ClimaEast

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Development of national policy on regulation of road transport CO_2 emissions and energy consumption in Ukraine

Produced as part of Clima East Expert Facility assignment CEEF2015-043-UA:

"*Development of potential in the elaboration of National policy on regulation of CO_2 emissions and energy consumption by road transport*"

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Table of contents

Table of figures

Table of tables

Acronyms and abbreviations

CRF	Common Reporting Format (for reporting under UNFCCC)
EU	European Union
GHG	Greenhouse gases
HDV	Heavy duty vehicle
LCV	Light commercial vehicle
LDV	Light duty vehicle
NAP	National Adaptation Plan
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

1 Executive Summary

1.1 Background and introduction to the project

Ukraine is an Annex I Party to the United Nations Convention on Climate Change (UNFCCC). As such, the Ukraine submitted its **Intended Nationally Determined Contribution** (INDC) in preparation of the 21st Conference of Parties (COP21) that was held in Paris in December 2015. In its INDC[1], Ukraine committed to not exceeding 60% of the country's 1990 GHG emissions level in 2030.

Also, according to the 2016-2018 **Association Agreement** between the European Union and its Member States, on the one hand, and Ukraine, on the other hand, Ukraine committed to improve and develop national policy on the regulation of CO_2 emissions and energy consumption in the area of road transport. More specifically, EU's provisions on energy efficiency regarding road transport should be reflected in Ukraine's legislation within 5 years, and implemented within 8 years, from the date of entry into force of the Agreement.

In line with Ukraine's above commitments, the main **objective of this project is to assist the Ministry of Infrastructure of Ukraine** (i.e. the beneficiary of this project) **to enhance its understanding and capacity in the area of GHG emissions regulation in the road transport sector**. As such, this project contributes to the development of road transport policy measures that can help achieve national and global GHG emission reduction targets. More specifically, this project should provide

i) A **review of the EU Member States national practices** in reduction of GHG emissions in road transport;
ii) An **analysis of Ukraine's current national policies**, standards and practices in the field of GHG emissions regulation and energy consumption by road transport;
iii) **Recommendations** based on the findings of the previous tasks on actions that should be undertaken to achieve Ukraine's GHG emission reduction and energy saving commitments in the road transport sector and develop the according capacity.

As part of the project, meetings were held to engage with relevant stakeholders in Ukraine (both in governmental departments and other expert organisations):

i) The inception meeting with the beneficiary and other stakeholders was held on 25th May 2016 where first findings were presented and inputs from stakeholders were requested.
ii) The final meeting was held 28th October 2016 with presentation the overall findings of the project and resulting recommendations.

1.2 Review of the EU practices and shortlisting of policy options

The objective of this task was to provide a comprehensive overview of policy instruments that have been implemented by EU Member States for the reduction of road CO_2 emissions. It provides a high-level overview of the different options available and a summary of the favourable conditions and obstacles for the options. As is common in the available literature, the measures are categorised into

- Economic instruments
- Regulatory instruments
- Instruments that enhance the transport infrastructure
- Educational and awareness raising instruments
- Instruments to stimulate innovation and development

[1] http://www4.unfccc.int/submissions/INDC/Published%20Documents/Ukraine/1/150930_Ukraine_INDC.pdf

In addition, a qualitative MCA (Multi-Criteria Analysis) assessment was carried out that compares the different policy options in terms of

- Their **benefits** (environmental impacts and other)
- The **costs/efforts** necessary to implement the policy option
- Their **coherence** with policy that is already in place in the EU and the Ukraine
- The **public acceptability** of the policy option, and
- The **time lag** until the CO_2 reduction materialises.

On the basis of this multi-criteria analysis, stakeholder input/feedback and findings regarding the current situation of Ukraine's road transport policy and structure (Section 1.4 below), recommendations were developed (discussed in Sections 1.5 and 1.6 below).

1.3 Analysis of methods and procedures for testing road transport vehicles

The objective of this task was to analyse the different methods and procedures for testing road transport vehicles with respect to CO_2 emissions and fuel consumption, and also to consider these in the context of the need to develop reliable input datasets for the national GHG inventory.

Vehicle testing and the development of suitable certification procedures is a highly complex area and the focus of the work involved a high-level summary for policymakers of the following information:

a) A comparison of the options, their advantages and disadvantages.
b) Information on what is happening/being proposed for the future in different territories
c) An assessment on practical implementation and the likely fit of the different options with what is available/possible in Ukraine.

1.4 Analysis of the legislation and experience of Ukraine

The objective of this task was to identify and systematize Ukrainian current national policies, standards and practices in the field of CO_2 emissions and energy consumption regulation by the road transport.

A general overview of national legislation has been provided in the main report, including existing economic instruments and their potential impacts in terms of potential growth or key measures to implement based on experience in the EU. In addition, the report provides information on:

(a) The experience of Ukraine in the development and implementation of government programs aimed at reducing energy consumption by road transport.
(b) The systemic barriers regarding technical regulation and road vehicle certification issues in Ukraine to the implementation of regulations on CO_2 emissions and energy consumption by the road transport in Ukraine.

A brief overview of the situation in the field of national reporting of GHG emission by road transport in Ukraine was also provided, and the current national policy was also be analysed for consistency with global GHG emissions reduction targets, and the Association Agreement between the Ukraine, the European Union and the European Atomic Energy Community.

Finally, a gap analysis of missing elements and obstacles to implementation in Ukraine of measures similar to those applied/planned in the EU was provided from this task to support development of appropriate recommendations.

1.5 General recommendations for the improvement of a road transport policy

To build suitable recommendations, the following findings with regards to the current situation of Ukraine's road transport policy and structure were considered:

- The system for the regulation of emissions in the transport sector is currently not well developed;

- The structure of the road vehicle fleet contains a significant proportion of older vehicles, with few incentives to shift to more efficient vehicles, and Ukraine's transport infrastructure needs further development;
- There is significant potential for the future application of newest information and logistics technologies and numerous other opportunities;
- There are significant issues with regards to financial resources, and corruption.

As a result, the Ukraine is seen to have a big potential for the reduction of specific GHG emissions in road transport. However, at the same time there are currently significant barriers to the implement the majority of the available options. The recommendations for this project were developed based on the detailed review, the multi criteria analysis (MCA) and on discussion with, and feedback from stakeholders at the kick-off meeting, questions posed at/after the meeting and informal discussions with the project team.

The following **Primary Prioritisation Options** were identified that should be taken forward/addressed as a top priority to maximise fuel economy/GHG savings.

I. Measures to improve fleet renewal and enhance fleet structure

- Vehicle emission and/or fuel consumption standards and MRV (initially for LDVs only).
- Vehicle labelling (all categories of road vehicles).
- Vehicle purchase and ownership taxes (to be based on CO_2 specific emission and a progressive tax scale, with more shift to ownership (or even operation) tax modes).
- Tax breaks and subsidies (to stimulate fleet renewal with more efficient vehicles).
- Green public procurement to stimulate investments in innovation and development.
- Component efficiency / requirements (including tyre efficiency ratings, etc.).
- Company car taxation and treatment of business travel (to force a more positive fuel economy policy at a company level).
- Parking fees

II. Measures to enhance fuel/energy infrastructure for road transport sector

- Fuel quality/GHG performance standards (to increase the share of low carbon fuels in the total energy consumption of transport).
- Fuel labelling (for customer information and as the base for differentiated taxes).
- Fuel Taxes (differentiated according to fuel quality/GHG performance of the fuels).
- Roll-out of alternative fuel infrastructure.

Secondary options are a lower priority that should ideally be further developed once progress has been started on the primary options. The following secondary options were identified.

III. Stimulation of innovation and development:

- Research and development.
- Fleet tests, demonstrations and pilot programmes.

IV. Measures to optimise fleet usage:

- Driver training (Eco driving).
- Information for vehicle operators.
- Potential further development the existing Fuel Rationing system.
- Information campaigns.

V. Measures to enhance/renew transport infrastructure:

- Traffic management.
- Urban planning.
- Public transport information.
- Spatial planning outside of urban areas.

The report further outlines a high-level policy implementation plan. Broadly, it can be summarised into the following steps (further details and more precise steps are provided in Chapter 6.4):

- Develop and approve an appropriate national strategy, targets, an implementation schedule and a legislative base.
- Develop appropriate national capacity required for implementation in practice (see Chapter 7).
- Put into practise the measures to realize the proposals and recommendations.

There will also be a need to monitor and control the implementation of the national strategy to make necessary and timely amendments and improvements where required - reliable reporting of GHG emissions by road transport is a key feature to control the effectiveness of the implemented measures.

A summary of the proposed short-, medium- and longer-term implementation actions is also provided in the main report.

1.5.1 Recommendations regarding vehicle CO2 regulations specifically (i.e. vehicle fuel economy/emission standards and labelling)

The recommendations from the project team regarding approaches to vehicle CO_2 regulation are presented in Table 3.1 below. More details, also regarding testing methods are provided below by vehicle category.

Table 1.1: Proposed scope of regulation in Ukraine on the first stage that is under consideration

Vehicle category	Vehicle sub-category	Fuel economy labelling [1)]	Fuel economy standards [2)]	Fiscal measures [3)]
Light Duty Vehicle (**LDV**)	Passenger Car (**PC**)	**Yes**	**Yes**	**Yes** (High Progressive scale. High intensity)
	Light Commercial Vehicle (**LCV**)	**Yes**	**Yes**	**Yes** (Medium Progressive scale. Medium intensity)
Heavy Duty Vehicle (**HDV**)	**General purpose** for cargo and passengers transportation	**Yes**	-	**Yes** (Medium Progressive scale. Low intensity)
	Special purpose (construction etc.)	**Yes**	-	**Yes** (Low Progressive scale. Low intensity)
	Military purpose	**Voluntary**	-	N/A
Powered two wheelers (**P2W**)		**Yes**	-	**Yes** (High Progressive scale. Low intensity)

Notes:
1) Obligatory as the base for fiscal measures to incite fuel efficient vehicle choices.
2) As a function of vehicle mass; phased implementation.
3) Maximum tax if fuel economy not defined or if there is non-conformity with the fuel economy standards.

Regarding **light duty vehicles** (LDVs) it is proposed to base vehicle testing on the Worldwide harmonized Light vehicles Test Procedures (WLTP), in line with the likely EU approach from 2017/18 onwards. Also LDV labelling should be established that includes information on fuel economy and also CO_2 data metrics. In addition to WLTP specific values, it may be useful to consider a limited programme of national fuel economy testing in a common system, to develop real-world calibration/adjustment factors to apply to the WLTP figures (similarly to what has been done for the US official fuel economy figures). This could help improve consumer confidence in the 'official' CO_2 / fuel consumption figures, which have become undermined in the EU due to significant differences between type approval and real world emission values.

Regarding **heavy duty vehicle** (HDV) labelling, one option could be to consider the World Harmonized Vehicle Cycle (WHVC) test procedure with other additional or intermediate test procedures, covering the same metrics as for light duty vehicles. In a case of HDVs, the cargo weight (or passenger loading) should also be considered. The EU certification procedure that is currently in development is based on the VECTO simulation model. It considers performance at zero, maximum

and average loading values, which could be applied similarly, to provide additional information for the customer. Regarding the choice of an HDV testing method, a flexible approach may be taken, based on e.g. chassis dynamometer readings, on-road tests, alone engine tests or complete vehicle simulations.

Regarding **powered two wheelers** (P2W), labelling is recommended to be based on the Worldwide harmonized Motorcycle emissions Certification/Test procedure (WMTC), potentially with other additional national test procedures used to develop calibration/adjustment factors for Ukraine.

In addition, it was recommended that following this project there is ongoing positive engagement with the GFEI (Global Fuel Economy Initiative) to help facilitate the development and implementation of policy in this area.

1.6 Recommendations regarding capacity development

Based on the recommended policy options and capacities already in place, the following main actions for capacity development in Ukraine are recommended that have the potential to drive the further shaping and implementation of road transport policy in line with energy consumption and GHG reduction targets:

- Create an interdepartmental coordination/working group (and maybe several sub-groups) to i) work on the further development of relevant policy and draft legal acts that require the coordination of positions of various institutions and ii) consolidate efforts towards the adoption of an appropriate institutional framework. The working group(s) should be empowered to work effectively, must have a clear timetable and clear responsibilities.
- (Re-) assign responsibilities regarding the recommended Primary and Secondary Policy Prioritisation Options, as presented in this report. However, more detailed planning should be undertaken to take into account also aspects that were beyond the scope of this current research project.
- Develop information and R&D infrastructure (both are key capacities required for the implementation of many policy measures that can curb road transport CO2 emissions and energy consumption in the sector). This is likely to require a significant amount of time and resources. It is therefore recommended to start this process as soon as possible, considering the prioritisation dictated by the high-level policy implementation plan (see Section 6.4) to support the timely implementation of relevant policy options.
- Create a National Transport Model (NTM) and set up an adequate data processing centre.
- Provide financing to create and maintain the necessary infrastructure and activity the area of road transport. It could also be beneficial to create a specialized State Fund for Sustainable Transport Development. Further work would need to be carried out to establish the appropriate budget that should be set aside for this purpose.

2 Background

2.1 Context

Ukraine is an Annex I Party to the UNFCCC, all Parties to the United Nations Convention on Climate Change were invited by the Conference of Parties to the UNFCCC (COP.19) in Warsaw, in November 2013, to initiate or intensify domestic preparations for their Intended Nationally Determined Contributions (INDCs) to the future global Climate Change Agreement, to be signed by Parties in December 2015 in Paris (COP.21), with the aim for it to enter into force in 2020.

The main objective of the task is to assist the Ministry of Infrastructure of Ukraine to increase capacity in elaboration of national policy on CO2 emissions regulation and energy consumption by road transport by collecting and studying relevant data of EU and EU MS national policies, standards and practices and various economic instruments (like levies and taxes, deposit and return systems, various kind of financial assistance) supporting national and global GHG emission reduction targets to 2030. Road transport GHG emissions in Ukraine were assessed in 2014 under Ukrainian submission of national inventory report and CRF tables for 1990-2012.

2.2 Introduction to the Project

This draft report is produced as part of the Clima East Expert Facility for Expert input under the Expert Facility Services CEEF2015-043-UA with the title: *"Development of potential in the elaboration of national policy on regulation of CO2 emissions and energy consumption by road transport"*.

The project consists of two phases:

Phase 1: Review of the EU Member States national practices in reduction of GHG emissions in road transport sector, analysis of Ukrainian current national policies, standards and practices in the field of CO2 emissions regulation and energy consumption by the road transport, and development of optimal approaches to achieving the objective in GHG emission reduction and energy saving in road transport sector of Ukraine;

Phase 2: Presentation of final results to broader auditoria and beneficiaries.

According to the terms of reference, the overall objective of the project is to *"provide the Government of Ukraine with the information necessary to take policies and measures at the national level to improve the situation with GHG emission growth in road transport sector."*

The project is providing a summary review and analysis of a number of different areas, which will be combined into a final report containing also the recommendations for Ukraine transport policy development in this area.

Also as part of the project a series of meetings are being conducted with Ukraine stakeholders both in governmental departments, and also other expert organisations where appropriate, to test the draft findings and help to develop suitable recommendations. The meetings are currently planned to be undertaken in May-July 2016. The kick-off meeting with the beneficiary and other stakeholders was held on 25th May 2016. The final workshop was held on 28th October 2016, where the findings of the project were presented, alongside the final report.

2.3 The Association Agreement

Regarding the provisions of the Association Agreement between the European Union and its Member States, on the one hand, and Ukraine, on the other hand, for 2016-2018 there is an objective to improve and develop an appropriate national policy on the regulation of CO2 emissions and energy consumption by road transport. The provisions of the Directive 2006/32/EC on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (and accordingly the Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC) regarding road transport should be reflected in the legislation of Ukraine in 5 years and implemented within 8 years from the date of entry into force of the Agreement.

3 Review of the EU and Member States national practices (Task 2)

3.1 Outline of the proposed approach

The objective of this task is to provide a comprehensive overview of policy instruments that have been implemented by EU Member States for the reduction of road CO_2 emissions.

There is a large spectrum of policy options for reducing road transport CO_2 emissions. Given that budget that is allocated to this Task, it is not possible to provide a detailed assessment of different policy options that have been implemented per Member State. Rather, this Task is to provide a high-level overview in order to identify the different options available. For this purpose have drawn upon to existing policy reviews that have already been carried out in the context of previous studies (e.g. such as the EU Transport GHG: Routes to 2050 project[2]). The output provided in the sections below includes as far as possible a summary analysis of the favourable conditions and obstacles for the options.

In addition, a qualitative MCA (Multi-Criteria Analysis) assessment has been provided on the feasibility of the implementation of the single measures in the Ukraine. This has been based on the experience of our local expert (Alexey Klimenko), together with information from our international experts on the factors and conditions relevant for each option under consideration. This was used to shortlist a number of policy options for a more detailed review in order to allow a better understanding of the functioning and impact of these measures as observed in other EU Member States.

3.2 High-level overview of policy instruments

There are numerous policy instruments that can contribute to reducing CO_2 emissions from road transport. In the following sub-sections, a high level overview of these measures is provided. As is common in the available literature, the measures are categorised into

- Economic instruments (Section 3.2.1)
- Regulatory instruments (Section 3.2.2)
- Instruments that enhance the transport infrastructure (Section 3.2.3)
- Educational and awareness raising instruments (Section 3.2.4)
- Instruments to stimulate innovation and development (Section 3.2.5)

Not all categories are clear-cut and there are several policy measures that could be classified within more than one category of policy instruments. Some of the allocations of specific measures to the categories may therefore be contested.

Section 3.3 then provides a qualitative assessment of the different policy options in terms of a multi-criteria analysis (MCA). The policy options that are top-ranked according to this MCA are then discussed in more detail in Section 3.4.

3.2.1 Economic instruments

Economic instruments are characterised by their use of market forces, i.e. the price mechanism, to achieve policy objectives. The use of market forces to influence transport demand and supply is what makes such instruments advantageous in the pursuit of a sustainable transport policy. Price instruments usually generate additional revenues – in many countries fuel and vehicles taxes play a major role for state funding and financing of transport policy programmes. By charging for the use of infrastructure and vehicles, only transport users pay for the costs of their mobility. These costs may include infrastructure set-up, maintenance, environmental damage etc. (GTZ, 2001).

In the following sections some of the most relevant economic instruments that have been implemented across EU Member States are described.

[2] http://www.eutransportghg2050.eu/cms/eu-transport-ghg-routes-to-2050-project-reports/

3.2.1.1 Fuel taxes

Road transport fuels are taxed in all European countries, mainly for fiscal reasons. The taxation of energy products and electricity in the European Union is governed by the provisions of Council Directive 2003/96/EC. For fuels, the structure of excise duties is harmonised across the EU, however the rates themselves still differ from one Member State to the other. This is because Directive 2003/96/EC only provides general *minimum* rates and also allows for specific derogations. Member States are therefore free to apply excise duty rates above these minima, according to their own national needs[3].

The Commission is currently examining a possible review of the Directive in view of aligning it to the energy and climate change goals of the Europe 2020 Strategy[4]. The current minimum excise duty rates as defined in Directive 2003/96/EC are provided in Table 3.1.

[3] A full list of excise duty rates applicable in the EU (as of 1st of January 2016) is available under http://ec.europa.eu/taxation_customs/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_ii_energy_products_en.pdf

[4] Europe 2020 strategy: http://ec.europa.eu/europe2020/index_en.htm

Table 3.1: *Minimum* excise duty rates that apply across the European Union (subject to specific derogations; as defined in Directive 2003/96/EC)

Minimum rates for motor fuels		
Fuel	**Rate expressed per**	**Rate**
Leaded petrol	Euro per 1000 litres	421
Unleaded petrol	Euro per 1000 litres	359
Gas Oil	Euro per 1000 litres	330
Kerosene	Euro per 1000 litres	330
LPG	Euro per 1000 kilograms	125
Natural Gas	Euro per gigajoule	2.6

Minimum rates for motor fuels used for commercial and industrial use		
Fuel	**Rate expressed per**	**Rate**
Gas Oil	Euro per 1000 litres	21
Kerosene	Euro per 1000 litres	21
LPG	Euro per 1000 kilograms	41
Natural Gas	Euro per gigajoule	0.3

Minimum rates for heating and electricity			
Fuel	**Rate expressed per**	**Rate for business**	**Rate for non-business**
Gas Oil	Euro per 1000 litres	21	21
Heavy fuel oil	Euro per 1000 kilos	15	15
Kerosene	Euro per 1000 litres	0	0
LPG	Euro per 1000 kilograms	0	0
Natural Gas	Euro per gigajoule	0.15	0.3
Coal and Coke	Euro per gigajoule	0.15	0.3
Electricity	Euro per MWh	0.5	1.0

3.2.1.1.1 Diesel rebates

Eight member states offer the option to transport undertakings to partially recover the diesel tax they pay (see Table 3.2). This measure has mainly been introduced to respond to pressure from the transport industry that see competitive disadvantages vis-a-vis foreign competitors due to the taxation policies that had been in place. Such policies also have the national benefit of increasing demand at national petrol stations to hereby secure domestic tax revenue from foreigners. Such measures are contested since they incite a 'race to the bottom' in fuel taxes (T&E, 2015).

Table 3.2: Diesel rebates offered by EU Member States

Member state	Diesel rebate for commercial users (€ cent / litre)
Belgium	7.63
France	4.89
Hungary	3.60 (11 HUF)
Ireland	5.50[51]
Italy	21.42
Romania	4.26 (0.19 RON)
Slovenia	12.14
Spain	2.71

Source: (T&E, 2015)

Over the long-term, higher fuel prices encourage consumers to purchase more fuel-efficient vehicles and to reduce vehicle kilometres by long-term changes like changing house or job resulting in smaller commuting distances. About two-thirds of long-term fuel savings for passenger cars typically come from increased fuel efficiency of the car fleet and one third from reduced vehicle travel and modal shift (PBL, 2009). Fuel taxation is also relevant in the context of the introduction of electric vehicles. Electricity charges are currently considerably lower than fuel taxes (in terms of €/kWh). Consequently this gives an incentive for electric driving. At the other hand, when electric cars become more common, these lower energy taxes may become problematic since they may result in an increase in the overall transport volume. Therefore, at the long run, there may be the need to balance such effects, e.g. by introducing charges per kilometre rather than taxing energy use. This may also become important if governments are confronted with significant taxation income losses due to a large take up of electric propulsion in transport (CEDelft, 2010).

Apart of the GHG benefits, fuel taxes can contribute to reducing the dependency on oil and make the national economies less vulnerable to oil shocks and price instability.

3.2.1.2 Kilometre charges and tolls

Kilometre charges or tolls (which are charged for e.g. bridges, tunnels or for a specific section of a motorway) increase the cost for vehicle use. This way they encourage less driving or modal shift. Unlike fuel taxes they do not necessarily incentivise the use of fuel efficient vehicles or fuel-efficient driving. They are therefore seen to be less effective in reducing GHG emissions than fuel taxes (CEDelft, 2010).

However, charges or tolls may also be differentiated according to the performance of the vehicles, e.g. in terms of their fuel efficiency or their noise emission class. They can also be differentiated according to the area (e.g. in terms of population densities) or time of the day (reflecting the different degrees of congestion levels). This way, such charges can also be effective in reducing CO_2 emissions.

Especially urban congestion charges, such as in place in central London, have proven to be an effective instrument in reducing road congestion and therefore CO_2 emissions. However, given the limited number of cities having implemented these schemes, it is difficult to predict the overall GHG reduction potential (CEDelft, 2010). According to studies cited by (CEDelft, 2010), in 2012, tolls and kilometre charges in Europe covered around 13% of the total infrastructure and marginal external cost of road transport. The introduction of charges at all roads in Europe, was expected to result in a long term GHG reduction of roughly 5 to 10%, compared to a business as usual scenario. Charges

differentiated according to the fuel efficiency of vehicles somewhat higher reductions may be achievable. Kilometre charging schemes have other important benefits, in particular a reduction of air pollution, noise, accidents and road congestion.

On the European level, obligatory kilometre charges or minimum levels (like for fuel excise duties) do not exist and have not been proposed so far. Typically, such measures are introduced on a local or regional level (or by specific road transport operators) and apply for specific infrastructure only. Commonly cited barriers for the introduction of such schemes are the costs of putting a charging system in place (both initial investments and operational cost) and public resistance (CEDelft, 2010).

3.2.1.3 Vehicle purchase and ownership taxes

Taxation of cars is a critical instrument in reducing the average emissions of the new car fleet. At present there is little Community legislation, or harmonisation of national fiscal provisions, applied by the Member States in the area of passenger car taxation. Individual EU Member States have relied to varying degrees on a combination of fuel-, registration-, and annual circulation taxes (i.e. annual motor vehicle taxes paid over the lifetime of the car) as both a source of revenue and as a mechanism for influencing driver behaviour (CEDelft, 2010).

There is a vast trend in a number of EU Member states to green the existing car taxes on the base of CO_2-criteria. In 2015, 21 EU Member States charged registration taxes on top of VAT. In most of these Member States (i.e. in 14) the taxes are explicitly based on the CO_2 performance of the vehicle. In many other Member States these taxes are indirectly related to the CO_2 performance of the vehicle (i.e. in terms of criteria that are related to the energy use or weight of the vehicles).

Table 3.3 provides a high-level overview of the taxes that applied to the purchase of new vehicles across the Union in 2015. It can be seen that VAT rates varied from 17% (in Malta and Luxembourg) to 27% (in Hungary). Registration taxes varied from 0% in several Member States to a very high level of taxation in Denmark (where the cost of the vehicle may be almost tripled after applying the registration taxes, depending on the price of the vehicle).

Table 3.3: Taxes on the acquisition of a vehicle across the European Union in 2015

Country	VAT	Registration Tax
Austria	20%	Based on CO2 emissions Maximum 32% + bonus/malus
Belgium	21%	Based on cc + age CO2 emissions (Wallonia) CO2 + Euro standards + fuel + age (Flanders)
Bulgaria	20%	None
Cyprus	19%	Based on CO2 emissions
Czech Republic	21%	None
Germany	19%	None
Denmark	25%	105% of DKK 80,500 + 180% on the remainder
Estonia	20%	None
Spain	21%	Based on CO2 emissions From 4.75% (121-159g/km) to 14.75% (200g/km or more)
Finland	24%	Based on price + CO2 emissions Min. 5%, max. 50 %
France	20%	Based on CO2 emissions From € 150 (131 to 135g/km) to € 8,000 (above 200g/km)
Greece	23%	Based on cc + exhaust emissions 5% -50% Luxury tax up to 40%
Croatia	25%	Based on price + CO2 emissions
Hungary	27%	Based on cc+ exhaust emissions
Ireland	23%	Based on CO2 emissions 14 to 36%
Italy	22%	Based on kilowatt /weight/seats
Lithuania	21%	€ 14.48 per vehicle

Country	VAT	Registration Tax
Luxembourg	17%	None
Latvia	21%	Based on CO2 emissions
Malta	17%	Based on price, CO2 emissions, vehicle length
The Netherlands	21%	Based on price + CO2 emissions
Poland	23%	Based on cc 3.1% -18.6%
Portugal	23%	Based on cc + CO2 emissions
Romania	24%	Based on cc + exhaust emissions + CO2
Sweden	25%	None
Slovenia	20%	Based on price + CO2 emissions
Slovakia	20%	Based on kilowatt
United Kingdom	20%	None

Source: (ACEA, 2016)

Unlike taxes on cars, minimum levels of ownership taxes on commercial vehicles over 12 tonnes are regulated at the European level, under the Eurovignette directive (Directive 1999/62/EC), which sets minimum tax rates for such vehicles. There is no differentiation on energy or CO_2 grounds according to Directive 1999/62/EC.

Table 3.4 shows the type of vehicle ownership taxes that were in place on the EU Member State level in 2015. It can be seen that 10 Member States based their ownership taxes explicitly on the CO_2 performance of the vehicle while in most other countries these taxes are indirectly related to the vehicles' CO_2 performance. In case of commercial vehicles, these taxes are predominantly based on the vehicles' weight and number of axles.

Table 3.4: Type of vehicle ownership taxes across the EU in 2015

Country	Passenger Cars	Commercial Vehicles
Austria	Kilowatt	weight
Belgium	Cylinder capacity	weight, axles
Bulgaria	Kilowatt	Weight, axles
Cyprus	CO_2 emissions	NA
Czech Republic	None	Weight, axles
Germany	CO_2 emissions	Weight, exhaust emissions, noise
Denmark	Fuel consumption, weight	Fuel consumption, weight
Estonia	None	Weight, axles suspension
Spain	Horsepower	Payload
Finland	CO_2 emissions / Weight x days	Weight x days
France	None	Weight, axles, suspension
Greece	CO_2 emissions/ cylinder capacity	Weight
Croatia	CO_2 emissions	NA
Hungary	Kilowatt	Weight
Ireland	CO_2 emissions	Weight
Italy	Kilowatt, CO_2 emissions	Weight, axles, suspension
Lithuania	None	Weight, axles, suspension
Luxembourg	CO_2 emissions	Weight, axles
Latvia	Weight, cylinder capacity, kilowatt	Weight
Malta	Cylinder capacity	NA

Country	Passenger Cars	Commercial Vehicles
The Netherlands	CO_2 emissions, weight	Weight
Poland	None	Weight, axles
Portugal	Cylinder capacity, CO_2 emissions	Weight, axles, suspension
Romania	Cylinder capacity	Weight, axles
Sweden	CO_2 emissions/ weight	Weight, axles, exhaust emissions
Slovenia	Cylinder capacity	Weight
Slovakia	None	Weight, axles
United Kingdom	CO_2 emissions/ cylinder capacity	Weight, axles, exhaust emissions

Source: (ACEA, 2016)

A key policy question is the extent to which tax incentives, including differentiated vehicle taxes based on CO_2, constitute an additional means for effectively promoting the purchase of more efficient vehicles. Especially in the debate of tax shift from annual (ownership) and one-off (registration) taxes into variable kilometre taxes (road charging), 100% variability may incur important risks of increasing car ownership and, through rebound-effects, transport demand and CO_2 emissions. A shift from fixed towards variable taxes is also not necessarily welfare-improving as there are important social costs related to the ownership of cars (parking, land use). Several studies on the welfare impact of kilometre charges show that optimal taxation implies some kind of registration and/or ownership taxes (CEDelft, 2010).

3.2.1.4 Parking fees

Every vehicle trip requires parking at its destination, so parking facilities are an integrated component of the roadway system. By charging motorists directly for using parking facilities, demand can effectively be reduced as parking fees can have significant impacts on the cost of car ownership and use (CEDelft, 2010).

In most European countries parking policy is a local policy. Each city and town is usually free to set the objectives of the policy and to select the policy instruments to implement it. National governments usually provide guidelines, mostly on parking requirements, but rarely interfere in policy making[5]. The main reason for this is the recognition that parking is a local matter and that local authorities will deal with it better than will regional or national government (Mingardo et al, 2015).

Differentiated parking fees – according to location, time and/or type of vehicle – might be introduced in order to make an efficient use of (scarce) parking capacity. In several cities this is considered as an efficient tool to regulate traffic and/or to apply the ‘‘polluter pays’’ principle in the attempt to reduce pollution caused by motor vehicles. Typically, parking fees are highest in the city centre and/or in the central business district and decrease gradually with distance from these central locations (Mingardo et al, 2015). Three major innovations took place in the last decennium in the methodology used to calculate parking tariffs (Mingardo et al, 2015):

(1) **Variable fees according to demand for parking**: In the first years after the introduction of paid parking, parking fees were mainly differentiated on the base of the time of day (e.g. at night parking fees are lower than during the day or even absent) and on the day of the week (e.g. during weekends fees might be lower than during the week). In the last decade the pricing scheme has changed in many cities and towns where on-street parking fees might vary several times during the day according to the expected parking demand. While having different prices in different areas of the city is a longstanding practice, the effort to make these variations respond more quickly and precisely to variations in demand can be seen as an innovation. For example Rotterdam was one of the first cities to introduce parking tariffs based on demand in the early 2000s. From July 2014 onwards, the on-street parking tariff in Madrid will be related not only to the type of vehicle (see point 2 below) but also to the actual demand.

[5] An exception to this is for example Poland, where the national government has the authority to decide the maximum price for on-street parking tariffs.

(2) **Variable fees according to vehicle's emissions**: introduce parking fees based on the emissions of vehicles: the more pollutant the vehicle is, the higher the fee that has to be paid to park in the borough. This held both for residents and business permits. In 2008 relatively very environmentally friendly cars (CO_2 emission equal or lower than 100 g/km) could get an annual parking permit for free, while the most polluting cars (CO_2 emission equal or larger than 225 g/km) had to pay a higher fee: £300 for resident permits and £1800 for business permits. The policy became very politically controversial locally and was overturned when the ruling Liberal Democrats lost a local election to the Conservatives. However, councils such as Edinburgh and several other London Boroughs have since introduced similar tariffs related to vehicles' environmental performance. Madrid was the first city in Europe to introduce a similar scheme on a wide area; as of July 2014, the fee motorists have to pay for on-street parking depends on the engine type and construction year. Electric vehicles can park for free; hybrids have a 20% reduction while heavy polluting vehicles pay 20% extra.

(3) Real-time parking fees: Typically, fees are calculated per hour or by other fixed time period (e.g. per 30 min). Recently this has created some doubts on why the consumer should pay for a larger period of time than what he actually uses. The technological development – namely ticketing machines, sensor technology and payment through mobile phones or in car navigation systems – makes possible to charge drivers for the exact amount of time they park their cars. Spain is the only country in Europe where a national law obliges all off-street private operators to charge drivers per minute since 2006.

Besides regular parking fees, various other types of instruments could be considered to charge for parking space (CEDelft, 2010):

- **Parking levies (to be paid by owner of a parking lot):** These levies exist Canada and in Australian cities (Perth, Sydney) and are usually paid as a special property tax on non-residential parking lots. This instrument can also contribute to congestion reduction.
- **Taxing parking lots offered for to employees:** Employees who use parking spaces are taxed for this subsidy in kind. An alternative would be that employees who do not claim parking spaces which are offered for free or below cost by their employer are entitled by law to get a compensation in cash. The amount cashed out has to be equivalent to the subsidy in kind which is given to a person who claims a parking space.
- **Property tax / land tax:** Land taxes are not directly transport related but they are important for developing efficient settlement structures. Promoting efficient settlement structures is an important means to reduce traffic and GHG emissions.

(CEDelft, 2010) reports that even modest parking fees can affect vehicle travel patterns. The price elasticity of vehicle travel with respect to parking price ranges from -0.1 to -0.3 (a 10% increase in parking charges reduces vehicle trips by 1-3%), depending on demographic, geographic, travel choice and trip characteristics. The effects on CO_2 have however not been assessed ex-post on a scientific basis. So there is no scientific evidence on CO_2-reduction. It should be noted that although in the end these reduction effects will be positive, a portion of the reduced travel demand will leak into increased transit use and car travel trip to other cities. Parking fees will have also all types of co-benefits associated with the reduced car use (energy security, noise, air pollution, congestion). An increasing number of towns have parking tax exemptions for efficient or flex fuel cars (Stockholm, Malmo or Graz). Implementation is relatively easy for parking licences of residents, but also possible for parking meters, e.g. by asking car drivers to give their licence plate number into the meter system. Effects have not been assessed thoroughly.

3.2.1.5 Company car taxation and fiscal treatment of commuting and business travel

Company car taxation is an aggregation of various types of taxation measures. It includes, for example, the taxation of the company vehicle itself as well as the fiscal treatment of the "benefit in kind" that employees obtain in form of a company car (and/or its use in terms fuel costs if used for business, commuting and/or private travel). Also, the fiscal treatment of commuting and business trips in private cars is relevant in this context. The specific fiscal instruments for the various combinations possible are summarised in Table 3.5.

About 50% of all new cars sold in the EU each year are company cars. This percentage includes cars used in the course of business, such as hire cars or taxis, as well as pooled cars that are not available for employees' private use. However, under a number of car tax systems that are in force in different Member States, company car taxation leads to perverse incentives, for example when fuel and/or vehicle expenses can be written off corporate taxes. In addition, the variable user cost of company car use for private purposes are often very low (or even zero) because most or even all costs are covered by the company. Therefore, users have hardly any incentive for limiting their car use. This could possibly be solved by targeted regulation on these types of arrangements, e.g. by prohibiting that the cost of private car use are covered by the company. An alternative approach could be to introduce incentives in the company car taxation schemes for putting the variable cost of private car use with the employee. With respect to this, a problem is the identification of the number of kilometres made for private purposes and for business purposes.

A study carried out for the European Commission in 2009 (Cophenhagen Economics, 2010) showed that most countries treat only 50% of the personal benefit to employees from company cars as taxable. Such under-taxation can be considered a form of an environmental harmful subsidy that incites more cars, more expensive cars and higher mileage. The effects of these consequences was estimated to have been an increased fuel consumption (and therefore CO_2 emissions) by approximately 4-8% across the EU (by extrapolating the results of two Dutch case studies to the EU level). Other environmentally harmful effects consist of the increase of noise, congestion and the emissions of local air pollutants.

From a government perspective, reform and abolition of company car tax benefits would improve government finances and reduce GHG emissions at a net negative cost to public finances (CEDelft, 2010).

In 2013, company cars were already inextricably linked to carbon emissions-based taxes in 20 member states across Europe, while other countries are keen to follow suit as governments continue to target the company car as a source of tax-raising revenue (FleetNews, 2013).

Table 3.5: Fiscal instruments for company cars and business, commuting and leisure travel

Type of entity	Car ownership type and instrument		Car use type and instrument	
	Type	**Possible fiscal instrument**	**Type**	**Possible fiscal instrument**
(Partly) Self-employed	**Private car**	*Tax deduction ownership costs*	Leisure	-
			Business	*Tax deduction for car and non-car travel costs*
	Company car	*VAT rules; amortisation rules*	Leisure	*Limits to driving private KMs on company car; incl. treatments of fuel cards and enforcement*
Employee	**Private car**		Commuting	*Tax deduction for car and non-car commuting if no employer reimbursement; maximum tax-free allowance from employers for car and non-car commuting*
			Business	*Maximum tax-free allowance for car and non-car business trips*
	Company car	*'Benefit-in-kind' rules employee*	Leisure	*Limits to driving private KMs on company car; incl. treatment of fuel cards and enforcement*
		Fiscal deduction rules employer	Commuting	*Share of commuting that is counted as private KMs*

Source: Based on (CEDelft, 2010)

3.2.1.6 Tax breaks and subsidies

Besides the implicit subsidies discussed in the previous sections that may apply to energy-efficient vehicles, various types of explicit subsidies exist that aim at improving fuel efficiency of new vehicles. Important examples are financial subsidies or tax breaks for electric vehicles. (ACEA, 2015a) provides an overview of the purchase and tax incentives for electric vehicles in the EU in 2015[6] (see Table 3.6). The list only includes tax breaks or subsidies that relate to the vehicle itself. Additional incentives may exist in certain counties for the installation of the necessary recharging infrastructure. It shows that in 2015, 18 Member States provided a tax break and/or subsidies for electric vehicles.

In some cases these subsidies may help to change consumer behaviour, but they also have the drawbacks associated with subsidies (e.g. free-riders, rebound effects) and should therefore be regarded as second-best policy options (CEDelft, 2010).

Table 3.6: Tax breaks and/or subsidies for electric vehicles across the EU in 2015 (ACEA, 2015a)

MS	Incentive
AT (Austria)	Electric vehicles are exempt from the fuel consumption tax and from the monthly vehicle tax. The Austrian automobile club ÖAMTC publishes the incentives granted by local authorities on its website (www.oeamtc.at/elektrofahrzeuge).
BE (Belgium)	Electric and plug-in hybrid vehicles are exempt from registration tax in Flanders. Electric vehicles pay the lowest rate of tax under the annual circulation tax in all three regions. The deductibility from corporate income of expenses related to the use of company cars is 120% for zero-emissions vehicles and 100% for vehicles emitting between 1 and 60 g/km of CO_2. Above 60 g/km, the deductibility rate decreases gradually from 90% to 50%.
CZ (Czech Republic)	Electric, hybrid and other alternative fuel vehicles are exempt from the road tax (this tax applies to cars used for business purposes only).
DE (Germany)	Electric vehicles are exempt from the annual circulation tax for a period of ten years from the date of their first registration.
DK (Denmark)	Electric vehicles weighing less than 2,000 kg are exempt from the registration tax. This exemption does not apply to hybrid vehicles.
FI (Finland)	Electric vehicles pay the minimum rate (5%) of the CO_2 based registration tax.
FR (France)	Electric and hybrid electric vehicles emitting 20 g/km or less of CO_2 benefit from a premium of € 6,300 under a bonus-malus scheme. For vehicles emitting between 20 and 60 g/km, the premium is € 4,000. For vehicles emitting between 61 and 110 g/km, it is maximum € 2,000. The amount of the incentive cannot exceed a given percentage of the vehicle purchase price including VAT, increased with the cost of the battery if this is rented. For vehicles emitting less than 20 g/km, this is 27% of the purchase price, for vehicles emitting between 20 and 61 g/km, it is 20% and for vehicles emitting between 61 and 110 g/km, it is 5%. Electric vehicles are exempt from the company car tax. Hybrid vehicles emitting less than 110 g/km are exempt during the first two years after registration.
GR (Greece)	Electric and hybrid vehicles are exempt from the registration tax, the luxury tax and the luxury living tax. Electric and hybrid passenger cars with an engine capacity up to 1,929 cc are exempt from the annual circulation tax. Hybrid cars with a higher engine capacity pay 50% of the normal circulation tax rate.
HU (Hungary)	Electric vehicles are exempt from the registration tax and the annual circulation tax.
IE (Ireland)	Electric vehicles benefit from VRT (registration tax) relief up to a maximum of € 5,000. For plug-in hybrids, the maximum relief is € 2,500. For conventional hybrid vehicles and other flexible fuel vehicles, the maximum relief is € 1,500. In addition, electric and plug-in hybrid vehicles receive a grant of up to € 5,000 on purchase.
IT (Italy)	Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of their first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to equivalent petrol

[6] http://www.acea.be/uploads/publications/Electric_vehicles_overview_2015.pdf

MS	Incentive
	vehicles in many regions.
LV (Latvia)	Electric vehicles are exempt from the registration tax.
NL (Netherlands)	Electric vehicles are exempt from the registration tax. Vehicles emitting maximum 50 g/km of CO_2 are exempt from the annual circulation tax.
PT (Portugal)	Electric vehicles are exempt from the registration tax ISV and from the annual circulation tax. Hybrid vehicles benefit from a 40% reduction of the registration tax.
RO (Romania)	Electric and hybrid vehicles are exempt from the registration tax.
SE (Sweden)	**Five year exemption from paying annual circulation tax**: Electric vehicles with an energy consumption of 37 kWh per 100 km or less are exempt from the annual circulation tax for a period of five years from the first registration. The same five-year exemption applies to electric hybrid and plug-in hybrid vehicles that fulfil the new green car definition applied for new registrations from 1 January 2013. The definition is dependent on the CO_2 emission in relation to the curb weight of the car. The formula for petrol, diesel, electric hybrid cars and plug-in cars is as follows: Maximum CO_2-emission allowed=95 g/km CO_2-emission + 0,0457 x (the curb weight of the car – 1372 kg curb weight). Example: a plug-in hybrid car has a CO_2-emission of 50 g/km and a curb weight of 1 500 kg: 95 + 0.0457 x (1500-1372) = 100.8. The actual CO_2-value 50 g/km is less than the calculated value 100.8 which means that the car is classified as a green car with a five year exemption from paying annual circulation tax. Moreover, for both electric cars and plug-in hybrids the electrical energy consumption per 100 km must not exceed 37 kwh to be regarded as a green car. **Reduction of company car taxation**: For electric and plug-in hybrid vehicles, the taxable value of the car for the purposes of calculating the benefit in kind of a company car under personal income tax is reduced by 40% compared with the corresponding or comparable petrol or diesel car. The maximum reduction of the taxable value is SEK 16,000 per year. **Super green car premium new cars**: A so called “Super green car premium” (Supermiljöbilspremie) of SEK 40,000 is available for the purchase of new cars with CO_2 emissions of maximum 50 g/km. The premium is applied both for the purchase by private persons and companies. For companies purchasing a super green car, the premium is calculated as 35% of the price difference between the super green car and a corresponding petrol/diesel car, with a maximum of SEK 40,000. The premium was introduced in 2012 and will be paid also in 2015 as long as the funds are sufficient to pay the premium.
SK (Slovakia)	Electric vehicles are exempt from the annual circulation tax. Hybrid vehicles benefit from a 50% reduction of the annual circulation tax (this tax applies only to vehicles used for business purposes).
UK (United Kingdom)	Purchasers of electric vehicles and plug-in hybrid vehicles with CO_2 emissions below 75 g/km receive a grant of up to £ 5,000. There are three categories: - Category 1: CO_2 emissions of less than 50 g/km and a zero emission range of at least 70 miles - Category 2: CO_2 emissions of less than 50 g/km and a zero emission range between 10 and 69 miles - Category 3: CO_2 emissions of 50-75 g/km and a zero emission range of at least 20 miles Electric vehicles are exempt from the annual circulation tax. This tax is based on CO_2 emissions and all vehicles with emissions below 100 g/km are exempt from it

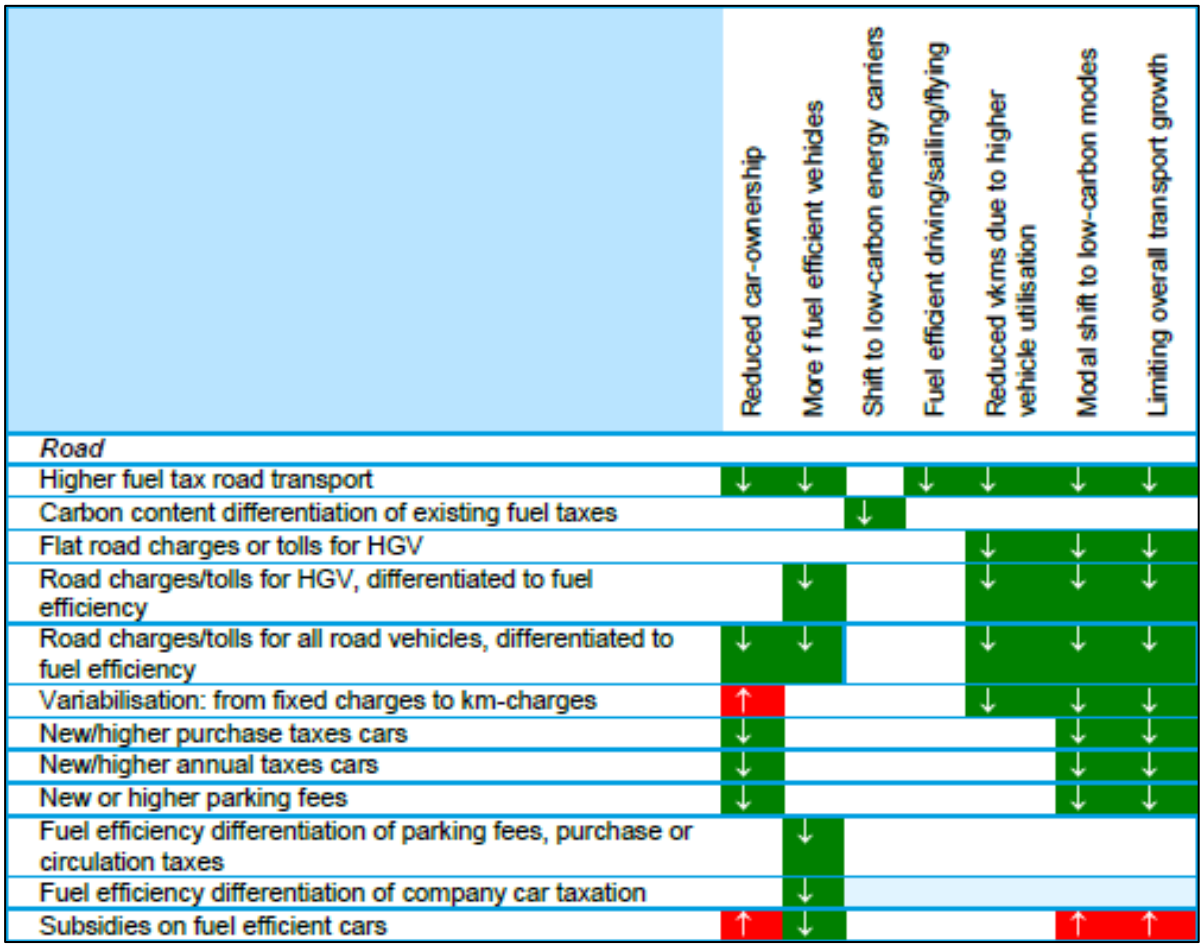
Source: (ACEA, 2015a)

3.2.1.7 Overview of economic instruments

Table 3.7 provides an overview of the policy instruments that were discussed above and gives a qualitative assessment of the impact of these instruments on the various CO_2 reduction options. The green colour indicates that this policy instrument could potentially lead to (minor or larger) CO_2

reduction in the long term by inducing this reduction option, the red colour indicates that a rebound effect is likely to be dominant: the policy instrument leads to CO_2 increase by negative impact on this reduction option.

Table 3.7 Overview of discussed policy instruments and their impact on the vehicle fleet and use (Economic instruments)



Source: (CEDelft, 2010)

3.2.2 Regulatory instruments

3.2.2.1 Targets for improvement in new vehicle CO2 emissions / energy consumption

3.2.2.1.1 European light duty vehicle (LDV) CO2 standards

The origins of the EU vehicle CO_2 regulations date back to 1995 when the Commission published a strategy on passenger car CO_2. The strategy to achieve a target of average CO_2 emissions from new passenger cars of 120 gCO_2/km by 2012 was based on three pillars covering both supply and demand measures:

1. Voluntary commitments from automobile manufacturers;
2. Promotion of fuel efficient vehicles through fiscal measures (taxation); and
3. Introduction of fuel economy labelling.

