cover transport fuels.

Appendix 2 – Savings delivered in transport sector by Energy Efficiency Obligation Schemes

Member State	Cumul-ative energy savings (ktoe)	Sectoral coverage	Transport share of energy savings	Comments
Austria	3,798	All sectors but mandatory minimum share for residential sector (40%)	9%	In 2014-2015 approximately 9% of savings were delivered in transport sector[13]. It was assumed that the same amount of savings will be delivered throughout 2014-2020.
Bulgaria	1,943	All sectors incl. energy transformation, distribution and transmission sectors	?	No measures in transport sector were implemented in 2014, except retailing of energy-efficient tyres labelled according to EU standards (Annual Report 2016). The effect of transport measures is expected to be minimal.
Croatia	529	All sectors	?	The scheme is planned to be operational in 2016 and there is no indication of types of measures implemented so far.
Denmark	4,130	All sectors except transport	0%	Transport sector not targeted.
France	27,212	All sectors except for actions in facilities subject to the ETS	1%	In 2014 2.9% of savings from standardised measures were achieved in transport sector[14], in 2015 it was however 1%[15]. In the second phase of the EEOS less than 1% of total savings were achieved in transport sector (Lees, 2014).
Greece	Not provided	Not provided	?	The scheme is in process of being designed.

[13] Based on communications with experts in Austrian Energy Agency
[14] Annual Report 2015. Retried from https://ec.europa.eu/energy/sites/ener/files/documents/FR_Annual%20Report%202015_en.pdf
[15] Annual Report 2016. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/FR%202016%20Energy%20Efficiency%20Annual%20Report_fr.pdf

Member State	Cumul-ative energy savings (ktoe)	Sectoral coverage	Transport share of energy savings	Comments
Ireland	1,081	Mandatory split: non-residential (75%), residential (20%) and energy poverty (5%)	1%	In years 2014-2015 71% of savings were achieved in the non-residential sector (which includes commercial buildings, as well as the transport sector) (Department of Communications, Climate Action & Environment, 2016). In 2016, transport was 1.3 % of the total non-residential savings and about 1% of total savings. Works are in progress to raise the share to at least 5%.[16]
Italy	16,030	All sectors	1.2%	According to FIRE (Federazione Italiana per l'uso Razionale dell'Energia) the transport sector accounted for 1.2% of annual energy savings in 2016. It was assumed that the same amount of savings will be delivered throughout 2014-2020.
Latvia	555	All sectors	?	No data available as the scheme is not operational yet; majority of measures are expected from household sector (Ricardo et al, 2016).
Luxembourg	515	All sectors	0%	No data available yet on share of measures; transportation measures are only expected to form a very small share (Ricardo et al, 2016). No transport measures were reported as taken in 2015.
Malta	10	Residential	0%	Transport sector not targeted.
Poland	14,818	All sectors including transport distribution, and own energy use	0%	Eligible actions list does not include any transport measures (ENSPOL, 2015).
Slovenia	314	All sectors	?	Efficiency end use measures in transport are in the list of eligible measures (ENSPOL, 2015). There is however no data available on the share of these measures.
Spain	6356	All sectors	?	Transport sector is expected to be supported (Ricardo et al, 2016). There is however no data available on the share of these measures.
United Kingdom	7,928	Residential	0%	Transport sector not targeted.

[16] Based on communications with experts in Sustainable Energy Authority of Ireland

Appendix 3 - Organisations contacted for further information on the share of transport savings associated with EEOS

Member State	Organisation
Austria	Federal Ministry of Science, Research and Economy
Austria	Austrian Energy Agency
Ireland	Department of Communications, Climate Action & Environment
Ireland	Sustainable Energy Authority of Ireland
Italy	FIRE (Federazione Italiana per l'uso Razionale dell'Energia)
Italy	GSE (Gestore dei servizi energetici)
Poland	Warsaw University of Technology - Chair of Rational Use of Energy
Poland	URE (Energy Regulatory Office) - Department of energy efficiency and cogeneration