In 1998, a voluntary agreement was reached with the European automobile manufacturers' association (ACEA) to reduce the average CO_2 emissions of new cars to 140g/km by 2008. This was followed by similar agreements to reach identical targets – to be achieved one year later – with the Japanese and Korean car manufacturers associations (respectively, JAMA and KAMA). The taxation pillar was expected to be delivered largely through Member State action, although by 2005 few had

taken any relevant action. Directive 1999/94/EC, which requires new cars to display a label showing fuel consumption and CO_2 emissions, implemented the third pillar of the strategy (see Section 3.2.4).

The Commission published a review of the strategy in 2007, which concluded that manufacturers' progress in reducing the CO_2 emissions of the new EU car fleet was not sufficient to meet the targets. This Communication set out an 'integrated approach' within which a target of 130 gCO_2/km would be delivered by mandatory requirements on manufacturers, while the additional 10 gCO_2/km would be delivered by other technological improvements and by an increased use of biofuels. In this way, the Regulation remained part of a wider package of measures that would work together to reduce the CO_2 emissions from passenger cars.

The proposal that eventually led to **the passenger car CO_2 Regulation (Regulation 443/2009)** was published at the end of 2007 and set an average fleet target for 2015 of 130gCO_2/km. The Regulation contained an indicative target for 2020 (of 95 gCO_2/km), which was subsequently confirmed by Regulation 333/2014, although it is to be achieved in 2021, one year later than planned.

Light commercial vehicles (LCVs) were not mentioned in the Commission's original 1995 strategy. However, as part of the preparation of the 2007 review of the strategy, the Commission held a public consultation, which expressed strong support for the extension of the strategy to LCVs. Mandatory requirements on LCV manufacturers, similar to those being proposed for cars. This eventually led to the publication of **the LCV CO_2 Regulation in 2011 (Regulation 510/2011)**, which set an average fleet emission target for 2017 of 175gCO_2/km and also included an indicative target for LCVs for 2020 (147 gCO_2/km). This target was subsequently confirmed by Regulation 253/2014.

Section 3.4.1 provides more information on the EU CO_2 regulations and their impact.

3.2.2.1.2 CO2 emission standards for heavy duty vehicles (HDV)

In May 2014, the European Commission adopted a HDV strategy[7] – it is the EU's first initiative to tackle CO_2 emissions from trucks, buses and coaches. Despite the importance of HDV's fuel consumption (Trucks, buses and coaches produce about a quarter of CO_2 emissions from road transport in the EU and some 5% of the EU's total greenhouse gas emissions – a greater share than international aviation or shipping), CO_2 emissions from HDVs are currently neither measured nor reported. The strategy therefore focuses on short-term action to certify, report and monitor HDV emissions - an essential first step towards curbing these emissions.

For this purpose, the Commission is developing a computer simulation tool, VECTO, to measure CO_2 emissions from HDVs (also discussed further in later Section 4.4.2). With the support of this tool the Commission intends to propose legislation which would require CO_2 emissions from new HDVs to be certified, reported and monitored. Once this legislation is in force the Commission may consider further measures to curb CO_2 emissions from HDVs. The most apparent option is to set mandatory limits on average CO_2 emissions from newly-registered HDVs, as is already done for cars and vans. Other measures to reduce CO_2 emissions from HDVs that are stated to be considered by the Commission include the development of modern infrastructure supporting alternative fuels for HDVs, smarter pricing on infrastructure usage, effective and coherent use of vehicle taxation by Member States and other market-based mechanisms (European Commission, 2016).

3.2.2.2 Targets for reduced GHG emissions from energy carriers

3.2.2.2.1 EU Fuel Quality Directive

In April 2009, Directive 2009/30/EC was adopted which revised the former Fuel Quality Directive (Directive 98/70/EC). It amends a number of elements of the petrol and diesel specifications as well as introducing in Article 7a a requirement on fuel suppliers to reduce the greenhouse gas intensity of energy supplied for road transport (Low Carbon Fuel Standard), namely by 6% by 2020. In addition the Directive establishes sustainability criteria that must be met by biofuels if they are to count towards the greenhouse gas intensity reduction obligation. The Fuel Quality Directive applies to all petrol, diesel and biofuels used in road transport, as well as to gasoil used in non-road-mobile machinery.

[7] http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/com_285_2014_en.pdf

The greenhouse gas intensity of fuels is calculated on a life-cycle basis, meaning that the emissions from the extraction, processing and distribution of fuels are included. Direct life-cycle greenhouse gas emission reductions are calculated from a 2010 baseline of fossil fuel greenhouse gas intensity. The exact methodology for calculating the greenhouse gas intensity of fossil fuels is provided within the Directive (Article 7d). The 6% reduction target is likely to be achieved through the use of biofuels, electricity, the use of less carbon intense, often gaseous, fossil fuels and a reduction of flaring and venting at the extraction stage of fossil fuel feedstocks.

For biofuels to count towards the greenhouse gas emission reduction targets they must meet certain sustainability criteria set out in the Directive to minimise the undesired impacts from their production. Also the calculation of greenhouse gas emissions for biofuels is set in the Fuel Quality Directive itself and results are to meet the following requirements:

- Greenhouse gas emissions must be at least 35% lower than from the fossil fuel they replace. From 2017, this will increase to 50% and, from 2018, the saving must be at least 60% for new installations;
- The raw materials for biofuels cannot be sourced from land with high biodiversity or high carbon stock.

However, as global demand for biofuels rises, their production can contribute to the conversion of land such as forests and wetlands into agricultural land, leading to increased greenhouse gas emissions. These emissions from indirect land use change (ILUC) can significantly reduce or even wipe out the greenhouse gas savings from biofuels. To account for this, in October 2012 the European Commission proposed amending the Fuel Quality Directive to include ILUC factors in the reporting of the greenhouse gas emission savings from biofuels. Furthermore, food-based biofuels and bio-liquids often contribute to land conversion. The Commission has therefore also proposed limiting the amount of food-based biofuels that can be counted towards the EU's target of reaching a 10% share of renewable energy in the transport sector by 2020. The proposed limit for food-based biofuels is 5%. This limit will allow non-food based biofuels to make a greater contribution to meeting the 10% target. Second- and third-generation biofuels produced from materials that do not create an additional demand for land, including algae, straw and various types of waste, have low or no ILUC emissions.

Besides reducing the greenhouse gas intensity of fuels, the legislation also governs other elements of fuel quality primarily linked to air pollutant emissions. Thanks to the mandatory introduction of sulphur-free fuels under the directive, by 2009 the average sulphur content of petrol and diesel was below 10 ppm (European Commission, 2016a).

3.2.2.2.2 EU Renewable Energy Directive

The use of energy sources for transport is also affected by the EU Renewable Energy Directive (Directive 2009/28/EC). It establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020. However, the Directive specifies national renewable energy targets for each country, taking into account its starting point and overall potential for renewables. These targets range from a low of 10% in Malta to a high of 49% in Sweden (see Table 3.8 for a full list of targets across the EU Member States).

Table 3.8: National overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020

	Share of energy from renewable sources in gross final consumption of energy, 2005 (S_{2005})	Target for share of energy from renewable sources in gross final consumption of energy, 2020 (S_{2020})
Belgium	2,2 %	13 %
Bulgaria	9,4 %	16 %
Czech Republic	6,1 %	13 %
Denmark	17,0 %	30 %
Germany	5,8 %	18 %
Estonia	18,0 %	25 %
Ireland	3,1 %	16 %
Greece	6,9 %	18 %
Spain	8,7 %	20 %
France	10,3 %	23 %
Italy	5,2 %	17 %
Cyprus	2,9 %	13 %
Latvia	32,6 %	40 %
Lithuania	15,0 %	23 %
Luxembourg	0,9 %	11 %
Hungary	4,3 %	13 %
Malta	0,0 %	10 %
Netherlands	2,4 %	14 %
Austria	23,3 %	34 %
Poland	7,2 %	15 %
Portugal	20,5 %	31 %
Romania	17,8 %	24 %
Slovenia	16,0 %	25 %
Slovak Republic	6,7 %	14 %
Finland	28,5 %	38 %
Sweden	39,8 %	49 %
United Kingdom	1,3 %	15 %

*Source: Annex of **Directive 2009/28/EC***

EU countries set out how they plan to meet these targets and the general course of their renewable energy policy in national renewable energy action plans[8]. Progress towards national targets is measured every two years when EU countries publish national renewable energy progress reports[9]. The Directive furthermore promotes cooperation amongst EU countries (and with countries outside the EU) to help them meet their renewable energy targets. This cooperation can take the form of:

- statistical transfers of renewable energy
- joint renewable energy projects
- joint renewable energy support schemes

[8] https://ec.europa.eu/energy/node/71
[9] https://ec.europa.eu/energy/node/70

Biofuels and bio-liquids are important in helping EU countries meet their 10% renewables target in transport. As a result, the Renewable Energy Directive sets out biofuels sustainability criteria for all biofuels produced or consumed in the EU to ensure that they are produced in a sustainable and environmentally friendly manner, in line with the Fuel Quality Directive (see Section 3.2.2.2.1). In addition, a methodology is provided to enable the inclusion of renewable electricity used for transport to also count towards the target (European Commission, 2016b).

3.2.2.3 Overview of regulatory instruments

An overview of the relationship between the regulatory instruments discussed above and the various reduction options is provided in the Table 3.9. In general, regulatory instruments do not directly target transport volume, but depending on the impact of GHG reduction measures on total cost of vehicle ownership, regulation may lead to an increase (if GHG reduction has a net user benefit) or decrease (in case of net user costs) of overall transport volume.

Table 3.9: Overview of discussed policy instruments and their impact on the vehicle fleet and use (regulatory instruments)

	Reduced car-ownership	More f fuel efficient vehicles	Shift to low-carbon energy carriers	Fuel efficient driving/sailing/flying	Reduced vehicle-kms due to higher vehicle utilisation	Modal shift to low-carbon modes	Limiting overall transport growth
Regulatory instruments							
Vehicles							
Vehicle emissions		↓	↓				?
Component efficiency		↓					?
Energy carriers			↓				?

Source: (Smokers et al., 2010)

3.2.3 Instruments that enhance the transport infrastructure

The relationship between infrastructure and spatial policy on the one hand and transport on the other hand is strong, but complex and often difficult to quantify.

Transport infrastructure, i.e., roads, are an enabler for transport, and building additional infrastructure is well known to create additional transport as it reduces travel cost and travel time for trips of people or goods. It affects fundamental choices of individuals and companies, such as location of houses and companies. It also affects the modal split, as, for example, additional railway infrastructure may result in a shift of transport from road, inland shipping or even aviation to rail (Kampman, 2009).

Spatial policy may have similar impacts on transport volume and modal choice. Urban sprawl typically creates extra road transport, whereas creating compact cities (high density) with mixed functions (houses, shops and businesses) may reduce transport. Traffic speed policy directly affects vehicle CO_2 emissions; traffic management policy can also affect kilometres driven i.e. transport demand. All these issues therefore have impact on the CO_2 emissions of transport, making them a potentially

important part of future CO_2 policy. Currently, however, these policy areas are often driven by other objectives than CO_2 emissions, namely economic development, reducing congestion, improving the environmental quality of urban areas, safety, etc. (Kampman, 2009).

In the following we categorise infrastructure-related measures into those that are set in urban environments, those that are set outside of urban areas and those that relate to traffic management.

3.2.3.1 Urban planning

3.2.3.1.1 Spatial planning

In the context of the aim to reduce CO_2 emissions from transport, it is desirable to counter urban sprawl and to introduce measures that reduce the distances travelled in cities and/or influence the mode choice towards more environmentally friendly modes. Spatial planning can contribute to decreasing the distance between the functions, with the aim to reduce the number of kilometres driven within the urban area. A planning concept, developed for this purpose, is the compact city: an intensive use of the available space within the city. The city has a high density of residential areas and new houses and offices are preferably built inside the city and not as extensions to the city (causing urban sprawl) (Kampman, 2009). (Kampman, 2009) reports that some experts expect that a reduction in CO_2 emissions of approximately 5% can be achieved by making cities more compact.

If it is assumed that spatial planning can have such an impact, it is expected that spatial planning policy instruments will show the largest effect in countries where strict planning regulations do not yet exist.

3.2.3.1.2 Enhancing public transport, cycling and walking infrastructure

Spatial planning policies have a link with public transport (PT) and cycling and walking policies as compact cities are typically attractive places to invest in high quality public transport and walking and cycling facilities.

Public Transport in urban areas is generally more environmentally friendly (depending on the occupancy rate) than car use because the CO_2 emissions per travelled kilometre per passenger are lower. Electric transport, like trains, light-rail or trolley buses, has no local CO_2 emissions, but the electricity generation may cause CO_2 emissions elsewhere. Buses can use alternative fuels to reduce the CO_2 emissions. In the future, also personal rapid transport can be an option (Kampman, 2009).

Public transport will however reduce the CO_2 emissions only if people shift from their car towards PT and if the road space that becomes available does not incite new car use. In practice it proves difficult to reduce the number of car movements by improving public transport. People typically use public transport when it is a good option compared to other modes of transport. In most urban areas, the speed of public transport is however low compared with that of cars. Congestion in the road network may increase the competitiveness of public transport (Kampman, 2009).

Examples of cities that invested in (improved) public transport can be found all over Europe. Some well-known examples can be found in France, where a number of light-rail projects in large and medium sized cities were carried out (Kampman, 2009). It generally takes a number of years until first investment ideas turn into actual public transport projects. A typical barrier is a shortage of resources (Kampman, 2009).

Walking and cycling are the two modes of transport with the lowest CO_2 emissions. Since cyclists and pedestrians typically do not cover large distances, compact cities help make these modes attractive. For cycling, the terrain should furthermore not be too hilly. Unfavourable weather conditions may prevent people from cycling (Kampman, 2009).

With investments, a more attractive infrastructure for walking and cycling can be created. Pavements and cycling lanes can make walking and cycling trips safer and direct routes can make travels very competitive when compared to car travel. Sustainable spatial and transport planning processes need to take the provision and improvement of these infrastructures into account, for new developments as well as for existing urban areas. Where there is little space for new or improved cycling and walking infrastructure, the closure of a lane for motorised traffic can be considered. It is also possible to give

priority to cycling and walking instead of motorised modes of traffic when these different modes cross each other. The English city of York made a policy decision to give pedestrians priority in the city. Planning and construction of new or improved infrastructure can take several years. The highest benefits can be expected when a *network* of bicycle lanes is constructed. Typically the construction of bicycle lanes is a task of local governments but it can be stimulated and/or funded by Europe or national governments (Kampman, 2009).

A co-benefit of investing into cycling and walking infrastructure is that travelling by car becomes less attractive due to the smaller amount of car infrastructure available. Also health benefits due to the physical activity of cycling and walking are important co-benefits. Furthermore an improvement of the air quality and noise pollution as well as reduced energy consumption can be achieved. Overall also the liveability of the city can be expected to improve when investing in cycle and walking infrastructure (Kampman, 2009).

3.2.3.1.3 Parking policy

Another option to influence the mode choice of people in cities is to reduce the number of parking spaces in city centres. This will encourage people to avoid car use. However, alternatives to the car should be offered to ensure that visitors will not stay away, e.g. public transport or cycling infrastructure. A shortage of parking licenses (for residents) in the city centre can help encourage residents to reduce their car ownership. In addition, rules for the number of parking spaces in or near office buildings can help to discourage driving to these buildings (Kampman, 2009). A risk is that people or companies might move out the city because of a lack of parking spaces. This can result in more CO_2 emissions because of larger travelling distances.

3.2.3.1.4 Enhancing goods deliveries

Freight transport in cities is problematic in several ways (e.g. liveability, safety). The current way the logistic chain is organised generally results in a high number of trips to cities for deliveries to shops. Current legislation for the distribution of goods (for example defining time windows and vehicle restrictions for such deliveries) can lead to an increase in CO_2 emissions because more trips may be needed. However, there are also several advanced distribution concepts that can help reduce CO_2 emissions from goods deliveries. An example is urban consolidation centres. Such centres can be located at the border of the city to collect and be used for bundling goods for the transport into the city. The use of an urban consolidation centre furthermore provides the option to use electric vehicles since typically only small distances are left to travel from such centres into the city (Kampman, 2009).

3.2.3.2 Spatial planning outside of urban areas

Outside urban areas most transport CO_2 emissions stem from cars and trucks (for shorter travel distances) and from airplanes and trucks (for longer travel distances). The main options for a reduction of CO_2 emissions are to avoid trips or to accomplish a shift from high-carbon kilometres towards lower-carbon kilometres for transport (Kampman, 2009), such as to (high-speed) rail or (inland) waterways by investing into the relevant infrastructure. The provision of new transport possibilities and/or infrastructure alone cannot be expected to lead to a CO_2 reduction. This should be part of a larger set of policy instruments like emissions legislation of vehicles, pricing policy (based on emitted externalities) or speed policy (Kampman, 2009).

3.2.3.3 Traffic management

Traffic management policy can be deployed to minimise fuel consumption and CO_2 emissions. Its main aims should be to reduce the number of kilometres driven (e.g. through better route planning and reduction of congestion) to favour environmentally friendly transport modes and to enable vehicles to operate at favourable and constant speeds (Kampman, 2009).

3.2.3.3.1 Advanced traffic management

There is a clear link between traffic management and infrastructure planning - the available infrastructure dictates how much can be achieved by traffic management measures. Traffic management measures that are currently commonly considered for reduction of emissions are (Kampman, 2009):

- Optimisation of traffic flows in cities (route choice and traffic control optimisation, ramp metering)
- Measures to reduce congestion on main roads (e.g. travel time information, route advice, incident management)
- (Dynamic) access restrictions for high emitting vehicles, e.g. environmental or green zones
- Speed management by deploying dynamic speed limits

In the future, traffic management will move from isolated measures to coordinated deployment of measures in a network (and finally will be made cooperative, i.e. including vehicle-vehicle and vehicle-infrastructure communication). In order to reduce CO_2 emissions, traffic management measures can be designed to favour low-emission modes. For instance, traffic control systems (e.g. traffic lights at intersections) can give priority to public transport or slow traffic (walking, cycling). Low emission vehicles can be made exempt from charges or restrictions. Traffic management measures may also be made more environmentally friendly by rethinking other objectives such as minimisation of travel times.

Technically, much is possible and the effects in terms of travel times and accessibility can be substantial, affecting people and businesses. Barriers are the lack of expertise on emission effects of traffic management measures and the costs for expensive equipment (e.g. traffic lights, variable message signs, etc.) and software (for programming the control strategies). Compared to building new infrastructure, however, traffic management is often considered to be a cheap option (Kampman, 2009).

3.2.3.3.2 Speed limitations

Speed limits have been introduced for reducing fuel consumption and emissions as well as for traffic safety. According to (Kampman, 2009), several studies have been carried out to estimate the effect of a speed limit reduction on CO_2 emissions. These studies mainly look at motorway passenger car traffic, where CO_2 reductions thanks to reducing the speed limit to 100 km/h are reported to be in the order of 7-15% (depending on the initial speed limit) (Kampman, 2009).

For other road types than motorways, it is more difficult to assess the effect of lower speed limits. Depending on the speed at which vehicles are most efficient (at around 80km/h in 2010) lowering a speed limit from 80 to 60 km/h or 50 to 30 km/h could potentially increase emissions, unless traffic flows are smoothed, i.e. vehicles drive at more constant speeds, or with fewer stops. If speed limits were to be lowered, or at least capped, throughout Europe, there are several added benefits (Kampman, 2009):

- if travel speeds decrease, and time budget theory holds true, people would travel less kilometres;
- the design of vehicle engines could also be adapted (leading to reduced CO_2 emissions), because the power of cars could be reduced as there are would not be any roads on which high speeds were allowed.

3.2.3.4 Overview of infrastructure instruments

Again, an overview of the relationship between the instruments discussed above and the various reduction options is provided in the Table 3.10.

All the above policies are supply oriented, i.e. focusing on facilities, as opposed to demand oriented, i.e. focusing on human behaviour and household decision making. The impact of changes in housing supply, parking charges, public transport networks and infrastructure all depend on the degree to which the consumers respond to this and actually change their behaviour. As long as this behavioural change is not stimulated in more direct ways (e.g. pricing or speed moderation), spatial planning and infrastructure policy seems to fall in the category “modest impact, low feasibility”.

Table 3.10: Overview of discussed policy instruments and their impact on the vehicle fleet and use (infrastructure instruments)

	Reduced car-ownership	More f fuel efficient vehicles	Shift to low-carbon energy carriers	Fuel efficient driving/sailing/flying	Reduced vehicle-kms due to higher vehicle utilisation	Modal shift to low-carbon modes	Limiting overall transport growth
GHG reduction in urban planning							
Location of living and business areas	■					■	
Investments in public transport							
Investments in cycling and walking infrastructure	■					■	
Parking policy	■					■	
GHG reduction spatial planning and infrastructure development outside urban areas							
Investments in long distance and high speed rail infrastructure	■		■			■	■
Investments in waterway infrastructure and ports						■	■
Investments in intermodal connections for freight transport						■	■
Traffic management policy and speed limits							
Optimization of traffic flows in cities	■			■		■	■
Measures to reduce congestion on main roads		■		■		■	■
Access restrictions for high emitting vehicles	■	■	■			■	■
Dynamic speed limits		■		■		■	■
Lower speed limits for road transport		■		■		■	■
Traffic management for non-road transport modes				■		■	■
Speed policy for non-road transport modes		■		■	■	■	■

Source: (Kampman, 2009)

3.2.4 Educational and awareness raising instruments

The provision of quality information on sustainable modes of transport is now commonplace in Europe, and shows increasing sophistication. A wide variety of different types of information campaign are used around the world to enable, and encourage, the use of public transport, cycling and walking, and to discourage journeys by single occupancy vehicle. It is impossible to place an absolute value on the direct impact of such campaigns or the effectiveness of information provision, as effectiveness is closely related to the quality and variety of the journey options they present. However, there are numerous examples that demonstrate that they can be successful, several of which are highlighted below (Brannigan et al., 2009).

Despite the difficulty in predicting their exact impact in any particular context, their widespread use is recommended for two reasons (Brannigan et al., 2009):

- They are usually low-cost compared to infrastructure and public transport improvements, and can add considerable value to these improvements by making sure they are well used.

- They are one of only a few measures that have the potential to manage journey demand, as opposed to reducing carbon emissions per journey (in addition to measures such as road pricing, spatial planning). Unless the growth in journey demand is managed, it will eventually offset any cuts in absolute emissions made through efficiency gains.

In the following sections some of the most relevant instruments that aim at raising awareness and provide information to transport users or other are described.

3.2.4.1 Information or awareness 'campaigns'

Information campaigns or travel awareness campaigns can take various forms, including:

- National information campaigns;
- Mode specific campaigns, e.g. for cycling or buses, or against car use;
- Information provided about accessing a specific destination or area; or
- Information provision aimed at specific origins, i.e. residents in a particular area.

At the highest level there are national travel awareness campaigns such as "Travelwise" in the UK. Campaigns for specific modes include "Bike it UK", a cycling campaign aimed at the 9-12 years age group which intends to increase the number of children cycling to school, thereby improving the health of children in the UK. The German "Bikes + Business" project promotes the use of bicycles in commuting to and from work in the Frankfurt/Rhein-Main region.

There are also campaigns against specific modes such as the international Car Free Cities who promote the possibility of a future design for cities that excludes cars. They promote a series of events including the annual World Car-free Day.

Information campaigns focussed on specific destinations are generally called **travel plans** or mobility management plans and are usually provided for new office, commercial or leisure development. They are now widespread in most European countries, and in the UK they can be required as a condition attached to planning approval for new development. An extension of travel plans for single buildings are the area wide information campaigns that have been developed by the Highways Agency and Transport for London in the UK.

Information campaigns focussed on specific origins are usually called **residential travel plans** and their popularity in the UK has increased in the last few years. They are usually linked to public transport information provided to new residents of a development. Sometimes they are also linked to actual physical public transport and walking and cycling improvements in the area. In the UK, they can be required as a condition to a planning application.

Another type of information campaign focussed on origins is **personalised travel planning**. This is a targeted marketing technique providing travel advice to households based upon personal trip patterns. This technique was first trialled in Australia with the Travel Blending campaign but is now also common in Europe with over 30 projects in the UK.

Information and awareness campaigns may also focus on other issues, such as health and physical fitness. Such campaigns often demonstrate the linkages between the issue of poor health and physical fitness and promoting the use of walking, cycling and public transport as part of the solution (Brannigan et al., 2009).

3.2.4.2 Public Transport Information

Public transport information has made a significant leap within the last decade. Public transport information is much more than a paper timetable. Most European countries have an **online national transport information service** such as Transport Direct in the UK or 9292 in The Netherlands. Public

transport information kiosks, where public transport information can be obtained using a computer, are available in most European city centres and at airports (Brannigan et al., 2009).

A **Mobility Centre** is a publicly accessible office, such as a town centre shop or office, from where information and advice about transport decisions can be given and where awareness raising and educational activities can be based (Brannigan et al., 2009).

Real time information on bus, rail and light rail services is now commonplace in most large European cities, combined with the use of hand-held devices such as mobile phones so that traveller scan plan their trip using public transport means 'on route'. They have access to immediate updates in case there are disruptions or the traveller decides to changes their route. Information providers such as Google provide smart phone apps that make such direct access to dynamic public transport information possible. In many cities also competitors exist that, depending on the public access of public transport data, provide information on the whole public transport system (e.g. *Citymapper* in London) or only for single transport modes (e.g. the *Velib* phone application that provides real-time information on the bike sharing system in Paris).

3.2.4.3 Information for vehicle operators

In addition to targeting the public, information can also be provided to businesses, such as companies that operate vehicles. Schemes include "best practice" campaigns, such as those aimed at the freight sector in the UK, which is funded by the UK government: Freight Best Practice provides a range of free advice and information for the freight industry on fuel efficiency, developing skills, equipment and systems, operational efficiency and performance management. The Energy Saving Trust (EST) in the UK also targets travel and driving, and delivers training courses for companies and their employees to learn smarter driving techniques to reduce fuel consumption and save money (Brannigan et al., 2009).

3.2.4.4 Driver training (Eco driving)

Eco-driving is the name often given to driving techniques that drivers can use to optimise their car fuel economy. Eco-driving is seen as a quick win solution to carbon reduction as it achieves personal cost savings as well as environmental benefits. It is therefore much easier to convince people of the positive effects of eco-driving compared to, for example, sustainable travel modes.

Next to awareness campaigns that can highlight the positive effects of fuel-efficient driving (such as fuel savings), there are a number of potential policy instruments that could help to achieve a widespread shift in driver behaviour towards more fuel efficient driving, including the following:

- Changes to driver training standards, both the standard driving test and training requirements for commercial drivers, to require an understanding of how driving style affects fuel efficiency.
- Changes in vehicle standards to require devices such as gear change indicators and mpg readout.
- Requirements for commercial fleets to audit fuel consumption more fully, potentially as part of other GHG reporting requirements – this will have the effect of making more companies aware of the extent of their fuel costs.

There are a large number of eco-driving programmes in Europe. Some examples are as follows:

ECO DRIVEN - ECODRIVEN is a synchronised European-wide eco-driving campaign aiming at drivers of passenger cars, delivery vans, lorries and buses in 9 EU countries. During a one-year campaigning period end-users will be regularly presented with Eco-driving activities within their familiar social environment, which will stimulate them to reflect on and optimise their driving behaviour in a safe and energy-efficient manner. The campaign is based on a bottom-up approach through European-wide local and regional collaborations of the ECODRIVEN consortium with relevant national and local stakeholders such as car dealers, fuel companies, touring clubs, drivers' associations, driving schools, municipalities, SMEs and hauliers etc. who will support campaign activities and disseminate campaign material.

SAFED, UK - SAFED (Safe and Fuel Efficient Driving) is a UK government eco-driving programme specifically for van, HGV, and bus and coach drivers. SAFED is a one-day complementary driver development course, consisting of driver training and assessment. It intends to improve the safe and fuel efficient driving skills of commercial drivers.

3.2.4.5 Labelling and provision of information at point of sale

Another form of information provision may be through energy or CO_2 labelling, often associated with the purchase of new vehicles. The European Union has enforced the publication on the fuel economy and CO_2 emissions of new passenger cars with Council Directive 1999/94/EC. The purpose of the Directive is to ensure that information is offered at point of sale or lease in the Community in order to enable consumers to make an informed choice when purchasing a vehicle. This fuel economy information scheme is designed to support and complement the other strands of the Commission's target to achieve a level of average CO_2 emissions from new passenger cars of 120 gCO_2/km by 2012 (see Section 3.2.2.1). The object of the Directive is to raise consumer awareness on fuel use and CO_2 emission of new passenger cars. By doing so consumers should be incentivised to purchase or lease cars which use less fuel and thereby emit less CO_2. In turn it should provide an additional incentive to encourage manufacturers to take steps to reduce the fuel consumption of new cars. The 'car labelling Directive' as demand-side policy is considered an important complementary measure to help car manufacturers to meet their specific CO_2 emission targets.

Specifically, the 'car labelling Directive' requires:

- A label showing fuel economy and CO_2 emissions to be attached to all new cars or displayed nearby at the point of sale;
- A poster or display to be exhibited showing prominently the official fuel consumption and CO_2 emissions data of all new car models displayed or offered for sale or lease at or through the respective point of sale;
- A guide on fuel economy and CO_2 emissions from new cars to be produced in consultation with manufacturers at least annually. The guide should be available free of charge at the point of sale and from a designated body within each Member State;
- All promotional literature to contain the official fuel consumption and specific CO_2 emissions data for the passenger car model to which it refers.

Annexes to the directive set out minimum requirements that each of these consumer information items must meet.

3.2.4.6 Overview of information and awareness instruments

As in the previous sections, an overview of the relationship between the information and awareness instruments discussed above and the various GHG reduction options is provided in the Table 3.11. It can be seen that these instruments can have a positive on a wide range of GHG reduction options.

Table 3.11: Overview of discussed policy instruments and their impact on the vehicle fleet and use (information and awareness instruments)

Policy Instrument	Reduced car-ownership	More fuel efficient vehicles	Shift to low-carbon energy carriers	Fuel efficient driving/sailing/flying	Reduced vehicle-kms due to higher vehicle utilisation	Modal shift to low-carbon modes	Limiting overall transport growth (reduced vehicle kms)
Provision of Information - Travel planning	↓				↓	↓	↓
Provision of Information - Personalised Travel planning	↓				↓	↓	↓
Provision of Information - General/other awareness campaigns	↓	↓		↓	↓	↓	↓
Provision of Information – Public transport information	↓				↓	↓	
Provision of Information – Information for vehicle operators		↓		↓			↓
Provision of Information - Encouraging fuel efficient driving through driver training				↓			↑
Provision of Information – At point of sale (e.g. CO_2 labelling)		↓					

Source: (Brannigan et al., 2009)

3.2.5 Instruments to stimulate innovation and development

Many instruments can contribute to stimulating technical innovation and development. For example, many instruments that reduce GHG emissions, potentially indirectly stimulate technical innovation/development. An example for such an instrument would be emission standards. However, effects of such instruments on innovation are likely to be more relevant for innovations in near-market technologies (Brannigan et al., 2009).

The instruments that are considered in this section target technologies at earlier stages of development.

3.2.5.1 Green public procurement

Public procurement refers to the purchase by public authorities of goods, services or works, which are governed by a series of national and European rules. This is to ensure that taxpayers' money is well spent, preventing fraud and discrimination and ensuring equal treatment of bidding. *Green* public procurement (GPP) therefore refers to the procurement process when contracting authorities use additional environmental criteria when deciding on which goods or services to procure.

As 'greener' goods are often relatively new on the market, they do not enjoy economies of scale and price is often an inhibitor to their uptake. However, through the use of public procurement, demand could be increased sufficiently to enable them to expand and therefore enjoy lower unit costs, aiding technologies that are not currently commercially viable to move into mainstream markets.

In terms of the transport sector, this is likely to include alternatively fuelled vehicles (e.g. hybrid or electric vehicles). This could therefore mean faster adoption of such resource-saving products across the economy, subsequently having positive environmental benefits, such as including the reduction of

energy consumption and energy imports, whilst boosting the region's ability to compete in global environmental product markets.

In the EU legislation that deals with environmental considerations in public procurement is in place. Directive 2004/18/EC on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts came into force in 2004. This Directive takes account of environmental and social aspects of public procurement, including:

- Relevant environmental and social requirements may be specified but must be defined sufficiently precisely to allow bidder to understand the requirement and to allow award of contract; and
- Production process standards and eco label criteria can be references but alternatives which demonstrate equivalence must be considered.

In April 2009, an EC Directive on the promotion of clean and energy efficient road transport vehicles (EC 2009/33/EC) was approved. One of the main aims of the Directive is to require contracting entities (as well as certain operators) to take into account lifetime energy and environmental impacts, including energy consumption and emissions of CO_2. Also certain pollutants when purchasing road transport vehicles are to be considered. The objective is to promote and stimulate the market for clean and energy efficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Community (Brannigan et al., 2009).

3.2.5.2 Research and development

Research and Development (R&D) is a key part of efforts to develop low carbon technologies. There are various types of R&D in a transport context including (Brannigan et al., 2009):

- Fundamental research;
- Development for transport applications; and
- Commercialisation.

Fundamental research aims to develop new technologies, processes or materials at their most basic level. These novel technologies, processes or materials often need to be developed or packaged in a certain manner for transport applications. Finally, further research is often required to reduce the production cost to ensure the new technology is commercially viable. A good example is new battery chemistries such as lithium-ion. Research into lithium-based batteries began in 1912 but it took until the early 1990's for lithium-ion (li-ion) batteries to be developed for consumer electronics (Brannigan et al., 2009). It is only in the last decade that have been refined sufficiently for use in electric vehicle applications. Efforts are ongoing to reduce the cost of li-ion batteries.

The EU has various funding mechanisms to support R&D in general and transport R&D more specifically. The main current EU framework programme for Research and Innovation is the "Horizon 2020" programme. Overall, €6.3 billion have been earmarked for Transport Research in Horizon 2020. For example, a EUR 0.5 billion has been made available specifically for projects under the 'transport challenge' that has the aim to turn European air, rail, road and waterborne transport into a greener, safer, more competitive and integrated system. In total, 75 projects were supported under this challenge. (EC, 2015a).

3.2.5.3 Fleet tests, demonstrations and pilot programmes

Testing and demonstration is a critical part of the R&D cycle. Significant issues can be exposed by subjecting the vehicle to 'real world' conditions, which must be resolved before the vehicle or process is production-ready. This is particularly the case in the transport sector where real-world conditions can differ significantly from test cycles. For instance, when cars are driven by the general public acceleration can be a lot faster, breaking a lot harsher and engine revs a lot higher than would be ideal, all of which stresses the key components such as the engine much more than bench tests using standard duty cycles.

Tests, demonstrations and pilot programmes can be employed as policy tool to stimulate the uptake of low carbon technologies. Case studies from well-run trials involving reputable organisations can be a powerful means of generating interest in a technology and ultimately accelerating it's uptake. In the

transport sector 'low carbon' often equates to significant fuel cost savings, which can be one of the largest operating costs for a company operating a sizeable fleet of vehicles depending on the sub-sector. For instance, fuel makes up a large proportion of the costs of road freight operators (Brannigan et al., 2009).

Across the European Union many mainly local or regional fleet tests and pilot programmes have been launched for testing electric and/or fuel cell electric vehicles. Frequently these are financed by stakeholder consortia that comprise (local, regional, national and/or EU-level) authorities, infrastructure providers and/or vehicle manufacturers.

3.2.5.4 Roll-out of alternative fuel infrastructure

In 2014, the EU adopted the Directive on the deployment of transport infrastructures based on electricity or other alternatives to fossil fuels (Directive 2014/94 EC). The main policy drivers behind this Directive were (EC, 2015b):

- The reduction of the EU transport systems oil dependence in order to diversify and secure energy supply;
- The reduction of EU GHG emissions the 2011 White Paper on Transport;
- Improving the air quality in urban areas in order to meet EU air quality obligations;
- Enhancing the competitiveness of the European industry, boost innovation and generate economic growth.

The infrastructure build-up that is foreseen in Directive 2014/94 contains electricity, hydrogen, CNG and LNG fuels. The Directive has to be transposed into national law by the Member States by 18 November 2016 and provides minimum targets that have to be achieved. Member States are free to set their own more stringent targets.

The aims of the EU-level Directive are to promote economies of scale in infrastructure deployment, interoperability across the infrastructure that will be deployed and ensure relevant, consistent and clear consumer information. Table 3.12 shows the timeline of the Directive's deployment objectives for the different types of infrastructure (EC, 2015b).

Table 3.12: Timeline for the deployment of alternative fuel infrastructure provided in Directive 2014/94/EC

ALTERNATIVE FUEL	COVERAGE	TIMINGS
Electricity in urban/suburban and other densely populated areas	Appropriate number of publically accessible points	by end 2020
CNG in urban/suburban and other densely populated areas	Appropriate number of points	by end 2020
CNG along the TEN-T core network	Appropriate number of points	by end 2025
Electricity at shore-side	Ports of the TEN-T core network and other ports	by end 2025
Hydrogen in the Member States who choose to develop it	Appropriate number of points	by end 2025
LNG at maritime ports	Ports of the TEN-T core network	by end 2025
LNG at inland ports	Ports of the TEN-T core network	by end 2030
LNG for heavy-duty vehicles	Appropriate number of points along the TEN-T core	by end 2025

Source: (EC, 2015b)

Many EU Member States had already made independent efforts to support the deployment of alternative-fuel infrastructure before the Directive came into force. Often such infrastructure build-up took place in the context of fleet tests or demonstration programmes (see previous Section) that were financed by stakeholder consortia (e.g. such as the electric recharge infrastructure in place in Paris thanks to the shared electric vehicle programme 'Autolib'[10]).

3.3 Qualitative assessment of policy options

Section 3.2 provided a high-level overview of different policy options that can help reduce CO_2 emissions from road transport. The scope of this project did not allow to analyse all these policy options in more depth. To shortlist and prioritise the different policy options, a policy assessment matrix was developed. This matrix allowed to assess the different options against a pre-defined set of criteria and to identify the most interesting options by the means of a so-called multi-criteria analysis. Table 3.13 provides an overview of the assessment criteria (along four different categories) that were used. The criteria reflect:

- the **benefits** of the different policy options (in terms of their environmental impacts and other) (criteria category 1)
- the **costs/efforts** that are necessary to implement the policy option (criteria category 2)
- the **coherence** of the policy option with policy that is currently already in place in the EU and the Ukraine, as well as the **public acceptability** of the policy option, (criteria category 3) and
- the **time lag** until the CO_2 reduction materialises (criteria category 4).

All policy options were assessed along the shown criteria on a 5-level scale, from -10 to +10 (with the interim scores of -5, 0 and +5). The weights (also shown in Table 3.13) show the relative importance that was assigned to the different criteria. To be in line with the objective of this project, the criteria

[10] https://www.autolib.eu/en/

'Long term CO_2 reduction potential' and 'Coherence with EU legislation and practice' were given the highest importance.

Table 3.14 provides the final scores and ranks of the different policy options. Annex I provides the full overview of the assessment that was initially developed by the authors and will be adjusted in line with the experts' opinions obtained during this project's coordination meetings.

Table 3.13: Assessment criteria and their weights used for the policy option multi-criteria analysis

	Weight
1. Criteria assessing policy benefits	
1.1. Long term CO_2 reduction potential	**10**
1.2. Congestion co-benefits	**3**
1.3. Air pollutant co-benefits	**3**
1.4 Other co-benefits (social/economic/energy security)	**4**
2. Criteria assessing policy implementation costs/efforts	
2.1. Cost to implement and run the measure	**5**
2.2. Time required to implement the policy	**5**
3. Criteria assessing policy coherence and acceptability	
3.1. Coherence with EU legislation and practice	**10**
3.2. Coherence with Ukrainian legislation and practice	**5**
3.3. Public acceptability	**5**
4. Other	
4.1. Time lag until CO_2 reduction materialises	**4**

Table 3.14: Final scores and ranks of the different policy options

Policy options	Final assessment score	Final rank
Economic instruments		
Fuel Taxes	265	**2**
Road charges and tolls	-80	21
Vehicle purchase and ownership taxes	195	5
Parking fees	75	16
Company car taxation and treatment of business travel	75	16
Tax breaks and subsidies	145	10
Regulatory instruments		
Vehicle emission and/or fuel consumption standards and MRV	280	**1**
Component efficiency / requirements	130	11
Fuel quality/GHG performance standards	230	**3**
Enhancement of infrastructure		
Urban planning	165	8
Spatial planning outside of urban areas	100	14
Traffic management	180	6
Education and awareness raising		
Campaigns	90	15
Public transport information	105	13

Policy options	Final assessment score	Final rank
Information for vehicle operators	160	9
Driver training (Eco driving)	170	7
Vehicle/fuel labelling	210	**4**
Stimulation of innovation and development		
Green public procurement	130	11
Research and development	55	19
Fleet tests, demonstrations and pilot programmes	50	20
Roll-out of alternative fuel infrastructure	65	18

Table 3.13 shows that the following four policy options are ranked highest according to the multi-criteria analysis. In the following section these shortlisted policy options are discussed in more detail:

1. Vehicle emissions and/or fuel consumption standards (see Section 3.4.1)
2. Fuel taxes (see Section 3.4.1.4)
3. Fuel quality/GHG performance standards (see Section 3.4.3)
4. Vehicle/fuel labelling (see Section 3.4.4)

3.4 Review of shortlisted priority policy options

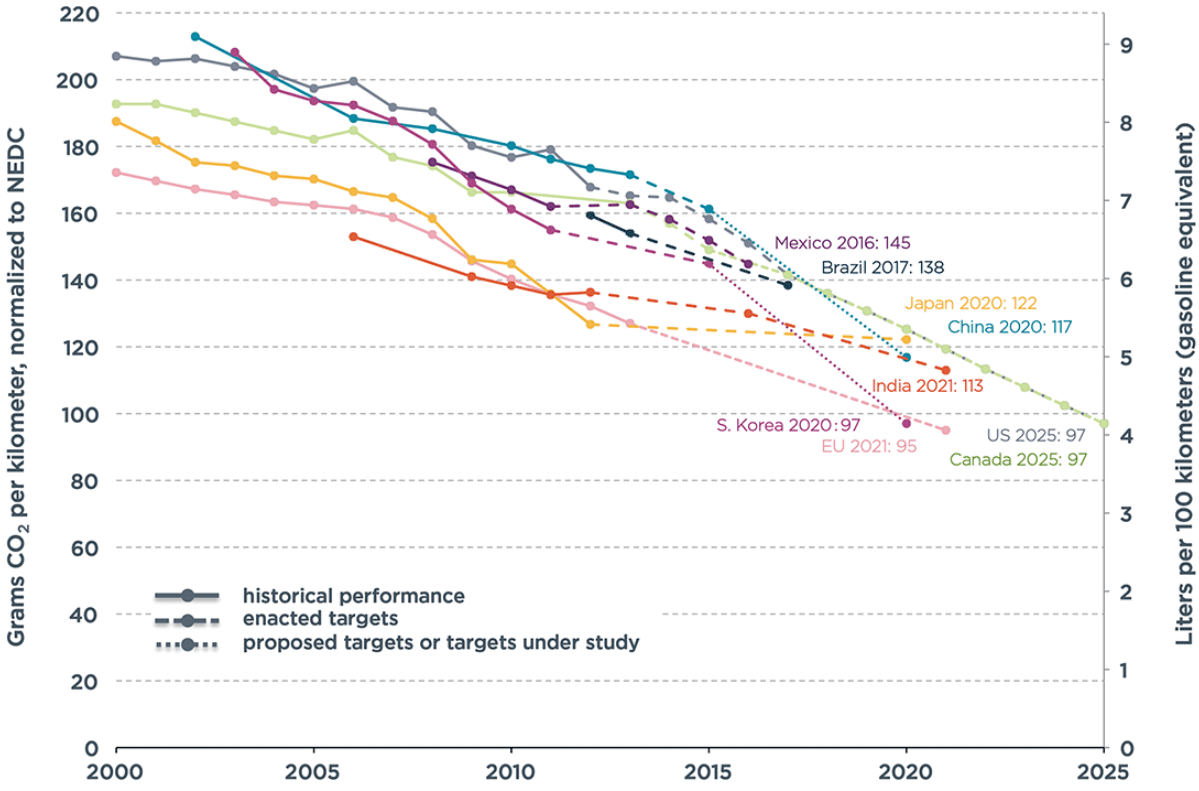
3.4.1 Vehicle emissions or fuel economy standards

3.4.1.1 Emission standards around the globe

Around the globe, a number of countries has implemented vehicle emissions or fuel consumption standards. Given the constant conversion factor between gCO_2/km and litre/km for a specific fuel, emission and fuel economy standards can be considered to be the same (as long as they both refer to the same reduction target; and unless greenhouse gases other than CO_2, such as methane and N_2O, are included).

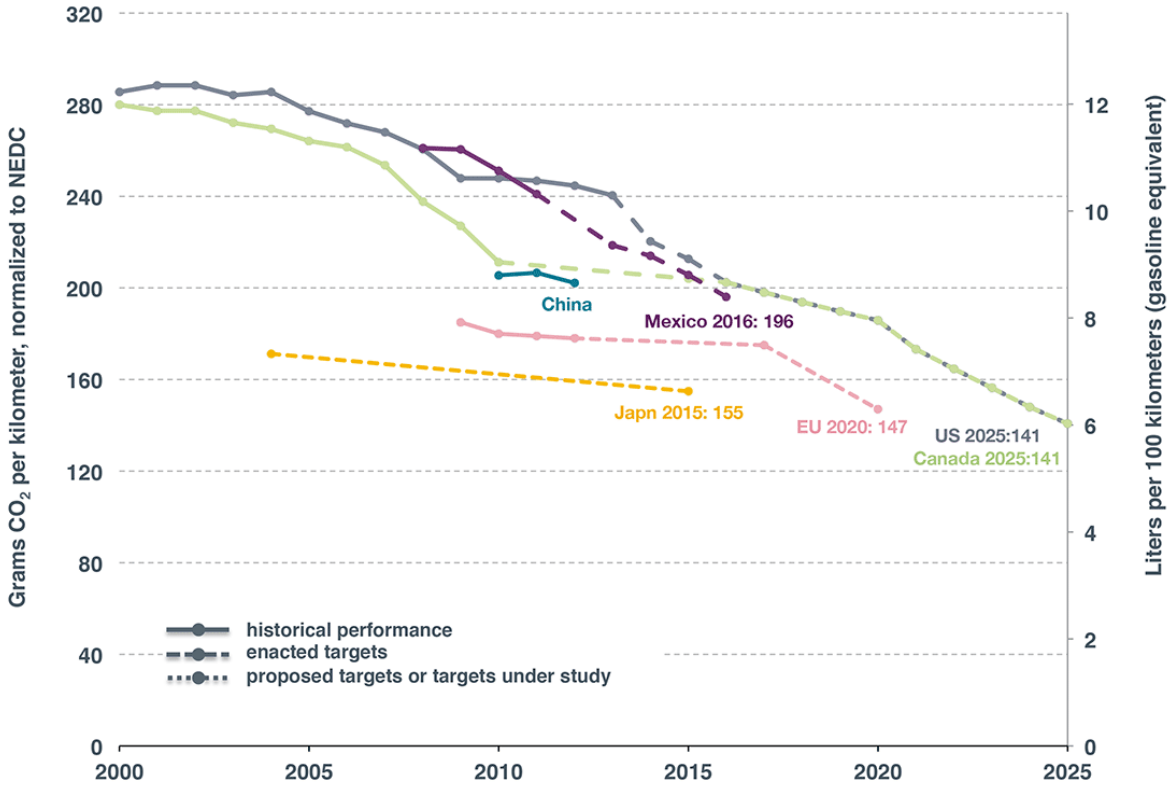
Figure 3.1 and Figure 3.2 provide an overview of countries' historic fleet CO_2 emission performances for passenger vehicles and light-commercial vehicles respectively (in terms of litres/100 km and gCO_2/km), which have been adjusted/normalised to an 'NEDC-equivalent' basis by (ICCT, 2014). They also show future proposed targets up to 2025. It can be seen that vehicles' average emissions performance has been improving over the past decade and it is set to further improve if future targets are met.

Figure 3.1: Historical fleet CO_2 emissions performance and current or proposed passenger vehicle standards



Source: (ICCT, 2014)

Figure 3.2: Historical fleet CO_2 emissions performance and current or proposed light commercial vehicle/ light truck standards



Source: (ICCT, 2014)

As already outlined in Section 3.2.2, the European vehicle CO_2 emission standards date back to 1995 when the Commission published a strategy on passenger car CO_2. They were finally introduced in 2009 for passenger cars and in 2011 for light commercial vehicles.

The regulations allow for a certain degree of flexibility thanks to a set of 'modalities' that has been defined. The following section describes these modalities in more detail and shows how the regulations work in practice.

3.4.1.2 The European LDV regulations - Modalities

The vehicle CO_2 regulations set mandatory fleet-based CO_2 reduction targets for new cars and LCVs. For cars, Regulation 443/2009 set a fleet-wide target of 130 gCO_2/km to be met by 2015, and a target for 2021 of 95 gCO_2/km. For LCVs, Regulation 510/2011 set a target of 175 gCO_2/km by 2017 and 147 gCO_2/km for 2020.

Both regulations use the same metric: the specific CO_2 emissions of a vehicle, measured in gCO_2/km on the vehicle emissions test cycle, which is currently the New European Drive Cycle (NEDC). The NEDC already existed prior to the regulations, as it was used (for example) to measure the performance of new vehicles in relation to air pollutant emission limits. Consequently, vehicle CO_2 emissions as measured on the test cycle were considered to be an appropriate proxy for the vehicle's CO_2 emissions in the real-world, and therefore a suitable focus for the regulations (Ricardo-AEA, 2015).

The regulations are applicable to manufacturers rather than Member States, and the targets are to be met by manufacturers through improvements in vehicle technology. The approach taken in the LDV CO_2 regulations is more complex than the approach used in EU legislation regulating air pollution from road transport vehicles, for example, as this generally sets limit values for each regulated pollutant[11].

It was considered that a similar approach would not be practical for CO_2 emissions, as it would restrict the range of cars that could be put on the market. Hence, the regulations set each manufacturer a different annual fleet-average CO_2 target that must be met by the fleet of new cars or LCVs that it sells each year (Ricardo-AEA, 2015).

In order for the targets to be able to reflect the characteristics of each manufacturer's vehicle fleet, it was necessary to relate the targets to a measure of a vehicle's 'utility'. Various possible ***'utility parameters'*** were considered in the studies that were undertaken in support of the legislation, but 'mass' (defined as the mass in running order) was chosen for both regulations. While making the regulation more complex compared to setting a single target value, as the emissions target is not the same for each vehicle, the utility parameter approach was considered to be competitively neutral as it took account of the diversity of manufacturers and their vehicles.

The relevant targets are calculated according to a formula set out in Annex I of the respective regulations, which determines a manufacturer's target as a function of the mass of its new vehicles that are registered that year. The target is therefore effectively a line: a manufacturer whose fleet is lighter than average will have a lower target than a manufacturer whose fleet is heavier than average. The ***shape and slope of the line*** are important to ensure that the emissions reductions required by heavier and lighter cars are appropriate (in order to ensure competitive neutrality), as well as to limit incentives for manufacturers to increase mass, rather than reduce emissions, to meet their targets. The flatter the slope, the higher the relative price increases will be for the manufacturers of heavier cars (European Commission, 2007).

The details – or ***modalities*** – of the two regulations are similar, although not all elements are present in both. Indeed, it was explicitly stated in the Impact Assessment supporting the proposed LCV CO_2 Regulation that there were "no obvious reasons" for the approach taken to be significantly different from that taken for cars. Hence, the approach was to design the LCV legislation to be as "similar as possible" to the one for cars, except where there was a justification for taking a different approach (Ricardo-AEA, 2015). An overview of the main modalities for both Regulations is given in Table 3.15.

[11] In other words, any vehicle being marketed within the EU has to have emissions that are no higher than these limit values.

Table 3.15: Summary of the main elements of the passenger car and LCV CO_2 Regulations

Element of the regulations	Car CO_2 regulation	LCV CO_2 regulation
First target (year)	130 gCO_2/km (2015)	175 gCO_2/km (2017)
Phasing in of first target	For the purpose of determining each manufacturer's average CO_2 emissions, 65% of registered cars are taken into account in 2012, rising to 75% (2013), 80% (2014) and 100% from 2015 to 2019.	For the purpose of determining each manufacturer's average CO_2 emissions, 70% of registered LCVs are taken into account in 2014, rising to 75% (2015), 80% (2016) and 100% from 2017.
Super-credits for first target	Each new car with CO_2 emissions of less than 50g shall be counted as 3.5 cars in 2012 and 2013, 2.5 cars in 2014, 1.5 cars in 2015 and 1 car from 2016; there is no limit as to the number of vehicles for which a super-credit can be given.	Each new LCV with CO_2 emissions of less than 50g shall be counted as 3.5 LCVs in 2014 and 2015, 2.5 LCVs in 2016, 1.5 LCVs in 2017 and 1 LCV from 2018; super-credits can be applied up to a maximum of 25,000 LCVs per manufacturer over the entire period.
Second target	95 gCO_2/km (2021)	147 gCO_2/km (2020)
Phasing in of second target	95% of registered cars taken into account in 2020 and then 100% from 2021.	100% of registered LCVs from 2020.
Super-credits for second target	Each new car with CO_2 emissions of less than 50g shall be counted as 2 cars in 2020, 1.67 cars in 2021, 1.33 cars in 2022 and 1 car from 2023; the limit for the use of super-credits is set at a maximum of 7.5 g/km for 2020 to 2022 for each manufacturer.	The use of super-credits is not allowed in relation to the 2020 target.
Pooling	Manufacturers may form a pool to meet their specific emissions targets (except for manufacturers with a 'small volume' or 'niche' derogation; see below).	Manufacturers may form a pool to meet their specific emissions targets (except for manufacturers with a 'small volume' derogation).
Excess emissions premium	From 2012 (or 2014 for LCVs) to 2018, where a manufacturer's (or pool's) CO_2 emissions exceed their target, they will have to pay an 'excess emissions premium' for each new vehicle registered that year of: €5 for the first gram over (or part thereof); €15 for the second gram over (or part thereof); €25 for the third gram over (or part thereof); and €95 for each gram thereafter. From 2019 the premium will be €95 for each gram.	
'Small volume' derogation	Manufacturers that are responsible for fewer than 10,000 new cars (or 22,000 new LCVs) registered each year and are not part of a wider group may apply for a derogation under which the manufacturer proposes a specific CO_2 emissions reduction target consistent with its reduction potential. The application needs to be approved by the Commission.	
'Niche' manufacturer derogation	'Niche' manufacturers, i.e. those responsible for between 10,000 and 300,000 new cars registered each year, can apply for a derogation to have a reduction target for 2012 to 2019 that is 25% less than their average specific CO_2 emissions in 2007 and a reduction target from 2020 that is 45% lower than the 2007 value.	No equivalent provision.
Eco-innovations	Manufacturers or suppliers can apply for the CO_2 savings achieved as a result of innovative technologies to be considered, as long as these deliver verifiable CO_2 emissions reductions that are not measured under the test cycle. The 'eco-innovations' that are approved by the Commission can be used to contribute up to 7g of the manufacturer's specific emissions target.	
De minimis	Manufacturers responsible for fewer than 1,000 new cars and LCVs registered each year do not have a specific emissions target.	

Element of the regulations	Car CO_2 regulation	LCV CO_2 regulation
'M_0 adjustment'	The average mass of the new vehicle fleet (referred to as M_0) is part of the formula used to calculate each manufacturer's CO_2 reduction target. From 2016 (2018 for LCVs) an adjusted M_0 will be used, which will be the average mass of the new vehicle fleet from 2011 to 2013 (2013 to 2015 for LCVs). A similar adjustment will subsequently occur every 3 years.	

Source: (Ricardo-AEA, 2015)

The existence of many of these modalities adds to the complexity of the LDV CO_2 regulations, although many of these have been included in order to improve the functioning of the regulations for manufacturers (Ricardo-AEA, 2015). Additionally, some of the modalities – such as super-credits – were not envisaged by the Commission in the original proposals, particularly in the initial proposal that led to the passenger car CO_2 Regulation, and hence no initial analysis of their impacts was undertaken.

The original proposal for the car CO_2 Regulation did not include a phase-in period; this was introduced later and justified in the preamble to the Regulation "to facilitate the transition". The original proposal for the LCV CO_2 Regulation did propose a phase-in period, which is also justified in its preamble "to facilitate the introduction" of the targets and to provide consistency with the phase-in period under the passenger car CO_2 Regulation. The Impact Assessment of the proposal to confirm the 2020 modalities assessed whether there was a need for a phase-in period for the 2020 targets and concluded that none was needed as manufacturers had had enough time to plan to meet the target (Ricardo-AEA, 2015).

Super-credits give manufacturers additional incentives to produce vehicles with low emissions by counting these as additional vehicles against their targets. For both cars and LCVs, the Impact Assessment supporting the proposal to confirm the 2020 targets concluded that there should be no continuation of super-credits, as they increase CO_2 emissions, reduce the stringency of the target, reduce cost-effectiveness and do not respect the principle of technological neutrality.

The inclusion of **pooling** was considered to be an important flexibility that could improve the overall cost-effectiveness of the regulation, as it allows manufacturers without a wide range of vehicles to create a pool with other more mainstream manufacturers. In this way, it also improves the equity and maintains the diversity of EU manufacturers. From an administrative perspective, it is fairly straightforward for manufacturers to form a pool (Ricardo-AEA, 2015).

The **excess emissions premium** was included in the car CO_2 regulation "to provide a sufficient incentive [to manufacturers] to take measures to reduce specific emissions of CO_2 from passenger cars, the premium should reflect technological costs". The preamble to the LCV CO_2 Regulation notes that the premium for LCVs should be similar to that for cars in order to ensure consistency. The Impact Assessment of the proposal confirming the 2020 modalities considered that it was not necessary to change the level of the premium (Ricardo-AEA, 2015).

The inclusion of the derogation for **small volume manufacturers** was justified on the basis that such manufacturers may not find pooling, or other types of flexibility, appropriate, as their limited range of vehicles may make it costly to meet the targets set by the limit curve. The original proposal for the passenger car CO_2 Regulation did not include a provision for **niche manufacturers**. For 2020, the retention of the derogation for small volume manufacturers was justified for the same reasons, as well as that it was in line with the competitive neutrality objective. Furthermore, a **de minimis** was introduced in both regulations to exclude manufacturers that produce very small volumes of vehicles (i.e. those that register less than 1,000 vehicles annually), in order to reduce burdens on SMEs. The information that manufacturers are required to provide in order to apply for a derogation – including a niche derogation – is set out in Article 11 of both Regulations. For each LDV CO_2 Regulation, this information is supplemented by separate Commission Regulations, which include additional definitions and more detail on what an application must cover, including a template of around three pages to be completed by each manufacturer that is applying for a derogation. The Commission is able to reject an application on the basis of incompleteness or if it concludes that the proposed specific emissions reduction target is not consistent with the reduction potential of the manufacturer concerned (Ricardo-AEA, 2015).

While not included in the original proposal for the passenger car CO_2 Regulation, **eco-innovations** are justified on the grounds that they result in significantly lower emissions and so contribute to the promotion of the long-term competitiveness of the European industry and the creation of more high-quality jobs. The retention of eco-innovations for 2020 was justified on the basis that they are effective and efficient as any innovations approved would reduce CO_2 emissions and cost less than alternative options, as otherwise they would not be proposed. Companies must apply to the Commission to have a technology approved as an eco-innovation. The eco-innovation provision is not limited to manufacturers, as suppliers are also able to apply to have a technology that they have developed recognised as an eco-innovation. Indeed, as of March 2015, most of the applications for eco-innovations that had been approved had been made by suppliers rather than manufacturers (Ricardo-AEA, 2015).

A mechanism to adjust the value of the average mass of the vehicle fleet, **M0**, which is used in the formula to calculate each manufacturer's CO_2 reduction target (known as the 'M0 adjustment'), was included in the original proposal for the passenger car regulation. This is important as the targets are a function of the mass and hence any changes in the average mass of the fleet would risk that the regulation under- or over-achieves the desired CO_2 reductions. The formulation to adjust M0 that is in the Regulations is simpler than that originally proposed, but still ensures that any changes in the average mass of the overall new car (or LCV) fleet are reflected in the calculation of manufacturers' targets. Hence, if the average mass of the EU's new car (or LCV) fleet increases, manufacturers' targets will be adjusted to become more stringent for a given mass of vehicle, while if the average mass decreases, the targets will become less stringent. The first M0 adjustment under the passenger car CO_2 regulation was made for 2016 by Regulation (EU) 2015/6 (Ricardo-AEA, 2015).

Monitoring and reporting requirements are set out in Article 8 of each of the LDV CO_2 regulations and are further specified in Commission Regulations. Each Member State has to monitor and report relevant data to the Commission each year based on the certificate of conformity (CoC) or type-approval documentation (TAD). At the time of registration, the vehicle owner, manufacturer/dealer or importer presents the CoC in electronic and/or paper format to the registration authority, which then incorporates the data into the national registry. The Member States transmit the relevant data for a full calendar year to the Commission at the latest by 28 February the following year using the Central Data Repository managed by the European Environment Agency. The Commission verifies the data, and may, in agreement with the Member States concerned, correct the data. At the latest by 30 June of each year the Commission makes public the aggregated provisional data and notifies each manufacturer individually of its provisional CO_2 average emissions and its emissions target based on the data received. After notification of the provisional data vehicle manufacturers may within three months verify the data and notify the Commission of the presence of any errors. The Commission considers any error notifications from vehicle manufacturers and either confirms or amends the provisional calculations by 31 October of each year (Ricardo-AEA, 2015).

3.4.1.3 Issues affecting the real-world CO_2 reductions of LDVs

As noted above, the regulations focus on reducing the specific CO_2 emissions of vehicles, as measured on the NEDC test cycle. According to (Ricardo-AEA, 2015), reductions in emissions according to this measure will deliver emissions reductions in the real-world *IF*:

- The CO_2 emissions per kilometre as measured on the test cycle are an accurate reflection of real-world emissions per kilometre;
- Any rebound effect, whereby more fuel efficient vehicles are used more intensively because average fuel costs per kilometre travelled have reduced, is less than 100% (i.e. the additional emissions associated with more intensive use do not outweigh the savings due to improved vehicle efficiency);
- Different types of vehicles are used in similar ways;
- The regulations do not encourage the use of fuels and energy sources with higher indirect emissions compared to the fuels that they replace; and
- The regulations do not encourage the use of vehicles with higher emissions associated with their production and disposal compared to the vehicles that they replace.

However, at least for cars, there is evidence that these conditions are not met in practice, i.e. in the real-world, as discussed below, and also in later Section 4.6.1.

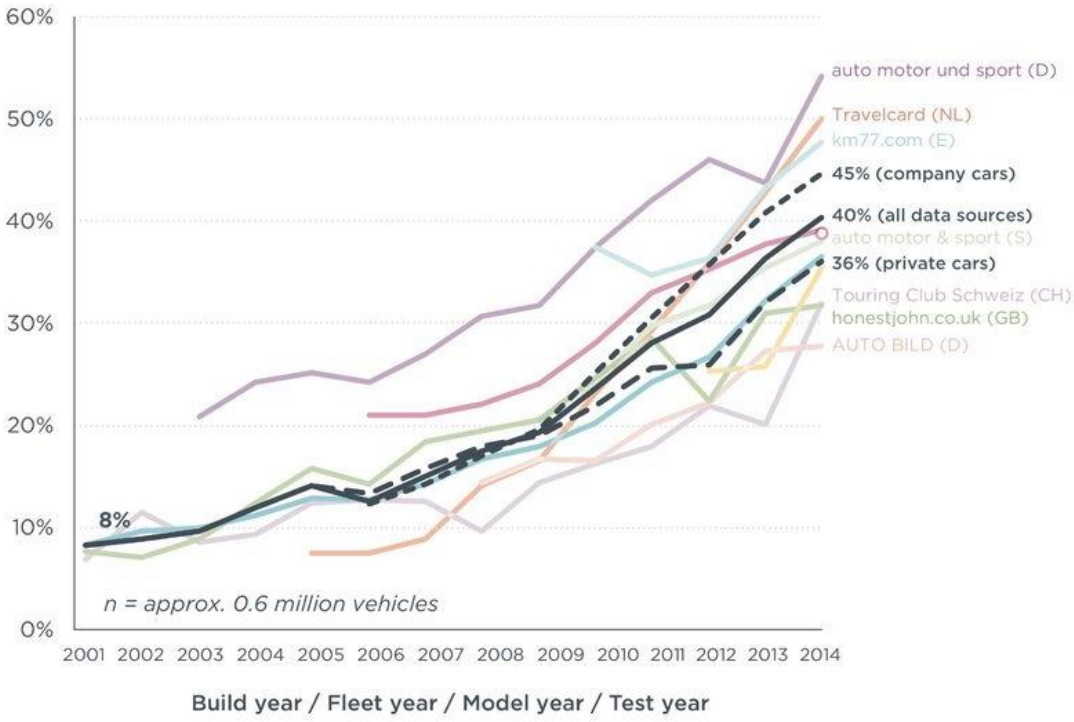
First, there is evidence of an increasing divergence between real-world CO_2 emissions and those measured on the NEDC (see Figure 3.3). While the methods for collecting these data will differ, in all cases the discrepancy over time is increasing and the discrepancy appears to be increasing at similar rates (ICCT, 2014a). As a result, only a proportion of the emissions reductions that have been achieved on the test cycle may have been delivered in the real-world. This would mean that the regulations are not delivering the real-world reductions that they appear to be if the test cycle figures were accurate.

There are three main reasons for the discrepancies (ICCT, 2013):

1. The NEDC test cycle is not representative of real-world driving;
2. Manufacturers are increasingly using flexibilities within the test cycle; and
3. The increased application and use of energy consuming devices to cars that are used in the real-world, but which are not operational when measuring emissions on the test cycle.

These issues have been recognised and some will be addressed through the development of a revised test procedure, which will be part of a new worldwide harmonised test protocol (WLTP).

Figure 3.3: Divergence between real-world fuel economy/CO_2 emissions and test-cycle fuel economy/CO_2 emissions for passenger cars



Source: (ICCT, 2014a)

Second, there are various 'rebound effects' that might occur as a result of the regulations. The most obvious and direct of these effects is that more efficient vehicles may be driven further than the less efficient vehicles that they replace, as they are cheaper to use. This will have an adverse impact on real-world CO_2 emissions, as these will be greater than expected as a result. The existing literature does not suggest that the rebound effect is large enough to reverse energy efficiency gains; however, it does mean that the emissions savings associated with the regulations would be lower than otherwise anticipated (Ricardo-AEA, 2015).

Third, there is increasing evidence to suggest that there is variation in the mileages that different vehicles travel. A report for the Commission showed that on average, diesel cars are driven nearly 50% further than petrol cars over their lifetime (Ricardo-AEA & TEPR, 2014). While there was no significant difference between the way in which different masses and sizes (measured in terms of their

respective footprints) of diesel cars and LCVs are driven, larger and heavier petrol cars are driven further than smaller petrol cars over their lifetime (Ricardo-AEA & TEPR, 2014). Some, but not all, of these differences were taken into account in the development of the regulations (e.g. different annual mileages were assumed for diesel and petrol vehicles). Mileage has not previously been assumed to vary with vehicle size and mass. This has a consequence for the cost-effectiveness of the regulations (Ricardo-AEA, 2015).

Fourth, for vehicles using alternative powertrains, indirect, well-to-tank CO_2 emissions associated with the production of electricity (and hydrogen) are a significant proportion of total lifecycle emissions. This is important, as it suggests that some of the reductions that have been achieved according to the specific CO_2 emissions as measured on the test cycle will have been replaced by increased emissions elsewhere. For example, as measured on the test cycle, electric vehicles are considered to have zero CO_2 emissions, but this is misleading as their true 'in-use' emissions should also include the CO_2 emitted (at least in most cases) as part of the CO_2 production of the electricity. This means again that in the real-world CO_2 emissions will again not have been reduced to the extent implied by the figures reported in the context of the regulations (Ricardo-AEA, 2015).

Finally, embedded CO_2 emissions associated with electric vehicles are typically higher than the equivalent ICE emissions, largely as a result of emissions associated with the production of the battery (Ricardo-AEA, 2014). Again, these emissions are not taken account of in the regulations as they currently stand, and so some (but by no means all) of the apparent CO_2 reductions that have been achieved will have been offset by increases in production emissions. Additionally, the use of a wider range of materials in vehicles, e.g. to make them lighter, will have knock-on effects on embedded emissions. Some alternative materials, such as aluminium, are more GHG-intensive to produce than steel, although lighter vehicles will require less energy (Ricardo-AEA, 2014). These issues all have implications for the evaluation of the effectiveness of the regulations (Ricardo-AEA, 2015).

3.4.1.4 Overall impact of the EU LDV regulations

Overall, (Ricardo-AEA, 2015) concludes that the car CO_2 regulation is likely to have had a positive impact in terms of contributing to the CO_2 emission reductions achieved following the introduction of the regulation, accounting for between 65-85% of the reductions seen in tailpipe emissions since the introduction of the regulations. Furthermore, the analysis indicates that the regulations have been more successful in reducing CO_2 emissions compared to voluntary agreements from industry. In addition, the targets required under the regulations have been met two years early, whereas the targets under the voluntary agreement were missed.

Similarly for LCVs, monitoring data shows that the fleet wide average emissions have already exceeded the required target for 2017, and place manufacturers in a strong position to meet their 2020 targets. The rapid rate of CO_2 emission reductions seen in recent years suggests that the Regulations have played an important role in speeding up specific emission reductions from LCVs. For LCVs, there were no equivalent voluntary agreements, but the rate of recent CO_2 emission reductions and the fact that the fleet average emission targets have been met four years early suggests that the regulations are more effective than voluntary targets would otherwise have been.

Also other impacts have been identified, as shortly summarised in the points below:

- In terms of **energy security**, the regulations are seen to have contributed to lifetime reductions in oil-based road transport fuel consumption. However, current impacts are seen to have been relatively minor and are expected to increase in future years.
- Impacts on **competitiveness and innovation** appear to be positive. There are promising signs that research and development of fuel-efficient technologies has ramped up, as well as clear trends towards increased market uptake of fuel efficient technologies both in cars and LCVs.
- The regulations were not in contradiction to its **competitive neutrality** objective. The shape and slope of the limit curve have been designed to address potential issues of competitive neutrality, but it is possible that the slope may not currently be sufficiently shallow to completely eliminate the possibility for manufacturers to "game" the system by increasing the mass of their vehicles.

- From the perspective of **social equity**, overall the impacts of the regulations can be considered positive. In terms of the impacts on fuel expenditure, it is clear that the car and LCV CO_2 regulations have led to significant reductions in annual fuel expenditure. As more fuel efficient vehicles move into the second-hand car market, where lower income consumers are more likely to purchase them, the rapid depreciation of car values in the first few years is likely to ensure that second-hand owners are able to benefit more from fuel cost savings compared to the first owners since they can reap the fuel savings without the fuel efficiency being fully reflected in the prices they pay for used cars.

3.4.1.5 Introducing LDV emission/fuel standards

If a decision has been made to formulate fuel economy standards for light vehicles, policymakers must evaluate the alternatives forms of standard as well as availability of data to formulate the actual standard. While standard development requires comprehensive data on vehicle attributes and sales, initial efforts should be focused on developing a conceptual framework of the standards. The conceptual design of the standard will drive the longer-term evolution of vehicle technology and manufacturers' response to the standards, and thus should be evaluated carefully (GFEI, 2015). The following are common design elements of an auto fuel economy standard (GFEI, 2015):

- **Identification of the primary piece of legislation and department or agency of the government** responsible for formulating and ensuring compliance with the standards.
- **Choice of regulated metric**: In general, concerns about petroleum use and energy security have prompted adoption of fuel economy standards as measured in kilometres per litre (km/l) or miles per gallon (mpg). On the other hand, when climate change was the primary driver, a greenhouse gas emission based standard (g CO_2equivalent/km or g CO_2equivalent /mile) was adopted.
- **Limit value or corporate average standards**: Under a limit value approach, each vehicle model in its weight class must meet the class fuel economy standard. This approach ensures a minimum fuel economy level for each weight class regardless of the sales data. Under such an approach, non-compliant vehicles have to remain out of the market. Under a corporate average compliance, the sales weighted fuel consumption of any vehicle manufacturer must be less than the sales weighted average of the standard that the vehicle manufacturer is subject to in that model year. Under a corporate average compliance, vehicle manufacturer can decide the most convenient schedule for improving individual vehicle model fuel economy while still meeting the overall fuel economy improvement target. Presently, all countries that have adopted a fuel economy standard follow this approach.
- **Form of the standard**: The fuel efficiency standards could be set as a single value (flat corporate average standard), or as a function of a vehicle attribute. If the standards are based on an attribute, then the standards could be a continuous function as is the case in Europe and United States or they could be a step function that varies according to class, as is the case in Japan and China.
- **Choice of attribute**: A flat standard i.e. a single numerical target that all manufacturers have to meet on a corporate average basis would be a simpler design choice. A flat standard fully incentivizes a range of technology options including vehicle light-weighting as well as vehicle downsizing to meet the CO_2 standard. An attribute-based standard (e.g. vehicle weight) is preferred by many as a means to a more equitable distribution of responsibility. Some manufacturers, typically those who specialize in producing vehicles of larger size, view flat standards as a competitive disadvantage, and can see their burden lessened by use of an attribute-based standard. In addition, attribute based standards ensure that vehicles across all fleet have to deploy newer technology since the standards cannot be met alone simply by selling smaller cars. Footprint indexed standards, which are used in the United States, have several important advantages over mass indexed standards for encouraging the significant benefits of mass reduction. Under a weight-based standard, engine downsizing improves efficiency but also reduces vehicle weight, in doing so exposing it to a stricter standard. The way the standard varies according to weight (the slope of the differentiation curve) can be adjusted to put more or less pressure on heavier vehicles to improve fuel economy. Weight-based standards provide fewer strategy options for automakers to use technology and fleet composition shifts to comply with standards.

- **Target year for standards**: Manufactures need to be provided with a lead-time to prepare for targets. Standards with longer lead-time can be progressively more stringent since manufacturers have adequate time in such cases to adjust design cycles of new products with anticipated standards. Given the long-life of modern automobiles, even small near-term improvements will have a lasting impact on reducing CO_2 emissions. Standards can be set for each subsequent year after the first target year (as is the case in US) or for specific target years (as in case of Europe or Japan). Even if specific target years are chosen, compliance with the standards can be required in the intermediate years through a phase-in requirement (as in case of Europe and South Korea).
- **Stringency of standards**: The stringency of standards could be determined on the basis of either a technology assessment or a best-in-class approach.

  a. Technology assessment: The fuel consumption reduction from additional vehicle technology is evaluated and then combinations of technologies in vehicle packages are assessed for the overall potential to reduce vehicle fuel consumption. Such an evaluation will require extensive data collection and vehicle modelling exercise, and is most useful for setting long term targets. This approach has been chosen for the EU LDV regulations. A set of technology cost and impact assessments has been carried out since 2006 to assess the potential costs that occur for different stringencies of the vehicle emission standards.

  b. **Best-in-class vehicles**: Vehicles leading their respective weight/size-class or market segment in terms of fuel economy are termed as front-runner or top-runner vehicles. Fuel economy standards can be designed with the goal of improving the average fuel economy in target year beyond the fuel economy of best-in-class vehicles. This type of approach is especially useful in setting the stringency of near-term standards, since the standard target is shown to be achievable by actual vehicles in the market at present.
- **Derogation for small volume and niche manufacturers** (as in the EU LDV regulations) may be considered since the limited volume or market niche may not allow some of these manufacturers to meet a standard designed for most major manufacturers.
- **Test Procedures**: Appropriate test procedures should be used to measure, report and verify fuel economy of light vehicles. Tests should be defined carefully to ensure that fuel economy of the vehicles being tested is truly representative of the fuel economy of model variants sold in the market (see Section 4 for a further discussion).
- **Administrative Protocol**: Appropriate protocols should be devised for collection, as well as sharing of test data, and vehicle sales as well as for monitoring compliance between concerned government agencies. An important part of this is to determine the legal entities responsible for complying with the standards. This is especially important in countries where a large fraction of vehicles offered for sale is imported. This would therefore be especially important for a country like the Ukraine.
- **Flexibility Mechanisms**: Averaging, trading, coupled with annual targets, can improve the cost-effectiveness of a given target. These flexibility mechanisms facilitate the implementation of the most cost-effective technologies, provide a greater incentive to improve emissions over the full spectrum of vehicles sold, and allow for more rapid progress towards emissions reduction goals.

Finally, also **penalties for non-compliance** are to be defined. Penalties for non-compliance are an important part of ensuring that the CO_2 reduction goals of the regulation are eventually met. It is important to set financial penalties at a level high enough to provide a strong incentive to comply with the standard rather than simply pay the penalty. In other words, the penalties should be higher than the cost of technology required to reduce CO_2 emissions to make compliance the more cost-effective option.

3.4.2 Fuel taxes

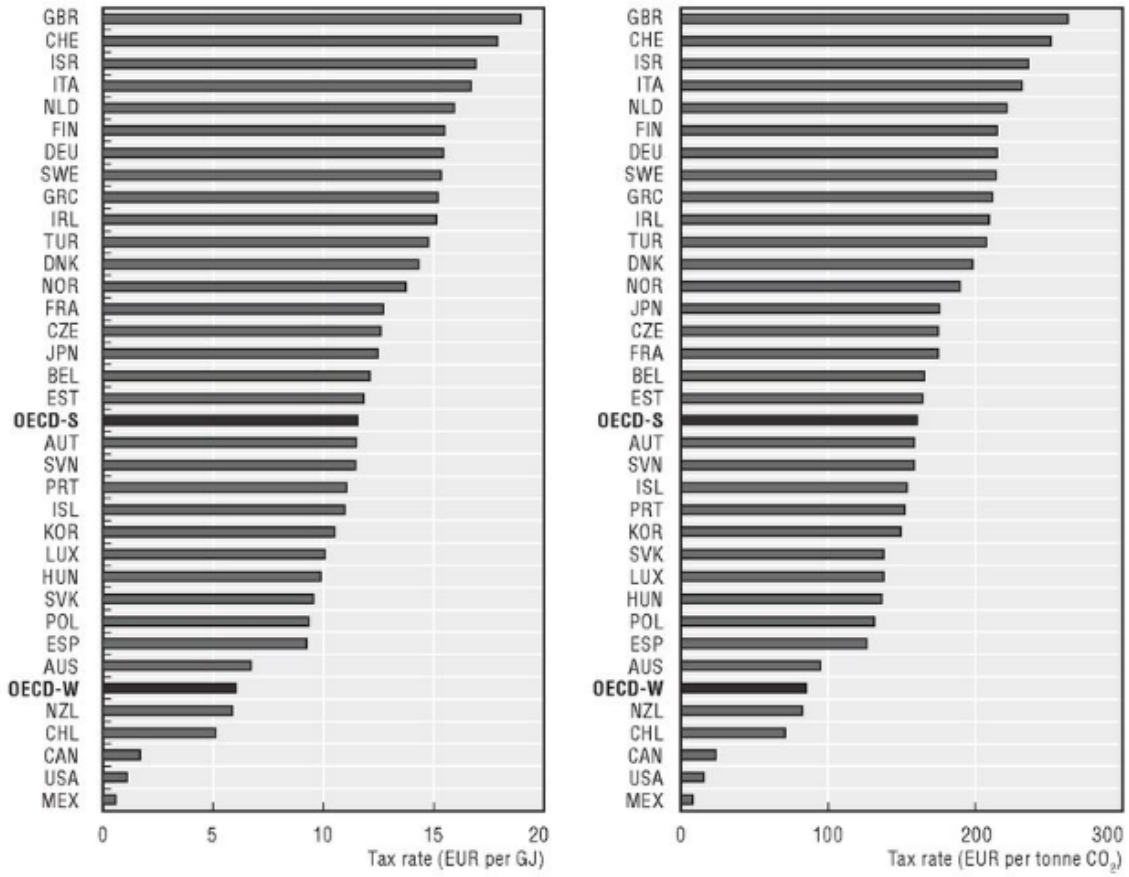
3.4.2.1 Fuel taxes around the globe

Transport fuels are taxed around the globe. In the average OECD country, transport accounts for 23% of total energy use, and 27% of the CO_2 emissions generated. However, as a result of the substantial

tax rates, it generates around 85%, on average, of total excise tax revenue from energy products in OECD countries.

The variation in the average effective tax rates that apply to transport fuels between countries is illustrated in Figure 3.4 below. Effective tax rates on energy (left part) range from EUR 0.57 per GJ in Mexico to EUR 18.9 per GJ in the UK. Effective tax rates on carbon (right part) range from EUR 8 to EUR 263 per tonne of CO_2 in the same two countries respectively (OECD, 2013).

Figure 3.4: Effective tax rates on transport fuel in terms of energy supplied (left) and CO_2 emitted (right) in OECD countries (OECD, 2013)



It is sometimes argued that diesel should be taxed at a lower rate per litre than gasoline on the basis that diesel vehicles are more fuel efficient than their gasoline counterparts. However, even in the absence of taxes, the increased fuel efficiency of diesel will be taken into account by consumers and incite increased vehicle use. Increased vehicle use also incites increased levels of congestion and accidents rates – arguments for avoiding preferential taxes for diesel.

To some extent, the traditionally lower rates on diesel may reflect concerns about industrial competitiveness, given the traditional reliance of commercial vehicles on diesel fuel. However, today, diesel fuel cannot be regarded as primarily a commercial fuel in many countries anymore. In recent years, the share of diesel passenger cars has increased substantially in many countries - likely in part in response to the tax advantage.

3.4.2.2 Fuel taxes in Europe and their impact

In Europe, the nominal prices of all transport fuels have risen considerably since 1980, to the extent that the average price was almost three times higher in December 2015. However, the real average price of road fuel - which covers all transport fuels, including taxes, expressed as the equivalent consumption in unleaded petrol, corrected for inflation to 2005 prices - has not changed significantly

during this time. Since 1980, the real price of transport fuel has fluctuated between 0.75 and 1.25 EUR per litre, with an average of 0.98 EUR (EEA, 2016).

Regarding taxes specifically, the %-share of taxes in fuel prices has not changed significantly over the past decades in Europe. Figure 3.5 shows the average real fuel taxes by fuel type (diesel or petrol) and group of Member States (i.e. the 'old' Member states, EU-15, and the 'new' Member States, the EU-13). In general, it can be said that taxes on transport fuels have not yet been widely used as environmental policy measures but rather for fiscal reasons (as already stated in previous section 3.2.1.1 on fuel taxes in the EU).

Figure 3.5: Consumption-weighted average of real fuel tax (EEA, 2016)

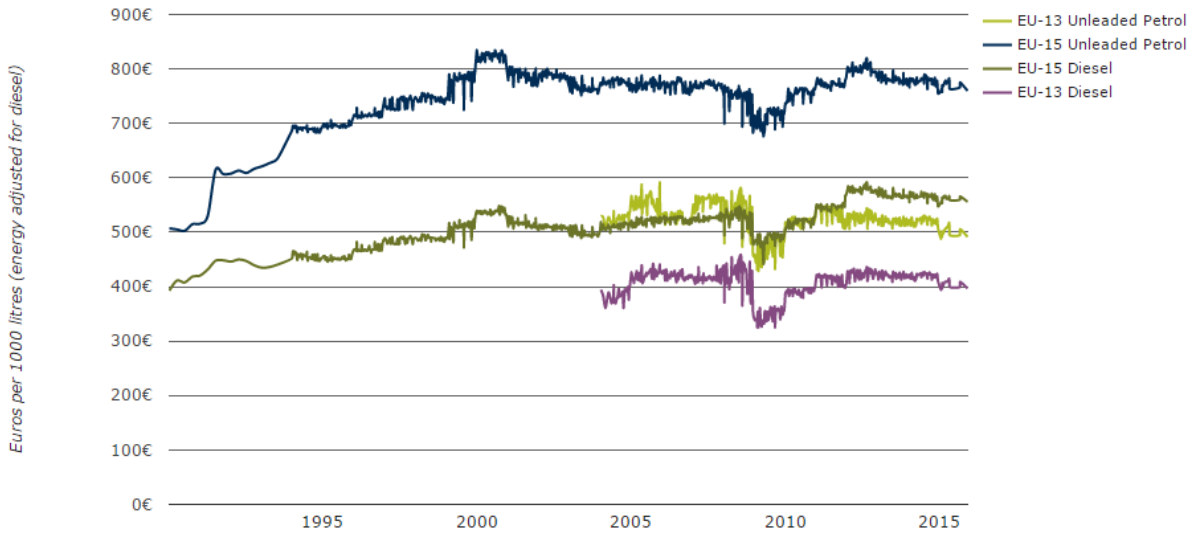
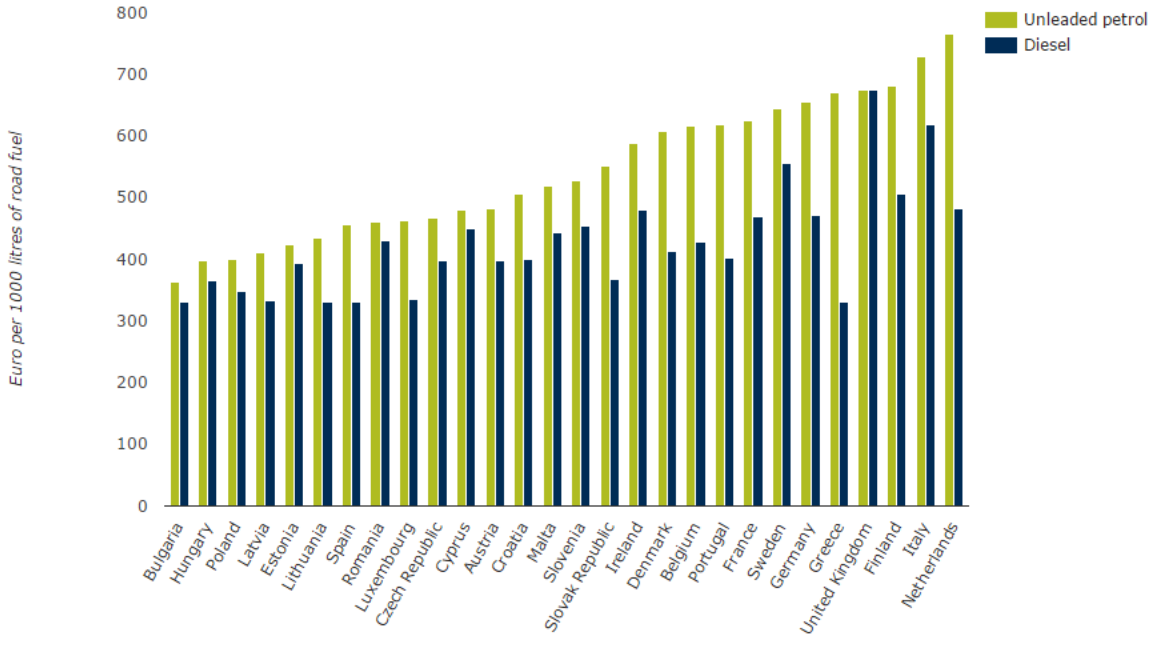


Figure 3.6: Road fuel excise duties by Member State (as of July 2015) (EEA, 2016)



As also shown in Figure 3.6, the overall rate of tax on diesel is generally lower than on petrol, with the exception of the UK, which applies almost the same tax to both. Therefore, in December 2015, despite being more expensive than petrol before tax, diesel was cheaper than petrol in most EU Member States. This taxation strategy is followed despite growing evidence to suggest that the external costs

of diesel vehicles are on average higher than those of petrol vehicles. Cheaper fuel prices for diesel have contributed to a shift from petrol to diesel vehicles in recent decades. The fraction of diesel as a road transport fuel has continued to increase, amounting to just over 70% in 2014, compared with 52% in 2000.

Different taxation levels in different countries can also lead to significant differences for countries where 'tank tourism' occurs, i.e. where fuel purchased within one country is actually used in neighbouring countries. This is a particular issue for diesel, where freight vehicles travel further to buy fuel in countries where the fuel tax is lowest. In Luxembourg, for example, the price of diesel remains one of the lowest in the EU, inducing 'fuel tourism' and negative externalities such as pollution and congestion.

3.4.2.3 Introducing/revising fuel taxes

A fuel tax is a carbon tax if the primary intent is the imposition of an explicit charge on the consumption of fossil fuels in order to compute the cost of greenhouses emissions in the final price. The two main objectives of taxing fuels – i.e. pricing negative externalities to achieve GHG emission reductions and fuel use, and mobilising fiscal resources – can coexist, but one is usually favoured over the other. For example, a prohibitive tax rate can steadily reduce GHG emissions but at the price of lower consumption (and future revenues). The optimal tax rate can be set either to achieve a specific emissions outcome (e.g. 30 per cent reduction of GHG emissions), the offset of an externality (e.g. the social cost of carbon) or the achievement of revenue targets (UNDP, 2016).

A law is usually required to introduce or amend the tax code. Feasibility studies are necessary to forecast the economic, social and environmental impact of the suggested fuel tax. The introduction or revision of a fuel tax requires a legal and economic assessment as well as technical inputs to amend the tax code. Also advocacy and awareness-raising campaigns are typically necessary to facilitate the approval of the legislation and to balance different interests, as well as to change perceptions among policymakers and the general public. The investment and running costs are small or null if the country already has a similar type of tax in place (UNDP, 2016).

Fuel taxes are appropriate in most economic and social contexts. However, the economic and social context should guide their design, including the selection of the appropriate tax rate, the timing/phasing-in of implementation and the identification of exceptions or complementary measures (e.g. income support for poor households). Fuel taxes are easier to introduce at times when oil prices are low (UNDP, 2016).

The following table provides some of the pros and cons as well as the risks of introducing/revising fuel taxes.

Table 3.16: Positive and negative aspects as well as risks of fuel taxes (UNDP, 2016)

Positive aspects	• An economically efficient and not distortive form of taxation, it corrects market failures. • It is easy to enforce with a low risk of tax avoidance/evasion. • Its tax base is large.
Negative aspects	• The price elasticity of fuel may increase in the longer term, affecting the amount of revenues. • The political cost of introducing fuel taxes is high. • Only a very high tax rate can substantially reduce fuel consumption, thus making other alternatives (e.g. fuel/vehicles standards) a more effective means. • The economic impact of fuel taxes might be high in certain contexts or periods of time, e.g. in cases where energy- intensive industries play an important role or at times of international price hikes.
Risks	• The tax might be unfair for a certain (vulnerable) segment of the population; the cost of the tax on fuel may be too high for poorer households. • The tax rate might not be set at the appropriate level to correct negative externalities. There is a risk of failing to ensure that the prices that firms and consumers pay for fuel reflect the full costs of their use.

	• Fuel taxes can modify the relative prices of fuels: large difference in tax rates among different categories/products can lead to consumers switching among products or to adulteration. Alternative and cheaper fuels may have greater negative impacts on health and the environment, for example if the tax generates a switch to burning brown coal or tyres. • Fuel taxes can multiply the impact of oil price increases with large negative effects on the economy. • If neighbouring countries (or states) apply a lower rate of taxation, consumers might simply shift to those territories. If the price difference is substantial and borders are porous, smuggling might emerge. • There may be considerable resistance to the introduction of the tax, making it politically or socially unfeasible and/or unsustainable. • Unless additional measures are taken, the price of public transportation will increase. • The impact on inflation and other inflation linked Government policies can be large. • The support mechanisms designed to balance the tax's impact on the poor might not be effective or efficient.

3.4.3 Fuel quality/GHG performance standards

3.4.3.1 Fuel quality/GHG performance standards around the globe

Fuel-related standards represent an important step in curbing GHG emissions in the transport sector. Around the globe there are currently five main low carbon fuel-related standards in existence:

- The European Renewable Energy Directive, combined with the European Fuel Quality Directive
- The US Federal Renewable Fuel Standard (US-RFS2)
- California Low Carbon Fuel Standard (CA-LCFS)
- The UK Renewable Transport Fuel Obligation (RTFO)
- The Canadian Low Carbon Fuel Requirements Act (RLCFR)
- The Australian Fuel Quality Standards Act 2000

The following Table summarises key elements of some of the above-mentioned low carbon fuel-related standards. As shown, biofuels constitute an important component of the standards to achieve desired GHG emission reductions. However, it should be noted that the question of whether biofuels can reduce GHG emissions relative to fossil liquid fuels may ultimately depend on whether or not indirect land use changes (ILUC) are included in the scope of the life cycle studies. For example, estimates indicate that corn ethanol may emit more GHG emissions than gasoline if GHG emissions from ILUC are considered as part of the life cycle (ICCT, 2009).

Table 3.17: Features of low carbon fuel-related standards (ICCT, 2009)

Features	US-RFS2	CA- LCFS	The Fuel Quality Directive (EU)	The Renewable Energy Directive (EU)	UK (Renewable Transport Fuel Obligation (RTFO)
Baseline fuels	Diesel and gasoline	Reformulated gasoline and 10% corn ethanol, diesel	Diesel and gasoline	Diesel and gasoline	Diesel and gasoline
Targets	36 billion gallons of biofuels by 2022, GHG emission reduction of 6.5%	10% reduction in GHG emissions by 2020	10% reduction in GHG emissions by 2020 (6% mandatory)	10% of biofuels (energy content)	5% of biofuels (energy content) by 2010/2011, GHG emission reduction of 1.9%

Features	US-RFS2	CA- LCFS	The Fuel Quality Directive (EU)	The Renewable Energy Directive (EU)	UK (Renewable Transport Fuel Obligation (RTFO)
Compliance pathways	Cellulosic ethanol, advanced biofuel, renewable biofuel	Biofuels, LPG, NG, electricity, H2	Biofuels, reductions in flaring and venting, carbon sequestration and capture	Biofuels	Sustainable biofuels
Market mechanisms	None	Credit trading	Credits can be purchased from CDM to meet 2% optional target	None	Tradable Renewable Transportation Certificates (RTFCs), buy-out option
GHG emissions from ILUC	Proposed but uncertain	Included	TBD (proposal by Dec. 2010)		None
Sustainability criteria	Included	To be included by 2011	Included	Included	Included
Status	Rulemaking stage	Rulemaking stage	Implemented	Implemented	Implemented

The analysis of the different fuel performance standards provided in (ICCT, 2009) derives some main conclusions:

- Low carbon fuel-related standards of Europe are more progressive in terms of sustainability requirements that lay out detailed provisions for environmental and social sustainability.
- Use of biofuels as low carbon fuels has the potential to reduce GHG emissions from the transportation sector but may create other environmental impacts such as acidification, soil erosion, and increased demand on water and land.
- While ILUC is very important for conventional biofuels, it is anticipated that second and third generation biofuels will have much reduced land use impacts and that a gradual transition to these fuels will lead to a much lower carbon fuel future.

3.4.3.2 The European Fuel Quality Directive and its impact

An overview of the European Fuel Quality Directive (Directive 2009/30/EC) was already provided in Section 3.2.2.2.1. From 2011, the amendments in Article 7a of Directive 2009/30/EC also introduced a requirement for fuel suppliers to report on the lifecycle greenhouse gas emissions of their fuels and reduce these by up to 10% by 31 December 2020 compared with the fuel baseline standard (as shown above in Table 3.17). This GHG emission reduction is to be achieved through the use of biofuels and alternative fuels with reduced GHG intensity on a well to wheel basis. As a result, the extraction, refining and processing of fuels is also taken into consideration with the aim of encouraging greater movements towards reduced GHG intensity fuel supplies. Directive 2009/30/EC therefore incorporates greater reporting obligations – and these obligations were scheduled to come into force with the 2011 Fuel Quality Monitoring report submissions. However, full reporting on GHG intensity is currently on hold whilst the methodological basis is being finalised – in particular relating to calculation of lifecycle emissions due to biofuels factoring in indirect land use change. These elements are addressed in a new Commission proposal to amend the Fuel Quality Directive posted in October 2012[12]. In addition a further proposal has been made in October 2014 (COM (2014) 617) to implement

[12] COM(2012) 595 final, Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Available at: http://ec.europa.eu/clima/policies/transport/fuel/docs/com_2012_595_en.pdf

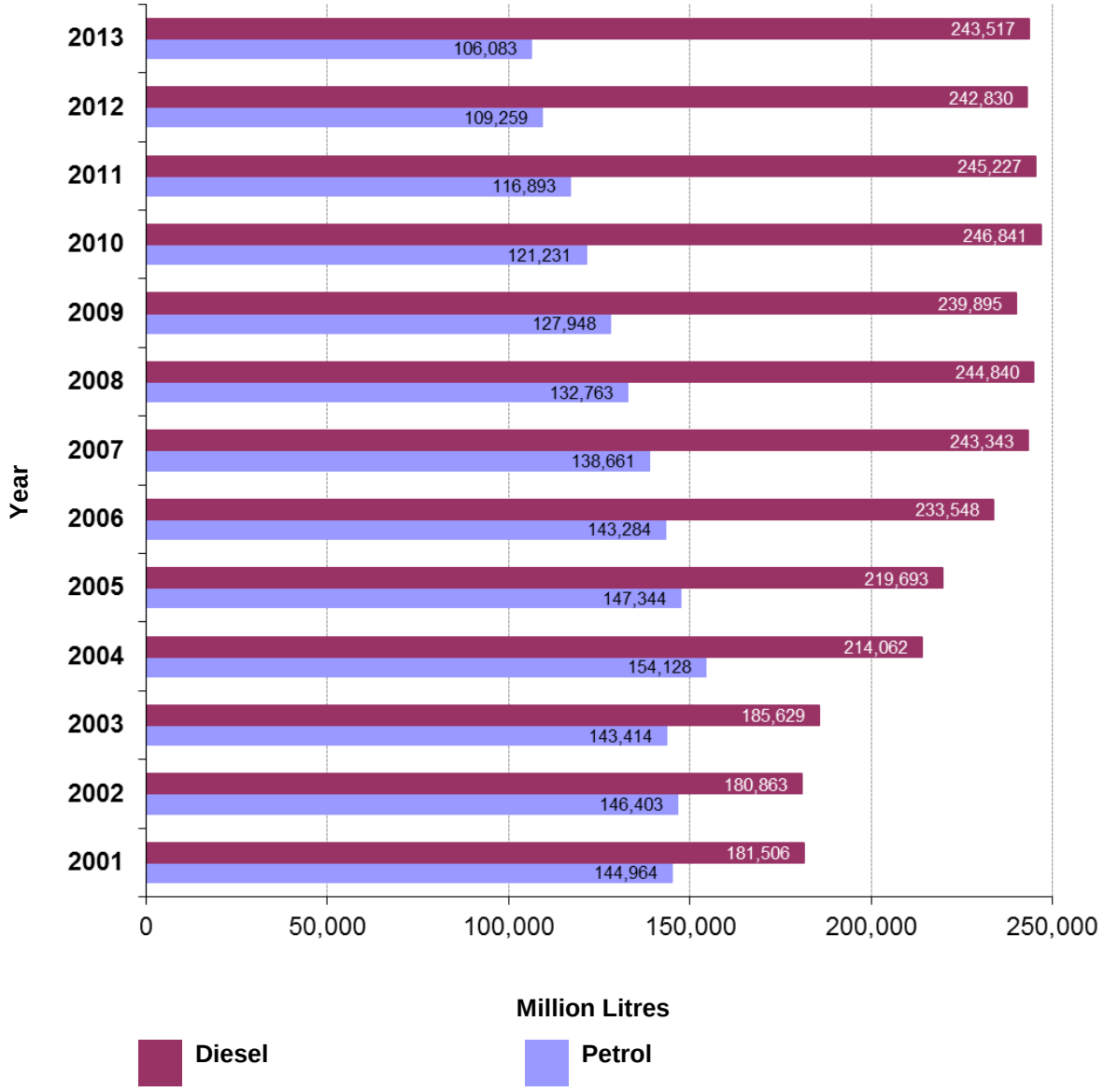
existing obligations and lay down calculation methods for life cycle GHG emissions of fossil fuels and reporting requirements.[13]

For the purpose of reporting, all Member States receive an annually updated reporting template to ensure the inclusion of all pertinent details and to enable European wide analysis and comparison of Fuel Quality Monitoring results. At the request of the European Commission's Directorate General for Climate Action (DG CLIMA), Ricardo Energy & Environment has carried out assessments of the reported data for several years. The following points present some of the main findings of the assessment that was carried out on the basis of the 2013 reporting data – the most recent assessment that is publically on the European Commission's website (see (Ricardo-AEA, 2014)).