Appendix 4 – Policy measures in transport sector implemented under Article 7 EED

A.1 Measures to promote more energy-efficient road vehicles

Member State	Policy measure title
Croatia	Financial incentives for energy efficient vehicles
Croatia	Special tax on motor vehicles based on CO_2 emissions
Greece	Replacing old public and private light trucks
Greece	Replacing old private passenger vehicles
Greece	LPG passenger vehicles
Ireland	VRT/Motor tax
Malta	Grant Schemes to Improve Vehicle Fleet Efficiency (2 measures)
Netherlands	Transport: Electric cars
Netherlands	Transport: Continuation of incentives for fuel-efficient cars
Portugal	More efficient State sector transport
Portugal	Green Taxes (rebates from vehicle and road taxes)
Romania	Car fleet renewal (cars and freight vehicles)
Slovakia	Renewal and modernisation of the fleet – Bus/coach transport
Spain	MOVELE
Spain	PIVE vehicle replacement scheme
Spain	Pima Air vehicle replacement scheme
United Kingdom	Low Emission Vehicle policies

A.2 Fuel-efficient driver training

Member State	Policy measure title
Croatia	Promoting eco-driving
Netherlands	Transport: Continuation of more fuel-efficient driving among new drivers
Portugal	Workshops to promote installation of equipment to fill tyres with nitrogen
Portugal	Fleet Management System and Promoting Eco-Driving
Spain	Eco-driving

A.3 Modal shift

Member State	Policy measure title
Greece	Thessaloniki Metro development
Greece	Extension of Athens metro
Netherlands	Transport: Electric bicycles with 10% car replacement (or autonomous)
Portugal	Minibuses and flexible transport services
Portugal	Use of bicycles and soft modes of transport

Member State	Policy measure title
Romania	Urban public transport modernisation
Romania	Bucharest underground extension
Romania	Alternative Mobility

A.4 Road user charging

Member State	Policy measure title
Austria	Tolls for trucks
Germany	Truck toll

A.5 Modernisation of rail transport

Member State	Policy measure title
Latvia	Modernisation of trains
Romania	Rail transport modernisation
United Kingdom	Rail electrification

A.6 Improved transport infrastructure

Member State	Policy measure title
Portugal	Mobi:E
Slovakia	Policy measures targeted on transport sector (that mostly consist of upgrades to infrastructure)

A.7 Other

Member State	Policy measure title
Germany	Air passenger duty levied on tickets
Netherlands	Transport: Construction of loading docks for inland waterway transport
Netherlands	Transport: Modal split in freight traffic through port policy
Portugal	Fleet management centres and the automatic attribution of taxi services
Portugal	Regulation to Manage Energy Consumption in the Transport Sector
Romania	Waterway transport modernisation

Appendix 5 – Energy savings potential from individual policy scenarios

This appendix provides scenario results in the form of graphs illustrating the final energy consumption trajectories (split by transport mode) between 2015 and 2030 under SULTAN scenarios, as well as further detail on input assumptions for each of the six policy scenarios.

A.8 Public transport, cycling and walking improvement measures

Figure 9 Transport final energy consumption trajectory for passenger mode shift scenario

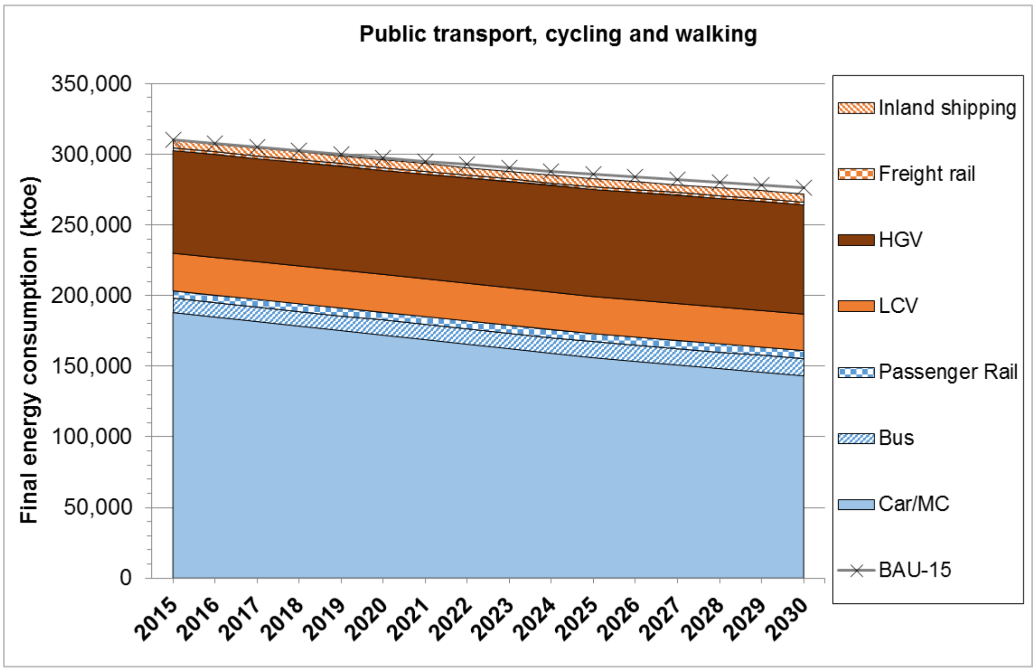


Table A1: Assumptions on modal shift from cars to other modes for different road types

Modal Shift - Urban	2015	2020	2025	2030
FROM:				
Car		2.0%	5.0%	8.0%
TO:				
Bus		40.0%	40.0%	40.0%
Passenger Rail		10.0%	10.0%	10.0%
Motorcycle		0.0%	0.0%	0.0%
Walk/Cycle		50.0%	50.0%	50.0%
	0.0%	**100.0%**	**100.0%**	**100.0%**

Modal Shift - Non-Urban	2015	2020	2025	2030
FROM:				
Car		1.0%	2.0%	3.0%
TO:				
Bus		35.0%	35.0%	35.0%

Modal Shift - Non-Urban	**2015**	**2020**	**2025**	**2030**
Passenger Rail		50.0%	50.0%	50.0%
Motorcycle		0.0%	0.0%	0.0%
Walk/Cycle		15.0%	15.0%	15.0%
	0.0%	**100.0%**	**100.0%**	**100.0%**

Modal Shift - Motorway/Met	**2015**	**2020**	**2025**	**2030**
FROM:				
Car		1.0%	2.0%	3.0%
TO:				
Bus		40.0%	40.0%	40.0%
*Passenger Rail**		60.0%	60.0%	60.0%
Motorcycle		0.0%	0.0%	0.0%
Walk/Cycle				
	0.0%	**100.0%**	**100.0%**	**100.0%**

** added to passenger rail non-urban*

Table A2: Split of new vehicle sales by powertrain (%) for rail reflecting increase in HSR

	2015	**2020**	**2025**	**2030**
Diesel	25%	15%	8%	1%
CR Electric	70%	73%	72%	79%
HSR Electric	5%	12%	20%	20%
Total	***100%***	***100%***	***100%***	***100%***

Notes: CR = conventional rail, HSR = high-speed rail

A.9 Improved freight intermodality

Figure 10 Transport final energy consumption trajectory for freight mode shift scenario