- In 2013, all Member States have complied with the fuel specifications. These specifications state that all automotive road fuels available on the market from 1st January 2009 contain less than 10ppm sulphur content.
- Member States have begun to report fuels with added ethanol from biofuels, which had been a mandatory reporting requirement from 1st January 2011.
- Fuel sales in the EU in 2013 were heavily weighted toward diesel with 243,517 million litres of diesel fuel sales compared to 106,083 million litres of combined petrol grade fuel sales.
- The overall EU-wide fuel sales in 2013 (see Figure 3.7) remained similar to sales in recent years, with a further decrease in petrol (reduction of 3,176 million litres compared to 2012) and an increase in diesel (increase of 688 million litres compared to 2012) fuel sales. This resulted in a total decrease of 2,488 million litres (0.71%) of automotive road fuels sold from 2012 to 2013.

[13] COM (2014) 617 final, Proposal for a COUNCIL DIRECTIVE on laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels. Available at: http://europa.eu/rapid/press-release_IP-14-1095_en.htm

Figure 3.7: Temporal trends in EU fuel sales (Ricardo-AEA, 2014)



Notes: * Excludes France in 2003 - 2005, as no submissions were provided. Excludes Luxembourg in 2007 to 2009 and Malta in 2006 and 2009 as no reports were provided. In addition, the EU expanded in 2004, 2007 from 15 to 27 Member States and in 2013 to 28 Member States.

3.4.3.3 The European Renewable Energy Directive and its impact

An overview of the European Renewable Energy Directive was provided in Section 3.2.2.2.2. It requires a use of 10% of renewable energy in transport by 2020. In 2015 the European Commission carried out mid-term assessment of the progress of the EU and its Member States towards this 2020 target, the sustainability of biofuels and bioliquids consumed in the EU and the impacts of this consumption in accordance with the requirements of the Directive. The assessment was based on 2013 Eurostat data on renewable energy and the Member States' progress reports that were submitted to the Commission in 2013.

The assessment showed that progress towards the 10% renewable energy target in transport was slow. Only 5.7% renewable energy in transport was projected for the year 2014. More specifically, half of Member States (Sweden, Finland, Slovakia, Poland, Austria, the Netherlands, Hungary, Italy, France, Ireland, Germany, Denmark, Czech Republic, and Bulgaria) had achieved at least 5% or higher share of renewable energy in transport. These Member States were on track towards 10% renewable energy target for transport. In the remaining Member States important progress remained

to be achieved. Sweden was the only Member State that has already reached its renewable energy target for transport with the 2013 share reaching 16.7%, well above the binding 10% target for 2020.

One reason for the lacking behind of the transport sector (compared to the other sectors) in terms of target achievement was seen to be the slower than planned progress in deployment of conventional biofuels and in developing advanced biofuels. In fact, in 2013 the biofuels consumption declined in the EU due to the changing conditions of the global biofuels market and uncertainty on the EU market. Up to 2020 the situation in advanced biofuels was however expected to improve and several countries are projected to progress well. However, for others, and for the EU as whole, the need for urgent policy and financial measures to advance the development and market entry of advanced biofuels is evident. Such measures were said to have to also target electricity use in transport, especially for road transport, and the use of fuel cells.

The assessment concluded that achieving the 2020 target for renewable energy in transport remained technically feasible and the progress achieved already in some Member States testifies this. An increase in the share of renewable electricity in non-road transport together with a minor contribution from electrification of road transport could further contribute to progress in the next years. However, given the debate about conventional biofuels and the fact that there are no alternatives to biofuels in heavy duty road transport and aviation, additional initiatives would be required as of 2015. Member States were therefore urged to do more to promote advanced biofuels and enable electrification of their transport fleet. Electrification will also help integration of variable renewable electricity, if administered accordingly. It was also proposed that improved funding of research, development and demonstration, cooperation between Member States but also partnerships within the industry, involving both fuel suppliers and consumers, would help fostering the necessary transition. (EC, 2015)

3.4.3.4 Introducing fuel quality/GHG performance standards

Introducing fuel quality/GHG performance standards requires comprehensive fuel monitoring and reporting systems. On the EU-level, specificities of the monitoring and reporting systems that were to be put in place by Member States are set out in the fuel quality directive.

The Directive required Member States to develop Fuel Quality Monitoring Systems (FQMS) in accordance with European Standard EN 14274:2003 and to implement these monitoring systems by 1 January 2004. A summary of monitoring and reporting requirements under the standard follows (Ricardo-AEA, 2014):

- Specification of information requirements in order to set up the FQMS, including regional level data (number of refuelling stations, sales, population and number of vehicles);
- The system is to be run twice a year, for the summer and the winter periods (as summer and winter fuels have different specifications);
- Specification of the minimum number of sample sites of fuel grades required (in order to make the FQMS as robust and representative as possible), depending on the statistical model being used (chosen depending on the size of the country and how it is split into regions);
- Specification of a list of all retail (public vehicle) and commercial (private fleet) fuel dispensing sites is required (by region) and that sampling should take place across randomly selected samples of these;
- Specification of the minimum number of samples/sites for fuel grades with less than 10% of sales.

Since 2009, an amendment to the Directive (since then Directive 2009/30/EC) requires fuel suppliers also to report on the lifecycle greenhouse gas emissions of their fuels. Article 7a on life cycle greenhouse gas (GHG) reporting states that Member States must designate the supplier(s) responsible for monitoring and reporting life cycle GHG emissions per unit of energy from fuel and energy supplied. According to the 2009 amendment, from 1 January 2011 onwards, the suppliers were required to report annually (Ricardo-AEA, 2014):

- Total volume of each type of fuel or energy supplied, indicating where purchased and its origin;
- Life cycle GHG emissions per unit of energy.

The aim of Article 7a was to ensure that a fuel supplier makes choices to achieve a reduction in aggregate GHG intensity for the fuel supplied to road transport and additionally to non-road mobile machinery (NRMM), inland waterways and rail networks. Directive 2009/30/EC also introduced a 10 ppm sulphur limit on NRMM fuels effective from 2011. Suppliers should, by 31 December 2020, reduce life cycle GHG emissions by up to 10% per unit of energy compared to 2010 levels. At least 6% of this target is expected to be achieved via the increased use of biofuels, the increased use of alternative fuels, and/or reductions in flaring and venting emissions and fuel production and refining facilities (i.e. reduction in lifecycle emissions of conventional fossil petrol and diesel fuels). Subject to review, a further 2% reduction should be obtained through the use of environmentally friendly carbon capture storage technologies and electric vehicles. An additional further 2% reduction should be obtained through the purchase of credits under the Clean Development Mechanism of the Kyoto Protocol. Annex D of Directive 2009/28/EC sets out a list of typical and default life cycle GHG emissions for a number of biofuel and bio liquid production pathways. The default values will be used unless the producer can demonstrate their emissions are lower than those that were assumed in the calculation of the default values. Annex C of the Directive sets out the methodology for calculating the life cycle GHG emissions from the production of biofuels. The biofuels used for compliance with the 6% reduction in life cycle GHG emissions should be sustainable and are required to fulfil sustainability criteria. These sustainability criteria are set out in Directive 2009/28/EC (Ricardo-AEA, 2014).

However, as mentioned above, since the 2009 Directive amendment there has been a delay in the implementation of the GHG intensity monitoring and reporting activities, due to difficulties agreeing the details of implementation with Member States and the methodology for fossil fuels.

3.4.4 Vehicle/fuel labelling

3.4.4.1 Fuel economy labelling around the globe

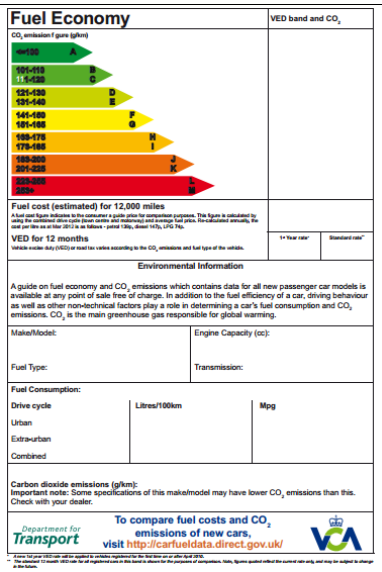
The provision of information on vehicle fuel economy is a crucial part of the auto fuel economy policy package. Information on the fuel economy of vehicles is essential if consumers are to understand the choices available to them. In isolation, labelling systems are unlikely to lead to significant fuel efficiency improvements. However, fuel efficiency labels do help consumers compare vehicle choices, and can help consumers understand the potential tax and fuel cost implications over the lifetime of the vehicle.

Different approaches are taken to vehicle labelling in terms of the metrics, amount and type of information provided, and graphical presentation (see Figure 3.8 for some examples). Vehicle fuel economy labels usually fall into one of three types, depending on how the information is provided:

- Graphical rating (e.g. from A to G) is used in New Zealand and in the UK;
- Direct information disclosure, by providing the value of the CO_2 emissions or fuel economy, as used in the US, South Africa, Australia, Singapore, Chile and India; or
- Relative vehicle performance compared to the fuel economy standard, as used in Japan.

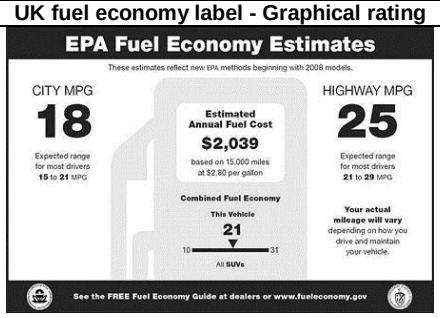
Each approach has advantages and disadvantages. Although the rating-style label may provide a very clear message to vehicle purchasers, the metrics used may be unclear and even controversial, depending on how the ratings are awarded. Simple information disclosure may be more transparent but may be difficult for consumers to relate to. For this reason, many fuel economy labels include not only the fuel economy measured in testing but also the annual fuel costs associated with operating the vehicle. For a detailed explanation of the benefits of each type of labelling approach see IEA (2012).

Figure 3.8: Examples of fuel economy labels



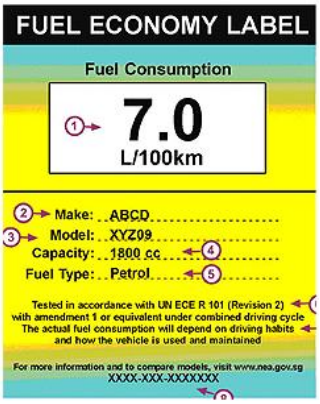
UK fuel economy label - Graphical rating

New Zealand fuel economy label - Graphical rating



US label – Direct info label

Chile fuel economy label – Direct info label



Singapore fuel economy label – Direct info label

Japanese fuel economy label – Relative performance label

3.4.4.2 European fuel economy labelling

Directive 1999/94/EC – the European 'car labelling Directive' – was part of a package of measures to reduce the CO_2 emissions of passenger cars. It was first proposed in a Commission strategy on passenger car CO_2 in 1995 (European Commission, 1995). As mentioned in Section 3.2.4, the proposed measures were complementary: a voluntary commitment by automobile manufacturers focused on the supply-side, i.e. ensuring that manufacturers developed more efficient cars, while the label and taxation measures focused on the demand-side as they encouraged consumers to purchase more fuel efficient vehicles.

The passenger car CO_2 strategy was also supported by Decision 1753/2000/EC, which set up a system to enable the monitoring of the implementation of the strategy, in particular the voluntary agreements, by requiring Member States to collate and report the necessary information.

The Directive requires information on fuel economy and CO_2 emissions to be displayed in the following ways:

- A **fuel economy label** for all new cars to be displayed at the point of sale.
- A **guide on fuel economy** and CO_2 emissions that should be available at the point of sale and from designated bodies.
- A **poster (or a display)** showing the official fuel consumption and CO_2 emissions data of all new passenger car models displayed or offered for sale or lease at, or through, the respective point of sale.
- All **promotional literature** must contain the official fuel consumption and specific CO_2 emission data for the passenger car model to which it refers.

The Directive has four Annexes, each of which sets out a more detailed specification of one of the four information sources (see below).

While the Directive has not been fully revised since its publication, there have been two changes (one required, the other recommended) relating to the way in which information is displayed, i.e.:

- Directive 2003/73/EC[14] required that, in addition to (or even instead of) the poster/display, information on fuel economy and CO_2 emissions should also be displayed on an electronic screen.
- Commission Recommendation 2003/217/EC (European Commission, 2003) recommended, rather than required, Member States to ensure that promotional material transmitted electronically or stored using electronic, magnetic or optical media should contain information on a car's fuel economy and CO_2 emissions. It also recommended that the latter information is available generally by electronic means.

3.4.4.2.1 The fuel economy label

According to the Directive, the car labels should meet the following requirements:

- Comply with a standardised format in order to allow greater recognition by consumers
- Are of a size of 297mm x 210mm (A4)
- Contain a reference to the model and fuel type of the passenger car to which they are attached
- Contain the numerical value of the official fuel consumption and the official specific emissions of CO_2
- Contain specific text on the availability of the guide on fuel consumption and CO_2 emissions
- Contain specific text on other factors that affect fuel consumption (i.e. driver behaviour) and that CO_2 is the main GHG responsible for global warming

The method of display for the required information and the content on the labels varies by Member State. The main elements of differentiation are:

- Label design
- The use of absolute or relative scaling
- The inclusion of additional information beyond the minimum required.

Among the 28 EU Member States, 11 have adopted a car label design that is similar in design to the EU Energy label. Estonia moves to this design in the beginning of 2016. Austria, Belgium and Portugal's label is colour-coded, but is based on a different design to the standard EU energy label for household products. In Belgium, the labelling classes are also differentiated on the basis of the fuel (petrol/diesel). The remaining 14 Member States do not mandate a specific format of the label and simply require that the information is provided in the form. Besides the minimum information required,

[14] Commission Directive 2003/73/EC; see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:186:0034:0035:EN:PDF

a few Member States have included information that goes beyond the scope of the Directive, such as the fuel consumption for different drive cycles, annual fuel costs, noise information etc (Ricardo Energy & Environment, 2016).

3.4.4.2.2 The guide on fuel economy

In relation to the guide of fuel economy, the Directive requires that the following elements are included:

- List all new passenger car models available for purchase within the Member States on a yearly basis, grouped by makes in alphabetic order
- For each model, the fuel type, the numerical value of the official fuel consumption and the official specific emissions of CO_2 should be given
- Prominent listing of the 10 most fuel-efficient new passenger car models ranked in order of increasing specific emissions of CO_2 for each fuel type
- Advice to motorists that correct use and regular maintenance of the vehicle and driving behaviour
- An explanation of the effects of greenhouse gas emissions, potential climate change and the relevance of motor a reference to the Community's target for the average emissions of CO_2 from new passenger cars and the date of which the target should be achieved
- A reference to the Commission's guide on fuel economy and CO_2 emissions on the Internet (when available)

It is also required that guide be portable, compact and available free of charge to consumers upon request both at the point of sale and also from a designated body within each Member State.

In terms of its availability, while the guidance is still available in hard copy and printed in thousands of copies to be made available to dealerships in some Member States, nowadays all Member States make them available online. Some of them (AT, IT, BE, EE, FI, NL, PT, SE, SK) provide exclusively electronic copies. In the UK hard copies are only provided on demand. In Austria the guidance is has been provided to the dealerships electronically since 2003 and each dealership will print one copy to have in the showroom. In nine Member States, additional information to the minimum required is provided in the guides (Ricardo Energy & Environment, 2016).

3.4.4.2.3 Poster

In relation to the poster, the Directive requires that the following elements are included:

- Poster / display has a minimum size (70 cm × 50 cm); its information is easy to read
- Screen size of any electronic display has a minimum size (25 cm × 32 cm)
- Models grouped and listed separately by fuel type. Within each fuel type, models are ranked in order of increasing CO2 emissions, with the model with the best fuel economy first
- For each model, the make, official fuel consumption and specific CO2 emissions are given
- Poster / display contains a specified reference to the guide and states that this is available free of charge at any point
- Poster / display contains specified text that other factors also influence a car's CO2 emissions / fuel consumption and that CO2 is the main greenhouse gas responsible for global warming
- Poster is to be completely updated at least every six months
- Between updates, new cars are to be added to the bottom of the list
- Poster / display may be substituted completely and permanently by an electronic screen that attracts the awareness of the consumer at least with the same intensity as a poster / display

The posters used by Member States typically include the same information as the labels in each of the Member States in a list format (as required by Annex III) (Ricardo Energy & Environment, 2016).

3.4.4.2.4 Promotional materials

In relation to the promotional material, the Directive requires that the following promotion material is provided:

- Information on CO2 emissions and fuel consumption should be easy to read and no less prominent than the main part of the information provided in the promotional literature.
- Easy to understand even on superficial contact.
- Official fuel consumption data should be provided for all different car models to which the promotional material covers. If more than one model is specified then either the official fuel consumption data for all the models specified is included or the range between the worst and best fuel consumption is stated.
- If the promotional literature only contains reference to the make, and not to any particular model, then fuel consumption data need not be provided.

All Member States appear to have met the minimum requirements of the Directive, most often by a verbatim adoption of the requirements set in Annex IV of the Directive. A few countries have gone beyond the Directive requirements with respect to promotional materials – either by introducing additional requirements (DE, ES, DK, SI), developing an advertising code to promote best practice or developing guidance documents and mechanisms for pre-screening of the promotional material to ensure compliance (UK) (Ricardo Energy & Environment, 2016).

3.4.4.2.5 Enforcement

Responsibility for enforcement of the national legislation implementing the Directive lies at different levels of government across the Member States. Furthermore, in some countries, responsibility is shared among two or even more authorities. Enforcement activities vary among Member States, both in terms of intensity as well as the focus on specific information sources (Ricardo Energy & Environment, 2016).

In most Member States, the fines for non-compliance - concerning not-provision of one of the information sources or provision of incorrect information- are in the range of a €500- €5,000. However, higher fines are also applicable (e.g. NL, SE) and there is often the possibility of criminal proceedings. On the other hand, in a number of Member States (DE, ES, UK) there are no specific fines provided in the text of the legislation, which are determined on a case by case basis. Furthermore, in some Member States (e.g. Austria) the national authorities indicated that penalties are not imposed in practice (Ricardo Energy & Environment, 2016).

3.4.4.2.6 Potential revision of the Directive

By 2006, it had become clear from the data monitored under Decision 1753/2000 that the voluntary agreements were not on course to meet the target of the passenger car CO_2 strategy, so the Commission proposed a new strategy in early 2007 (European Commission, (2007a) and, (2007b)). In the strategy, the Commission also stated that it would publish a proposal to amend Directive 1999/94 later that year in order to improve its effectiveness, including the harmonisation of the design of the label, as well as to extend the scope of the label to vans (European Commission, 2007b). However, a proposal to amend Directive 1999/94 was not published.

The Commission undertook a consultation and held a stakeholder workshop on the revision of the Directive in 2008; another stakeholder workshop was held as part of the service contract that led to the production of the 2011 report on the implementation of the Directive (AEA and TEPR , 2011). Action to amend the label was also one of the initiatives set out in the Commission's 2011 Transport White Paper, which included a review of the label that was to consider the extension of the label to LCVs and to L-category vehicles (e.g. motorcycles, tricycles and quadricycles), as well as the harmonisation of the label, particularly with respect to vehicle efficiency classes. However, as mentioned above, a full revision of the Directive has not been carried out since its publication.

3.4.4.3 Overall impact of the EU car labelling Directive

Ricardo Energy & Environment (2016) carried out an ex-post evaluation of the car labelling Directive. It concluded that there is supporting evidence that awareness of the information on fuel economy and CO_2 emissions has been improving steadily since the Directive was implemented and is now medium-to-high (>75%) in many countries. However, there is less evident impact in terms of its ultimate goal of reducing new car CO_2 emissions.

(Ricardo Energy & Environment, 2016) further found that the costs of the implementation of the Directive are mainly linked to ongoing annual costs for authorities and industry. Implementation costs appeared to be rather minor. Given the relatively low cost of the Directive and the fact that cars are driven for many years after purchase, even significantly small contributions to reductions in new car fuel consumption can yield high benefit:cost ratios.

3.4.4.4 Introducing car/fuel labelling

(Ricardo Energy & Environment, 2016) identified a number of drivers and barriers of the effectiveness of the Directive that should be considered when car labelling is defined and introduced:

- With regards to the effectiveness of the **information tools**, (Ricardo Energy & Environment, 2016) found broad consensus in support of the label as the most successful tool to date. There is also a general consensus that the poster does not have any beneficial impacts and is probably now redundant. Similarly the printed guide is not found to be very useful, although an online version of the guide can be effective.
- There is a need to provide the relevant **information online**, adapting to changes in how consumers collect and analyse information prior to a purchase and to ensure that consumers trust the information provided.
- In terms of the **design of the label**, the use of colour-coded categories, as applied in some Member States, is well recognised and understood by consumers. Furthermore, absolute scaling is more transparent and easier to understand for consumers than relative scaling, although a car class specific rating is also seen as providing useful guidance for consumers.
- In terms of the **information provided on the label**, provision of additional information on running costs (including taxes) on the label is considered as important since cost is a key determinant of purchase decisions. The absence of this information in some countries limits the effectiveness of the label. Similarly, the label is most effective if coupled with fiscal measures – hence this information is also useful to have on the label.
- With regard to the **scope** of the labelling, excluding *used* cars from limits the ability to inform the majority of consumers (since used car market volumes are typically greater than new car market volumes), thereby limiting the measure's effectiveness.
- A **lack of guidance on how to deal with alternatively-fuelled cars** and like-for-like comparison with other cars has had a limited impact on the effectiveness of the label to date due to the small market share of such vehicles. However, this is expected to change in the future, as the number of such vehicles increase.
- The diversity of national label designs clearly demonstrates that Member States have taken advantage of the **flexibility permitted** in the label/Directive to implement their own schemes. However, this flexibility has not been translated into greater effectiveness in all cases as only a limited number of countries have adopted a labelling scheme which consumers finds easy to understand. The consensus from stakeholders across the market is that a more harmonised approach would enhance the effectiveness of the label by aiding recognition and understanding of the label.

It is also to consider that fundamentally important for the operation of the Directive is the methodology for measuring the CO_2 emissions and fuel efficiency of cars. The existence of an agreed, consistent and transparent methodology is a necessary condition for the measurement and reporting of the CO_2 emissions and fuel consumption of vehicles. Currently, the approach for measuring these values for new cars is based on a methodology set out in Regulation (EC) No 715/2007 which sets out the methodology for such measurements using an agreed test cycle. See Section 4.3 for more information.

4 Analysis of methods and procedures for testing road transport vehicles (Task 3)

4.1 Outline of the approach

The objective of this task was to analyse the different methods and procedures for testing road transport vehicles with respect to CO_2 emissions and fuel consumption, and also to consider these in the context of the need to develop reliable input datasets for the national GHG inventory.

It should be noted that vehicle testing and the development of suitable certification procedures is a highly complex area which would require significant time/resource to explore thoroughly. However, this project work is also aimed at policy-makers, therefore the focus of the work was to develop a high-level summary the following information:

d) A comparison of the options, their advantages and disadvantages.
e) Information on what is happening/being proposed for the future in different territories
f) An assessment on practical implementation and the likely fit of the different options with what is available/possible in Ukraine.

The results of this work task are presented below in the following chapter sections.

4.2 General requirements for establishing CO2 emissions/energy consumption of road vehicles

This report section provides general information on some of the requirements necessary to establish vehicle CO_2 emissions/energy consumption, i.e. certification procedures, testing facilities, IT/database facilities, and the ability to gather and utilise information from previous testing external to Ukraine, etc. The first subsection provides some background to the significance of European GHG emissions from road transport at the EU- and Ukraine- levels for context.

4.2.1 Background on European transport emissions and the Ukraine road-transport fleet

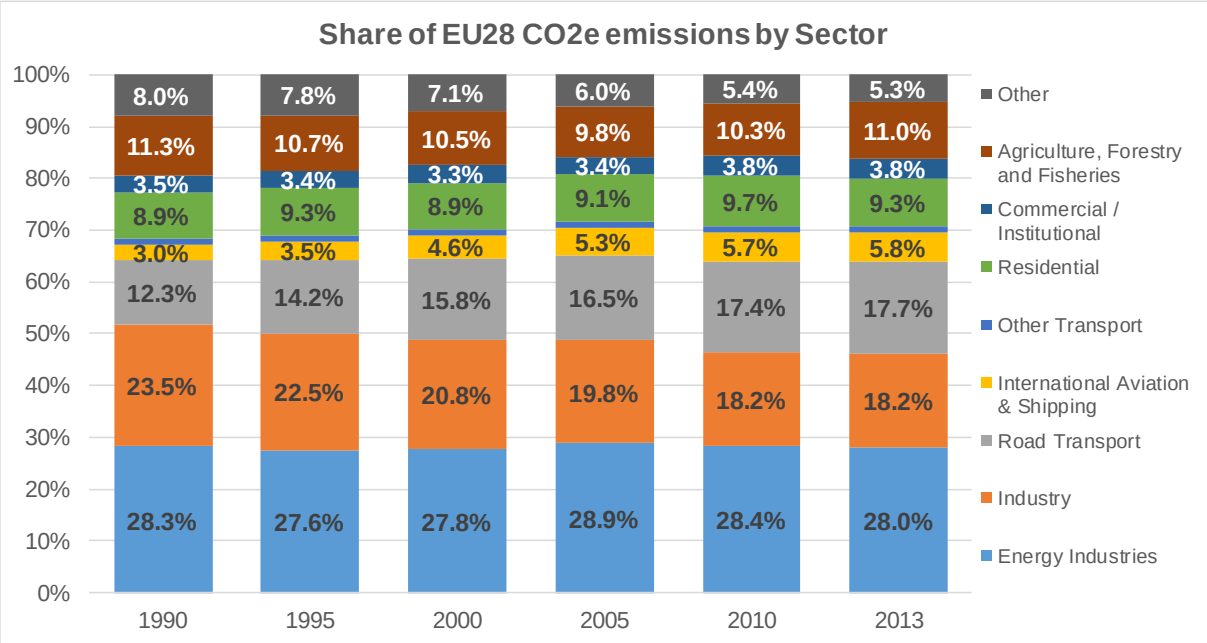
The following Figure 4.1 and Figure 4.2 summarise the timeseries breakdown of GHG emissions in the European Union by sector, based on reporting under UNFCCC. These figures illustrate the increasing significance of transport emissions in Europe since 1990 (as emissions from other sectors declined), until around 2007 when transport emissions also began to decline. This is also the year when European Commission proposals for regulation of new car CO_2 emissions put forward, with the first mandatory CO_2 reduction targets proposed for 2015. Despite this, the transport share of overall GHG emissions has continued to increase in recent years, and is now around 17.7% of all emissions. Cars account for around 60% of all road transport emissions in the EU, hence policy to date has focused on them.

A breakdown of GHG emissions in Ukraine for 2014 by Sector is also provided in the draft 2016 report on Ukrainian National Inventory for 1990-2014 period, as shown in Figure 4.3 . The changes in the structure of emissions from fuel combustion overtime are also shown in Figure 4.5, and the breakdown of Ukraine transport GHG emissions for different type of transport are provided also for information in Figure 4.4. This shows that according to the available data, transport's share of overall emissions hasn't significantly changed over the last 20 years, although there is still significant uncertainty on the estimates due to the lack of availability of detailed datasets. However, over that period road transport's share has increased to around 75% of overall transport emissions (i.e. a similar proportion to the EU as a whole).

Specific estimates on the structure of the Ukraine road transport fleet have been provided in (Ukraine SRTRI, 2015). However, since no explicit statistical or administrative data exist in Ukraine on the

specific breakdown of the fleet, the representation used range of analytical techniques to produce the estimates based on a range of different, largely incomplete and inconsistent datasets. Nevertheless, the results of this analysis, as presented in Figure 4.6, have shown that between 1990 and 2014 the shares due to passenger cars and vans/light commercial vehicles (LCVs) have grown very significantly.

Figure 4.1: EU GHG emissions: breakdown by sector



Notes:
** Excluding LULUCF (Land Use, Land – Use Change and Forestry) Emissions*

Industry =	Emissions from Manufacturing and Construction and Industrial Processes
Agriculture, Forestry and Fisheries =	Emissions from Fuel Combustion and other Emissions from Agriculture
Other =	Emissions from Fuel Combustion in Other (Not elsewhere specified), Fugitive Emissions from Fuels, Solvent and Other Product Use, Waste, Other

Figure 4.2: EU GHG emissions: indexed timeseries

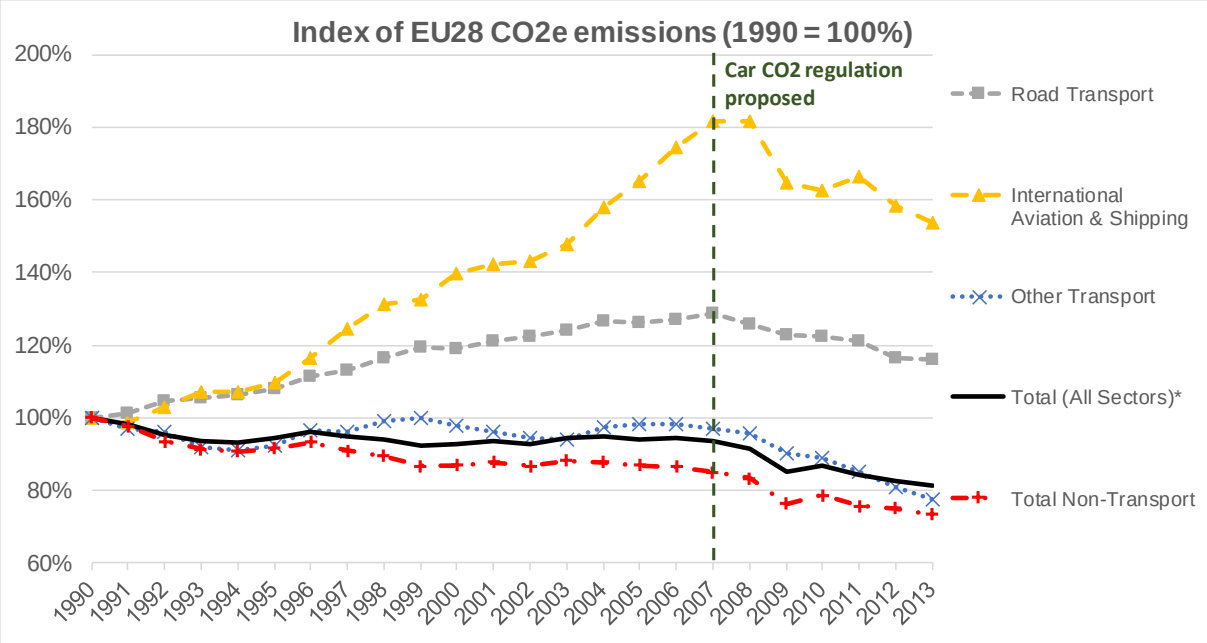
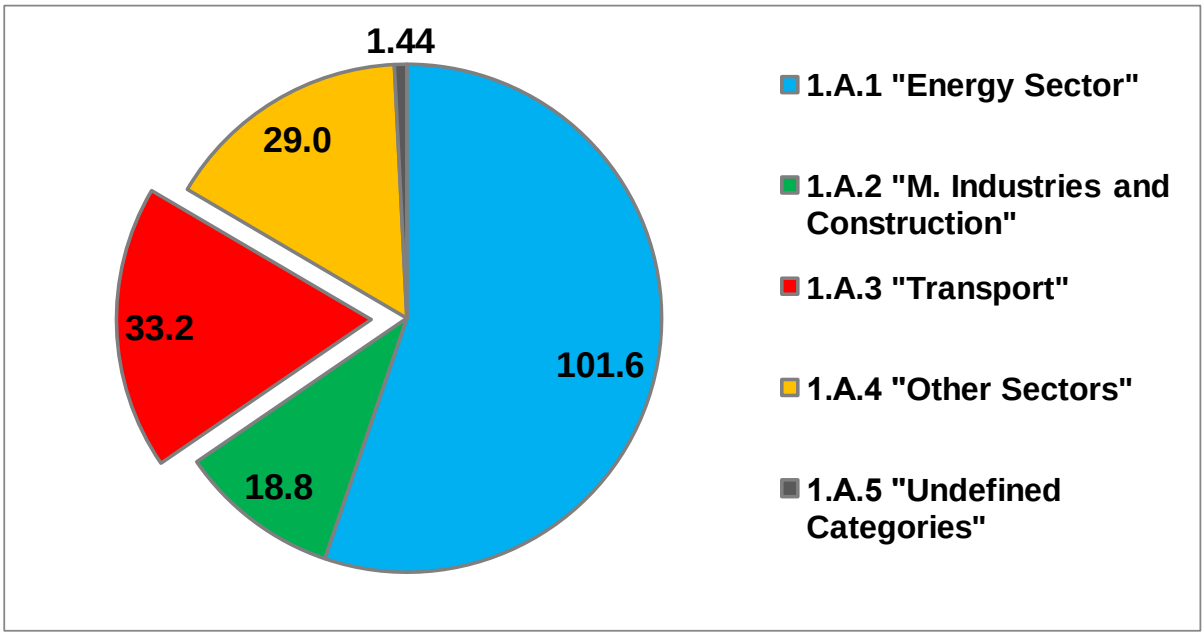
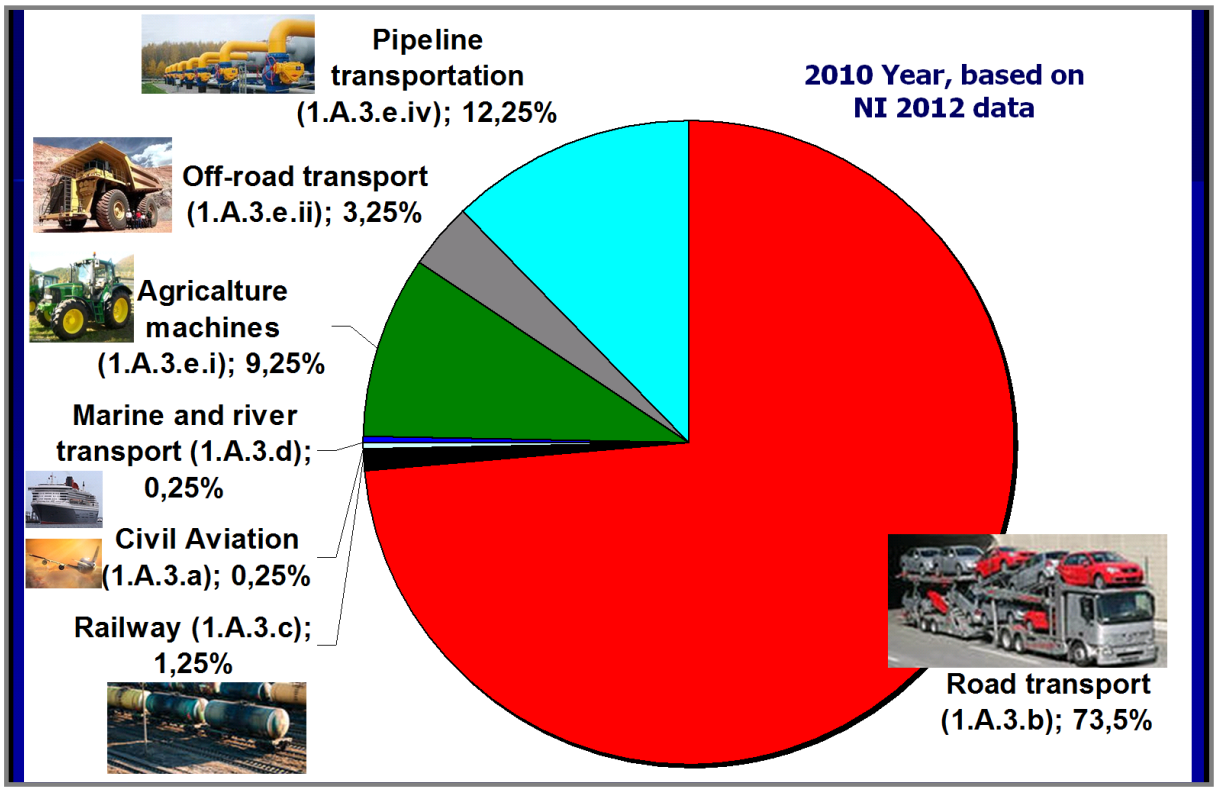


Figure 4.3: Share of GHG emission in Ukraine by Sector in 2014



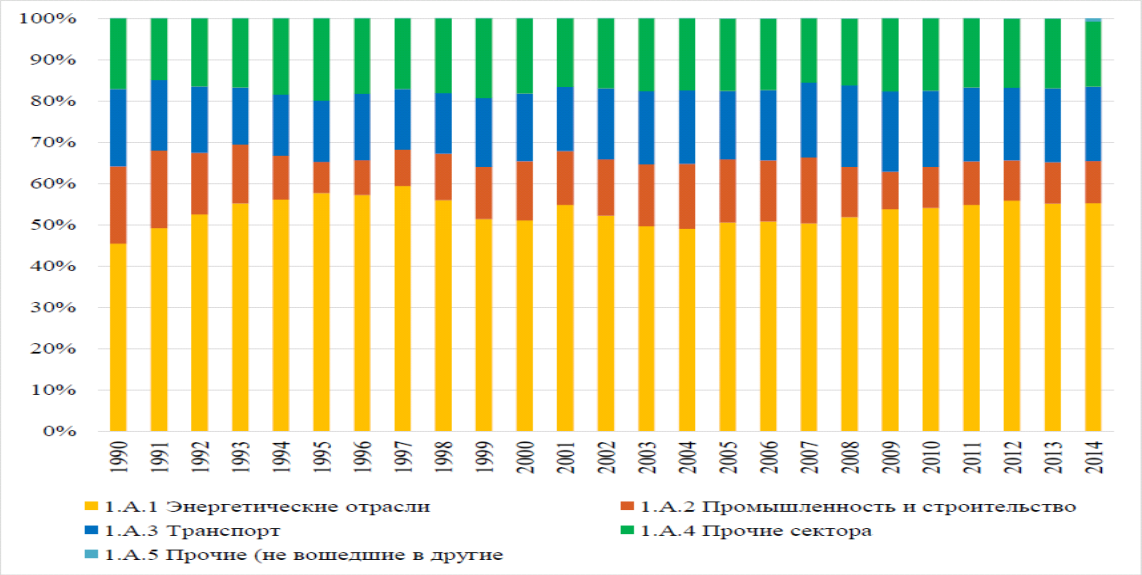
Source: Ukrainian National Inventory Draft Report for 1990-2014 period of time. (MENR, 2016)

Figure 4.4: Ukraine GHG emissions: contribution by different type of transport



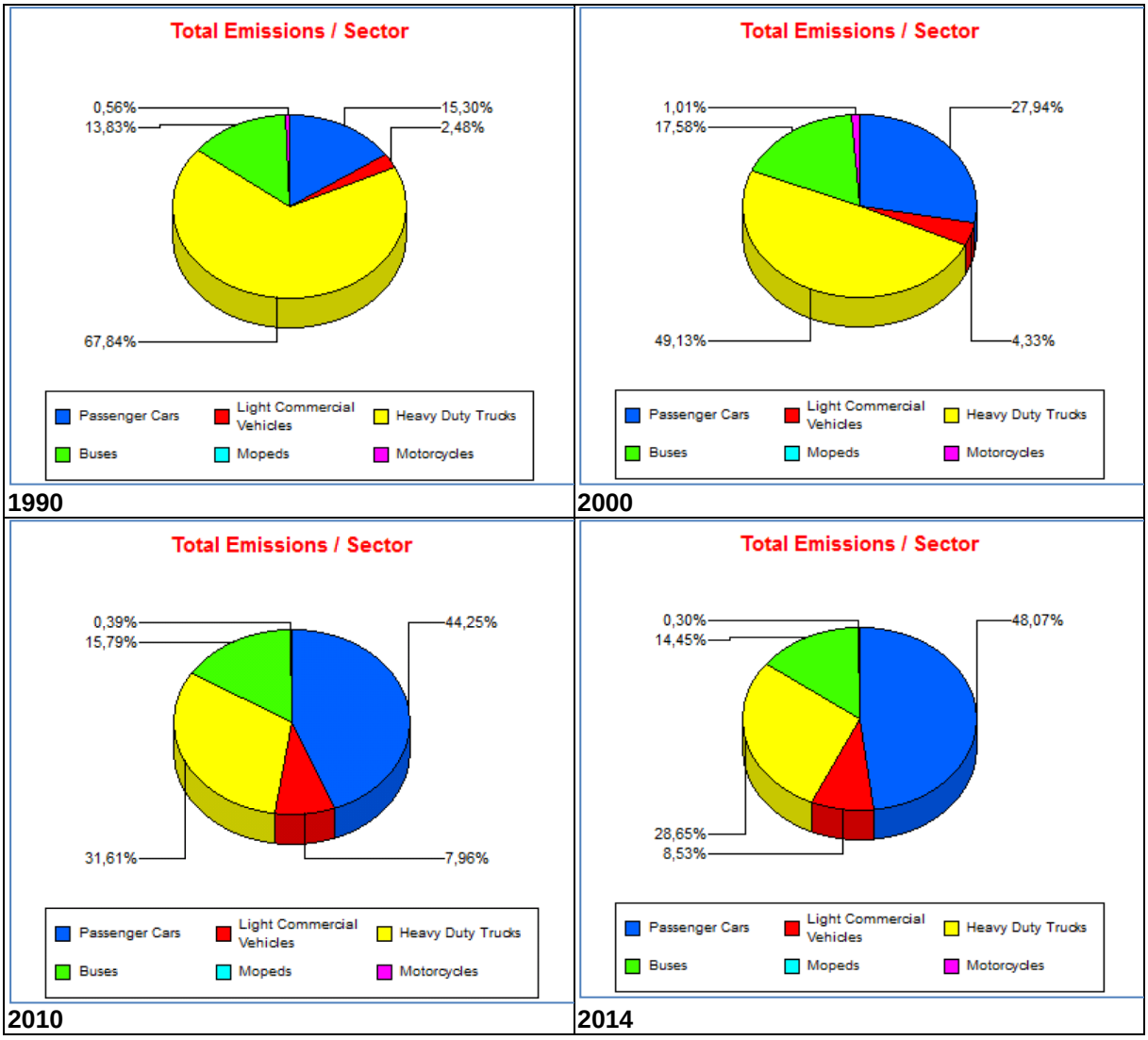
Source: Data based on the Ukrainian National Inventory 2012 Report for 1990-2010 period (data is for 2010).

Figure 4.5: Changes in the structure of emissions from fuel combustion



Source: Ukrainian National Inventory Draft Report for 1990-2014 period of time. (MENR, 2016)

Figure 4.6: Different road vehicle types share of CO2 emission in Ukraine in 1990



Source: (Ukraine SRTRI, 2015).

4.2.1.1 Fleet structure projections and CO_2 emission trends within different scenarios

In (Ukraine SRTRI, 2015) a number of first-approach scenarios of road transport development in Ukraine were also proposed. This work considered the following outline scenarios of road transport development up to 2020, given the very high level of uncertainty of future economic development.

I. The first ("Stagnation") scenario is in conformity to forecast of economy stagnation up to 2020 (in general as for a whole period 2014-2020) in spite of current crisis.

The "Stagnation" scenario of economic activity to 2020 means approximately the same in comparison to 2014 level of transportation activity due to 2017-2020 slow growth after a 2015-2017 decline. Within the "Stagnation" scenario no other wide-scale measures are considered besides formal and gradual implementation of vehicle (Euro) emissions and fuel standards (as prescribed in the current national legislation without reforms), resulting in relatively slow renewal of fleet and low actual requirements for a newly registered vehicles (in spite of formal, i.e. legislative, restrictions).

II. The second ("Negative") scenario conforms to a forecast decline of permanent economic and transportation activity as well as relevant total fuel consumption in the 2015-2020 period (in comparison to 2013).

It was assumed in this project that within both "Stagnation" and "Negative" scenarios Ukraine would have either only a few restricted opportunities (or variants), or none at all, to effectively govern the situation with road transport pollutant/GHG emission issue due to the lack of available resources. Furthermore such a problem might be considered to be a second, or third (etc.) level item in the list of priorities of the country, which is faced with the threat of loss of territorial integrity and other higher order problems.

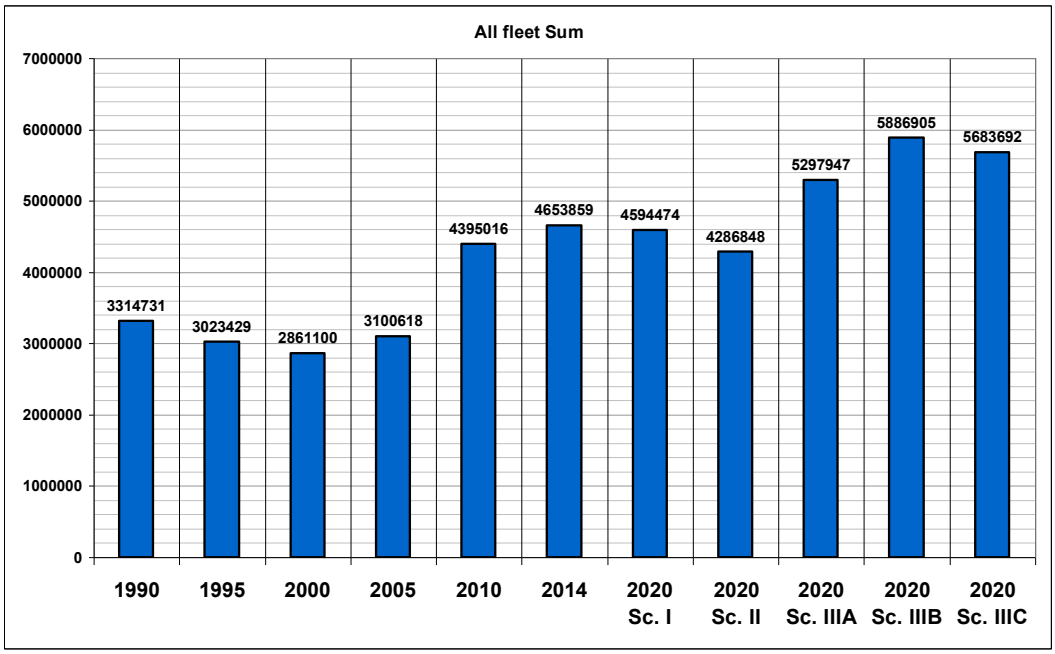
III. The third ("Positive") scenario is considered to have opportunity for moderate economic growth in general for a whole period 2014-2020 in spite of current crisis. "Positive" scenario is considered in three variants:
    A. "Low Requirements for Growth and Fulfilment";
    B. "High Requirements for Growth and Fulfilment";
    C. "High Requirements for Growth and Fulfilment plus Optimization of transportation".

Within the first sub-scenario “IIIA” it is assumed that no other wide-scale measures considered beside of the vehicle and fuel Euro standards formal and gradual implementation (as it is prescribed in current national legislation). Middle rate renewal of fleet here (within third scenario is natural effect since economic activity growth). The sub-scenario “IIIB” included particularly conditions (policies and measures) for fast rate renewal of fleet and high actual (in spite of formal (i.e. legislative) restrictions) requirements for newly registered vehicles. Finally, the sub-scenario “IIIC” included wide set of policies and effective measures in addition to sub-scenario “IIIB”.

The above mentioned scenarios and appropriate estimations of CO_2 emission gives image of regulation borders and potential within different macro economical scenarios and different variants of policy that can be applied.

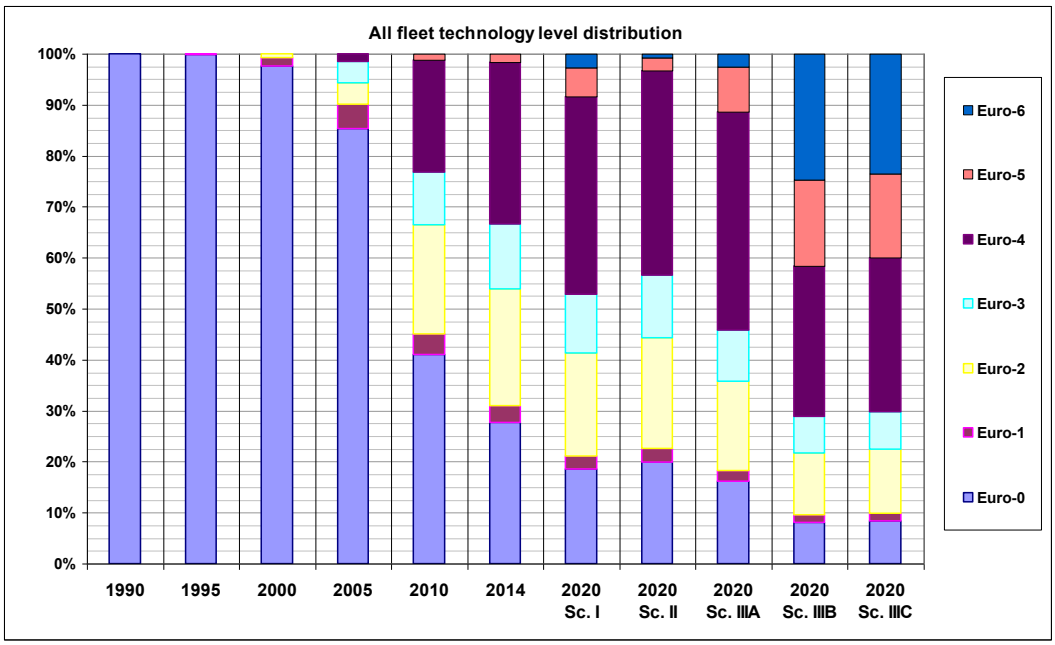
A more detailed summary of the proposed scenarios is provided in Annex II of this report.