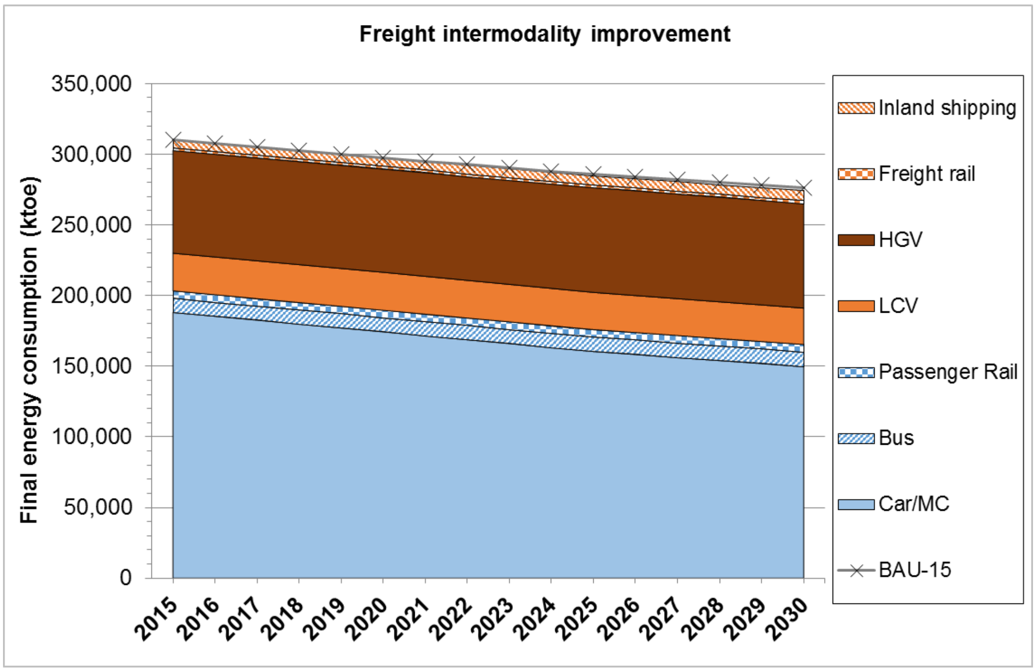
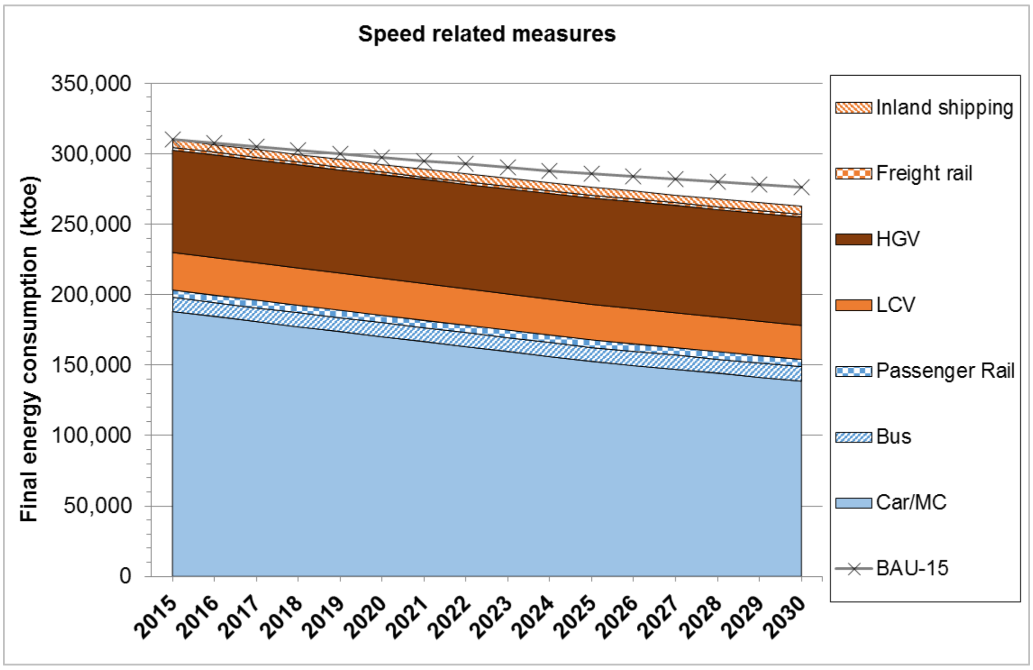


Table A3: Assumptions on modal shift for improved freight intermodality

Modal Shift (all roads)	2015	2020	2025	2030
FROM:				
LCV	0.0%	0.0%	0.0%	0.0%
Medium Truck	0.0%	0.0%	0.0%	0.0%
Heavy Truck	0.0%	1.0%	3.0%	6.0%
TO:				
Inland Shipping		30.0%	30.0%	30.0%
Freight Rail		70.0%	70.0%	70.0%
		100.0%	**100.0%**	**100.0%**

A.10 Speed related measures for road vehicles

Figure 11 Transport final energy consumption trajectory for speed-limiting scenario



These include (a) improved speed enforcement and (b) reduction of average motorway speeds. Elasticity of speed change to demand change is assumed to be 100% for passenger modes and 25% for freight modes.