Figure 4.7: All fleet total amount trends



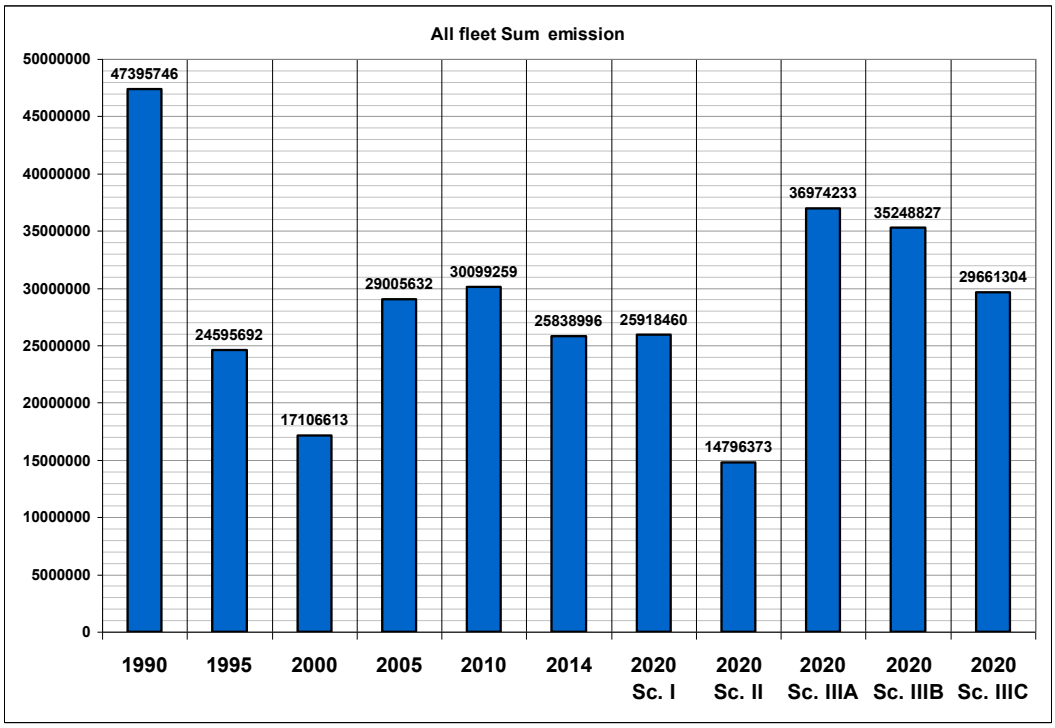
Source: (Ukraine SRTRI, 2015).

Figure 4.8: All fleet in average technology level distribution



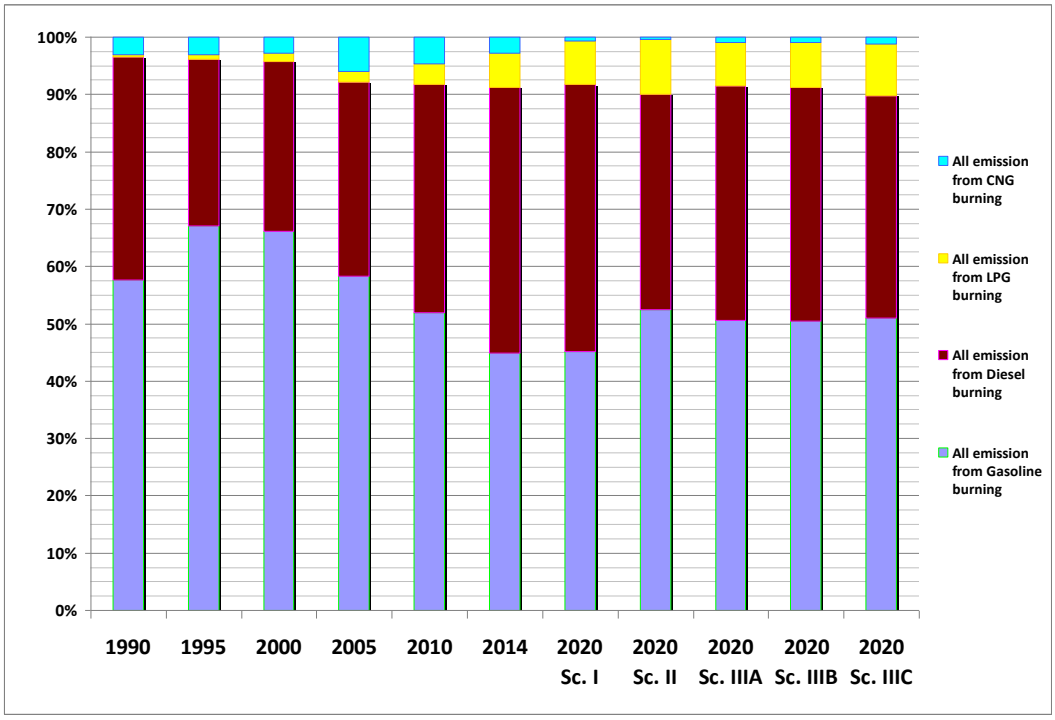
Source: (Ukraine SRTRI, 2015).

Figure 4.9: CO2 emission (t) trends (All fleet)



Source: (Ukraine SRTRI, 2015).

Figure 4.10: CO2 emission trends (% distribution of emission from different fuels powered vehicles)



Source: (Ukraine SRTRI, 2015).

4.2.2 General requirements for vehicle measurements and testing

There are some key general requirements regarding infrastructure and institutional aspects must to be fulfilled by a country to regulate CO_2 emissions and energy consumption in road transport sector. In a simplified form the most crucial part of them can be considered as follows:

I. Strong legislative background;

II. Testing facilities;

III. A central vehicle statistical database governed by the State.

These elements are discussed briefly in the following subsections.

4.2.2.1 Strong legislative background

First, it is important to establish a strong legislative background including the scope of regulation and mechanisms that make regulation clear, efficient, balanced and (most importantly) obligatory. This should include a vehicle's on market entry procedures and certification procedures. These need to ensure near to absolute compliance with the requirements of nationally established laws/regulations, and should in principle, as far as possible, eliminate loopholes or possibilities for corrupt practices.

An extremely important inclusion in the design of the legislation are monitoring and enforcement activities, to carried out by an independent organisation and should include random sampling of vehicle tests as well as other mechanisms (such as ideally in-use performance compliance testing).

4.2.2.2 Testing facilities

To regulate CO_2 emissions and energy consumption of newly registered vehicles there is a need for a set of testing facilities that conform to certification procedure demands, and are able to cover LDV, HDV and ideally also P2W:

a) *Proving ground testing facilities:* for on-road driving cycles or constant speed tests as well as for vehicle's resistance to move determination (i.e. including coast-down or constant speed with torque measurement tests; the last is important input data source for vehicles that are subsequently tested in the laboratory on chassis dynamometer tests, or for whole vehicle mathematical simulation of fuel efficiency), etc.;
b) *Chassis dynamometer based vehicle emission testing laboratories* set (i.e. LDV, P2W and for HDV also in a complete vehicle testing approach);
c) *Engine dynamometer based emission testing laboratories* set to test a wide range of engines regarding torque and speed to be designed for different categories of vehicles, including real-time vehicle and transmission simulation features;
d) *Vehicle component testing laboratories*, including tyres, transmission, auxiliary equipment also, which are important constituent parts of a vehicle's fuel efficiency;
e) *Whole vehicle fuel efficiency mathematical simulation software* as well as proven and comprehensive regularly updated input data libraries on the performance of all significant consistent parts of a vehicle (i.e. as results of numerous tests on a vehicle's components).

Consideration of climatic and other conditions should ideally be included as part of regulation, particularly in areas subject to extremes, including for instance cold weather fuel economy or hot weather vehicle behaviour, including heating and air conditioning system efficiency tests, etc. Otherwise there will be a greater risk of vehicles not performing to the expected levels in actual application/usage.

In addition to the high cost of construction and expensive sets of equipment, the above mentioned testing facilities are expensive to operate, requiring: highly trained staff, often significant electricity consumption, test cells conditioning, consumables for analytical equipment, etc. Nevertheless, such testing facilities are not only essential for regulation, but also serve as keystone for R&D activities in the sector. They can therefore be considered as fundament for development of new technologies, or as a bridge between already presented technologies and its introduction on the market.

The importance of independent vehicle testing, in subsequent in-use compliance testing, has also been further illustrated through the currently ongoing diesel emissions investigations in Europe and the US.

4.2.2.3 A central vehicle database governed by the State

Establishing a central vehicle statistical database/dataset is also an essential part of the regulation, as this will enable the better measurement and control of overall vehicle fleet emissions. Such statistical datasets are routinely gathered by the national statistical and vehicle certification agencies of many European (and other) countries, feeding into their national inventories and various legislative controls and fiscal mechanisms.

Such a unified statistical dataset/database should contain overall fleet information regarding at least the following elements in an ideal situation:

1) Whole vehicles, vehicles parts and automotive spare parts cross boundary operation;
2) Whole vehicles, vehicles' parts and automotive spare parts to be produced in Ukraine and being subject for the internal market, or for imports;
3) Certificates of conformity;
4) Database of vehicles' fuel efficiency and GHG emission data, including any information required for vehicle labelling;
5) Vehicles' registration events;
6) Vehicles' tax payments;
7) Any other essential events, related to vehicle, including engine/fuel replacement, owner change, with related set of information, etc.;
8) Vehicles operated in Ukraine without registration on a temporary base;
9) Transit vehicles, operated via territory of Ukraine;
10) Missing vehicles listed in the search;
11) Vehicles' periodical technical inspections results;
12) Vehicles' random sample tests results;
13) Vehicles' mandatory and voluntary insurance data;
14) Vehicles' utilization;
15) Other vehicle data (e.g. total/annual mileage, etc.)

The national road vehicle database ideally should also have the possibility for interconnection with another countries and international resources of information, including the ability to gather and utilise information from previous testing external to Ukraine, etc.

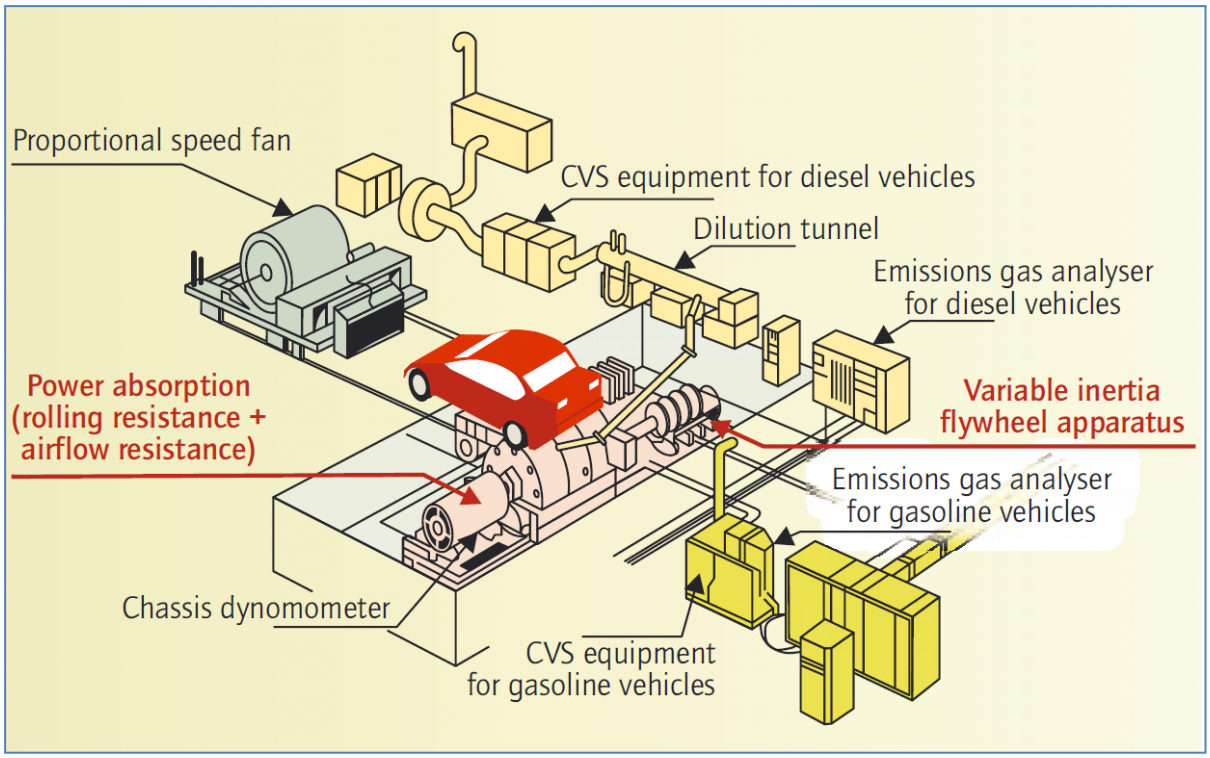
Fuel economy and GHG information as well as other open information should be published on government website with defined frequency, including for instance the standards and targets description, trends of average fuel efficiency, vehicles' arrangements regarding fuel efficiency to attract public's attention, level of compliance and enforced penalties for noncompliance, fuel economy policies impacts evaluations, etc.

4.3 Light duty vehicles (passenger cars and light commercial vehicles)

This section provides a summary review of the implementation of methods used in different regions for determination of LDV CO_2 emission / fuel consumption, and the currently in place/proposed future regulatory systems.

The methods for testing light duty vehicles (LDV) regarding fuel economy and CO_2, as well as other pollutants emissions, are in general very similar. They are based predominantly on a laboratory test cell set (e.g. simplified example provided in Figure 4.11) with unified temperature conditions, using a chassis dynamometer to simulate vehicles' inertia mass and resistance to movement, proportional blower for cooling, and emission mass measurement system including constant volume sampling system and analytical system. Vehicles are operated virtually, as on a road, via a prescribed time/speed pattern, known as a driving cycle. The objective of this set cycle is to reproduce some part of a vehicle's real driving conditions in a uniform, strictly predefined and reproducible way. Fuel consumption is measured by a carbon balance method.

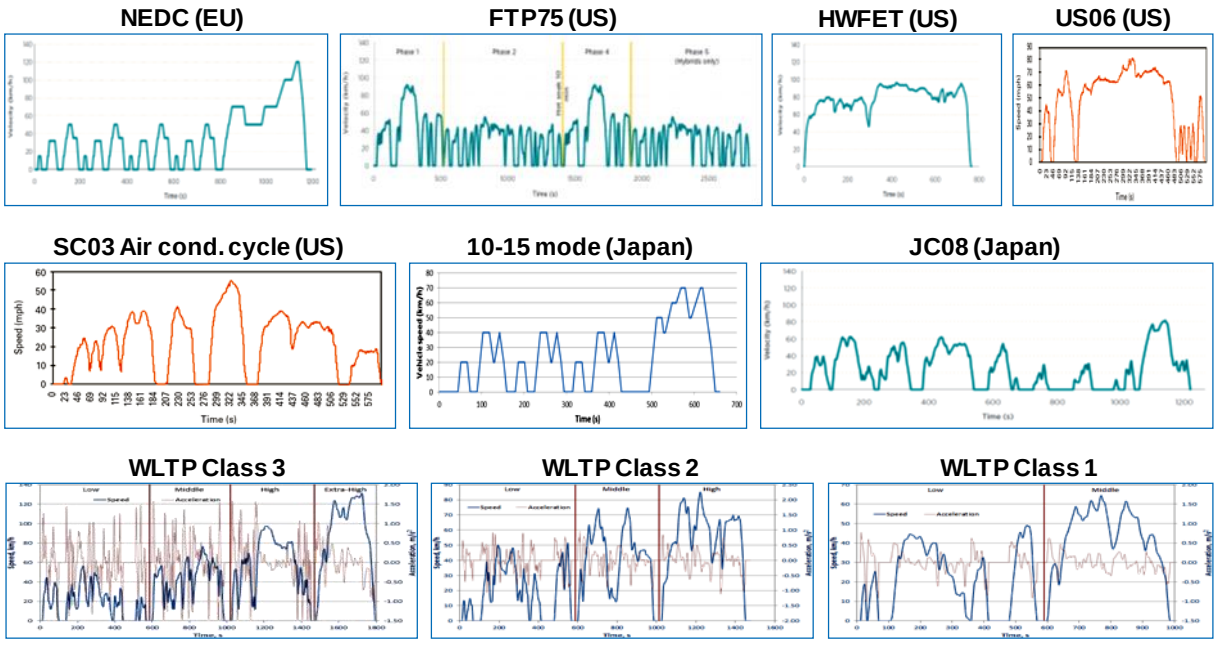
Figure 4.11: Simplified example of a laboratory test cell set to measure a vehicle fuel economy and emission



Source: Technology Roadmap: Fuel Economy of Road Vehicles. (OECD/IEA, 2012)

There are currently a wide range of different driving cycles applied in LDV CO_2 and fuel consumption testing world-wide, as illustrated in Figure 4.12. The differences in test driving cycles and test procedures and their incompatibility is likely pose a significant problem for potential regulation in Ukraine where vehicles are sourced/imported from different regions applying different standards. The following subsections provide a summary of the basis of CO_2 and/or fuel economy / consumption testing in the major global regions, and considerations/implications for Ukraine.

Figure 4.12: Illustration of the range of test cycles used in LDV CO2 and fuel economy testing worldwide



Sources: (ICCT, 2014a), (Delphi, 2015), (Dieselnet, 2016)

4.3.1 Review of the standards in-use or planned in different regions for determination of LDV CO2emission / fuel consumption in different regions

The review of the main standards from different regions mainly concentrated on Europe, the US, Japan and China as the primary regions of production. In addition, many other countries/regions already base their own requirements on the standards set in these primary regions. Other regions of the world are considered only in cases where there is some content of potential interest of regulation in Ukraine.

4.3.1.1 European Union

The New European Driving Cycle (NEDC), last updated in 1997, is the current basis for EU type approval testing of emissions (CO_2 and other air pollutants) and fuel consumption from light duty vehicles. The NEDC test procedure is defined in UNECE R101 for the measurement of CO_2 and fuel consumption and/or the measurement of electric energy consumption and electric range in hybrid and fully electric M1 and N1 vehicles, and UNECE R83 for the measurement of emission of pollutants of M, N1 and M2 vehicles. It is maintained by the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29).

The NEDC consists of two parts:
- four segments of the Urban Driving Cycle (UDC, also known as ECE or ECE-15 cycle) representing city driving conditions;
- the Extra Urban Driving Cycle (EUDC) to account for more aggressive, high-speed driving modes.

Fuel consumption and CO_2 emissions are stated for both for urban and extra-urban driving parts with no additional weighting factors to be applied among the two sub-cycles, and for the complete NEDC taking in to account weighing factors. The full cycle must be performed on a cold vehicle at 20–30 °C (typically run at 25 °C) and so this means that the NEDC implicitly weighs the cold start effect at 100%. The cycle is also used as a basis for official type-approval emission and fuel consumption figures in other world regions (e.g. India). Further information on the test cycle is also provided in Annex III.

Particularly in recent years, the NEDC cycle is a subject of significant criticism among expert community and vehicle owners since it is too far from real life driving conditions (discussed further in later Section 4.6), including such an artificial features as very soft accelerations, a lot of constant speed cruises, urban part contains maximum speed limit that is too far from actual urban speeds in some regions of world, constant predefined accelerations, and a lot of idle. As a result this cycle do not represent very well the actual driving/fuel consumption and CO_2 emission behaviour of vehicles in many cases. Similar concerns have also been raised with regards to air quality pollutant emissions previously.

Another concern that has been raise is that the cycle's pattern is relatively easy to use by manufacturer for automated recognition by ECU's (energy control unit) software, potentially allowing for closer artificial adjustment to laboratory/regulatory conditions, and different ECU settings for real world driving. The recent and ongoing diesel emissions scandal has only heightened such concerns.

Evidence for such concerns appears to be provided in recent comparisons of official fuel consumption/CO_2 emissions figures and those found in real-world conditions (ICCT, 2015). In part due the above reasons, the European Union is currently on a path to replace the NEDC and the associated test-procedure by a new cycle Worldwide harmonized Light vehicles Test Cycle (WLTC) and the associated Worldwide Harmonized Light Vehicle Test Procedure (WLTP). A comparison between the NEDC and WLTC test cycles is provided in the following Figure 4.13, with further discussion of WLTP provided in later Section 4.3.1.6. This change is currently anticipated to be introduced before the end of the decade; according to Regulation (EC) No 333/2014:

> *"…the WLTP should be applied at the earliest opportunity. In view of that context, Annex I to Regulation (EC) No 443/2009 establishes emission limits for 2020 as measured in accordance with Regulation (EC) No 715/2007 and Annex XII to Commission Regulation (EC) No 692/2008 (1).*

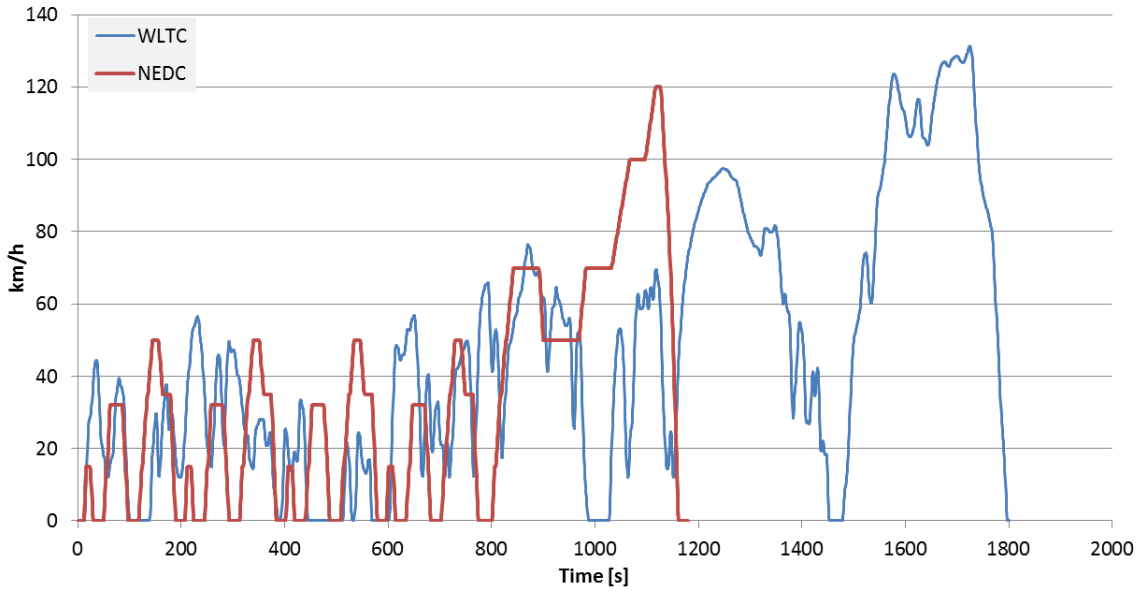
When the test procedures are amended, the limits set in Annex I to Regulation (EC) No 443/2009 should be adjusted to ensure comparable stringency for manufacturers and classes of vehicles."

As already discussed at length in earlier Section 3.2.2 and 3.4.3, at present passenger cars and Light Commercial Vehicles (LCV) have been subject of CO_2 emission regulations in Europe since 2009 (for cars)/2011 (for LCVs). The specific emissions targets for new **passenger cars** are 130 gCO2 per km for 2015, and 95 gCO2 per km for 2021 on an industry wide basis. For **LCVs** the corresponding targets are 175 gCO_2 per km by 2017, and 147 gCO_2 per km by 2020.

As well as overall targets for all new cars and LCVs sold in the EU, there are mass-based organisation sub-targets and in addition, some 'ultra-low emission vehicles' (ULEVs) are eligible for so-called 'supercredits', which have also been discussed earlier. Finally, OEMs may also apply for additional credits for 'eco-innovations', which provide verifiable real-world fuel consumption benefits, but which are not captured under the regulatory cycles.

The current 2021/2020 regulatory CO_2 targets for passenger cars/LCVs (discussed previously in Section 3.2.2) are set relative to the NEDC-based values. Therefore a range of work has been carried out, and is ongoing, investigating the correlation between results from the two cycles/procedures, the potential implications of the change in this regard and options for monitoring/assessing compliance with the regulation following the change.

Figure 4.13: NEDC and WLTC test cycles



Source: (Ricardo Energy & Environment et al, 2016 (forthcoming))
Note: The comparison is for the WLTC Class 3 cycle (high-power vehicles with PWr > 34), most relevant to European vehicles.

4.3.1.2 United States

In the US, there are two sets of parallel standards, the Corporate Average Fuel Economy (CAFE) (in miles per gallon, mpg) standards adopted by the NHTSA and GHG emission standards (in CO_2 equivalents, also including CH_4 and N_2O) adopted by the EPA (Delphi, 2015). The standards set targets for LDVs (cars and light duty trucks) as well as Medium Duty Passenger Vehicles (MDPVs, <10,000 lbs GVWR). The CAFE standards were first adopted in 1975, and were significantly tightened in 2007 under the Energy Independence and Security Act (EISA), as well as the separate introduction of GHG standards under the Clean Air Act (CAA) in the same year.

The fuel economy measurement method in the US is prescribed in 40 CFR Part. 600. For up to MY (model year) 2010 the CAFE standards and label requirements in the US consist of city (FTP75) and highway (HWFET) test results with weighting factors 0.55 and 0.45 respectively to calculate the combined average value from the two cycles:

i. The "city" cycle EPAIII also known as FTP75 (Federal Test Procedure) is used for emission certification and fuel economy testing of LDV in the United States and is a chassis dynamometer driving schedule. The cycle has a number of phases, which are collected and analysed separately before being combined using prescribed weighting factors.
ii. The Highway Fuel Economy Test (HWFET or HFET) cycle is a chassis dynamometer hot start driving schedule developed by the U.S. EPA for the determination of the highway fuel economy rating.

For MY 2011 and beyond the combined fuel economy value is calculated on a 5 cycle formula based upon combination of FTP75, cold FTP(20F), US06, SC03 and HWFET. (The 5 cycle calculation was optional for 2008-2010 and at present above prescribed 2 cycle calculation remains as option also):

iii. The cold FTP(20F) cycle is cold exhaust emissions test designed to simulate the cold start and operation of vehicles in cold climate areas (20°F) and uses the same FTP75 driving schedule.
iv. Driving schedule of the US06 cycle is also known as the Supplemental FTP Driving Schedule (high speed/high load cycle).
v. SC03 is the Air conditioning cycle.

The standards are based on CO_2 emissions-footprint curves (i.e. different from the mass-based approach in the EU), so that each vehicle has a different compliance target based on its 'footprint' value. The regulation also allows for trading of credits between manufacturers and between cars and light trucks via a system of Averaging, Banking and Trading (ABT). Under CAFÉ manufacturers were able to pay fees for non-compliance, but under the Clean Air Act must comply with the CO_2 standards. However, there are also a number of incentive for encouraging advanced technologies, and credits that can be applied for 'off-cycle' technologies that show additional savings in the real-world that are not captured under regulatory test procedures.

California (via the California Air Resource Board, CARB) previously has been granted a waiver to also have its own, tighter, CO_2 equivalent emission targets for passenger cars and LCV, but GHG regulations have been harmonised with the EPA from 2017-2025.

Information on the relevant US targets for passenger cars and LCVs was provided earlier in Figure 3.1 and Figure 3.2, in Section 3.2.2, normalised to NEDC by (ICCT, 2014). Further information on the individual test cycles is also provided in Annex III.

4.3.1.3 Japan

In the near past, Japanese emission regulation and fuel economy was based upon the 10-15 mode driving cycle. This is a 'hot cycle', meaning that the preliminary 15 mode (the same as the last relatively high-speed part of the cycle pattern) is first run without measurements to warm the vehicle up, prior to starting actual emissions measurements over the full cycle. The current JC08 cycle was introduced in 2005 into Japanese emission regulation and fuel economy determination and was fully phased-in by October 2011. Under the revised protocols, measurement is made twice, with a cold start being weighted by 25% and a hot start being weighted by 75%. Further information on the profiles of the different cycles is also provided in Annex III.

Japanese fuel economy (km/l) targets for the period up to 2010 were based upon a weighted average for all manufacturers in Japan determined over the 10-15 cycle. Targets were set separately for gasoline, diesel and LPG passenger cars (the latter two categories having only small levels uptake in Japan, in contrast to the dominance of diesel vehicles in Europe), and for different weight categories.

The 2015 fuel economy (km/l) average and vehicle weight based targets for passenger cars, LCVs and small buses are based on fuel consumption determined on the cold and hot JC08 cycle (weighted at 25% and 75% respectively). The regulation considers gasoline (as the base) and also diesel and

LPG fuelled vehicles together via conversion factors applied for diesel (FE_JC08_total / 1.1) and LPG fuel economy (FE_JC08_total / 0.78), mainly to account for differences in energy density. The targets (applicable from March 2013) represent a 23.5% reduction in fuel consumption for passenger cars versus 2004, and a 12.6% reduction for LCVs (Delphi, 2015). More stringent targets were also set (applicable from March 2013) for 2020.

Information on the relevant Japanese targets for passenger cars and LCVs was provided earlier in Figure 3.1 and Figure 3.2, in Section 3.2.2, normalised to NEDC by (ICCT, 2014).

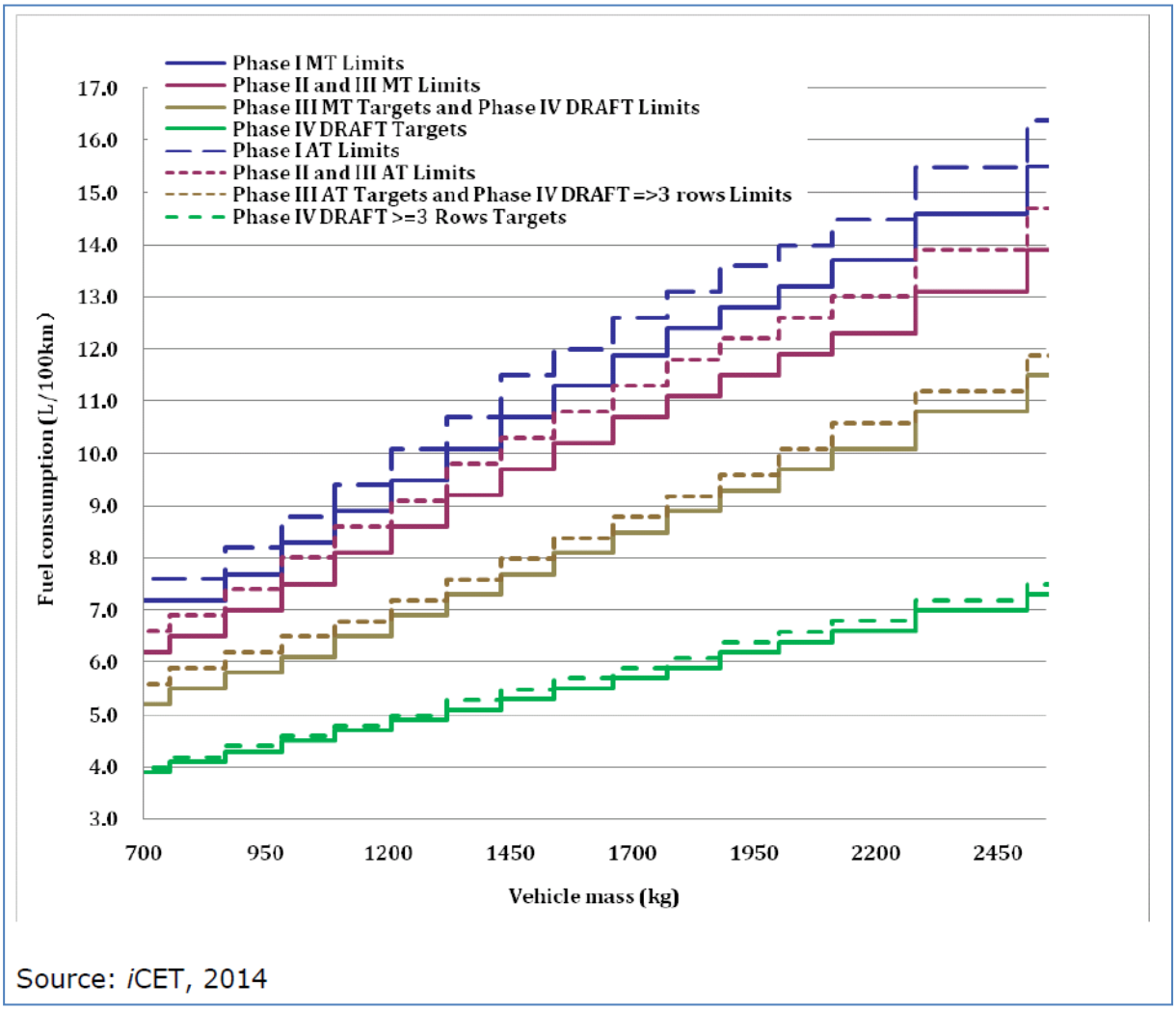
4.3.1.4 China

Automotive fuel consumption regulation in China began in 2004 with the national standard of *"Limits of Fuel Consumption for Passenger Cars"* (GB 19578-2004), targeting an average fuel consumption of 6.9L/100km by 2015 which is equivalent to CO_2 emissions of 167kg/km. The testing standard for LDV fuel economy is the national standards/ "GuoBiao" No. 19233 and fuel consumption and emissions are determined in China using the "New European Driving Cycle", or NEDC. Under the standard, for Phase III onwards, separate limit values are applied to 16 different mass categories for passenger cars (lower bound 750kg, upper bound 2.5 tonnes unladen kerb weight). LCVs (N1 category) are covered under GB 20997-2007 and have 4 mass categories (on a gross vehicle mass basis, up to 3.5 tonnes), and separate targets for gasoline and diesel vehicles.

The current standard (for Phase III, up to 2015/16), which also includes per-vehicle limit values, was established by GB27999-2011, and includes overall fleet average targets for the national corporate-average fuel consumption (CAFC), based on a sales weighted average across all models. The CAFC requirement was enacted in 2012 and allows automotive manufacturers until 2015 to gradually reduce their fuel consumption levels and meet the target, towards the CAFC binding period starting in 2015 (UNEP, 2015). The Chinese government has also set targets to reduce the average fuel consumption further to about 5 litres/100km (equivalent to 120g CO_2/km) by 2020 (as updated under GB 27999-2014 for Phase IV). Similarly to other regions (i.e. US and Europe), manufacturers may gain an additional fuel consumption credit for adopting off-cycle fuel saving technologies (see also later section 4.6.1 for a discussion).

A graphical illustration of the China weight-based passenger vehicle fuel consumption limits is provided in Figure 4.14 below. In addition, the overall targets for passenger cars and LCVs was also provided earlier in Figure 3.1 and Figure 3.2, in Section 3.2.2 from (ICCT, 2014).

Figure 4.14: Chinese weight-based passenger vehicle fuel consumption limits (Phases I, II and III, draft IV)



Source: (UNEP, 2015)

4.3.1.5 Other regions

Most of the other world regions have testing protocols and standards based around those used in the major world regions. For example, Canada's Company Average Fuel Consumption (CAFC) program was introduced in 1976 to track the fuel consumption of the new light duty vehicle fleet. CAFC is similar to the U.S. CAFE program with the exception that the CAFC program does not distinguish between domestic and imported vehicles. The fuel consumption goals set out by the program have historically been equivalent to CAFE standards (ICCT, 2007). Similarly, in South Korea the LDV GHG emission and fuel economy targets are also based on US driving cycles (Delphi, 2015).

In Taiwan LDV fuel economy standards based on *both* the US FTP75 driving cycle *and* European driving cycle (under the EU Directive 1999/100 that adapting Directive 80/1286/EEC), and are weight-based targets (Delphi, 2015). This has particular relevance for the Ukraine (where a significant share of vehicles are imported from outside of Europe), as it suggests the potential for a compromise/hybrid route to be offered, with similar levels of ambition applied over the different regulatory regimes, to be applied based on the primary market that the vehicle is sourced from. Clearly some care would need to be taken in defining such a standard, to reduce the potential for OEMs to simply use the standard to which their vehicles can more readily be compliant.

4.3.1.6 Worldwide harmonization

The Worldwide harmonized Light-duty Test Cycle is a chassis dynamometer cycle that is being developed by the UN ECE GRPE (Working Party on Pollution and Energy) group, with the predominant participation of European, Japanese and Indian experts) within the framework of the **W**orldwide harmonized **L**ight vehicles **T**est **P**rocedure (WLTP) as replacement the European NEDC procedure for type approval testing of LDV. In Europe, it is expected the transition to align with the introduction of the Euro 6c emission standards in September 2017 or later. The WLTP will therefore gain high importance on a global level as it is expected that other countries will also adopt WLTP in the future (particularly those already using the previous NEDC basis, such as India). According to (Frost & Sullivan, 2015), other regions may initially only adopt WLTP only in urbanized high emission areas, whilst the industry is hopeful that other major world regions participating in UN-ECE on WLTP (such as China, India, South Korea, Japan and the USA), will adopt the WLTP when ready (ACEA, 2014). According to ICCT, it is expected that Japan will also adopt WLTP and that the Japanese 2020 standards for cars and LCVs will be adjusted to align with WLTP (ICCT, 2013a)

The WLTP procedure includes three test cycles applicable to vehicle categories of different power-to-mass ratios (PMR) and taking in to account the maximum declared speed of the vehicle, as it is shown in Table 4.1. The PMR parameter is defined as the ratio of rated power (W) to curb mass (kg), and is relevant to the definition of the representativeness of the cycle class category for typical vehicles in different regions. The curb mass means the “unladed mass” as defined in ECE R83. The cycle definitions may also depend on the maximum speed (V_max) which is the maximum speed of the vehicle as declared by the manufacturer (ECE R68) and not any use restriction or safety based limitation. Further information on the different cycle categories under WLTP is also provided in Annex III.

Table 4.1 : WLTP Test Cycles

Cate-gory	PMR, W/kg	Speed Phases	Comments	Representativeness
Class 3	PMR > 34	Low, Middle, High, Extra-High	If V_max < 135 km/h, phase ‘extra-high’ is replaced by a repetition of phase ‘low’.	Vehicles driven in Europe and Japan
Class 2	34 ≥ PMR > 22	Low, Middle, High	If V_max < 90 km/h, phase ‘high’ is replaced by a repetition of phase ‘low’.	Vehicles driven in India and of low power vehicles driven in Japan and Europe
Class 1	PMR ≤ 22	Low, Middle	If V_max ≥ 70 km/h, phase ‘low’ is repeated after phase ‘middle’. If V_max < 70 km/h, phase ‘middle’ is replaced by a repetition of phase ‘low’.	Vehicles driven in India

Source: (Dieselnet, 2016)

4.3.1.7 Comparative analysis of standards for determination of LDV CO_2 emission / fuel consumption

The European Union, Japan and the US have developed its own unique test procedures in efforts to establish emission and fuel consumption evaluation base that reflects local real world driving conditions. A great difference exists in vehicle choices/specifications, road types, traffic regulation, driving habits around the world.

There are significant differences among known around the world cycles regarding the vehicle speed and acceleration pattern as well as engine rpm and loads, starting conditions etc. resulting incompatibility of the same vehicle`s fuel economy (or emission, including GHG) representation within different standards:

- The **NEDC** has a narrow area of low load conditions of engine as a result of its construction based on artificial phases of equal velocity, constant acceleration and deceleration phases. The required acceleration power of the NEDC is the lowest of all cycles on the total cycle level because of the overall low temporal share of accelerations despite of relatively high during the acceleration phases.

- The **WLTC** is more dynamic in comparison with NEDC and reaches the highest maximum speed of all cycles and also the highest load conditions.
- The **U.S. cycles**, summarized as composite CAFE, are high dynamic and show the highest mean velocities.
- The **JC08** requires more aggressive accelerations but on a rather low velocity level.

A useful summary of the main descriptive parameters of a range of driving cycles is provided in Table 4.2 below, from (ICCT, 2014a).

Table 4.2: Descriptive parameters of some driving cycles

	Units	FTP75 weighted	HWFET	CAFE	NEDC	JC08	WLTC
Start condition		43% cold / 57% hot	hot		cold	25% cold / 75% hot	cold
Duration	s	1369	765		1180	1204	1800
Distance	km	11.99	16.51		11.03	8.17	23.27
Mean velocity	km/h	31.5	77.7	52.3	33.6	24.4	46.5
Max. velocity	km/h	91.2	96.4		120.0	81.6	131.3
Stop phases		18	2		14	12	9
Durations							
Stop	s	241	4		280	346	226
Constant driving	s	109	126		475	21	66
Acceleration	s	544	338		247	432	789
Deceleration	s	475	297		178	405	719
Shares							
Stop		17.6%	0.5%	9.9%	23.7%	28.7%	12.6%
Constant driving		8.0%	16.5%	11.8%	40.3%	1.7%	3.7%
Acceleration		39.7%	44.2%	41.7%	20.9%	35.9%	43.8%
Deceleration		34.7%	38.8%	36.6%	15.1%	33.6%	39.9%
Mean positive acceleration	m/s^2	0.50	0.19	0.36	0.59	0.42	0.41
Max. positive acceleration	m/s^2	1.48	1.43		1.04	1.69	1.67
Mean positive 'vel * acc' (acceleration phases)	m^2/s^3	3.86	3.45	3.67	4.97	3.34	4.54
Mean positive 'vel * acc' (whole cycle)	m^2/s^3	1.53	1.52	1.53	1.04	1.20	1.99
Max. positive 'vel * acc'	m^2/s^3	19.19	15.17		9.22	11.60	21.01
Mean deceleration	m/s^2	-0.58	-0.22	-0.42	-0.82	-0.45	-0.45
Min. deceleration	m/s^2	-1.48	-1.48		-1.39	-1.19	-1.50

Source: (ICCT, 2014a)

Other important considerations include cold starts and the number of stop phases in a cycle. The cold start effect has big influence on total test results because of higher engine and transmission lubricant viscosities and other increased friction losses as well as due to not yet warmed up and inefficient work of emission control system components. A summary of the cold start weightings and effects on total cycles' CO_2 emissions has also been provided in (ICCT, 2014a) and are summarised Table 4.3 below.

Stop-start systems relative effectiveness in test procedure is also directly dependant on the share of stop phases relative to the total duration of the cycle. In the NEDC and the JC08 these are significant, which have stop shares of 23.7% and 28.7% respectively. However, testing these systems under the US cycles for CAFE (9.9% stop share) or WLTC (12.6%) schedules provides considerably lower CO_2

savings. Such variability demonstrates the influence of the cycle/protocol in terms of representativeness to real-world conditions, and on the potential prioritisation of different technical options for implementation to meet the regulatory standards in different regions.

Table 4.3: Cold start weightings and effects on total cycles' CO_2 emissions

	Distance (km)	Weighting factor	Scaling factor	Cold start effect on total CO_2 test result	
				low	high
FTP75	11.99	0.43	0.40	4%	6%
HWFET	16.51	0	0	0%	0%
CAFE*)			0.22	2%	3%
NEDC	11.03	1	1	9%	15%
JC08	8.17	0.25	0.34	3%	5%
WLTC	23.27	1	0.47	4%	7%

*) 55/45 FTP/HWFET relation by assuming similar CO_2 levels for both cycles

Source: (ICCT, 2014a)

Despite of progress achieved in EU correlation programmes, and lower-level research by (ICCT, 2014a), the development of a reliable set of test cycle conversion factors, the practical (i.e. not on mathematical simulation only) implementation of such an approach is questionable due to the complexity of real ECU, the entire drive train and vehicle behaviour, and would provide a significant level of uncertainty for the results for regulatory purposes at least.

From a wider perspective it must be noted that not only have a number of different test procedures, fuel consumption and emission values determination methods have been developed, but also a different base approaches to regulate fuel economy and GHG emissions have evolved around the world (as discussed in the earlier sections). The policy objectives of these regulations are most often applied in order to reduce either fuel consumption or GHG emissions (though in some cases, like the US, both have been implemented). While first approach focuses on a vehicles basic efficiency to reduce the amount of fuel used by the vehicle under operation, GHG emission standards have the potential to target not only CO_2 emission or whole suite of GHG emissions from the vehicle on road, but also can take in to account wider impacts. For example, they can be extended to account for refrigerants from the air conditioning system or nitrous oxide (N_2O) from the catalytic converter, or potentially extend beyond the vehicle in whole product life cycle approach comprising the GHG emissions generated from the production of fuels and vehicle's components also as well as the vehicle utilization, etc. (although it should be noted that such an approach would be highly complex and extremely difficult to effectively regulate).

4.3.2 Current situation and summary assessment of the suitability of different options for Ukraine regarding LDV

UN/ECE Regulation No. 101[15] is included in the field of regulation by the Order of the Ministry of infrastructure of Ukraine dated 17.08.2012 No. 521: *"On approval of Procedure for approval of design of vehicles, their parts and equipment and the Procedure for maintaining the register of certificates type of vehicles and equipment issued by the manufacturers certificate of conformity of vehicles or equipment"* registered in the Ministry justice of Ukraine 14.09.2012 No. 1586/21898.

Therefore, according to this requirement, at present for newly registered LDV of categories M1 and N1 the CO_2 emission and fuel consumption are measured, but do not yet regulated in Ukraine. The requirements mean that results of CO_2 emission and fuel consumption measurements must be attached to certificate of conformity (CoC) of a vehicle, as it is stated in the above mentioned Order of

[15] Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M1 and N1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range.

the Ministry of infrastructure of Ukraine dated 17.08.2012 No. 521, but no labelling (or complete data collection) system is established in Ukraine yet. Importantly, the requirements applied to different procedures of certification schemes and do not contain UN/ECE Regulation No. 101 as obligatory for "individual" import or second-hand vehicles, so certificates of conformity for these might contain any (based of any standards) figures in principal (although this is a similar situation as for EU countries).

To set up regulatory targets Ukraine would first need to know what the average new fleet CO_2 emissions levels were, in order to clearly define a baseline that is specific to Ukraine. This is currently not possible, as although CO_2 information has to be provided with CoC (as indicated above), it is not systematically collected into a database currently, which would be required (but potentially difficult to set up). Ukraine is also not a large market, so practically it would be potentially much more difficult to set the industry-wide targets in place in other countries. However, it would perhaps not be impossible with the appropriate supporting mechanisms (e.g. penalties for not meeting reduction levels), and complimentary policy (e.g. labelling, graduated vehicle tax levels, etc). To do this would require additional measures for verification, as currently there is an reportedly issue with corruption / the accuracy of the information provided on such official papers. (There are obviously also wider issues currently being discussed in the EU and global context with the accuracy of official CO_2 and fuel economy from certain manufacturers).

The introduction of technical regulations on the CO_2 emissions in Ukraine for new LDVs are therefore not currently possible by direct implementation of the current European approach, and would require significant work to move forwards to a position where similar mechanisms might potentially be implemented. Proposals for the design of a combined policy approach regarding vehicle's GHG regulation in Ukraine, taking in to account Ukrainian specific conditions, is set out in later Section 4.7 of the report.

4.4 Heavy duty vehicles (medium and heavy trucks, buses and coaches)

This section provides a review of the options in-use or planned in different regions for determination of HDV CO_2 emission / fuel consumption.

4.4.1 Overview of the main options available for determination of HDV CO2 emission/fuel consumption

In general the development whole-vehicle fuel consumption/CO_2 emissions testing procedures/certification for heavy duty vehicles (HDVs) is at a less-developed stage in comparison to light duty vehicles (LDVs). This section provides a high-level summary of the different options that might be considered for application (i.e. prior to any issues of practicality or cost); these include principally the following four options relevant to certification:

1. On-road or test-track based testing (e.g. from ECM, using PEMS equipment, fuel tank measurement or fuel-flow meters);
2. Chassis dynamometer testing of the whole vehicle;
3. Engine / powertrain testing;
4. Complete vehicle simulation (e.g. with inputs based on testing of individual components, other vehicle specifications);

In addition, it is possible to get information on the real-world performance of vehicles in use from:

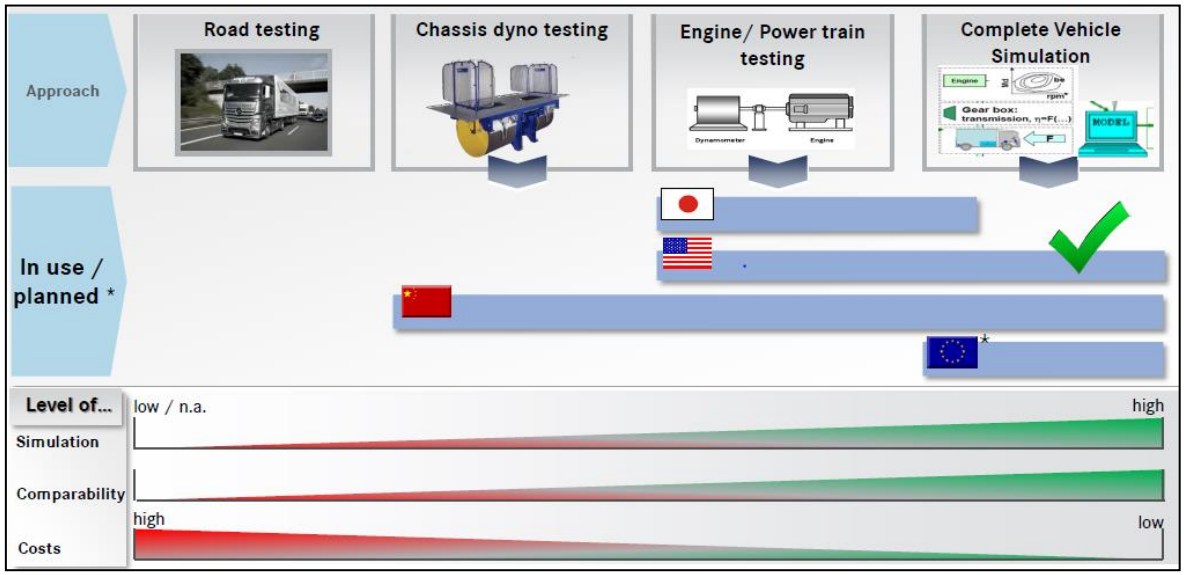
5. On-road real life fuel consumption data

Figure 4.15 illustrates how the four testing methodologies are used across the different markets, and the relative comparability and cost of implementation.

There are currently some concerns with regards to the test cycles used, as it is perceived that they do not match real world driving. As a result inaccuracies could compromise the achievable reduction in fuel consumption, as perceived efficiency improvements are not matched on the road. Due to the number of vehicle sizes and formats that are available within an HDV segment, the lack of standardisation can also make vehicle testing difficult and potentially expensive. Table 4.4 below

provides a comparative analysis, including an overview of the pros and cons of the different testing approaches that are available.

Figure 4.15: Test method application in major markets



Source: (Daimler Trucks NA, 2013)

Table 4.4: Advantages and disadvantages of testing approaches for HDVs

Test method	Advantages	Disadvantages
Road testing	Dynamic incentive for all technologies	Very expensive – Time consuming
	High accuracy	Low comparability
	Suitable for large fleet vehicles	
Chassis dyno testing	Allows varied engine / transmission / chassis / tyre configurations to be assessed in 'real-world'	Test cycles may not reflect real world conditions.
		Very costly test and facilities
Engine / powertrain testing	Give real-life assessment of engine efficiency	Test cycles may not reflect real world conditions.
		Does not allow assessment whole vehicle efficiency (transmission, Aero, tyres etc.)
		Expensive equipment and testing
Vehicle simulation	Rapid test, low cost, good comparability	Variable accuracy determined by rigour of simulation method
	Allows many vehicle formats to be assessed	
	Good repeatability	

The relevance of the above testing approaches for the Ukraine is discussed in more detail in section 4.4.3.

In terms of on-road real life fuel consumption data, ICCT recently also conducted a literature review on the data available on real-world performance of heavy duty vehicles (ICCT, 2015a). A summary of the key findings on data availability and conclusions on the advantages and disadvantages of different sources is provided in Table 4.5.

Table 4.5: Findings from research by ICCT into real-world fuel consumption data for different regions

Table 4: Types of real-world fuel consumption data

Data type	Data collection methods	Resource intensity	Data publicly available?*		
			US	China	EU
National, fleet-wide	Aggregate fuel sales; activity rate surveys, estimates	Moderate	X	X	X
Numerous fleets (e.g., SmartWay)	Fleet-reported fuel consumption and activity levels	Moderate	X		
On-road or closed track testing	ECM data; fuel flow meters; fuel tank mass measurement; PEMS	High	X	X	X
Chassis dynamometer testing	Laboratory emissions measurements; fuel flow meters	High	X	X	X

* The fields that have X marks with the green shading are the types of data sources referenced in this literature review.

Table 5: Comparison of fuel consumption data types for assessing efficiency improvements

Data type	Assessing fuel efficiency improvements	
	Advantages	Disadvantages
National, fleet-wide	• Able to assess efficacy of fuel efficiency policy measure at the highest level	• Challenging to break down fuel consumption and activity levels to the various HDV types • Difficult to accurately estimate MY-to-MY improvements
Numerous fleets (e.g., SmartWay)	• Shippers and logistics providers can see comparative performance data on fleet for various trucking carriers	• Many variables affect fuel consumption results: driver behavior, environment, payloads • Depends on accurate self-reporting from fleets
On-road or closed track testing	• Ability to test changes in specific vehicle model performance year-to-year • Can test the impact of specific technologies	• High dependence on driver, environmental conditions • Fleets may have low confidence in OEM-generated results
Chassis dynamometer testing	• Good test-to-test repeatability due to minimal environmental factors and standardized test protocols	• Stakeholders may have low confidence that laboratory-generated results translate to real-world savings

Source: (ICCT, 2015a)

4.4.2 Summary of standards applied/being considered for HDVs in different regions

USA, Japan and China have all enacted different approaches to fuel economy standards for HDVs, with this legislation being implemented at different times, and requiring manufacturers to reach differing targets. Table 4.6 provides an overview of the HDV certification in these three countries, as well as the proposed standard to be adopted in the EU.

Table 4.6: HDV certification worldwide

Examples of HDV certification and standards schemes				
Feature	**USA**	**Japan**	**China**	**proposed EU**
Regulatory details				
Type	FE and GHG.	Fuel economy.	Fuel economy.	Likely to be GHG.
Regulating agency	NHTSA for fuel efficiency; EPA for GHG emissions	Ministry of Economy, Trade and Industry (METI)	Ministry of Industry and Information Technology (MIIT)	N/A
Regulation timing	Adopted in 2006, effective starting 2015	Adopted in 2011, effective from 2014	Final rule in 2013, starting in 2014	Development and testing of certification procedure
Testing process and technology efficiencies captured				
Testing process	(a) Engine: dynamometer testing; (b) Vehicle simulation: standard engine, transmission; standard trailer depending on cab roof height.	Simulation using engine fuel consumption map and transmission properties:	Chassis test of basic vehicle; simulation or chassis testing for vehicle variants:	Simulation using a range of manufacturer supplied data: engine map, transmission properties, drag, rolling resistance.
Engine	✓	✓	✓	✓
Transmission	(✓) [2]	(✓) [1]	✓	✓
Hybridisation	(✓) [2]	?	✓	(✓) [3]
Aero drag and tire rolling resistance	✓	X	✓	✓
Simulation data requirements & responsibilities				
Engine	Standard value	Engine fuel consumption map	Chassis test required for baseline.	Actual vehicle values
Transmission	Standard value	Optional testing or standard value		Actual vehicle values
Trailer	Standard, depending on roof height	Standard value		Actual vehicle values
Aerodynamic drag	Manufacturer testing (coast-down preferred)	Standard value	Manufacturer testing (coast-down preferred) or standard value	Manufacturer testing (constant speed test preferred)
Rolling resistance	OEM or tire manufacturer testing	Standard value	Manufacturer testing or standard values	Standard value from tyre label

Notes: (1) manual: average simulated; automatic: fixed % efficiency loss; (2) by demonstration outside of the protocol; (3) planned for future

4.4.2.1 European Union

There is currently no EU-wide legislation to limit CO_2 emissions from heavy duty vehicles. It has, however, recently been made necessary to measure CO_2 emissions from new engines with the introduction of the Euro VI standard in 2014 under Regulation 595/2009 (European Commission, 2009). This will lead to the quantification of CO_2 emissions per kWh over the WHTC and WHSC test cycles, but will not introduce a standard that has to be met. The European Commission have been carefully considering and now evaluating practical methods of quantifying whole-vehicle CO_2 emissions (via a simulation-based approach) before any future implementation.

Other major reasons for allowing HDV CO_2 to go unregulated thus far are the existing financial drivers towards improving fuel consumption (which is a significant proportion of total operating costs in

Europe) and the interconnected nature of road freight transport and economic development which has been even more politically challenging in the wake of the 2008 financial crisis. As European economies resurge from recession, this political impediment to CO_2 regulation is diminishing.

While CO_2 emissions from new cars and vans are being successfully reduced under recent EU legislation, these are not directly transferable to HDVs, as this sector is characterised by a wide variety of vehicle configurations and options and thus the associated testing and data costs are very high. The HDV strategy, adopted in May 2014, is the EU's first initiative to tackle such emissions from trucks, buses and coaches. This strategy focuses on short-term action to certify, report and monitor HDV emissions - an essential first step towards curbing them. Fundamental challenges specific to HDVs in this regard include:

- The relatively large number of vehicles sold for each passenger vehicle "type" that is approved makes vehicle type approval practical. For trucks the numbers of vehicles registered, and the diversity of vehicle types makes testing of each vehicle type much less practical.
- For light duty vehicles there are a relatively large number of chassis dynamometers with emissions testing facilities. There are very few heavy duty vehicle chassis dynamometers with emissions testing facilities capable of testing, for example up to 50 tonne GVW vehicles.

The approach being developed by the European Commission is to use a vehicle simulation tool rather than whole vehicle chassis testing because of the cost and practicality benefits in the context of the European heavy duty vehicle fleet. Key inputs to the simulation are the actual performance of key components, e.g. the vehicles engine, transmission, wheels, body weight and aerodynamics, trailer characteristic, auxiliary systems etc. Use of a vehicle simulator is being shown to provide fuel efficiency and CO_2 emissions data for existing whole vehicles, thereby circumventing the direct cost of dynamometer testing.

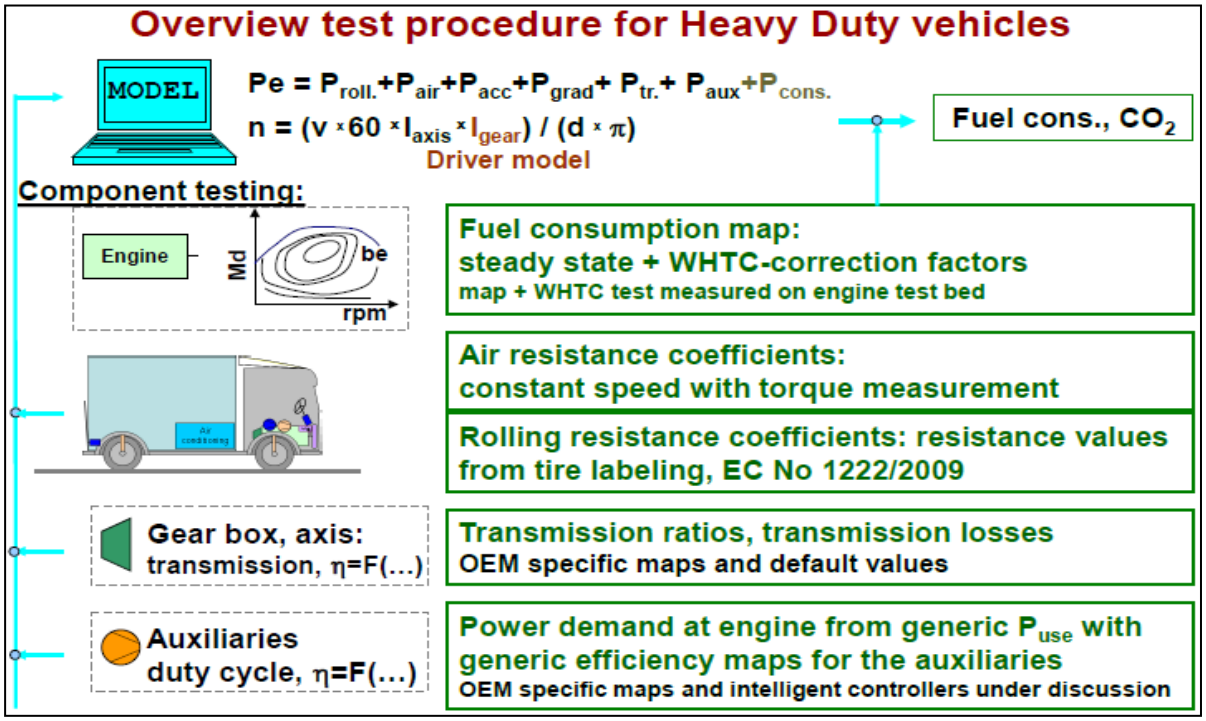
The 2012 certification procedure development report (TU Graz et al., 2012) proposed a simulation tool that took the results from the testing, or measurement, of key relevant components of the HDV as inputs to a tool that simulates the whole vehicle. This simulation tool, VECTO (Vehicle Energy Consumption Calculation Tool), calculates the fuel efficiency and CO_2 emissions of vehicles driven over a range of different mission profiles. VECTO's over-arching design is illustrated in Figure 4.16 below.

Extensive evaluation of the results obtained from the simulation tool against real vehicle emissions measurements obtained from physical tests showed that this approach delivers robust CO_2 figures for HDVs. Two follow up projects have provided further insight into this approach, referred to as *"Reduction and testing of greenhouse gas emissions from heavy duty vehicles: Lot 3"* (TU Graz et al, 2015) and a study (led by Ricardo Energy & Environment) developing and implementing a more sophisticated module for bus and coach auxiliaries (i.e. the electric, pneumatic and HVAC systems) that is currently being integrated into the main VECTO simulation tool.

With the support of the VECTO tool the Commission intends to propose legislation which would require CO_2 emissions from new HDVs to be certified, reported and monitored. This will contribute to a more transparent and competitive market and the adoption of the most energy-efficient technologies. Initial reports suggest this could be implemented from 2018 (European Commission, 2014), at least for diesel trucks (buses may follow in 2019 or 2020, as will alternative powertrains). Industry experts believe 2018 is likely for a CO_2 monitoring and declaration regulation, with possible limits to follow between 2020 and 2023 (AVL, 2015). Any targets introduced under such regulation would ideally need to be in line with the high level transport sector GHG reduction targets included in the EU's 2011 Transport White Paper (European Commission, 2011b).

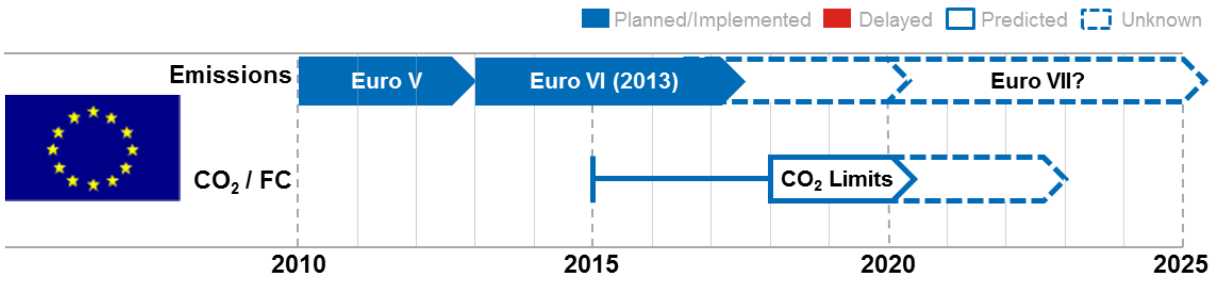
VECTO has two major differences from the US' GEM simulation model: it requires detailed engine map and transmission data from the manufacturer (whereas the EPA use default engine and transmission data) and has no separate standard for engine dynamometer testing.

Figure 4.16: EU's Vehicle Energy Consumption Calculation Tool (VECTO)



Source: (TU Graz et al., 2012)

Figure 4.17 - European legislative timeline (diesel HDVs only; type approval dates rounded to closest year)



4.4.2.2 North America

Although most countries have fuel economy standards for passenger vehicles, the United States[16], Japan and China are currently the only countries to set efficiency and GHG emission standards for HDVs. Medium and heavy duty GHG and fuel economy standards have been effective under US Federal law since 2014, having been published jointly by the EPA and NHTSA in September 2011. These are part of 'Phase 1' of the Heavy Duty National Program and were developed in response to a Presidential Memorandum in May 2010 to specify regulations over the 2014-2017 period. Phase 1 is intended to force engine manufacturers to "redesign and upgrade" their products (EPA, 2010).

The current rules have several important elements, they:

1. Drive efficiency improvements in many important aspects of the heavy-duty vehicle for the two highest fuel consumption classes: tractor trucks and pickup trucks;
2. Set separate standards for engines and vehicles;
3. Establish standards for four major GHG in addition to fuel consumption limits. (The inclusion of non-CO_2 GHG is particularly relevant/important for gas-fuelled HDVs).

[16] Including Canada, who adopted regulations largely consistent with those of the US in 2013.

The standards are also split into three vehicle categories, for which different rules apply:

- Combination tractors[17];
- Vocational vehicles[18]; and
- Heavy duty pickup trucks and vans (GVW >8,500lbs (3,856kg))

The latter category concerns HGVs from classes 2b and 3 (EPA, 2010) and thus is excluded from the scope of this study. The standards set to improve fuel efficiency that are, on average, 12% higher than in 2010 baseline. In 2017, the standards are expected to reduce GHG emissions by an average of 23% for combination tractors and 6-9% for vocational vehicles, as compared to a 2010 baseline (McCarthy & Yacobucci, 2014). Heavy duty pick-ups and vans, which are to achieve a 15% reduction by 2018 model year.

Within the combination tractor trailer category, standards have been further split into nine different subcategories of vehicles, which are based on weight class, cab type and roof height. All of which have different standards for 2017 (TransportPolicy.net, 2013). Similarly to Japan and the EU (in development), the US uses a simulation tool to predict whole vehicle fuel consumption, encouraging the use of aerodynamic design, lower rolling resistance tyres, extended idle reduction technologies and weight reduction. The US fuel economy procedure is distinct from these other regions though, principally due to the use of a separate engine standard.

In the US regime, both engines and vehicles have to undertake separate testing as part of the approval process. Engines are subject to the engine standards, with testing conducted over one test cycle: Tractor engines are tested over the steady-state Supplemental Emissions Test (SET), and vocational engines are tested over the Federal Test Procedure (FTP) transient test. This is so that engine manufacturers *"will design engines for the best GHG and fuel consumption performance"* relative to their real-world usage.

Chassis manufacturers are subject to vehicle standards, and this compliance is determined based on the USA Environmental Protection Agency's (EPA) Greenhouse gas Emission Model (GEM), which has been developed specifically for this regulation. The GEM model uses a combination of following three testing cycles, weighted differently depending on the vehicle type:

1. ARB Transient cycle;
2. 55mph cruise;
3. 65mph cruise.

The particular engine characteristics to be used in the vehicle are not considered, and another engine is selected that is representative of the vehicle type. The regulation does not require chassis dynamometer testing due to the large variety of vehicle configurations, and the scarcity of heavy-duty chassis dynamometer test facilities.

The EPA and National Highway Traffic Safety Administration (NHTSA) have derived the baseline engine and vehicle configuration by examining engines and vehicles in the existing fleet to represent the typical 2010 model year vehicle and engine. To attain the data the authorities had to undertake an additional testing programme of engines and vehicles, as this information was not available through existing gathered data. The technology paths considered for determining what regulatory standards would be cost-effective, technologically feasible, and otherwise appropriate in the lead time afforded by the rulemaking are, in turn, built from this baseline.

The agencies developed the baseline tractor attributes for each subcategory to represent an average 2010 model year tractor, including:

- Aerodynamics (Cd);
- Steer, and Drive tyres' rolling resistance (Crr kg/metric ton);
- Weight reduction (lb);
- Extended Idle Reduction (gCO_2/ton-mile reduction);
- Whether the vehicle has a speed limiter;
- Engine capacity.

[17] Combination tractors are tractor units for articulated haulage vehicles. Vocational tractor units are subject to the vocational vehicle standards.
[18] 'Vocational vehicles' include refuse and utility vehicles, school buses, emergency vehicles, tow trucks, etc. Recreational vehicles are exempt from the fuel economy legislation but are required to conform to the CO2 legislation.

The approach was to define the individual vehicle variables and input them to the EPA's GEM. Evaluating the industry's tractor offerings, it was concluded that the average tractor contains a generally aerodynamic shape (such as roof fairings) and avoid classic features such as exhaust stacks at the b-pillar which increase drag. The agencies consider a baseline truck as having "conventional" aerodynamics.

The agencies then assessed the potential to reduce emissions, and improve efficiency of engines based on the technical potential of different engine technologies. These included various engine technologies, such as EGR cooler, water pump, oil pump, amongst others. Options to improve efficiency of the tractor units have also been considered. Here they factored in variables as low rolling resistance tyres, single wide tyre, aerodynamic fairings, and weight reduction[19].

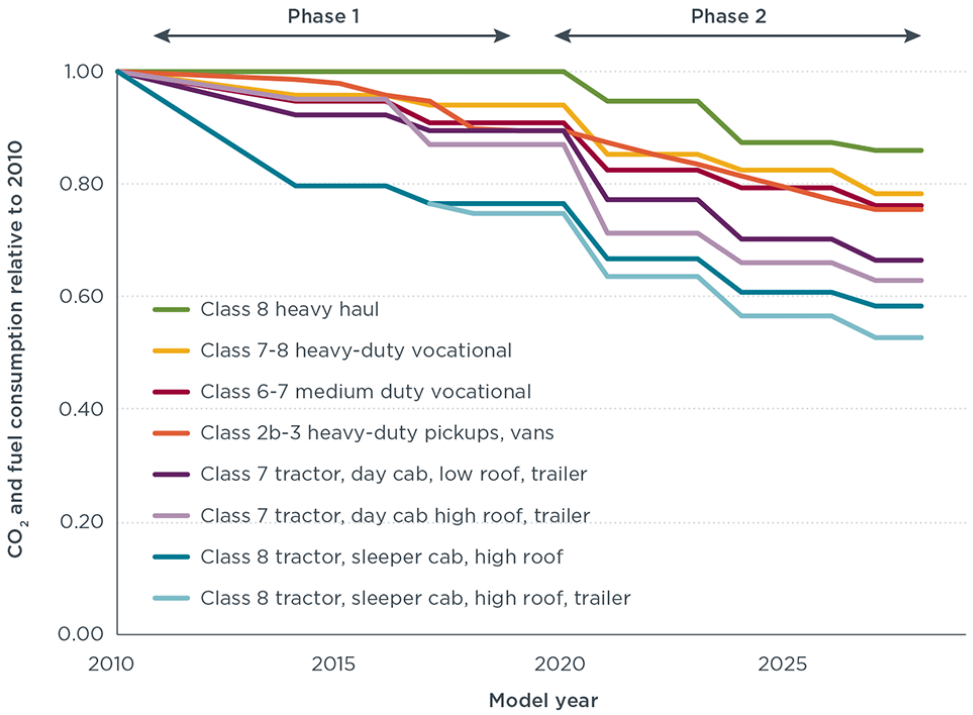
The EPA's current fuel economy and CO_2 standards cover the period 2014-2017. However, draft standards for a second round of GHG and fuel economy standards for medium duty and heavy duty vehicles were published in June 2015 (EPA, 2015) and are due to be finalised in early 2016. They will be effective from the 2018 model year[20] and will either follow 'Alternative 3' (tightening in MY 2021, MY 2024 and ending in MY 2027) or 'Alternative 4' (tightening in MY 2021 and ending in MY 2024)[21]. The second round of changes ('Phase 2'), cultivates a single national program, aligning the standards of the EPA, NHTSA and CARB to allow manufacturers to build a single fleet of vehicles and engines for the US market.

The Phase 2 standards are described in (EPA, 2015) as a "more technology-forcing[22] approach" which is "predicated on use of both off-the-shelf technologies and emerging technologies which are not yet in widespread use." The authorities state that it will be likely for manufacturers to require extensive use of such technologies and to apply them to all vehicles by 2027, additionally expecting compliance to be achieved via 'advanced' technologies such as hybrids and waste heat recovery systems in a lesser number of cases. Phase 2 brings further use of the simulation approach, and improved consideration of the whole vehicle. Figure 4.18, from (ICCT, 2015c), shows the relative impacts of Phase 1 and 2 on CO_2 emissions. Separate limits exist for both vehicle and engine emissions.

An averaging, banking and trading (ABT) scheme, which was in place since pre-2000, was also extended to fuel economy and CO_2 under the current regulation and additionally allows manufacturers to offset CH_4 or N_2O emissions against CO_2 credits at a rate based upon the relative global warming potential of the gases. Credits were also made available for meeting the standards early, introducing advanced powertrain technologies and the use of off-cycle CO_2 reduction technologies.

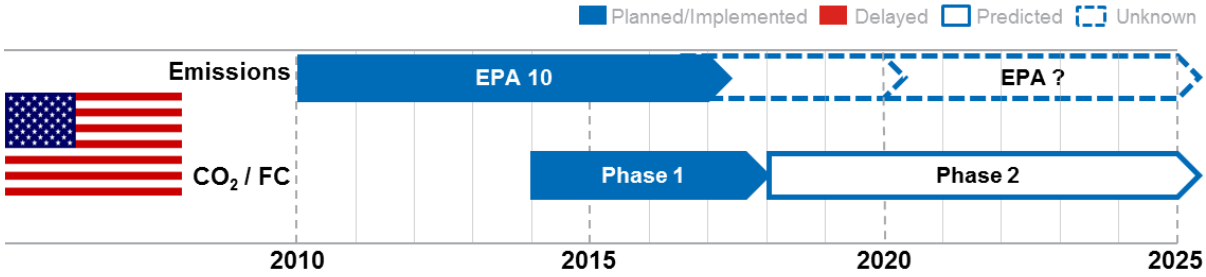
[19] http://www.theicct.org/sites/default/files/publications/ACEEE%202013%20HDV%20alignment.pdf
[20] Trailer standards from the EPA only; NHTSA trailer regulations will be voluntary from 2018-2020 and mandatory from 2021.
[21] The remainder of this text will refer to Alternative 3. Alternative 4 principally brings forward the 2027 requirements to 2024, though this does have technology *cost* implications as described in section **Error! Reference source not found.**. It would appear that Alternative 3 is the authorities' preferred option.
[22] From (EPA, 2015): "In this context, the term "technology-forcing" is used to distinguish standards that will effectively require manufacturers to develop new technologies (or to significantly improve technologies) from standards that can be met using off-the-shelf technology alone. Technology-forcing standards do not require manufacturers to use any specific technologies."

Figure 4.18: Summary of CO_2 and fuel consumption reduction from adopted Phase 1 and proposed Phase 2 heavy duty vehicle standards



Source: (ICCT, 2015e)

Figure 4.19: North American legislative timeline (diesel HDVs only; type approval dates rounded to closest year)



4.4.2.3 China

The Chinese government started researching fuel consumption measures from 2008, seeking a procedure which combined chassis dynamometer results with a simulation. Two sets of standards were created, and operate in parallel for Chinese fuel economy standards. The adopted standards are known as 'Stage I' and are binary pass-or-fail, though they were intentionally designed to be relatively easily met:

- Industrial Standard QC/T 924-2011 (Ministry of Industry and Information Technology, 'Stage I')
- JT 719-2008 (Ministry of Communications Highway Research Institute)

The former specifies fuel economy limits in litres per 100km for HDVs applicable from February 2012 for type approvals and July 2014 for all vehicles. The standards require that the fuel economy of a vehicle be evaluated over a chassis dynamometer test procedure based on, and very similar to, the World Harmonised Vehicle Cycle (WHVC)[23] if it was a *base model*, or a vehicle simulation if it is a

[23] A chassis dynamometer test based on the same data from which the WHTC was developed, hence qualitatively comparable to it. The WHVC is not a standardised procedure, however. The original WHVC acceleration and deceleration values are reduced in order to reflect Chinese HDVs more accurately, for example to factor in the lower horsepower of Chinese trucks, and lower peak power of some points of the test cycle. The urban, rural and motorway cycle segments are also weighted differently to reflect the national driving patterns of China.

variant model[24]. Using the chassis dynamometer, a fuel consumption result is established by applying weighting factors to the fuel consumption over 3 distinct phases within the cycle. Using the simulation approach, tyre rolling resistance and rolling radius, air resistance, engine speed and torque profiles and gear-shift strategies are input into a model, and in combination with the base model data the simulation is able to estimate the fuel efficiency of the variant. The standard has separate limits for articulated and rigid trucks.

The latter standard was issued in September 2008 by the Ministry of Transport and is known as *"Limits and Measurement Methods of Fuel Consumption for Commercial Trucks"*, testing not over the WHVC but at steady speeds with applied weighting factors. It is used to validate commercial vehicle licences. The limits are split into those for diesel articulated trucks, diesel rigid trucks and diesel off-highway vehicles. *Note*: the different procedures for the two parallel standards means that they cannot be accurately compared.

In 2012, Stage II standards ('National' standards) were stipulated, and the final rule was published in February 2014:

- National Standard GB 30510-2014 (Ministry of Industry and Information Technology, 'Stage II')

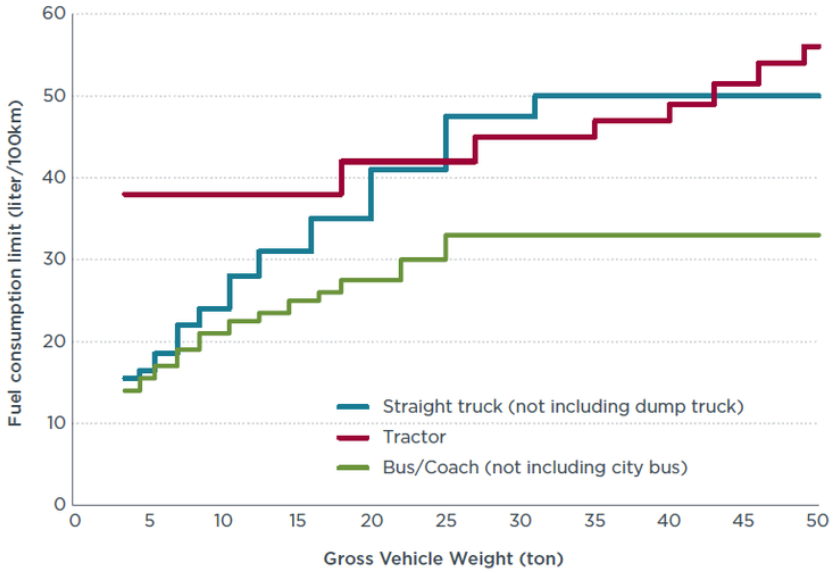
Introduction was set for July 2014 for type approval and July 2015 for all vehicles (MIIT, 2013). This added maximum fuel consumption levels for construction HDVs ('dump trucks') and urban buses, but continued to omits specialised vocational vehicles (8% of the market) from the regulations (ICCT, 2013).

To develop a baseline fuel consumption case, laboratories in China conducted a study in 2010 and 2011 to estimate the consumption of the newest vehicles in the fleet. The resulting test collected chassis and simulation tests of over 300 HDVs. In addition, before the standard took effect in July 2012, all new type approved models were required to submit fuel consumption data (starting February 2012). This allowed MIIT (Ministry of Industry and Information Technology) to collect fuel consumption data that would be used for establishing a future national fuel consumption standard for HDVs.

Stage II tightens vehicle consumption limits for articulated trucks, rigid trucks and coaches. After developing an initial baseline standard for vehicles in 2012, fuel consumption standards were tightened by 11.5% for trucks, 10.5% for coaches and 14% for tractors. This tightening of the standard is noticeable from the differential in fuel consumption between Figure 4.20 and Figure 4.21. The standards are consequently not as easily met by manufacturers (versus Stage I) and approximately half of applicable HDVs are not expected to be able to meet Stage II limits, according to the ICCT. Gasoline vehicle limits are allowed a 20% higher fuel consumption limit than diesel vehicles, reduced from 30% in Stage I. The reduction in fleet average fuel consumption is expected to reach 11% by 2015 (ICCT, 2015a).

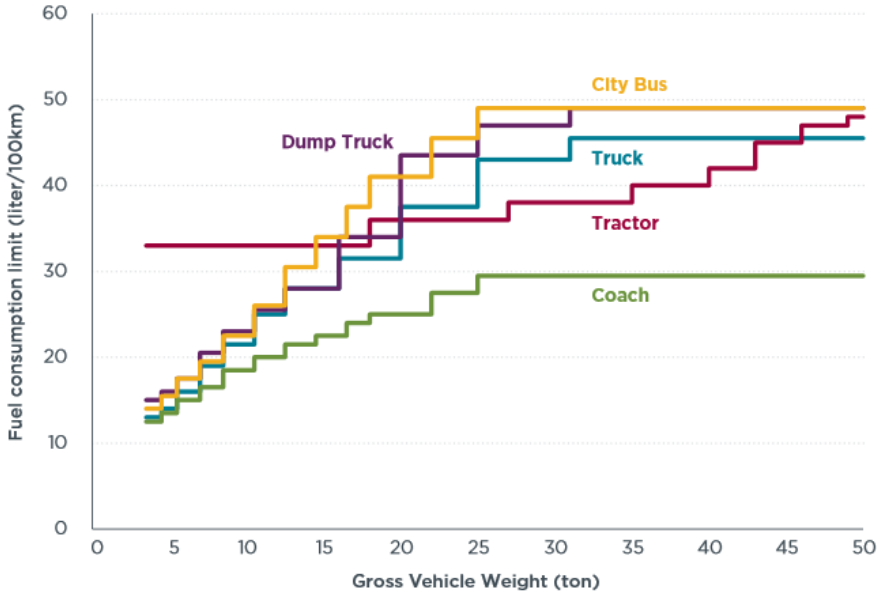
[24] A vehicle can be considered a variant if it has no changes in specified design parameters. These are given officially in (CVTSC, 2012), or are summarised in Box 1 of (ICCT, 2014).

Figure 4.20: Graphical representation of Chinese Stage I fuel economy standards



Source: (TransportPolicy.net, 2013)

Figure 4.21: Graphical representation of Chinese Stage II fuel economy standards



Source: (ICCT, 2013)

4.4.2.4 India

India does not currently have fuel economy or CO_2 standards. In 2007 the Indian government attempted to draft fuel economy standards, however these were adjourned after pressure from the automotive industry. Low-CO_2 HDVs are indirectly supported by the wide availability of natural gas fuels, particularly in public fleets. For example, the Supreme Court formed a Directive in 1998 which stated that all buses in Delhi must be converted to CNG by April 2001, eventually occurring in December of 2002.

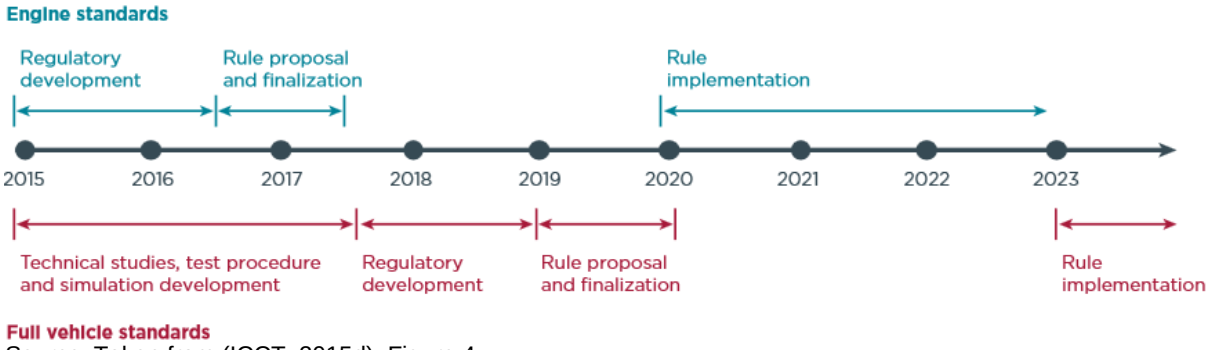
India announced minimum fuel efficiency limits in January 2014 for passenger vehicles starting in 2017, so it was expected that HDV standards would soon follow. Indeed, in July 2014 it was announced that India would develop fuel economy standards for HDVs and policymakers and stakeholders have begun the regulatory development process. Ricardo Energy & Environment was

previously commissioned by the Indian government to help inform the possible development of the new standards.

As the standards are in their earliest stages, the majority of the strategy is unknown. The ICCT argue that as the Indian market is comparable to the US market – regarding both its large independent component manufacturers at odds with its OEMs, and its large variety of HDV configurations – the first phase of any such regulation would benefit from separate engine standards (ICCT, 2015c). Conversely, the ICCT do not believe chassis dynamometer testing should be used for the purpose of fuel efficiency measurement (ICCT, 2015d). Experts at a recent IEA workshop (IEA, 2015) also determined that a simulation tool would be costly and difficult to develop for India. Even to adapt a tool (such as VECTO being developed for Europe) to Indian conditions was envisioned to take long enough that India is unlikely to follow a simulation-only approach.

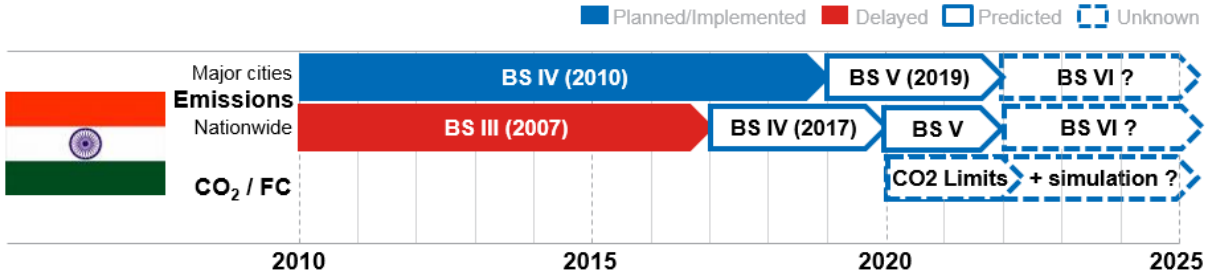
Signifying that under ideal conditions the engine standards could be implemented from 2020, ICCT believe that a second set of rules could be introduced by as early as 2023. This, they suggest, would begin to make use of other testing strategies such as simulation models and would cover the full vehicle. This is potential scenario illustrated in Figure 4.22 below.

Figure 4.22: An ICCT-proposed idealised regulatory timeline for fuel economy standards in India



Source: Taken from (ICCT, 2015d), Figure 4.

Figure 4.23: Indian legislative timeline (diesel HDVs only; type approval dates rounded to closest year)



4.4.2.5 Japan

Japanese emission and fuel economy standards are the joint responsibility of the Ministry of Environment, the Ministry of Land, Infrastructure and Transport (MLIT) and the Ministry of Economy, Trade and Industry (METI). The ministries create noxious emissions regulation under the Air Pollution Control Law and fuel economy under the Energy Conservation Law.
There are three sets of approval systems in Japan:

- The Type Designation System: the type approval applying to mass produced vehicles of identical construction.
- The Type Notification System: used mainly for large heavy duty applications where there are many variants in configuration and for type approval of modified vehicles.

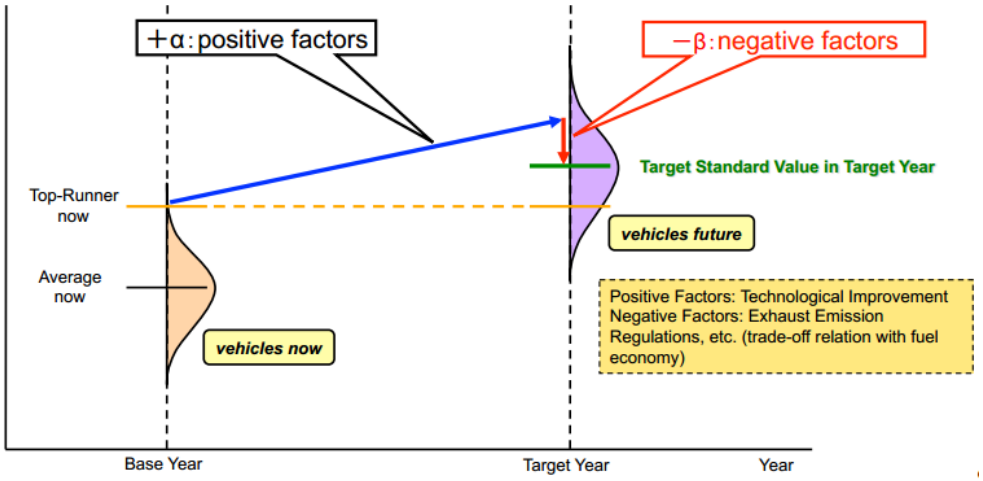
- The Preferential Handling Procedure: type approval of imported vehicles of less than 2,000[25] of each type, per year.

Japanese standards specify a type approval limit and, additionally, a production average[26] which is lower. The mean limits are used for the Type Designation and Type Notification Systems. The maximum limits apply to individual vehicles and these are used for the Preferential Handling Procedure.

Originally, Japan classified a heavy duty vehicle as one with a GVW in excess of 2,500kg. This was brought in line with Europe to 3,500kg in 2005. All Japanese HDVs of over 3,500kg are treated equally in terms of current noxious emission limits (with minor deviations for buses) but at a more disaggregated categorisation level for fuel economy standards.

Japan's fuel economy standards are set using the 'top runner' principle, which identifies the most energy efficient product available at the time of developing the standards and sets this as the requirement for the same class in the target year, after adjusting for external factors. This is not just a minimum bar that all vehicles must reach, but is a fleet average, which Figure 4.24 below illustrates. As this 'top runner' was not readily available through existing data gathered by the authorities, tests were undertaken to discover this 'top runner' HDV. The 2015 standard is such that average fuel consumption of the vehicle fleet must be higher than the 2002 'top runner'.

Figure 4.24: Japanese approach to setting baseline performance of HDVs



Source: (MLIT, 2011)

Japan was the first country in the world to apply these to HDVs, enacting the standards for diesel vehicles in April 2006 and making them applicable from the 2015 model year. These effectively required an average HDV fuel economy improvement of 12.2% by 2015 over 2002 levels[27] (HVFESE, 2005). Spark-ignition vehicles are not regulated – only diesel fuelled HDVs (GVW > 3,500kg), including trucks and buses. Transit buses, non-transit buses, rigid trucks and articulated trucks are given separate fuel efficiency targets.

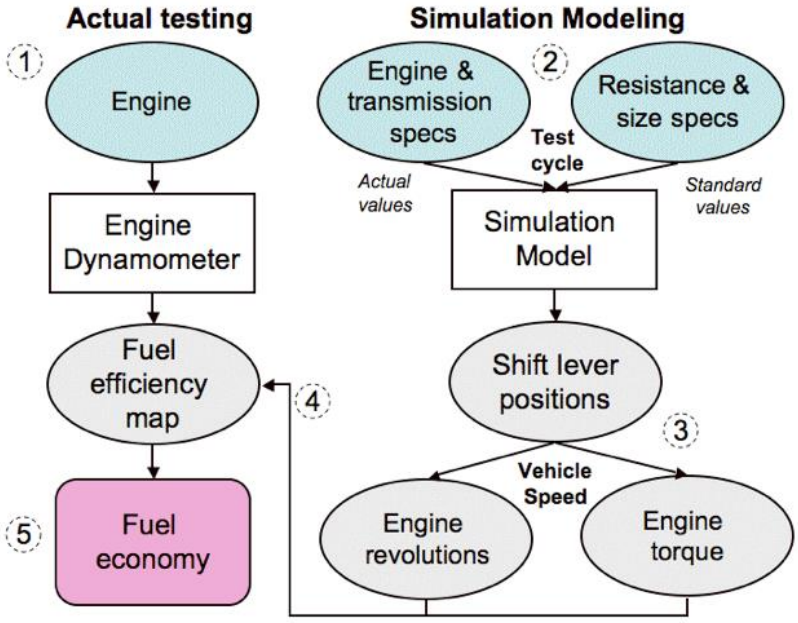
The testing criteria is split into two categories: (i) engine, and (ii) vehicle. Engines are tested on an engine dynamometer to generate fuel consumption data on a minimum of thirty speed-torque points, as chosen by the manufacturer. These results are used to produce an engine map based on two dynamometer tests, which is fed into a simulation tool. The vehicle's overall fuel efficiency is derived from aggregated simulation results using inputs from these two engine dynamometer tests: (a) a JE05 urban cycle and (b) an 80kph constant speed, variable load interurban transient cycle[28] (see Figure 4.25:). This aggregation is based upon weighting factors reflecting assumptions about the mix of operating environments within which vehicles of a given class and gross vehicle weight operate. The

[25] This may be increased to 3,000 per year on condition of an early transfer to the Type Notification System, according to (JAIA, 2004).
[26] This average is over vehicles of the same type which have already passed the type approval process.
[27] 12.2% for trucks, 12.1% for buses; 9.7% for articulated HDVs, however this makes little difference as they are a very small proportion of the fleet.
[28] For further detail see reference (HVFESE, 2005).

simulation also takes into account other vehicle parameters such as tyre diameter, gear ratios, gear efficiency and approximates air drag based on the frontal area.

Unlike the US, who use a 'default' transmission, and the EU, who could potentially use full manufacturer transmission data in VECTO, Japan is half-way between and uses average transmission specifications from the manufacturer from the relevant vehicle category. The standards are expressed in km per litre, are based on GVW and apply as a corporate average fuel efficiency (CAFE) across GVW ranges each year, though a credit system could be used between ranges until full enforcement in 2015.

Figure 4.25: Japan's method of deriving HDV fuel economy

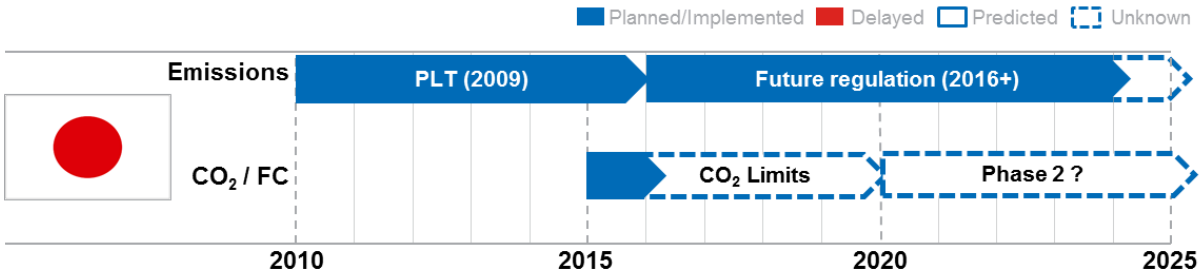


Source: (TransportPolicy.net, 2012)

There are financial incentives to meet the mandatory standards in the form of tax reductions, though conversely, fines for non-compliance are not substantial. Indeed, the Ministry of Economy, Trade and Industry described the penalties as "relatively loose".

Japan's fuel economy legislation was fully enforceable from 2015. It is thus expected that revisions or the next phase will shortly begin development, as is typical for vehicle emission legislation cycles. It is anticipated that the fuel economy standards will be tightened in the mid-term (Daimler, 2011).

Figure 4.26 : Japanese legislative timeline (diesel HDVs only; type approval dates rounded to closest year)



4.4.2.6 Ukraine

An old (from former Soviet Union times) standard GOST 20306-90 is still used in Ukraine to determine the fuel consumption of road vehicles of a variety of categories (though mainly heavy duty vehicles)

that are not yet already covered by European or other standards. The standard covers all types of road vehicles except off-road vehicles. The standard is not currently obligatory, but is used in some cases when putting a new vehicle into production within the overall procedures of approval of technical specifications for automotive use or in other cases when the fuel consumption parameters are a subject of particular interest.

It must be noted that GOST 20306-90 was replaced in Russian Federation from 2012 to new standard, namely it is GOST P 54810-2011 with mainly minor changes in comparison to GOST 20306-90, expect for narrowed field of application. Vehicle types such as passenger cars and LDV are now excluded, taking in to account in-use international standards within 1958 Geneva Agreement and new worldwide procedures. Hybrid and gaseous powered vehicles are also not covered by new GOST P 54810-2011. In addition, the fuel-speed feature on extra-urban hilly roads is excluded from GOST P 54810-2011.

GOST 20306-90 and its successor GOST P 54810-2011 (applied in the Russian Federation) are interesting in terms of their methodological approaches to test vehicle on a road track and the set of parameters used to characterize fuel efficiency properties of a vehicle. The GOST 20306-90 set of parameters, used to characterize fuel efficiency properties of a vehicle, consist of the following elements. (More information on the specific cycles provided in Annex III of this report):

1. So called *'control fuel consumption':* this is the function of set of two constant speed fuel consumption points, that are different depending of vehicle type:
    a. 40 km/h and 60 km/h for city bus and full-drive trucks with fully loaded mass over 3500 kg;
    b. 60 km/h and 80 km/h for different types of cargo vehicles and buses;
    c. 90 km/h and 120 km/h for passenger cars and other vehicles with loaded mass < 3500 kg;

    Plus chassis dynamometer urban cycle results for vehicles with loaded mass < 3500 kg;
2. Fuel consumption on an extra-urban driving cycle on a road track;
3. Fuel consumption on an urban driving cycle on a road track;
4. Fuel consumption on an urban driving cycle on a chassis dynamometer (based on an old European driving cycle for passenger cars);
5. Steady-speed fuel consumption curve: on road track test using top gear from maximum to minimum stable speeds with 20 km/h step for passenger car and 10 km/h step for other types of vehicle;
6. Fuel-speed feature on extra-urban hilly road.

The testing methodology, and especially the full fuel delivery acceleration phases, have been the subject of criticism previously. However, other known vehicle's testing standards that have utilised constant (or strictly pre-set) acceleration curves have also been shown to be far from perfect and subject to a similar degree of criticism.

4.4.3 Current situation and summary assessment of the suitability of different options for Ukraine regarding HDVs

There is currently no standard testing protocol applied across all HDVs in Ukraine. However, the introduction of technical regulations on the CO_2 emissions for new HDVs on the base of fuel economy or GHG emission labelling together with appropriate fiscal measures to stimulate more fuel efficiently technologies choice has significant potential in Ukraine in the long term. Nevertheless, there are significant challenges that need to be overcome in the short-term.