Table A4: Assumptions on impacts of speed enforcement on average speed, and reduction in average motorway speed limits

	Motorway		Urban		Nonurban	
	LDVs	HDVs	LDVs	HDVs	LDVs	HDVs
Current Average Speed Limit (kph):	123	82	49	49	95	70
Reduction in Av. Speed (kph):	105	78	45	47	88	67
Speed Enforcement %Change	-15.2%	-4.8%	-8.0%	-4.0%	-8.0%	-4.0%
New Harmonised Speed Limit (kph):	110	80				
Total % Change	**-15.2%**	**-4.8%**	**-8.0%**	**-4.0%**	**-8.0%**	**-4.0%**

Table A5: Average % efficiency improvement due to speed change for road transport modes

All roads	2015	2020	2025	2030
Car	2.7%	3.0%	3.2%	3.3%
Bus	-1.0%	-1.0%	-1.0%	-1.0%
Motorcycle	2.5%	2.7%	2.9%	2.9%
LCV	8.3%	8.4%	8.5%	8.5%
Medium Truck	0.1%	0.1%	0.1%	0.1%
Heavy Truck	0.0%	0.0%	0.0%	0.0%
% Application	**2015**	**2020**	**2025**	**2030**
Car	0.0%	20.0%	40.0%	60.0%
Bus	0.0%	20.0%	40.0%	60.0%
Motorcycle	0.0%	20.0%	40.0%	60.0%
LCV	0.0%	20.0%	40.0%	60.0%
Medium Truck	0.0%	20.0%	40.0%	60.0%
Heavy Truck	0.0%	20.0%	40.0%	60.0%

A.11 Fuel efficient driver training

Figure 12 Transport final energy consumption trajectory for fuel efficient driver training scenario

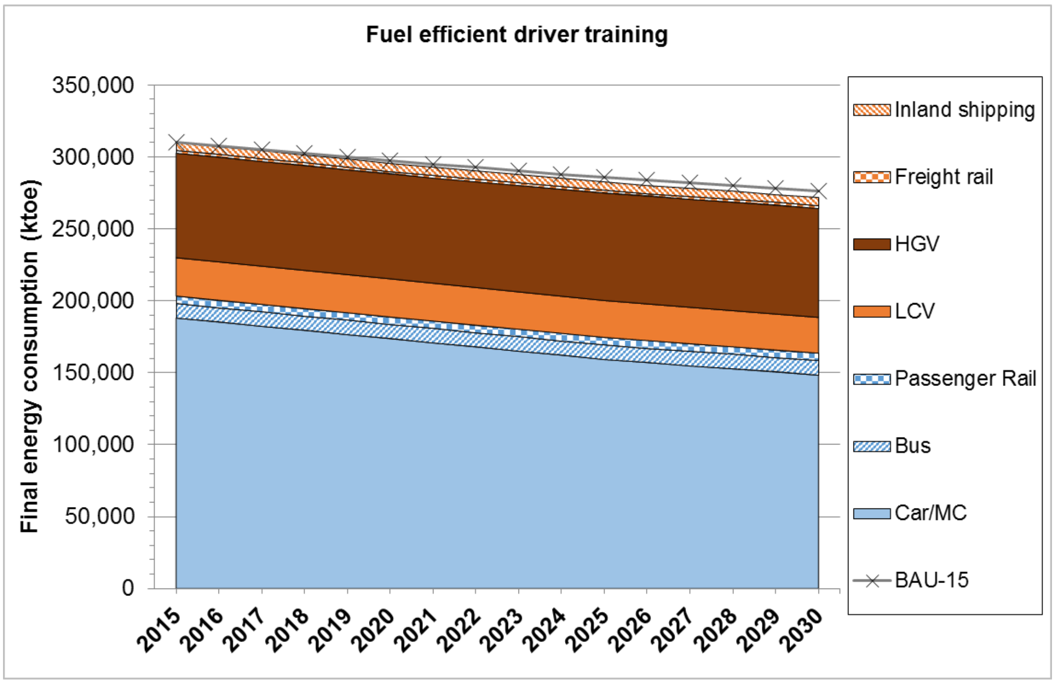


Table A6: Assumptions on impact of fuel efficient driver training used in the definition of the scenario

Saving for driver training	2015	2020	2025	2030	% decline in effectiveness per year
Car	4.07%	3.68%	3.32%	3.00%	2.0%
Bus	4.25%	3.84%	3.47%	3.14%	2.0%

Saving for driver training	2015	2020	2025	2030	% decline in effectiveness per year
Passenger Rail	4.52%	4.09%	3.69%	3.34%	2.0%
Motorcycle	4.07%	3.68%	3.32%	3.00%	2.0%
LCV	6.51%	5.88%	5.32%	4.81%	2.0%
Medium Truck	3.89%	3.51%	3.18%	2.87%	2.0%
Heavy Truck	3.89%	3.51%	3.18%	2.87%	2.0%
Inland Shipping	0.00%	0.00%	0.00%	0.00%	2.0%
Freight Rail	2.71%	2.45%	2.22%	2.00%	2.0%

Notes: Decline in effectiveness of driver training is assumed (from 2010 starting point), due to technology performance being increasingly insensitive to driver/driving style either intrinsically (e.g. electric vehicles) or through technologically helping to optimise driving style automatically. This is already applied at the level indicated to periods after 2010 in the above table.

Table A7: Assumptions the level of application of fuel efficient driver training used in the definition of the scenario

% drivers /fleet covered	2015	2020	2025	2030	% drivers trained per year
Car	0.0%	10.0%	20.0%	30.0%	2.0%
Bus	0.0%	25.0%	50.0%	75.0%	5.0%
Passenger Rail	0.0%	25.0%	50.0%	75.0%	5.0%
Motorcycle	0.0%	10.0%	20.0%	30.0%	2.0%
LCV	0.0%	25.0%	50.0%	75.0%	5.0%
Medium Truck	0.0%	25.0%	50.0%	75.0%	5.0%
Heavy Truck	0.0%	25.0%	50.0%	75.0%	5.0%
Inland Shipping	0.0%	25.0%	50.0%	75.0%	5.0%
Freight Rail	0.0%	25.0%	50.0%	75.0%	5.0%

Notes: % of drivers trained per year has been used to derive the figures in the main body of the table.

A.12 Reform of company car tax

Figure 13 Transport final energy consumption trajectory for company car tax reform scenario