It is assumed that the most promising way for Ukraine is to develop approaches and practical proposals here would be to first take into account the approach being currently considered for the EU above, as well as taking in to account experience, conditions and limitations, considered for Ukraine. Ukraine has already used specific approaches regarding HDV testing procedures (GOST 20306-90, being voluntary), that might be a subject for deeper evaluation together with other established approaches to help reduce the size of the "off-cycle" emissions differential.

The approach being currently developed in the EU involves a combination of specific component tests and mathematical simulation to estimate the overall whole-vehicle results over different duty cycles. The mathematical simulation of road vehicles' fuel consumption and emissions is also already widely established in Ukrainian scientific school (the National Transport University first of all). The State Enterprise State Road Transport Research Institute, being in close joint scientific activities with the National Transport University has developed and uses its own original sophisticated mathematical simulation system and "Vehicle Performance Analysis System" software with appropriate national scale experience in this field. "Vehicle Performance Analysis System" contains software set used as for mathematical simulation as for real life testing of vehicle on the test bench or on the road and engine on the test bed in one common system. However, at the same time, sufficient input data set for reliable mathematical simulation is in itself still a big problem in practical terms. Furthermore, developing a separate, new approach would likely be expensive and time-consuming, therefore it would seem to make more sense to utilise/align with an approach at least based on that already developed/being developed elsewhere.

Therefore in the short-medium term the main options would appear to be:

(a) Build up an approach based on the currently voluntary GOST 20306-90 standards, with further development and moving to make this mandatory. However, this could be an expensive approach if significant physical whole-vehicle testing were required, and would require significant investment in relevant infrastructure. *OR*

(b) Start with an engine-based regulatory approach, for example, the quantification of CO_2 emissions per kWh over the WHTC and WHSC test cycles will be required for Euro VI, so it may be that initial engine-based standards could be developed based off this.

- Potentially this could be supplemented with an approach similar to the SmartWay programme in the US with specific credits also given also for the use/inclusion of certain technical options.

(c) In the medium term it may make more sense to align with the component testing and whole vehicle simulation approach of the EU if possible, also taking into account the specific characteristics of the Ukraine HDV market, and use conditions.

In general terms, the approach to be taken in the short-medium term should in any case aim to develop an affordable, adequate and effective system on the base of international scientific cooperation in this field for future subsequent broader harmonization.

Proposals for the design of a combined policy approach regarding vehicle's GHG regulation in Ukraine, taking in to account Ukrainian specific conditions, is set out in later Section 4.7 of the report.

4.5 Powered two-wheelers (P2W)

4.5.1 Review of the approaches in-use or planned in different regions for determination of P2W CO2 emission / fuel consumption

This section provides a review of the options in-use or planned in different regions for determination of P2W CO_2 emission / fuel consumption. The methods for testing P2W regarding fuel economy and CO2 as well as other pollutants emission are in general similar to those applied for LDVs.

4.5.1.1 European Union

The measurement/provision of CO2 emissions data for P2W as part of the overall type-approval process is now mandatory in the EU. According to EC Directive 2002/51/EC [29] :
"…from 1 January 2006 Member States may no longer grant EC type approval and shall refuse national type approval for a two- or three-wheel vehicle if its CO2-emission and fuel consumption are not established in accordance with the relevant provisions."

[29] DIRECTIVE 2002/51/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, of 19 July 2002, on the reduction of the level of pollutant emissions from two- and three-wheel motor vehicles and amending Directive 97/24/EC. From: http://eur-lex.europa.eu/resource.html?uri=cellar:df192962-66a9-45ef-bdd9-33e609632388.0004.02/DOC_1&format=PDF

Reporting requirements for motorcycles/P2W from 2016/17 are also expanded and updated in Regulation (EU) No 168/2013[30], and include the provision of information to the consumer:
"In addition to the indication on the certificate of conformity, the manufacturers shall ensure that the CO2 emission, fuel consumption, electric energy consumption and electric range data are provided to the buyer of the vehicle at the time of purchase of a new vehicle, in a format which they consider appropriate."

This regulation also updates the required test cycle to be used for future reporting to the Worldwide harmonised Motorcycle Testing Cycle' (WMTC) as defined by UNECE global technical regulation No 2. This new test cycle has been designed to be more representative of real-world driving conditions.

There are currently no regulatory limits for CO_2/fuel economy from new vehicles, nor official requirements central monitoring of such information (i.e. there are no centrally managed databases of this information).

4.5.1.2 United States

Similarly to the EU, there are no government regulations regarding for fuel economy on motorcycles and there is also no standardized test used for motorcycle fuel economy in US yet.

According to (IB Magazine, 2011), despite the lack of standardized reporting requirements, every motorcycle with an engine larger than 169 cc is required to be tested using exactly the same "City" driving cycle that is used to produce the fuel economy values car and truck manufacturers are required to disclose. This is because this driving cycle is used to determine compliance with exhaust emissions standards. As a result, many manufactures in the US report 'unadjusted' city fuel economy values for motorcycles and scooters. Some others (e.g. BMW and Harley-Davidson) also report fuel economy values based on both the EPA City test and the EPA Highway test used for LDVs.

4.5.1.3 Japan

There is currently no regulatory requirement to report on fuel consumption or CO_2 emissions in Japan (and consequently also no regulatory target standards) (UNECE / ME Japan, 2016).

Previously, Japan's standard, steady-state motorcycle test measures vehicle fuel consumption at 60 km/h for over-50cc motorcycles with rider and passenger, and at 30 km/h for 50cc-and-under motorcycles with rider. However, according to (JAMA, 2013), four Japanese motorcycle manufacturers (Honda Motor Co., Ltd., Kawasaki Heavy Industries, Ltd., Suzuki Motor Corporation, and Yamaha Motor Co., Ltd.), who are also members of the Japan Automobile Manufacturers Association (JAMA), have adopted a voluntary initiative for the display of new, World Motorcycle Test Cycle (WMTC)-based motorcycle fuel consumption values in motor vehicle catalogues and other materials, effective as of July 2013, to complement Japan's standard steady-state motorcycle test method-based values. (Japan's standard, steady-state motorcycle test measures vehicle fuel consumption at 60 km/h for over-50cc motorcycles with rider and passenger, and at 30 km/h for 50cc-and-under motorcycles with rider).

According to Ricardo's EMLEG service ***(EMLEG, 2016), the current motorcycle emissions standards, established by the Ministry of Environment and the Ministry of Land, Infrastructure and Transport, were introduced in September 2013. The standards for motorcycles and larger mopeds now use the WMTC test cycle. However, the standards for smaller mopeds continue to be based upon the ISO 6460 test cycle. New standards for air quality pollutants, to include OBD and evaporative emissions, are proposed for the beginning of 2017 and these will be based upon Euro 4 limits (with some variations) and will use the WMTC procedures and vehicle classifications also.***

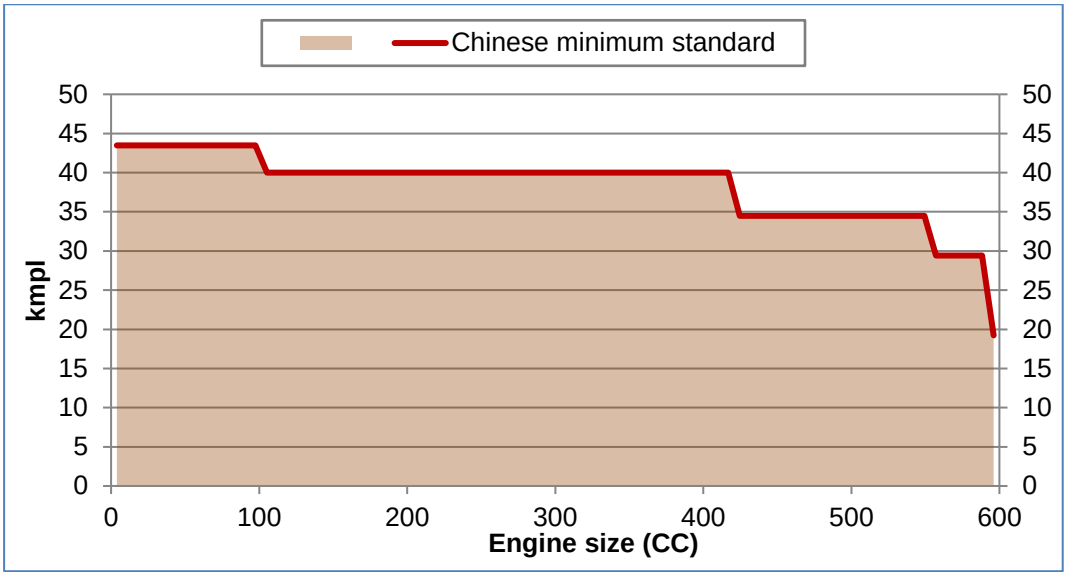
[30] REGULATION (EU) No 168/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, of 15 January 2013, on the approval and market surveillance of two- or three-wheel vehicles and quadricycles. From: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0168&from=EN

4.5.1.4 China

Mandatory standards for 2 wheelers have been implemented only in China and in Taiwan, in the form of minimum standards, as shown in Figure 4.27; they allow manufacturers to sell only models which are above a lower efficiency limit, specified according to engine size. China's national standards GB 15744-2008 and GB 16486-2008 set these fuel consumption limits for motorcycles (applying to engines larger than 50cc) and mopeds (only defined for engines ≤50cc), respectively (TransportPolicy.net, 2016). Both standards set different limit values for two and three-wheelers. This type of policy has the advantage of being easy to implement and to eliminate quickly the worst polluters from the market. However, minimum standards do not encourage manufacturers to improve above the baseline. Similar (but not identical) standards are also applied in Taiwan according to (ICCT, 2011), but are not directly comparable as they use different testing protocols (TransportPolicy.net, 2016).

China's Stage II standards are reportedly still under development by the Ministry of Industry and Information Technology (MIIT) and Certification and Accreditation Administration (CNCA).

Figure 4.27: Chinese minimum standards on fuel economy of powered two-wheelers



Source: Ricardo analysis of information from (ICCT, 2011)

4.5.1.5 India

In India, powered two-wheelers (P2W) are currently the second largest contributor to road transport fuel consumption/GHG emissions (HDVs being the largest) and are responsible for 15-20% of total CO_2 emissions from transport. India is therefore considering the potential for fuel economy standards for P2W. (ICCT, 2012). In 2011 SIAM published the declared fuel efficiency of most two-wheelers available on the market; it was a one-off voluntary initiative and the final list included nearly 80 models (SIAM, 2011).

Market reviews and analysis, available through websites and periodicals, also routinely provide a comparison between declared values and on the road tests, suggesting that manufacturers often release figures that are not achievable in real world driving conditions. In 2012, ICCT published a study on the Fuel Consumption Reduction Potential from Two and three wheelers in India (ICCT, 2012a), which included a summary of on the road tests carried out on models included in the 2011 list released by SIAM. Real world consumption proved to be 10-15% higher than that declared by manufacturers. For example, while the declared average fuel economy reported for motorcycles with engine size between 75-125cc was 80 km/l, the average measured was only 68.5 km/l.

4.5.1.6 Worldwide harmonization

Driving cycles patterns of Worldwide harmonised Motorcycle Testing Cycle (WMTC) as defined by UNECE global technical regulation No 2, are provided in Annex III, and have already been taken up in Europe and Japan. Further modifications of WMTC driving patterns are under discussion for better representation different regions of the world.

4.5.2 Summary assessment of the suitability of different options for Ukraine regarding P2W

The share of P2W in GHG emission from vehicles in Ukraine is very low (0.3% in 2014), but is growing relatively quickly. Whilst there does not seem to be a compelling need for regulatory standards, it is assumed that the introduction of P2W fuel consumption labelling in Ukraine will lead positive effect in any case.

4.6 Other considerations for measurement of vehicle emissions

There are two further key considerations that are discussed briefly below and which are related to:

1) The issue of off-cycle / real-world emissions gap, its consequences and potential solutions;
2) The incompatibility of standards of different regions of the world with respect to regulation in Ukraine.

4.6.1 Off-cycle / real-world emission considerations

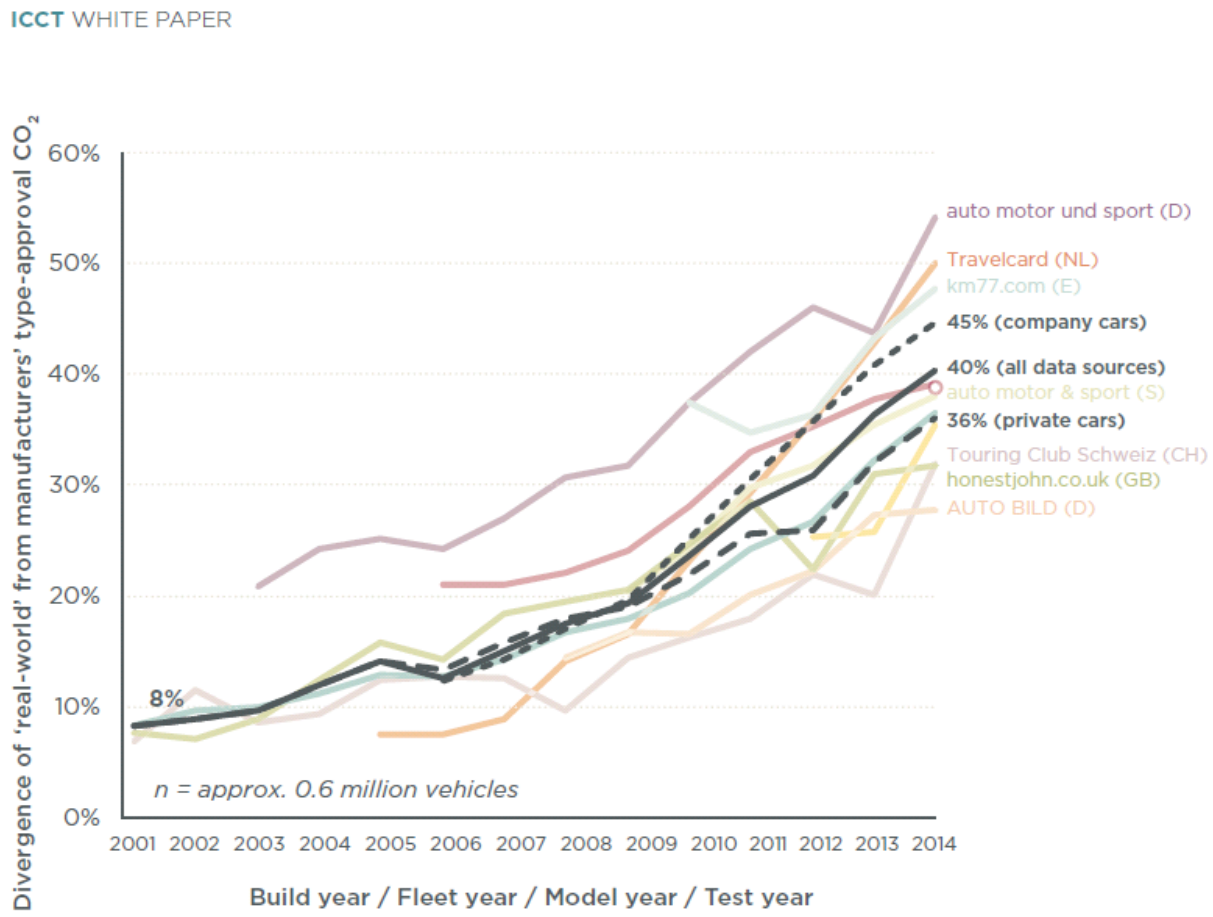
4.6.1.1 The problem and its impacts

The off-cycle / real-world emission problem can be considered throughout imperfection of vehicle and engine test procedures regarding obtained values of emission and fuel consumption, resulting not only in the divergence from average real operating conditions, but in principal opportunities for manufacturers to present a misleading picture to consumers, and the state as a regulator, with aim of fulfilling legal requirements at the lowest cost and/or gain a competitive advantage in the market.

At present, vehicle emission and fuel efficiency regulations rely on results obtained from certification tests, also called type-approval tests. But the certification tests include a number of tolerances and flexibilities that, together with strictly predefined test pattern, can be exploited to produce even unrealistically low CO_2 emission values. In addition, a range of technologies that have been applied to vehicles to aid compliance with regulatory targets, are not nearly as effective under real-world driving conditions, for example these include hybrid technologies, stop-start systems, automatic transmissions designs, as well as gasoline combustion engines that make use of direct injection and downsizing.

Recent research from (ICCT, 2015) has shown a significantly increasing divergence over time of regulatory values for CO_2 emissions from passenger cars in Europe, versus real-world data, as shown in Figure 4.28. In the US, the situation is much better as there are fewer flexibilities possible under their testing protocols and some adjustments are also made to the test figures to bring them into better alignment with likely real-world average performance.

Figure 4.28: Divergence between real-world and manufacturers' type-approval CO 2 emissions for various real-world data sources, including average estimates for private cars, company cars, and all data sources.



Source: (ICCT, 2015)

(ICCT, 2015) also has estimated the main reasons for the divergence between type-approval and real-world CO_2 emission levels for new passenger cars in the past as well as in the future, with and without introduction of the WLTP, with the main reasons including:

- Road load determination "underestimation" when vehicle`s input data are putted in the chassis dynamometer settings that simulate road load in real conditions;
- Chassis dynamometer testing flexibility (increasing use of 'flexibilities' or permitted variances in the type-approval procedure in a favour of "better" results in testing reports);
- Technology deployment (including increasing application of technologies that show a higher benefit in type-approval tests than under real-world driving condition, etc.);
- Other factors including external factors changing over time (for example, increased use of air conditioning, driver behaviour, etc. (Although for the time being these later considerations are considered as not the determining factor in the current tendency for widening deviations).

It is anticipated that the size of the gap could continue to increase to as much as 50% in the future, due to a combination of further exploitation of flexibilities and increasing market share of hybrid and especially plug-in hybrid vehicles (i.e. if their usage pattern diverges from that assumed in the tests). With the introduction of WLTP, it is estimated that the overall level of divergence could drop to about 23 percent by 2020. However, it is uncertain what the effects of PHEV uptake will be, and on whether additional flexibilities in WLTP might be discovered/exploited.

The considerable and moreover far growing divergence between type-approval (or regulated) and a real life CO_2 emission values has policy implications for all key transport stakeholders:

- From a ***government's perspective***, the growing divergence may undermine the efficacy of vehicle taxation schemes that means at least:
  - Governments experience an increasing loss in tax revenues (most EU member states use type-approval CO_2 emission values to determine vehicle taxes);
  - Misallocation of public funds since vehicles that benefit from low carbon type-approval's figures may not deliver the desired performance under real-world conditions.

  For tax authorities, the gap between type-approval and real-world CO2 values translates into a gap between actual and potential revenues from vehicle taxes.

- From a ***customer's perspective***, the growing divergence may:
  - Introduce consumer confusion and increase expected costs (since manufacturers' proclaimed fuel savings and reductions in fuel expenses may not materialize under real-world conditions);
  - Undermine consumer trust not only to fuel consumption values (due to unexpected fuel expenses), but also to fuel-saving technologies as a whole.

- From a ***societal perspective***, the growing divergence weakens efforts to mitigate climate change and to reduce oil dependence of a country. If consumers progressively lose faith in type-approval fuel consumption values, this in turn may undermine government efforts to encourage the purchase of fuel-efficient vehicles through labelling and tax policy.

- From a ***manufacturer's point of view***, reducing CO_2 emissions on regulatory cycles, rather than in real-world conditions may constitute the most cost-effective pathway in the short term, but undermine consumer confidence in the longer term. Increasing discrepancies between type-approval and on-road CO_2 emissions can also result in a competitive disadvantage for some manufacturers, as it tilts the playing field.

It is worth noting that the current diesel emissions scandal appears to have propagated further resulting in the uncovering of wider misreporting of CO_2 emission and fuel consumption figures in a number of territories. As a result, this is further undermining consumer confidence and it seems likely that much more rigorous enforcement of existing regulations and the development of improved protocols in the future will result.

4.6.1.2 Potential solutions

Improved vehicle emission testing schemes

Improved vehicle emission testing schemes and more stringent enforcement of regulations will help to create a more level and fair playing field for car manufacturers. The objective should be for improvements to the current regime to better cover both the positive and negative impacts of 'off-cycle' emissions from technologies – i.e. to better capture benefits of some measures in the real-world.

In-use conformity testing for CO_2 and, in the same time, toxic pollutants emission of vehicles

In-use conformity testing for CO_2 and, at the same time, toxic pollutants emission of vehicles, even within the existing type-approval laboratory test is a very important element to be implemented, since new vehicles tested in the laboratory use often specially prepared pre-series vehicles. Ideally, such vehicles should be suddenly and randomly selected and tested by independent bodies in manner that it would be at least difficult to predict and/or control from the side of manufacturer in this process.

Real-Driving Emissions on-road testing

Recently adopted by the European Commission, the Real-Driving Emissions (RDE) test procedure using of portable emission measurement systems (PEMS) to test vehicles on normal roads during real-world driving patterns gives the potential to see real-world toxic pollutant emissions and can be considered as a big step forward. This type of on-road emission measurement might also be extended also to official CO_2 emissions monitoring. A real-world CO_2 adjustment factor is a feature for consumer information that might also be considered as a complementary measure here according to (ICCT, 2015).

On-board diagnostic (OBD) system can be good source of real world data regarding emission

On-board diagnostic (OBD) systems are used to diagnose and report technical malfunctions, and track a wide range of vehicle parameters that could also be used in principal for fuel consumption and CO_2 emission real data gathering. The most recent proposal here of the California Air Resources Board (ARB) (ICCT, 2015) requires OBD systems to provide standardized fuel consumption and emissions data output. Implementation similar measures in other regions of the world are a subject of big interest due to its potential for continuous evaluation of real-world observations against manufacturers' figures they shown on exhibitions.

The new WLTP for LDV

It is believed that the new WLTP will help in some extent to reduce tolerances and flexibilities and to align the test procedure more closely with the real-world experience of the average consumer. It is therefore in the interest of all stakeholders to introduce the WLTP in the EU by 2017, as intended by the European Commission.

Off-cycle emissions (OCE) testing requirements for HDV

For HDVs, the Euro VI regulation has also already introduced off-cycle emissions (OCE) testing requirements for air quality pollutant emissions. OCE measurements, performed during the type approval testing, follow the NTE (not-to-exceed) limit approach. Euro VI regulation also introduced in-use testing requirements that involve field measurements using PEMS (Portable Emissions Measurement Systems). The testing is conducted over a mix of urban, rural and motorway conditions. It has previously been noted by (ME Japan, 2012) that there was also a need to ban so-called "defeat strategies" (i.e. a nullifying function of emission reduction devices at off-cycle) prior to the Global Technical Regulation (GTR) implementation by 2016.

To pay more attention that many of new technologies effectiveness can be very sensitive to real operating conditions

For instance, hybrid electric vehicles can benefit in urban driving due to energy recuperation and more effective average engine operating regime utilization and in the same time can be usefulness in others conditions (as in average a steady speed on the highway). Again for plug-in hybrid electric vehicles, it would be beneficial to pay more attention to the actual use of these vehicles. The introduction of measures to incentivize car dealers and customers to select a powertrain that fits best with driving and re-charging patterns in daily life would provide benefits here.

Conclusions

The fundamental problem in vehicle emission regulation design is that precise definition of real-world driving is elusive because of practically infinite set of variations in driving and ambient conditions, vehicle features and driving behaviour. In contrast to the diversity of reality, standardized testing procedures cover only a part of this, and contain a substantial number of predefined conditions that can often be well controlled by manufactures to gain competitive advantage in the marketplace.

The off-cycle/real-world emission problem can still be considered a significant impediment to effective regulation of CO_2 emission by road vehicles, reducing their effectiveness. However, there are a number of known (and in-use), and recently proposed advanced technologies to improve vehicle testing, as well as new initiatives to enhance real-life representativeness and effectiveness of vehicle testing and conformity assessment procedures as a whole. Whilst these are still far from a total solution of the "off-cycle" emission problem, they are expected to make significant progress in reducing negative impacts.

4.6.2 Consideration of the compatibility of standards with respect to regulation

CO_2 emission and fuel consumption figures have been shown to have significant differences not only in comparison of vehicle's real life behaviour with artificial, obtained in a laboratory results, but also in comparison of different regulatory driving cycle results for similar vehicles tested in accordance to regulations of different regions of world. Some attempts have been made to develop conversion factors for results between various test procedures (ICCT, 2014) and there is still ongoing a significant

correlation exercise in the EU to develop a conversion between the current NEDC and future WLTP based results.

However, in general, results, obtained in different driving cycles vary significantly and correlations /conversions are hard to predict in an accurate way. These differences are present due to many reasons, including related to above mentioned off-cycle/real-world emission problem, and thus not only due to the differences in modes in a test cycle, or differences in the wider testing protocol. It can be said that the main test procedures currently used in the world include/are based upon those used by the EU, US and Japan, and that whilst they are not mutually compatible/consistent there is a move to provide better worldwide unification in the future, via WLTP.

However, ideally other options may needed to overcome the problem of handling within regulation results from different systems and to develop a common base for evaluation, labelling, taxation etc., while there are many different/incompatible requirements from their original markets. For example, in Taiwan it is possible for manufacturers to comply with either NEDC-based standards *or* US-based standards, although this situation would still not be ideal from a customer labelling perspective. Alternatively, since the vast majority of models sold in Ukraine may be expected to be also sold/available in the EU, it might be possible to require NEDC-based (or in the future WLTP-based) values for CO2 to be provided /mandated alongside other type-approval information required for registration of the vehicle in Ukraine.

The above mentioned uncertainty needs to be taken into account in regulation mechanism development for a country. Some proposals regarding the treatment of these issues for the case of Ukraine are considered further in the next section (4.7) of the report.

4.7 Overall conclusions and recommendations for Ukraine

4.7.1 The critical steps and actions overview

Regarding the critical steps and actions for policy pathway to improved fuel economy of new vehicles based on such measures as fuel economy labelling and standards, linked with appropriate fiscal measures, it is useful to refer to the IEA's summary of the critical steps and actions for policy pathway to improved fuel economy, presented in Figure 4.29.

The schedule presented can be used in Ukraine also to help plan, implement, monitor and evaluate the appropriate policy measures set in order for continuous improvement, and adaptation correspondingly to shifting conditions. For the last can be considered new technologies developed, fleet structure changes, economic demands, new policy objectives posed by the state, etc.

A comparison of the adopted regulations (2014 status) for LDV and HDV fuel efficiency in selected regions from (ICCT, 2015b) is also provided in Figure 4.30. Mandatory standards for P2W for the time being have been implemented only in China and in Taiwan, in the form of minimum standards as it is described in earlier Section 4.5 above.

Figure 4.29: Summary of fuel economy policy pathway, critical steps and actions

Phases	Critical steps	Actions		
PLAN	❶ Decide scope, type and schedule of policies	• Gather information • Determine scope and type of fuel economy measures • Consult on policy schedule with stakeholders • Decide target year aligned with national goals		
	❷ Decide measurement method	• Gather information about traffic conditions • Determine measurement approach • Develop driving cycle		
	❸ Secure resources	• Allocate fiscal and human resources • Develop system for gathering and certifying essential information • Engage in broad consultation		
	❹ Design policies	Fuel economy labelling and information	Fuel economy standards	Fiscal measures
		• Decide scope of labelling scheme • Select fuel economy label design • Align design of the label with other measures • Determine requirements for vehicle promotional and other materials	• Decide on form of fuel economy standard • Determine attribute on which to base fuel economy standard • Choose target values • Introduce measures for increasing vehicle weight • Sign compliance process	• Decide type of fiscal measure • Determine level of fiscal measure • Set duration of fiscal measure
IMPLEMENT	❺ Certify fuel economy	• Decide fuel economy certification process, utilising existing vehicle certification schemes • Define certification vehicle family		
	❻ Make information accessible to public	• Require manufacturers to display fuel economy information • Publish fuel economy information on government website • Time release of information when introducing fiscal incentives		
MONITOR	❼ Check compliance with fuel economy policies	• Collect data to monitor fuel economy • Check conformity of vehicles sold • Check compliance with policies		
	❽ Publish monitoring data	• Publish information about trend of average fuel efficiency to fulfil government's accountability • Publish information on some of most fuel-efficient vehicles to attract public's attention		
EVALUATE	❾ Evaluate and enforce policies	• Evaluate level of compliance and enforce penalties • Evaluate impacts of fuel economy policies		
	❿ Revise policies	• Change design and mix of fuel economy policies if needed • Develop new target values as technology improves		

Source: Improving the Fuel Economy of Road Vehicles. A policy package (OECD/IEA, 2012a)

Figure 4.30: Comparison of the adopted regulations for LDV and HDV fuel efficiency in selected regions (2014 status)

		Light-duty vehicles			Heavy-duty vehicles		
Region[a]	Percent of world vehicle sales, 2013	Baseline model year[b]	Implementation period (model year)	Reduction in average CO_2 rate (grams/vehicle-km)	Baseline model year	Implementation period (model year)	Reduction in average CO_2 rate (grams/vehicle-km)
China[c]	25%	2011	2012-2015	9%	2012	2014-2015	11%
EU	19%	2015	2020-2021	27%			0%
US	17%	2017	2017-2025	35%	2011	2014-2018	14%
Japan	6%	2015	2020	16%	2006	2015	12%
Brazil[d]	4%	2013	2013-2017	12%			0%
India	4%	2012	2017-2021	17%			0%
Russia	3%			0%			0%
Canada[e]	2%	2011	2011-2016	20%	2011	2014-2018	14%
South Korea	2%	2011	2012-2015	9%			0%
Australia	1%			0%			0%
Mexico	1%	2012	2014-2016	13%			0%

Adopted or newly implemented between Jan. 2013 and Aug. 2014 | Adopted or implemented prior to Jan. 2013

[a] Includes eleven major vehicle markets
[b] Percent reduction in new fleet fuel consumption estimated from a baseline year (determined by expert judgment rather than regulatory requirement) to the final model year covered by the regulation. Reductions for HDVs are activity-weighted by vehicle type.
[c] China has adopted separate standards for passenger cars and light commercial vehicles. The latest adopted standard for passenger cars (Phase 3) is summarized here.
[d] Brazil's Inovar-Auto program requires a 12.1% improvement for manufacturers to qualify for a 30% reduction in vehicle sales tax.
[e] Canada has announced intention to harmonize with the US 2017-2025 GHG standards; however formal adoption has not occurred as of August 2014.

Source: (ICCT, 2015b).

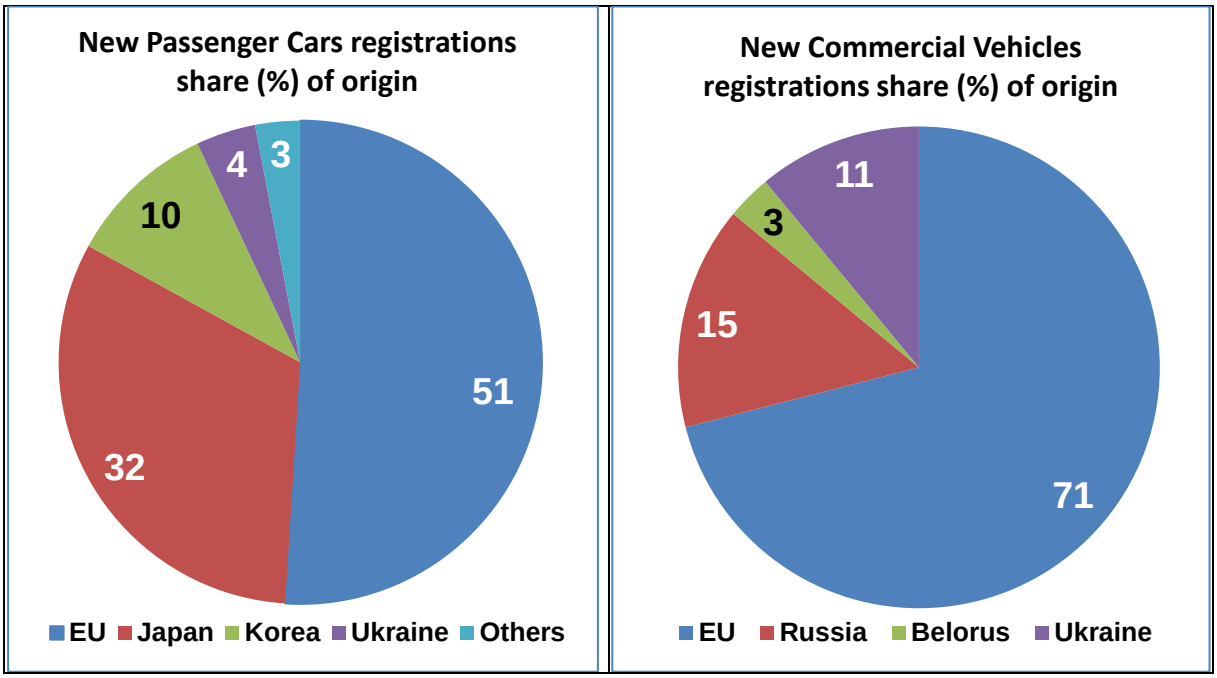
4.7.2 Automotive market in Ukraine

The automotive market in Ukraine is currently in a deep crisis due to the severe economic decline, very low purchasing power of the population and the lack of investment funds of the commercial carriers as well. It also represents a very small percent of total world vehicle sales.

The following Figure 4.31 provides a summary of the manufacture brand origin shares for first registrations of new passenger cars and commercial vehicles from the Ukrainian Motor Vehicle Manufacturers Association for April and May 2016 (UMVMA, 2016).

It should be noted that the registration shares in Figure 4.31 are data provided only for a short period of time, and are dictated by many factors, and so can be subject of change during assumed period of future fuel economy regulation in Ukraine. Nevertheless, they provide a useful starting picture of the relative importance of the different vehicle origins. Whilst it is not clear specifically whether the indicated vehicles were manufactured in Europe or elsewhere from these figures, it is to be anticipated from the respective shares of manufacturer brand origins that most of the vehicles (models) have likely been type-approved for the EU market also, so should have associated certification information.

Figure 4.31: New passenger car and commercial vehicles first registrations share of manufacturer brand origin (April and May 2016)



4.7.3 Some general considerations regarding fuel economy regulation of road vehicles in Ukraine

In the process of developing recommendations, the experts took into account a range of key aspects and assumptions for Ukraine. In the first instance, Ukraine does not belong to a list of world-wide scale or key automakers and cannot be considered as a very significant market for global automotive industry. Therefore, it seems unlikely to be able to perform significant role in shaping the global or regional requirements for the construction of vehicles.

According to the IRF (IRF, 2016) the level of motorization of Ukraine in 2010 amounted to only 148 per 1,000 inhabitants. This is very low in comparison to other nearby countries, for example: Poland – 451, Hungary – 298, Lithuania – 284, Belarus – 274, Russian Federation – 233, Latvia – 515, Germany – 517, Italy – 602. Ukraine still significantly lags behind on this indicator from many countries of the world therefore, and in particular European averages. In addition, these data from the IRF are based on the data of registered vehicles. However the actual number of cars on the roads (those that are in active operation) is much less than in Ukrainian conditions due to a combination of factors including imperfections in the official registration system. Therefore, it is reasonable to assume that the true indicator of the level of car ownership in Ukraine is even smaller than indicated by IRF.

Ukraine has a significant potential for an increase to the number of private cars and as a result, also the consumption of motor fuels, once the socio-economic situation has stabilised and the economy has begun to recovery. Therefore, Ukraine might be considered as perspective market for significant growth by the global automotive industry in the medium and/or long term.

Ukraine's current requirements for imported and internally produced/assembled vehicles is in general based on the UN/ECE uniform technical prescriptions. There is also an intention to shift gradually towards European requirements for design safety with objective of full harmonisation of the level of requirements in the future, including safety and emissions. The majority of vehicles being imported by Ukraine are already currently based on the requirements of the European market. US and other original markets with different requirements and regulation to the EU also supply vehicles to the Ukrainian market, though in relatively small amounts at the moment. Nevertheless, their significance should not be disregarded, since their market share in Ukraine could rapidly change.

In addition, there are other markets around the world with lower / obsolete level of requirements (in comparison with established in EU, US or Japan for instance, and in Ukraine also) for which vehicles exported from above mentioned countries being in conformity to much lower requirements including vehicle's lower technology level and production price. So the country of origin itself for the product does not guarantee that 100% of production to be satisfied its own internal market technical requirements and vehicles' fuel economy standards as well.

Regarding fuel economy direct technical regulation (i.e. standards), realistically Ukraine can rely mainly on already existed standards and produced vehicle types around the world, with focus on European requirements first of all. The following main principles for vehicles fuel economy regulation in Ukraine are therefore assumed:

- The direct technical regulation of vehicles' fuel economy (fuel economy standards) or CO_2 emissions could be introduced based on European standards first of all, and taking in to account Global Technical Regulations testing procedures potential as well where it is appropriate. Only LDV (PC & LCV) can be considering as affordable and reasonable for direct technical regulation of fuel economy in Ukraine at this time. In EU, in order to do not restrict the range of PC & LCV that could be put on the market, CO_2 emissions regulated via complicated annual fleet-average CO_2 target for manufacturer, included a range of utility functions, flexibilities and derogations (e.g. for niche manufacturers). These elements cannot be directly introduced / spread to Ukraine, since Ukraine is not part of the EU, and it is not possible to establish reliable mechanisms to control the import of vehicles into the country in such a manner.
- Instead of this, another option that might be considered for Ukraine would be to set "individual" (i.e. disregarding total annual production/import/registration structure of an automaker) performance targets, followed by "average" CO_2 performance regulation in Ukraine initially, which would set minimum performance criteria for different vehicle types.
- Such "individual" standards (being differentiated by vehicle mass or footprint, and potentially class, designation, etc.) for fuel consumption / CO_2 emission norms could be established on the basis of EU regulations to inform starting / intermediate points and goals, and e adapted to Ukraine's own needs/market situation. Such fuel economy norms could be established in a way based on a reasonable balance between general targets for CO_2 emission reduction and the range of vehicles that could be realistically put on the market and/or to be in demand on the market of Ukraine.
- In principal, the norms should be mandatory though it may be necessary to provide for some exceptions for particular vehicle types (e.g. racing cars for instance, etc.). Such exceptions could be handled also via punitive financial sanctions (like in EU) on a more progressive scale than is offered below to establish the framework of fiscal measures linked to labelling of fuel economy/CO_2 emissions.
- Since there are likely to be some restrictions in the way direct CO_2 emission targets (norms) for manufacturers might be implemented from the point of view of regulation, it will be beneficial to also provide national fuel efficiency/CO2 emissions labelling requirements. As well as for LDVs, this should ideally be applied also to HDV and P2W. This system would also benefit will links to fiscal measures, such as graduated road/ownership/purchase taxes based on performance (and depending of vehicle type and destination). This will also help to stimulate customer demand in favour on more fuel efficient vehicle choices.
- Such combined fuel economy labelling and fiscal measures one might be considered as similar to fuel economy regulations in combination with punitive financial sanctions (depending on the levels set). The principal difference here that while fuel economy labelling and fiscal measures cover all vehicle variations / options available on the market with gradual or relatively "soft" in some range scale of taxes, the "individual" fuel economy norms and punitive fiscal measures would provide a clear target (limit) and operate only when this target is not fulfilled.
- In order to reduce the negative impacts of "off-cycle" / "real-world" emission performance issues may be to establish additional specific tests of vehicles to account for additional fuel consumption not captured by existing and widely used standards during product certification. Such additional tests and gathered information might be used to provide a calibration factor to adjust original test-cycle based figures to better represent real-world conditions. Such information would give to customer a better estimate regarding a vehicle's fuel economy in real life, helping them to make a more informed choice.

- In designing a regulation scheme it may be important to account for different original markets (and their requirements) which are the sources of supply of different kind of vehicles to Ukraine. Vehicles can be imported in Ukraine in different ways, e.g. by importing party for subsequent sale or imported individually, be it for new or second-hand vehicles. One of these parties may have some fuel economy data to be subject available for clear regulation, the other likely not.
- To overcome the problem where there are no appropriate technical data established for CO2 emission regulation for the case of individual or very small numbers of annual imports certain vehicles, and it is not feasible to test vehicle from economy point of view, on option could be to determine an approximate figure based on a standard algorithm based on a number of vehicle parameters. However, this is likely to pose its own problems and so derogations for such cases might be more appropriate (i.e. as applied in the EU for niche manufacturers /imports).
- In addition it should be noted, that LDVs and HDVs as well as P2Ws fuel consumption / CO2 emission tests should be carried out at the same time as toxic pollutants simultaneous measurement/control.

4.7.4 The recommendations from the project team regarding scope, type and methods of regulation for Ukraine

The initial outline proposals / recommendations from the project team regarding scope and type of regulation and optimal approaches / choice to different categories of vehicles are presented in Table 4.7. Below there are presented the proposals and recommendations from the project team regarding the optimal approaches to testing methods as the base for labelling and regulation of vehicle's fuel economy considered as a starting point.

Table 4.7: Initial proposed scope of regulation in Ukraine on the first stage that is under consideration

Vehicle category	Vehicle sub-category	Fuel economy labelling [1)]	Fuel economy standards [2)]	Fiscal measures [3)]
Light Duty Vehicle (**LDV**)	Passenger Car (**PC**)	**Yes**	**Yes**	**Yes** (High Progressive scale. High intensity)
	Light Commercial Vehicle (**LCV**)	**Yes**	**Yes**	**Yes** (Medium Progressive scale. Medium intensity)
Heavy Duty Vehicle (**HDV**)	**General purpose** for cargo and passengers transportation	**Yes**	-	**Yes** (Medium Progressive scale. Low intensity)
	Special purpose (construction etc.)	**Yes**	-	**Yes** (Low Progressive scale. Low intensity)
	Military purpose	**Voluntary**	-	N/A
Power two wheelers (**P2W**)		**Yes**	-	**Yes** (High Progressive scale. Low intensity)

Notes:
4) Is obligatory as the base for fiscal measure to force fuel efficient / GHG low emission choice.
5) As a function of reference mass for each vehicle, not per fleet produced (phased implementation).
6) Maximum tax if fuel economy not defined, as for second-hand goods or a single imported vehicle, or if do not conforms to the fuel economy standards.

4.7.4.1 LDVs

Regarding LDV's it is assumed that the preferable way would be to consider WLTP-based emissions (since this is also likely to be the standard from 2017/18 in the EU) and the EU's policy based regulation, but with "individually" acting and "soft" CO_2 emission norms (limits) designed to take into account national specific conditions. LDV labelling should be established to include simultaneously information on fuel economy (as this is clear for customer) and also CO_2 data metrics.

In addition to WLTP specific values (which should help provide a better comparative vehicle-to-vehicle basis than NEDC), it might be useful to consider a limited programme of national fuel economy testing in a common system, in order to develop real-world calibration/adjustment factors to apply to the WLTP figures, in a similar way as is done in the US official fuel economy figures. This could also help improve consumer confidence in the 'official' CO_2 / fuel consumption figures, which have become undermined in the EU due to the significance to type approval figures. The final figures would therefore be based on chassis dynamometer complete vehicle testing within standard LDV emission test procedure, producing as metrics the specific fuel consumption in l/100 km, and CO_2 emissions of a vehicle, measured in gCO_2/km.

4.7.4.2 HDVs

Regarding HDV labelling, one option could be to consider the WHVC test procedure with other additional or intermediate test procedures (including those based on GOST 20306-90 approaches) covering the same metrics, i.e.: the specific fuel consumption l/100 km and CO_2 emissions of a vehicle, measured in gCO_2/km. In a case of HDVs, the cargo weight (or passenger loading) should also be ideally considered. The currently in-development EU certification procedure based on the VECTO simulation model considers performance at zero, maximum and average loading values, which could similarly be applied here. Such additional metrics could therefore potentially be added quite easily for the customer, i.e. in l/100 tkm and gCO_2/tkm for full loaded vehicle (where tkm is tonne-kilometres), or in similar pkm (passenger-kilometre) equivalents for passenger vehicles.

Regarding the choice of HDV testing method, a flexible approach for Ukraine on the manufacturer decision includes any of:

1) Chassis dynamometer based test of complete vehicle;
2) On-road test of complete vehicle using PEMS within the same standard (uniform) driving cycle pattern;
3) Alone engine test on engine dynamometer bench with simultaneous (real-time) simulation of gear, transmission and whole vehicle, based on mathematical model and beforehand supplied by manufacturer input data (being themselves results of other measurements);
4) Complete vehicle mathematical simulation, again based on reliable set of data including engine mapping as well as transient correction factors, etc. (where proved data can be provided by manufacturer).

Complete vehicle fuel consumption measurements, engine tests, component tests and other kind of tests can be used as input data in mathematical simulation to prove and tune model for other variants of configuration in order to cover wide production program with minimisation of testing. This is the approach that has been followed in all the major regions for the development of HDV certification and target setting, since there are typically many vehicle and (importantly also) operational/duty cycle variations that cannot cost-effectively be assessed through physical testing alone.

It has been suggested in smaller production programs with low vehicle configuration variety, the initial data gathering can consume more time and financial resources in comparison with complete vehicle testing. However, the Ukraine market is served predominantly by vehicle manufacturers that are serving the main EU market, providing similar basic vehicles. Therefore, rather than go thought the cost of setting up a new system, it would most likely seem optimal for the Ukraine to follow the approach being taken for the EU with regards to establishing certified HDV fuel consumption using the VECTO simulation tool, as these manufacturers will already be developing the relevant set of underlying data (and experience) to produce these figures.

With regards to an efficient labelling system, the same set of useful work metrics could in principal be extended to LCVs being used for cargo transportation, and as well as for passenger cars and buses in such units as l/100 pkm and gCO_2/pkm for full loaded vehicle (where pkm is passenger-kilo-meters). For passenger-carrying vehicles these could be based on the seating capacity and standing places also (for city bases), average standard passenger weight, and taking in to account average standard mass of luggage per passenger for long-distance buses, and representative loading factors where relevant.

4.7.4.3 P2Ws

Regarding P2W labelling it is assumed the most preferable way will be to consider the WMTC test procedure, potentially with other additional national test procedures used to develop calibration/adjustment factors to Ukraine conditions. The metrics would include the specific fuel consumption in l/100 km and CO_2 emissions of a vehicle, measured in gCO_2/km.

5 Analysis of the legislation and experience of Ukraine (Task 4)

5.1 Outline of the proposed approach

The objective of this task was to identify and systematize Ukrainian current national policies, standards and practices in the field of CO_2 emissions and energy consumption regulation by the road transport.
The analysis will be built on legislation, subordinate regulations, standards, practices as well as existing draft projects reviews, also public and expert data of policy options that were designed, under consideration at present, and/or actually utilised in Ukraine.

A general overview of national legislation has been provided in the following report sections, including existing economic instruments and their potential impacts in terms of potential growth or key measures to implement based on experience in the EU. In addition the report provides information on:

(c) The experience of Ukraine in the development and implementation of government programs aimed at reducing energy consumption by road transport.
(d) The systemic barriers regarding technical regulation and road vehicle certification issues in Ukraine to the implementation of regulations on CO_2 emissions and energy consumption by the road transport in Ukraine.

In general, where it is applicable, the analysis takes into account also the structure of the earlier chapter (Section 0) on experience of EU review to facilitate a comparative analysis. This includes a brief overview of the Ukrainian fuel rationing system for road transport and its potential futures as an in-use instrument to control and reduce fuel expanses by road transport.

A brief overview of the situation in the field of national reporting of GHG emission by road transport in Ukraine is also provided, with the aim of helping to identify which measures should be prioritised to help make and track progress in the sector during new policy implementation. In addition, the current national policy will also be analysed for consistency with global GHG emissions reduction targets, and the Association Agreement between the Ukraine, the European Union and the European Atomic Energy Community.

Finally, a gap analysis of missing elements and obstacles to implementation in Ukraine of measures similar to those applied/planned in the EU is provided from this task to support development of appropriate recommendations in the subsequent tasks.

5.2 General overview of national legislation in the part that is directly or indirectly related to regulation of CO2 emissions and energy consumption by the road transport

Generally in terms of potential growth or as key points (places to make changes to the legislation) to implement measures for regulation of GHG emission and fuel consumption can be considered following national and sectoral scale documents that have programmatic nature or key milestones that will influence air-quality in practical manner, or at least have some declarations of some goals for the road transport sector, that directly or indirectly can be concerned with fuel consumption and/or air pollution issues (some of them already finished their the period of validity or implementation of the provisions, but nevertheless may be of interest):

1. The law of Ukraine "On some issues of import to the customs territory of Ukraine and registration of vehicles" (is about gradual introduction of environmental standards "EURO-2"..."EURO-6").
2. Resolution of the Cabinet of Ministers On approval of the Technical regulation concerning requirements for automotive petrol, diesel fuel, marine vessel fuel and heating boiler fuel approved from 1 August 2013 No. 927 (with amendments from 25 June 2014 No. 253).

3. Resolution of the Cabinet of Ministers of Ukraine dated 09.02.2011 No. 738 "Some questions of certification of vehicles, their parts and equipment".
4. Order of the Ministry of infrastructure of Ukraine dated 17.08.2012 No. 521 "On approval of Procedure for approval of design of vehicles, their parts and equipment and the Procedure for maintaining the register of certificates type of vehicles and equipment issued by the manufacturers certificate of conformity of vehicles or equipment" registered in the Ministry justice of Ukraine 14.09.2012 No. 1586/21898.
5. The Transport Strategy of Ukraine for the period till 2020, approved by decree of the Cabinet of Ministers of Ukraine dated 20.10.2010 No. 2174-R.
6. The Concept of the State target economic program of development of road transport for the period up to 2015, approved by the decree of the Cabinet of Ministers of Ukraine dated 03.08.2011 No. 732-R.
7. Basic principles (strategy) of state environmental policy of Ukraine for the period till 2020, approved by Law of Ukraine dated 21.12.2010 No. 2818-VI.
8. National action plan on environmental protection for 2011-2015, approved by the decree of the Cabinet of Ministers of Ukraine dated 25.05.2011 No. 577-p.
9. The state target economic program of energy efficiency and development of the energy production from renewable energy sources and alternative fuels for 2010 - 2015, approved by the decree of the Cabinet of Ministers dated 01.03.2010 No. 243.
10. The sectoral program of traffic safety in road transport for 2013-2015 approved by the order of the Ministry of Infrastructure of Ukraine dated 04.04.2013 No. 210 (with additions made by the order of the Ministry of infrastructure of Ukraine from 8.04.2014 No. 171).
11. The Transport sector energy efficiency and reducing energy consumption program for 2010 - 2014 years, approved by the decision of the Collegium of the Ministry of transport and communications of Ukraine dated 17.09.2009 No. 18.