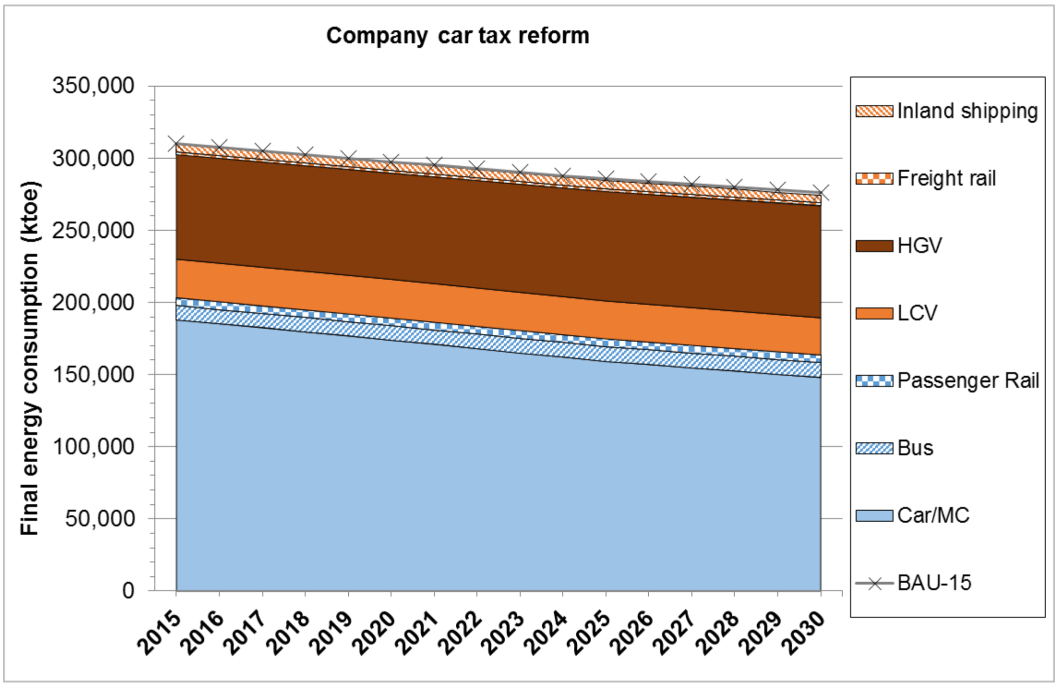


Table A8: Assumptions used in the definition of the scenario on reforming company car tax

Assumed to be in BAU	2015	2020	2025	2030
Company Cars % Fleet	15.0%	15.0%	15.0%	15.0%
Company Cars % New Vehicles	50.0%	50.0%	50.0%	50.0%
Increase in total EU fleet numbers	5.0%	5.0%	5.0%	5.0%
Company Cars increased fuel consumption	6.0%	6.0%	6.0%	6.0%
Increased annual km	1,200	1,200	1,200	1,200
% total annual km	10.3%	10.3%	10.3%	10.3%

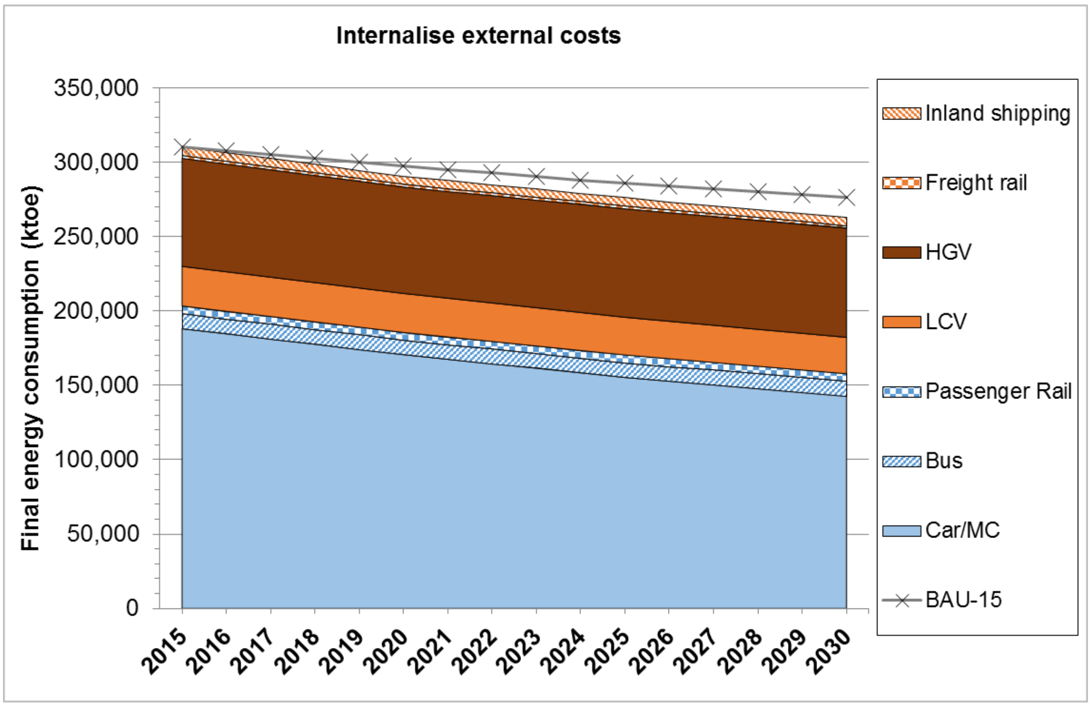
Application	2015	2020	2025	2030
Implementation of reform	0.0%	50.0%	100%	100%
Change in total car demand (1)	0.00%	-0.77%	-1.55%	-1.55%
Improvement to new car efficiency (2)	0.0%	1.4%	2.8%	2.8%
Change in new car stock growth	0.0%	-2.5%	-5.0%	-5.0%

Notes:

(1) *Based on reduction in annual km from company cars averaged out across whole fleet at level of implementation for the year*
(2) *Company car improvement in efficiency applied to % of new fleet that are company cars at level of implementation for the year*

A.13 Environmental taxes

Figure 14 Transport final energy consumption trajectory for environmental taxes scenario



- CO_2 prices/tax using the EC IMPACT study damage costs, central case.
- Tax is applied as an addition to existing duty levels based on carbon intensity of the energy carrier.
- NOx and PM prices/tax using damage costs based on EC IMPACT study figures.
- NOx and PM taxes applied as an addition to existing duty levels based on average NOx and PM emissions of the energy carrier (i.e. emissions weighted by relative activity for different modes).
- Energy security price/tax applied as additive to basic duty level at 0.145 €cents/MJ (~5 €cents/litre) for all conventional road transport fuels (i.e. excluding hydrogen and electricity).

Table A9: Fuel price elasticities used in the definition of illustrative scenarios modelled in SULTAN

Mode	Elasticity
Car	-0.54
Bus	-0.38
Passenger Rail	-0.24
Motorcycle	-0.41
LCV	-0.30
Medium Truck	-0.30
Heavy Truck	-0.30
Inland Shipping	-0.18
Freight Rail	-0.24

Source: UK MARKAL ED model (AEA, 2008)

Table A10: Proportion of fuel price response split between demand reduction and new vehicle efficiency

% Allocated to demand reduction	2015	2020	2025	2030
Car		40.0%	40.0%	40.0%
Bus		50.0%	50.0%	50.0%
Passenger Rail		90.0%	90.0%	90.0%
Motorcycle		40.0%	40.0%	40.0%
LCV		67.0%	67.0%	67.0%
Medium Truck		67.0%	67.0%	67.0%
Heavy Truck		67.0%	67.0%	67.0%
Inland Shipping*		90.0%	90.0%	90.0%
Freight Rail		90.0%	90.0%	90.0%

Source: Estimates agreed with project partners in the absence of a quantitative data source.

Speed-Demand Response

Demand response to speed reduction measures is assumed 1:1 for passenger modes (i.e. 1% reduction in pkm for every 1% reduction in speed) and 1:4 for freight modes (i.e. 0.25% reduction in tkm for every 1% speed reduction).

External Costs

The assumptions on the external costs of CO_2, NOx and PM emissions are based on information from the EC's IMPACT project and are summarised in Table A11 and Table A12. In addition, an indicative figure for energy security from the IMPACT handbook of approximately 5 €cent/litre has also been utilised.

Table A11: External costs of climate change from IMPACT project (in €/tonne CO_2), expressed as single values for a central estimate and lower and upper values

Year of application	2010	*2015**	2020	2030
Central value	25	*32.5*	40	55

*Notes: * interpolated from IMPACT study values for 2010 and 2020*

Table A12: External costs of NOx and PM used in defining illustrative scenarios

External costs of NOx and PM		2010	2015	2020	2030
EU27 NOx	**All**	7,424	8,642	9,261	9,650
EU27 PM	**Non-urban**	89,571	98,629	96,427	92,328
EU27 PM	**Urban**	251,282	279,002	275,397	262,014

Source: Based on weighted average of figures from IMPACT project (in 2000€/tonne pollutant), corrected for GDP growth in future years with elasticity of 0.5.

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com