There are also developed proposals for Ukraine's implementation strategy concerning the Göteborg protocol. These proposals envisaged the realisation of a set of measures to implement EU environmental standards and technologies in the field of road and off-road transport in Ukraine, as well as motor fuels which are used by road and off-road transport and are laid down in the Second report (Activity 2) in accordance to the Amendment No. 1 dated on 19 June 2014 to the Contract No. 20 dated on 14 October 2013 within Air Quality Governance in the ENPI East Countries (AIR-Q-GOV) project.

In addition it is important to also consider the Action plan for the implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European atomic energy Community and their member States, on the other hand, for 2014 - 2017 approved by the Cabinet of Ministers of Ukraine from 17.09.2014 No. 847-R.

From above mentioned instruments it is important to first consider the following milestones, that form an important basis for road transport development in the scope of environmental issue. Within the law of Ukraine the following milestones are set for new firstly registered in Ukraine vehicles:

- **Euro 3:** 01.01.2013 (in EU: 2000-2001);
- **Euro 4:** 01.01.2014 (in EU: 2006);
- **Euro 5 (Euro V):** 01.01.2016 (in EU: 2010);
- **Euro 6 (Euro VI):** 01.01.2018 (in EU: 2015).

Therefore the limit values Euro 6 for power-driven vehicles with at least four wheels and used for the carriage of passengers (category M) and goods (category N) as well as the limit values for Euro VI for engines for heavy-duty vehicles, will be fulfilled by Ukraine from 01.01.2018 in accordance with present national legislation. This law could potentially be considered for further amendments with the aim to expand scope of toxic pollutants regulation regarding other types of vehicles and GHG as well as fuel economy direct technical regulation in Ukraine.

To compliment/enable the introduction of the vehicle Euro emission standards, the Resolution of the Cabinet of Ministers On approval of the Technical regulation concerning requirements for automotive petrol, diesel fuel, marine vessel fuel and heating boiler fuel approved from 1 August 2013 No. 927 (with amendments from 25 June 2014 No. 253) set the following mandatory norms for gasoline and diesel oil, used by road transport:

- Class Euro 4, limit of sulphur content 50 mg/kg – 01.01.2016;
- Class Euro 5, limit of sulphur content 10 mg/kg – 01.01.2018.

It is worth noting that these mandatory norms do not align with the dates for introduction of the vehicle Euro standards mentioned previously. However, in spite of the mandatory norms for gasoline and diesel above, it is already proposed to put on the market fuel brands that satisfy more stringent requirements, that for instance Euro 4 sulphur and aromatic content levels. An overview of all the existed measures and options is described in the next report sections below.

5.3 General regulation in Ukraine

5.3.1 General overview of regulatory practice in Ukraine related to CO2 emissions / energy consumption by road transport

Currently the regulatory practices in Ukraine relevant to CO_2 emissions / energy consumption by road transport are restricted mainly to:

- Fiscal measures regarding vehicle purchase, ownership (for some category) and fuel prices
- Fuel rationing system for road transport.

At this time the fiscal measures regarding vehicle purchase and fuel price in general cannot be considered as efficient or adequate regulatory measures/instruments set to reduce CO_2 emissions and fuel consumption in transportation sector. The current fiscal measures in general are not clearly linked with fuel consumption reduction in sector, and moreover even contradict these purposes in some places.

The fuel rationing system for road transport covers only commercial transportation or transport service provision. The system is primarily focused on the efficient use of already in-service vehicles by their owners and does not set requirements for vehicles manufacturers to improve new vehicle efficiency.

There is some experience with strategic documents as well as state and sectoral scale programs with planned measures and stated goals to reduce CO_2 emission and fuel consumption in transportation sector. However, these documents are generally not reinforced by practical mechanisms for implementation, and there is a lack of state funding, but other financing mechanisms are not provided.

5.3.2 Declared targets for reduction of road fleet CO2 emissions / energy consumption

5.3.2.1 The Transport Strategy of Ukraine for the period till 2020

The Transport Strategy of Ukraine for the period till 2020 was approved by decree of the Cabinet of Ministers of Ukraine dated 20.10.2010 No. 2174-R. To prepare the strategy, the EU actively supported Ukraine by introduction of such projects – Twinning “Support to Transport Policy Design and Implementation in Ukraine” and “Support to the Integration of Ukraine in the Trans-European Transport Network TEN-T”. It defined the main development goals for transport sector of Ukraine for the period until 2020, including:

- Modernization of transport system and an increase in its efficiency;
- Satisfaction of transport needs for the national economy and population, and improvement of the quality of and access to transport services;
- Guaranteed on-time goods delivery;
- Improvement of transport sector governance;

- Increase of capacity of transport network;
- Higher safety in transport;
- Reduction of polluting substances emissions in the air by 30%;
- Reduction of the specific energy consumption in the whole transport sector by 15-20%; and
- Faster integration of the national transport system into European and world transport systems.

For road transport there is a specifically defined goal to reduce specific energy consumption "from 43.6 to 34.8 g.o.e.[31] per ton × km" or on 20%. However, the above mentioned objectives still remains mainly only as a declaration of intent for road transport and its infrastructure, as no adequate plans/timeline for realisation of these objectives has been established and approved with appropriate implementation mechanisms, and there is currently no real financial support provided until now.

5.3.2.2 The Concept of the State target economic program of development of road transport

The Concept of the State target economic program of development of road transport for the period up to 2015 has been developed and was finally approved by the decree of the Cabinet of Ministers of Ukraine dated 03.08.2011 No. 732-R. The Concept is focused on the problems identified above, with the following definitions and description of the general situation in the sector. The main options for solving these problems are also defined as follows within the Concept. Further information on these is provided in Annex IV of this report.

The estimated funding for the Program is 57.9 billion UAH (~€2.05 billion), including: 2.5 billion UAH (~€88.6 million) at the expense of the state budget, 55.4 billion UAH (~€1.96 billion) other sources .

5.3.2.3 Basic principles (strategy) of state environmental policy of Ukraine for the period till 2020

The basic principles (strategy) of the state environmental policy of Ukraine for the period till 2020, was approved by Law of Ukraine dated 21.12.2010 No. 2818-VI. In the Ukrainian state environmental policy strategy, the following goals related to the road transport development are included:

"To reduce emissions of common pollutants by:

- *stationary sources in 2015, 10 percent, and by 2020, 25 percent of the base level;*
- *mobile sources by establishing standards for the content of pollutants in the exhaust gases by 2015 in accordance with the standards of Euro-4, 2020 - Euro-5".*

However, it is must be noted that again that the law of Ukraine "On some issues of import to the customs territory of Ukraine and registration of vehicles" set the following milestones (for new firstly registered in Ukraine vehicles): Euro 4 – 01.01.2014; Euro 5 (Euro V) – 01.01.2016; Euro 6 (Euro VI) – 01.01.2018.

The Ukrainian state environmental policy strategy integrated management approach has also set the next tasks for road transport and road infrastructure, which also include:

"*Creating, by 2015, the economic conditions for the development of infrastructure environmentally friendly modes of transport, in particular public, increase by 2020 the share of public transport in total infrastructure by 25 percent.*"

5.3.2.4 Action plan on environmental protection for 2011-2015

The Action plan on environmental protection for 2011-2015, was approved by the decree of the Cabinet of Ministers of Ukraine dated 25.05.2011 No. 577-p, and included the following key tasks related to road transport that are also relevant to controlling/reducing energy consumption and CO2 emissions:

[31] g.o.e. = gram of oil equivalent

Paragraph 51. Prepare and submit for consideration of the Cabinet of Ministers of Ukraine draft laws on (to June 2011 - December 2015):

- setting low standards for sulphur content in fuel oil and diesel fuel, prohibition from 2016 them use only, provided the sulphur content higher than the specified threshold;
- gradual introduction of environmental standards for certain categories of wheeled vehicles first registered in Ukraine - Euro-3 - from 1 January 2012 - "Euro-4" - 1 January 2014;
- encouraging increased production and use of bicycles, hybrid automotive vehicles and electric vehicles, in particular through the **introduction of differentiated environmental tax on vehicles depending on the volume of fuel consumption**;
- **the introduction of an environmental classification and labelling of wheeled vehicles**;

Paragraph 56. The conversion methodology inventory of sources and emissions of pollutants in accordance with the requirements of the joint programme monitoring and evaluation distribution of air pollutants over large distances in Europe (to January 2013 - December 2015).

Paragraph 188. Encourage the development of Bicycle, electric and other types of environmentally friendly transport, and that runs on bio fuels, creation and maintenance of network services, to increase the fleet and the number of routes (lines) urban electric transport (to January - December 2012).

5.3.2.5 The state target economic program of energy efficiency and development of the energy production from renewable energy sources and alternative fuels for 2010 - 2015

The state target economic program of energy efficiency and development of the energy production from renewable energy sources and alternative fuels for 2010 - 2015, was approved by the decree of the Cabinet of Ministers dated 01.03.2010 No. 243.

It was declared that to 2015 "The Program will give the opportunity to:

- **reduce the energy intensity of gross domestic product by 20 percent compared with 2008**;
- **optimize the structure and energy balance of the state in which the share of energy from renewable energy sources and alternative fuels, will be in 2015, at least 10 percent**";
- **to ensure reduction of 15-20% of the volume of emissions of pollutants**.

5.3.2.6 The sectoral program of traffic safety in road transport for 2013-2015

The sectoral program of traffic safety in road transport for 2013-2015 was approved by the order of the Ministry of Infrastructure of Ukraine dated 04.04.2013 No. 210 (with additions made by the order of the Ministry of infrastructure of Ukraine from 8.04.2014 No. 171) and was contain important task to develop in Ukraine state proving ground - road transport testing facilities to promote safety and fuel ecology technologies and European standards implementation. However, due lack of available finances in the state budget the task was later removed from the program.

5.3.2.7 The Transport sector energy efficiency and reducing energy consumption program for 2010 - 2014

The Transport sector energy efficiency and reducing energy consumption program for 2010 - 2014 years, was approved by the decision of the Collegium of the Ministry of transport and communications of Ukraine dated 17.09.2009 No. 18 and contains the following:

"To ensure a significant reduction in energy consumption in road transport important role come from a tasks related to optimization of road infrastructure, especially in large cities and suburban areas. It is expected the implementation of measures to optimize traffic and improving the structure of the wheeled vehicles fleet by economic incentives and technical regulation. It will be widely implemented modern technologies of transportation and transport logistics, navigation, communication and information technology. Significantly expand the use of alternative motor fuels, including compressed natural gas, liquefied petroleum gas, ethanol and biodiesel. The priority of the underlying measure of national importance with a significant increase in energy efficiency of vehicles will be the creation of a national research test center of wheeled vehicles".

A list of tasks for above mentioned program for 2010 - 2014 years contained for the road transport branch the next general directions of sector development in the aggregated direction of optimization of road infrastructure, the structure of the vehicle fleet, transportation technologies:

***1**) integrated wide-scale optimization of transport infrastructure, based on adduced macroeconomic criteria of the efficiency of the transport sector taking into account current and future needs, includes modern technologies and involves the construction of new and reconstruction of existing roads, construction of multi-level interchanges, separate lanes for public transport, creation of private car parking and ride facilities near public transportation, including subway and so on, as well as the introduction of modern information technologies for traffic optimization;*

***2**) wheeled vehicles fleet structure optimization through the mechanisms of state incentives/regulation and including:*

- *(**2.1**) the creation on the base of notified to UN/ECE technical service of Ukraine, the National Research Test Centre of Wheeled Vehicles as a complex of laboratories to research and prove of vehicles constructive energy efficiency as well as environmental and safety standards conformity proving (including proving ground test facilities).*
- *(**2.2**) practical implementation of modern standards of energy efficiency of road vehicle, environmental friendliness and safety. Development of proposals for the introduction of mechanisms of state incentive regulation of gradual optimization of the structure of the road transport fleet. Conduct R&D for development of technologies for efficient use of alternative motor fuels (including renewable) energy sources, improving design efficiency of road vehicles, etc.*

***3**) optimization of transportation technologies, modern transport logistics, navigation, communication and information technology, including:*

- *(**3.1**) Optimization of road transportation with the use of modern (including satellite) telecommunications and information technologies.*

As a result of the execution of a programme of improving transport sector energy efficiency and reducing energy consumption it was expected that a reduction of the specific energy consumption by transport by 22% (as % of 2009 levels) could be achieved. The level of reduction split by year was expected to be as follows [plus cumulative]: 5% by 2012 , a further 7% [to 12%] by 2013, and the remaining 10% [up to 22%] by 2014. However, only one concrete state project realization was considered within the programme, which was the creation of a National Research Test Centre of Wheeled Vehicles.

Initially it was assumed that, in accordance with the defined general directions, this national research test centre would be developed via specific state level and local level programs and projects, involving the business environment as well as tasks with interagency nature. However, no state budget funding was in the end provided, and this has not been taken further forwards to date.

5.3.2.8 Action Plan for the Implementation of the Association Agreement between Ukraine, on the one hand, and the European Union

Another important element that must be considered is the Action Plan for the Implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European atomic energy Community and their Member States, on the other hand, for 2014 - 2017 approved by the Cabinet of Ministers of Ukraine from 17.09.2014 No. 847-R.

One consequence of this Action Plan is the gradual implementation of EU Directives in Ukraine, including road transport standards and economic activity rules in many aspects. Another important consequence of this Action plan was the pre-planned creation in of Ukraine the National Research Test Centre of Wheeled Vehicles, which to date has not occurred (as already mentioned).

5.3.2.9 The project "Creation in Ukraine the National Research Test Centre of Wheeled Vehicles"

This state national scale project was pre-planned in a range of national state documents, including those already mentioned above as well as others, for example:

- the Action plan for the implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European atomic energy Community and their

member States, on the other hand, for 2014 - 2017 approved by the Cabinet of Ministers of Ukraine from 17.09.2014 No. 847-R.

- the Transport Strategy of Ukraine for the period till 2020, approved by decree of the Cabinet of Ministers of Ukraine dated 20.10.2010 No. 2174-R.
- the Transport sector energy efficiency and reducing energy consumption program for 2010 - 2014 years, was approved by the decision of the Collegium of the Ministry of transport and communications of Ukraine dated 17.09.2009 No. 18;
- the sectoral program of traffic safety in road transport for 2013-2015 was approved by the order of the Ministry of Infrastructure of Ukraine dated 04.04.2013 No. 210 (with additions made by the order of the Ministry of infrastructure of Ukraine from 8.04.2014 No. 171) *[Notes: proving ground test facilities to enhance fuel efficiency and safety of road transport fleet were originally included in this, but later this project was removed due to a lack of state budget funding].*

The main goal of this project was to increase the safety and efficiency of road vehicles and to reduce the harmful effects of road transport on the environment and people's health.

The creation of the National Research Test Centre of Wheeled Vehicles and its functioning is only a technological tool that will help within effective state policy of sustainable transport development, based on European standards:

- to improving the safety of road transport and therefore reduce the number of death and injured people;
- to reduce macroeconomic losses from accidents;
- to reduce of specific consumption of energy by transport;
- to expand of alternative energy sources and the use of cleaner alternative fuels and efficient technologies for their use;
- to reduce the energy dependence of the country;
- to reduce of environmental pollution by transport as well as to reduce macroeconomic losses from environmental pollution;
- to implement of effective control and 100% execution of the established by state requirements (EU standards);
- to meet the needs of the economy in transportation, improve the quality and efficiency of transport services, increase the competitiveness of the industry as a whole and increase the efficient use of resources;
- to establish of relevant to WTO requirements and effective mechanisms to protect the domestic market from unfair competition (protect market of Ukraine and market of EU from dangerous (i.e. not in conformity with the standards) vehicles;
- to establish technological integration of the national transport system to international (first of all - European) transport systems level requirements for the vehicle and transportation technologies;
- to ensure and support using the pre-planned proving ground facilities the proper level of training and defensive driving training for drivers as well as to establish a national scale programs of eco-driving and safety-driving and widespread to common practice of a techniques of a vehicle use (it has a huge potential for fuel economy and pollution reduction).

5.3.2.10 General conclusions regarding state documents

All the above mentioned plans unfortunately had (and still have) the same common problem, in that there is practically a total absence of state budget financing, and as a result for the most part they have not been executed in practice.

5.3.3 Monitoring, verification and certification (MVC) of new vehicle performance

There are currently no requirements in Ukraine regarding MVC of new vehicle performance. At present the creation of a common database of certificates of conformity of vehicles in Ukraine is still under discussion.

5.3.4 Other regulatory options in use

Ukraine has a number of unique regulatory options related to a road vehicle fuel rationing system, briefly described in later Section 5.9.

5.4 Technical regulation and road vehicle certification issues in Ukraine

5.4.1 Normative and legislative base overview

The normative and legislative base for the conformity assessment of wheeled vehicles historically based on, or linked with, the following main acts in Ukraine:

1. The Law of Ukraine "On Standards, Technical Regulations and Conformity Assessment Procedures" dated 1 December 2005, under №3164-IV.
2. The Law of Ukraine "On Conformity Assessment" dated 17 May 2001, under №2406-III.
3. The Law of Ukraine "On Motor Vehicle Transport" dated 05 April 2001, under №2344-III.
4. The Law of Ukraine "On Consumers Rights Protection" dated 12 May 1991, under №1023-XII.
5. The Law of Ukraine "On Traffic" dated 30 June 1993, under №3353-XII;
6. The Law of Ukraine "On Amendments to the Law of Ukraine "On certain issues of importation onto Ukraine's Customs Territory of Motor Vehicles" dated 30 November 2005, under №3151-IV.
7. Decree of The Cabinet of Ministers of Ukraine "On Standardization and Certification" dated 10 May 1993, under №46-93.
8. Decree of The Cabinet of Ministers of Ukraine "On some aspects of Certification of vehicles, parts and equipment" dated 9 June 2011, under №738.
9. The Law of Ukraine "On Accreditation of Conformity Assessment Bodies" dated 17 May 2001, under №2407-III.
10. The Law of Ukraine "On Accession to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be fitted and/or used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions of 20 March 1958, with Amendments 1995" dated 10 February 2000, under №1448-III.
11. "List of products that come under mandatory certification in Ukraine", approved by the Order of Derzhspozhyvstandard of Ukraine on February, 2, 2005 under № 28 (registered by the Ministry of Justice of Ukraine on May, 4, 2005, under №466/10746.
12. "Rules for mandatory certification of carrier vehicles, their components and devices", approved by the Order of Derzhspozhyvstandard of Ukraine on January, 17, 1997 under No. 23 (registered by the Ministry of Justice of Ukraine on February, 11, 1997, under No. 29/1833).

5.4.2 Systemic barriers to implement regulation of CO2 emissions and energy consumption by the road transport in Ukraine

For a long period of time Ukraine operated a wheeled vehicles certification system (UkrSEPRO) which doesn't comply with the well-established European conformity assessment principles, and the technical requirements and regulatory acts were not harmonized with the 1958 Geneva Agreement and European Community legal frameworks established by the Directive 2007/46/EC. However, in 2011 the Decree of the Cabinet of Ministers *"On Some Aspects of Certification of Vehicles, Their Parts and Equipment"* (No 738 of 5 June, 2011) were issued with the aim of implementation and harmonisation of these in Ukraine legislation.

A new procedure for the approval of design of vehicles, their parts and components was consequently approved by order of the Ministry of Infrastructure of Ukraine 17 August 2012 No. 521 and registered

at the Ministry of Justice of Ukraine 14 September 2012 No. 1586/21898 *"On approval of Procedure for approval of design of vehicles, their parts and equipment and the Procedure for maintaining the register of certificates type of vehicles and equipment issued by the manufacturers certificate of conformity of vehicles or equipment"*.

However, due to wide-spread corruption within the certification bodies, a process of new (European model based) certification system implementation was essentially de-facto blocked from 2012 until the end of 2015. Even at the beginning of 2016 the process of transformation of the certification system to the European standards and practices was not yet completely finished. As a result, there is not yet full compliance with emission standards as well as other vehicle safety issues requirements for vehicles that are imported into Ukraine. In accordance with the research of SE SRTRI, in 2015 about 30% of imported cars in reality is did not conform to "Euro-4" norms (which was an obligatory requirement in 2014-2015), despite the information provided on their official papers, as issued by many of the authorised bodies in Ukraine.

In addition to the issues regarding falsification of certificates of conformity, there are further corrupt practices in operation via supposedly authorised/officially accredited certification test laboratories. Such 'laboratories' can have insufficient equipment and staff to be able to possibly carry out the required certification tests, but are able to somehow provide 'certified' values for certification purposes nevertheless. There are significant difficulties for law enforcement authorities to tackle this corruption problem in Ukraine.

A further problem regarding introduction of technical regulation of greenhouse gas emissions from transport is lack of laboratories with the necessary test equipment. The establishment and proper equipping of these laboratories, as well as ground test facilities to bring them up to the standards of the more technologically developed countries requires significant investments. In addition, the vast majority of the equipment necessary for testing vehicles is also not produced commercially in Ukraine. Currently, Ukraine has very limited financial capacity to resolve this issue.

5.4.3 Regulation of CO2 emissions and energy consumption by the road transport in Ukraine

As already indicated, the procedures for the approval of design of vehicles, their parts and components were approved by order of the Ministry of Infrastructure of Ukraine 17 August 2012 No. 521, which includes UN/ECE Regulation No. 101. According to these requirements, CO_2 emissions and fuel consumption data must be attached to the certificate of conformity of LDV of categories M1 and N1. However, there is currently no central database for collection of this information, no technical regulation and no labelling system in Ukraine regarding CO_2/GHG emission and fuel consumption of road vehicles.

5.5 Economic instruments

5.5.1 Road vehicles taxes

The Tax Code of Ukraine (status on April 2016) contains the following measures regarding road vehicle purchase and automotive fuel taxation. The current VAT rate is 20% (according to article 193).

5.5.1.1 The fee for the first registration of the vehicle

Historically, the fee for the first registration of the vehicle has been differentiated based on engine volume and vehicle age. However, at present, Title VII, the Fee for first registration of the vehicle is excluded on the basis of Law No. 71-VIII, dated 28.12.2014.

5.5.1.2 Excise duty

The article 215 *"Excisable goods and rates of the Tax code of Ukraine"* includes excise duty values for different categories of road vehicles, differentiated also by engine volume and type, vehicle mass, vehicle age, and whether they are new / second hand vehicles in their origin (i.e. where imported from outside of Ukraine).

The differentiation here is quite complicated and detailed data regarding excise duty values are presented in Annex VI. The tax rates for buses are relatively low (and not significant to force product

choice on practice and therefore not significant from the point of view of regulation). The tax rates for passenger cars and other motor vehicles intended mainly for transportation of people can be in simplified as follows for only new vehicles, which shows there are already some incentives for electric vehicles:

Table 5.1: Summary of the excise duty rates for LDVs in Ukraine

Volume	Excise Duty Rate
LDVs with PI engine of volume (V):	
V ≤ 1000 CC	€ 0.102 per CC;
1000 CC < V ≤ 1500 CC	€ 0.063 per CC;
1500 CC < V ≤ 2200 CC	€ 0.267 per CC;
2200 CC < V ≤ 3000 CC	€ 2.213 per CC;
V > 3000 CC	€ 2.209 per CC
LDVs with CI engine of volume (V):	
V ≤ 1500 CC	€ 0.103 per CC;
1500 CC < V ≤ 2500 CC	€ 0.327 per CC;
V > 2500 CC	€ 2.209 per CC
LDVs equipped with electric motors	
All	€ 109.129

The tax rates for motor vehicles for the transport of goods are differentiated by weight and engine volume, new / second hand origination and vehicles destination. For instance, the tax rate for a new truck with gross vehicle weight over 5 tonnes but not exceeding 20 tonnes with CI engine is € 0.013 per CC with the total sum to pay for engine volume 6000 CC – € 0.013 × 6000 = € 78 each.

Second hand vehicles are penalised by with progressive scale under the age.

5.5.1.3 Transport tax

Article 267 of the Tax Code of Ukraine sets transport tax for taxpayers which are physical persons and legal entities, including non-residents who have registered in Ukraine according to the current legislation. Under the legislation cars of age up to five years (inclusive) and an average market price of more than 750 times the minimum wage (as established by law on 1 January of the tax (reporting) year) must pay each year the sum of UAH 25 000 (~€916) for each vehicle meeting these criteria.

5.5.1.4 The duty on mandatory state pension insurance

The resolution of the Cabinet of Ministers from November 3, 1998 No. 1740 “About approval of the Procedure for payment of duty on mandatory state pension insurance from separate types of economic operations” sets additional payments of duty on mandatory state pension insurance from separate types of economic operations according to the Law of Ukraine "On collecting the mandatory state pension insurance".

Those who are required to pay fees on obligatory state pension insurance on the disposal (e.g. sale) of their owned vehicles (cars) include: enterprises, institutions and organizations of all forms of ownership or physical persons who acquire ownership of the cars to be the first state registration in Ukraine in the divisions of the state traffic Inspectorate of the interior Ministry, by:

- Purchase of the cars, including by manufacturers and trade organizations (except for cases of vehicles of disabled persons according to the legislation);
- Barter;
- Of gift (donation);
- Inheritance (except for inheritance of a passenger car according to the law).

The duty on mandatory state pension insurance from operations, defined in paragraph 12 of this Order, shall be paid in the amount depending on the value of a motor vehicle, determined in accordance with the contract of sale, the account trade organizations, contract of exchange,

certificates of the customs authorities, act of expert evaluation of the value of the car, other documents certifying this cost, in the amount of:

- 3 percent if the cost of the car does not exceed 165 living wage for able-bodied persons established by law on 1 January of the reporting year;
- 4 percent - if the value of the car exceeds 165 but does not exceed 290 living wage for able-bodied persons established by law on 1 January of the reporting year;
- 5 percent - if the value of the car exceeds 290 living wage for able-bodied persons established by law on 1 January of the reporting year.

5.5.1.5 Customs tariff (import duty)

The customs tariff (import duty) for vehicles is established by the Law of Ukraine *"On Customs tariff of Ukraine"* dated 19 September 2013 No. 584-VII in the Group 87 *"Vehicles other than railway or tramway rolling stock, parts and equipment"*. Differentiation of the tariff is quite complicated (including engine type and power as well as volume in some cases, vehicle destination, new / second hand origination, vehicle age). Detailed data on the specific rates are presented in the Annex 4.

The import duty on the vast majority of vehicles is 10% of a certain custom value, however although the duty on electric cars is lower at 8%, the duty on new passenger cars with engine capacity over 3 litres is 6%, which would seem to provide a perverse incentive (especially given the trend for more efficient downsized engines). For diesel buses with an engine over 5 litres and for more than 10 passengers the rate is 20%.

The costs associated with customs clearance are very expensive in comparison to other countries, and consist of the following (which are relevant to potential taxes differentiated by GHG or fuel economy):

1) Import customs duty;
2) Excise tax;
3) Special duties;
4) VAT;
5) Import excise duty.

5.5.1.6 Additional import duty

In pursuance the terms of the Memorandum on economic and financial policy between Ukraine and the International Monetary Fund (IMF) and the Memorandum Of Understanding between Ukraine as the Borrower and European Union as the Lender dated May 22, 2015, the Law of Ukraine "On measures to stimulate foreign economic activity" from 24.12.2015 No. 912-VIII cancels additional import duty, which was introduced temporarily in Ukraine for a period of 12 months. The rate of additional import duty was 5% for vehicles.

5.5.1.7 Special duties on cars

A special tax on cars in Ukraine was introduced in 2013 for a period of 3 years as a result of national car manufacturers lobbying activities to protect domestic car assembly plants from concurrency with imports. The initial fees were set to 6.46% for cars for engine capacities of 1000-1500 cc and 12.95% for cars with an engine capacity of 1500-2200 cc. It was originally intended for the duty intended to be reduced to 2.14% and 4.3%, respectively after this period. However, complaints were raised about these duties by a number of countries-importers of cars to Ukraine, in particular Japan complained to the WTO (world trade organization). In June 2015, the WTO concluded that the introduction of the special duties of Ukraine goes against the WTO rules. Therefore, in 2015 the tax was cancelled before officially pre-planned period of validity came to an end.

5.5.2 Conclusion regarding vehicle taxes

The process of customs clearance is currently highly complex, opaque and ambiguous in general so does not function in a way to encourage the uptake of more efficient/lower GHG vehicles (in fact, arguably it does the opposite in some cases).

5.5.3 Automotive fuels taxes

In the past an environmental tax for legal entities per tonne of consumed automotive fuel was applied, however this was removed in a favour of the excise tax for fuel sold, which is collected from the sellers of the fuel (and passed on to the users). A summary of the applied rates is provided in the table below.

Table 5.2: Summary of automotive fuel taxes for fuel sold in Ukraine

Type of fuel	Excise tax rate
Gasoline, diesel fuel of different types and other petroleum products	171.50 Euro/1000L
LPG	31 Euro/1000L *
Biodiesel and its blends (not containing or containing less than 70 wt. % of petroleum oils or oils obtained from bituminous minerals) on the basis of monoalkyl esters of fatty acids	97 Euro/1000L
The alternative motor fuel (with more than a 40% by volume of bio-component)	120 Euro/1000L.

Notes: LGP contains ~65% of the energy per litre compared to diesel, and ~72% compared to gasoline.

By adopting the Law No. 909-VIII "On amendments to the Tax code of Ukraine and certain legislative acts of Ukraine concerning balancing of budget revenues in 2016", 24 December 2015 a flat rate excise tax was introduced on retail sales of petroleum products at the level of €0.042 per litre instead of the previously existing 5%.

The Cabinet of Ministers of Ukraine are required by the Law No. 928-VIII "On State budget of Ukraine for 2016" until 15 February of the 2016 to submit to Parliament proposals (that should be developed) for the redistribution of the excise tax on oil products to fund road repair, maintenance, and construction.

5.5.4 Vehicle parking taxes

In terms of parking fees, Article 10 of the Tax Code of Ukraine. Local taxes, determine elements relating to the fees for vehicles parking. According to the Tax Code:
"10.2. Local councils are required to establish a single tax and property tax (in terms of vehicle tax and land fee).
10.3. Local councils within the powers defined by this Code, resolve issues in accordance with the requirements of this Code regarding the establishment of the property tax (tax on real property other than land) and the establishment of a fee for Parking of vehicles, tourist tax."

The legislation also provides the definitions by which the rates for parking should be set and the types of land/property that they can/should be applied to.

5.6 Infrastructure and spatial policy, speed and traffic management

Infrastructure and spatial policy, speed and traffic management in Ukraine is (or was) considered as a part of following acts in particular:

- The Transport Strategy of Ukraine for the period till 2020, approved by decree of the Cabinet of Ministers of Ukraine dated 20.10.2010 No. 2174-R;
- The Concept of the State target economic program of development of road transport for the period up to 2015, approved by the decree of the Cabinet of Ministers of Ukraine dated 03.08.2011 No. 732-R;
- The Transport sector energy efficiency and reducing energy consumption program for 2010 - 2014 years, approved by the decision of the Collegium of the Ministry of transport and communications of Ukraine dated 17.09.2009 No. 18;
- The law of Ukraine "On road traffic";
- Road traffic regulations in Ukraine.

In addition, the Action plan for the implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European atomic energy Community and their member States, on the other hand, for 2014 - 2017 approved by the Cabinet of Ministers of Ukraine from 17.09.2014 No. 847-R contains a number of tasks that are relevant in this area, many of which are designed to provide input data for National transport model and as an instrument for regulation in the sector, including:

- **Measure 272 (Article No. 369 of the Agreement)**
  "Ensuring of development the projects:
  - The concept of the National (priority) transport network of Ukraine for 2015-2025;
  - The program of the National (priority) transport network of Ukraine for 2015-2025"

  Note: in principle, this concept should be based on National transport model.
- **Measure 274 (Article No. 369 of the Agreement)**
  "Support of introduction of Transport strategy of Ukraine for the period until 2020, in particular in terms of implementing such key areas as:
  - the development of transport infrastructure;
  - rolling stock renewal;
  - improving the investment climate;
  - ensuring the availability and improving the quality of transport services;
  - the integration of the domestic transport system to the European and international transport systems;
  - security of transport processes."

  Note: in principle, National transport model should be used as the base for the justification of measures.
- **Measure 275 (Article No. 369 of the Agreement)**
  "Development at national level Integrated development plan of logistics to ensure the development of a network of logistics centers, optimizing the transportation of grain cargoes, including with the use of inland waterways, improvement of process of organization of freight traffic through the optimal use of existing transport infrastructure".
- **Measure 277 (Article No. 369 of the Agreement)**
  "Development, implementation and use of National transport model in the planning and implementation of the strategy of development of transport infrastructure"

  Note: A data processing center to support National transport model creation and processing is currently under development.
- **Measure 278 (Article No. 369 of the Agreement)**
  "Creation of automated information-analytical system of collecting and analysing data related to the transportation of passengers and goods, including transit"

  Note: It is considered as important input data for National transport model and as a key instrument for traffic flows optimization with the aim of resources consumption reduction.
- **Measure 279 (Article No. 369 of the Agreement)**
  "Strengthening the institutional capacity of the Ministry of Infrastructure the policy of transport infrastructure development, in particular by implementing the best practices of the EU in the formation and implementation of state policy to ensure stable and efficient functioning of the transport industry"
- **Measure 286 (Article No. 368, 369, appendix XXXII of the Agreement)**
  "The creation of the single state electronic register of road carriers in accordance with Regulation (EC) No. 1071/2009 of the European Parliament and of the Council of 21 October 2009, which introduces common rules concerning the conditions of access to work for road transport operators"

Overall, the development of the National transport model as well as Data processing center to support National transport model are considered as important consistent for strengthening the institutional capacity of the Ministry of Infrastructure in the field of GHG emission and fuel consumption regulation in transport sector.

5.7 Behavioural change measures

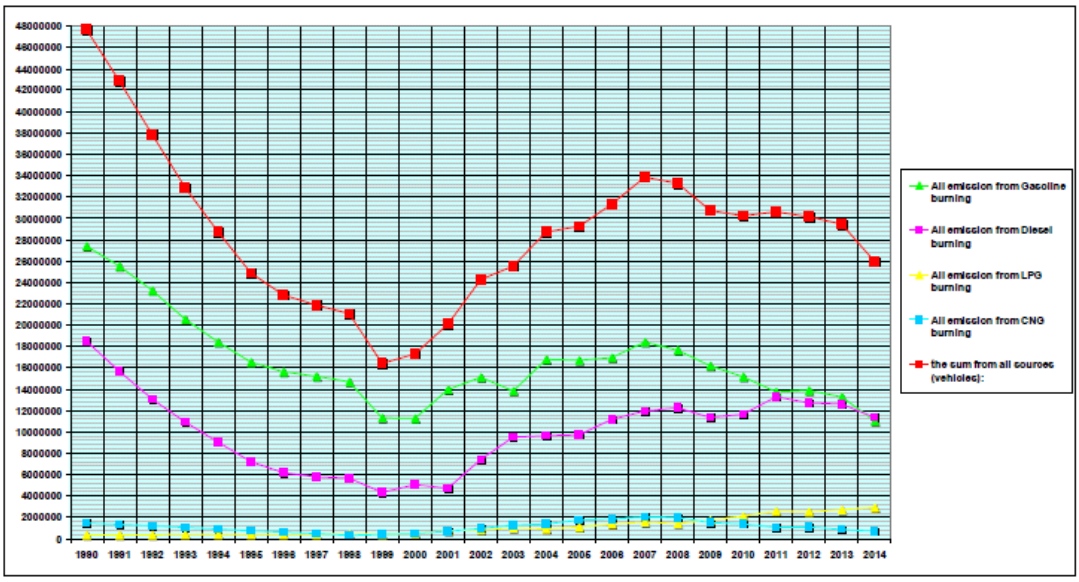
There are not yet any significant measures established in Ukraine to raise awareness and encourage behavioural change with the aim of GHG emission and fuel consumption reduction from road transport.

5.8 Alternative fuels opportunities in Ukraine

5.8.1 Fuel consumption trends

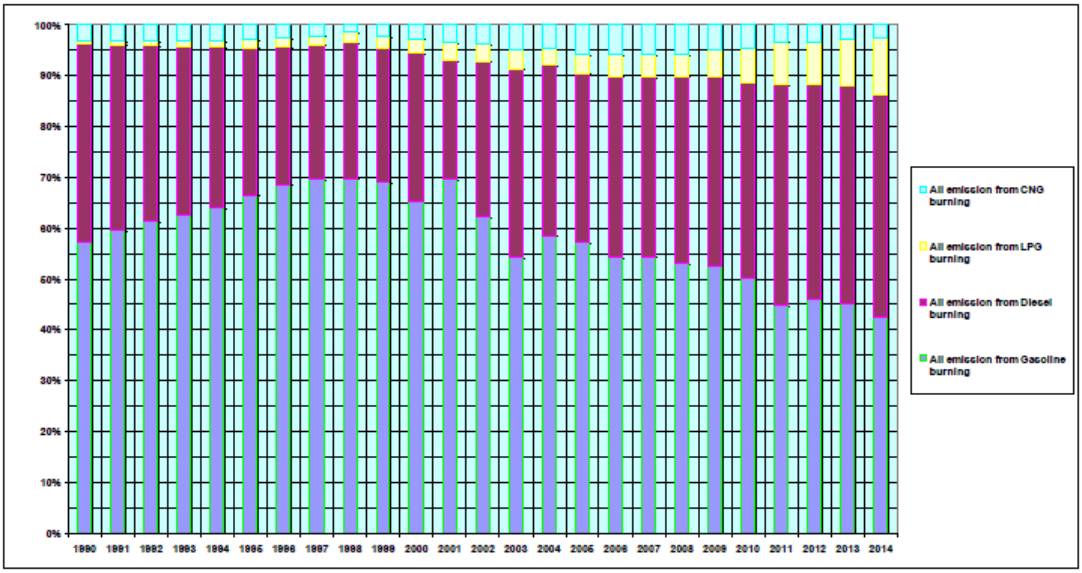
There is already a significant degree of experience with alternative gaseous and liquid fuels in Ukraine (though not with electrified vehicles), with around 1.25 million of vehicles propelled by CNG and LPG in Ukraine, more than 2000 LPG refuelling stations and 317 CNG filling stations. The overall historical motor fuel consumption trends, including gasoline, diesel, LPG, CNG, can be illustrated by consideration of data on CO_2 emissions (which are directly related to fuel consumption), disaggregated on different fuels powered vehicles. These are shown in Figure 5.1, and the relative percentage share of total emissions by road transport fuel is shown in Figure 5.2. The figures show that previously there was a relatively significant share of CNG fuelled vehicles in the past, but this has declined since 2007-2008 and the economic crisis. Since this point all motor fuel consumption has dropped, but the share of CNG has decreased more rapidly due to the relatively high price for natural gas. Conversely, LPG consumption has shown some growth during 2013-2014 despite the decline in gasoline and diesel fuel consumption.

Figure 5.1: CO2 emission trends (t), disaggregated by vehicle fuel propulsion type



Source: (Ukraine SRTRI, 2015)

Figure 5.2: Percentage distribution of CO2 emission trends by vehicle fuel propulsion type



Source: (Ukraine SRTRI, 2015)

The use of alternative and non-traditional motor fuels in Ukraine and the EU in 2007 and 2010 and a forecast for 2020 is shown on the Table 5.3 (as percentage of the total consumption of motor fuels by energy equivalent).

Table 5.3: Historical and forecast use of alternative and non-traditional motor fuels in Ukraine and the EU (as a percentage of the total consumption of motor fuels by energy equivalent)

	Share of total road transport fuel consumption (%)							
	European Union[1)]				Ukraine[2)]			
Year	CNG & LNG	LPG	Bio-fuels	**Total**	CNG	LPG	Bio-fuels[4)]	**Total**
2007	0.2	1.6	2.3	**4.1**	5.3	5.2	0	10.5
2010	0.2	1.8	3.9	**5.9**	4.0	7.9	0.1	12.0
2020	0.3	2.0	7.4	**9.7**	5.35[5)]	13.9	10.0[6)]	29.2[7)]

Source: the SE SRTRI, 2012 data, Ukraine

Notes:

1) Statistical data and projections given according to the analytical review of the EU Directorate General for Energy and Transport "Trends to 2030 – update 2007" of 08.04.2008;
2) Statistical data applied in the inventory of GHG emissions (2012) and projections of SE "SRTRI";
3) Provided that balanced LNG pricing, stimulating carriers, is introduced for a long-term period;
4) Provided that legislative regulation for stimulation of biofuel production and consumption is introduced;
5) In 2016 the CNG share forecast is much less then was considered in 2012, and is around 0.4%, so 1.6% may be more realistic if current policy will continue;
6) Such levels in 2020 cannot be already achieved in accordance to the present situation and due to objective reasons;
7) In 2016 the share is around 14%, so 18% might be considered as more realistic updated forecast.

5.8.2 Renewable energy resources opportunities in Ukraine

There is currently a relatively small share of biofuel sold on the Ukraine market, however there are significant problems with the way biofuels are promoted in Ukraine. At the moment there are many cases where high-blend biofuels (e.g. up to 40% bioethanol claimed) are mis-sold/aggressively promoted as providing cost benefits, improved performance and reliability, without any consideration of vehicle compatibility. The use of high blend fuels in vehicles that have not been designed to use them has been shown to have negative impacts on emissions (e.g. NOx and carcinogenic components), as well as on the vehicle performance, reliability and service life. As a result there is significant consumer confusion and disillusionment, and the general opinion of many motorists to such energy sources is negative.

Despite of current poor practice of bio-fuels promotion, it is nevertheless recognized by the expert community that a higher bio-fuels share is not realistic in Ukraine to 2020 due to objective reasons. There is therefore a need for a new balanced approach in Ukraine, with the aim to more efficiently promoting the development of renewable energy sources in transport sector.

In the medium-long term, the uptake of electrified vehicles would also provide a potential route for further use of renewable energy in road transport. At the moment there are not significant numbers of plug-in electric vehicles in Ukraine, although the Ukraine police force has just ordered 651 Mitsubishi Outlander PHEVs (Plug-in Hybrid Electric Vehicles) (Autoblog, 2016).

5.8.3 Legislation

The main normative legal acts which regulate the market of alternative fuels in Ukraine and the issues of taxation of participants in this market include:

- The Law of Ukraine "On alternative fuels" dated 14.01.2000 year 1391 - XIV;
- The Law of Ukraine "On alternative energy sources" of 20.02.2003 No. 555-IV;
- The Law of Ukraine "On amendments to some laws of Ukraine on facilitating the production and use of biological types of fuel" year of 21.05.2009 No. 1391-VI;
- The Law of Ukraine "On amendments to some laws of Ukraine regarding production and use of motor fuels with contents of bio-components" from 19.06.2012, No. 4970-VI (lost power in accordance with the Law of Ukraine from February 12, 2015 No. 191-VIII);
- Order of the State Committee on Energy Conservation No 183 of 10.12.2004 (registered in the Ministry of Justice on 27.12.2004) On Approval of the Procedure of Conducting of Expert Assessment for Confirming Alternative Fuels (with amendment of 2007));
- Resolution of the Cabinet of Ministers of Ukraine dated 05.10.2004, No. 1307 "On the procedure for issuing certificates of belonging to alternative fuels" (with amendments);
- Tax code of Ukraine;
- Customs code of Ukraine;
- Resolution of the Cabinet of Ministers dated 01.03.2010 No. 243 "On approval of State target economic program of energy efficiency and development of sphere of production of energy from renewable energy sources and alternative fuels for 2010-2015";
- Resolution of the Cabinet of Ministers of Ukraine of 18.05.2011, No. 581 "On approval of the Procedure of import into the customs territory of Ukraine appliances, equipment, technical and transport facilities used for the development of production and ensuring consumption of biological kinds of fuel";
- Resolution of the Cabinet of Ministers dated 28.09.2011, No. 1005 "On approval of list of goods of own production, 80% of the profits from the sale of which in the customs territory of Ukraine is exempted from taxation".

The Law of Ukraine on Amendment of Some Laws concerning the Production and Use of Biological Types of Fuel No 1391-VI of 21.05.2009 with amendment of 2010. This law is dedicated to stimulation of production and usage of biofuel, the development of a national fuel market based on application of biomass as renewable raw resource for production of biological types of fuel. In particular, the Law foresees a partial release from customs duties and excise duties of equipment and vehicles propelled by biofuel.

In 2012 amendments were introduced to require mandatory content levels of bioethanol for all petrol produced and sold in the country, with a recommended level of 5% (by volume) in 2013 becoming mandatory from 2014-2015, and then increasing to 7% (by volume) from 2016. Unfortunately, this law was passed despite the fact that around two-thirds of the Ukrainian road fleet are not designed (and not adapted) to use petrol with more than 5% (by volume) of bio-ethanol content. As a result of this, and the other reasons mentioned previously, this regulation has not been applied in full and lost later power, and has been removed in accordance with the Law of Ukraine from February 12, 2015 No. 191-VIII.

At present, the introduction of legislative requirements for mandatory content of bio-ethanol and bio-diesel in motor fuels is actively discussed in the expert and regulatory communities in Ukraine with the declared aim of creating a market of components of biological origin in Ukraine with the active lobbying of the business community.

Currently the existing legislation does not include suitable controls to ensure the overall sustainability of the biofuels sold on the market, i.e. equivalent to recent legislation in the EU in this area to ensure biofuels deployed do actually result in net GHG emissions savings.

5.8.3.1 Tax benefits

Article 9 of the Law of Ukraine "On alternative fuels" provides a range of organisational-economic measures to stimulate the production and consumption alternative fuels. In particular, there are provisions of tax incentives for legal and physical persons to stimulate the development and introduction of new technologies, equipment, materials in the production process of alternative fuels (with special references to biofuels). In accordance with the Tax and Customs codes of Ukraine there are two types of tax benefits to market participants of alternative fuels, which include:

1) Taxation benefits to income tax (reductions for the sale of relevant goods);
2) Benefits for import (regarding waving of some duties and VAT).

5.8.4 Conclusions

At this point in time there is policy development is not fully consistent, justified and effective in this area. In particular, the sustainable development in this field in concordance with latest EU approaches and legislation is very important, as this is currently not present in Ukraine legislation. This would include the introduction of suitable policy safeguards to ensure that sustainable biofuels are sold on the Ukraine market, and avoid potential unintended negative impacts (e.g. from indirect land use change).

5.9 Ukrainian fuel rationing system for road transport

Ukraine currently operates a unique and effective system of fuel rationing which is used for commercial and municipal road transport. The current version of the system was approved by the order of Ministry of infrastructure of Ukraine dated 24.01.2012 No. 36 and is named “Rationing system of fuel and lubricants for road transport”.

This instrument was put in place for the control and forecasting of fuel expenses and takes into account all major factors affecting fuel economy. The system provides for each type of vehicle a so-called base fuel consumption norm, representing design particularities, the vehicles’ basic fuel efficiency and designation, with the last designed to represent average operating conditions. Since the real life fuel consumption of vehicles varies significantly, a moderately wide set of correction coefficients (factors) have been established. These provide additional norms and their values (including limits) to take into account real driving conditions, the road (including hilly or mountains as well as speed limits), traffic, ambient (weather) conditions, as well as cargo weight, air conditioning usage, average trip length and cold engine driving influence, type of operation, vehicle idling time, etc. Further information on the fuel consumption basis data is also provided for heavy duty vehicles in earlier Section 4.4.2.6.

Road vehicle fleet owners are able to design their own policy to control fuel expenditures based on this effective unified system. At the initial stage, the owner uses base vehicle norms together, with additional norms and correction coefficients set to values that represent their own specific operating conditions, together with actual monitored fuel consumption data, with the aim of establishing the normative fuel consumption. These normative fuel consumption values can be established by the owner to take into account the internal policy of the company. For example, it is possible to set very tight values to force fuel efficient driving practice by the drivers, and also specific operational demands can be taken in to account, for example where fast goods delivery or customers comfort are important criteria. However, other criteria and circumstances may also act to increase the fuel consumption from the base level. For example, the speed corresponding minimum fuel consumption might be lower than practically acceptable (or even safe taking into account the speed of traffic in general). Similarly, other factors will affect the fuel consumption such as the route chosen, the delivery time, etc. In reality the fuel consumption policy is often a compromise between a range of different criteria, however the driver skills and discipline is also an important factor in this.

During operation the actual fuel consumption will vary in accordance to changes in the operating conditions, however this may be taken into account by an adjustment using the set of correction factors to recalculate the normative fuel consumption. When the actual fuel measured consumption becomes significantly different from the normative fuel consumption, this can be used as an indication for the need to check whether the factors used are still correct, and if necessary to adjust them to more accurately reflect the reality. Alternatively, it might be discovered that there is another reason for the increased fuel consumption. These could include, for example, exceedances of the speed limit, aggressive style of driving, low tire pressure, poor technical condition, serious technical fault, a poor vehicle route and/or operation time planning leading to significant downtime in traffic jams, or even simply fuel theft (e.g. drivers use the fuel for other purposes or for illegal sale to third parties). This, therefore, enables the owner to quickly decide whether to exclude the factors causing increased fuel consumption, review the operational fuel economy improvement practices within drivers, to reforecast future fuel expenditures, or to make decisions about service or repair of vehicles, etc. At the same time the system helps facilitate transparent, fair and equitable relations between the owners of vehicles and their drivers.

In addition, the fuel rationing system can be an effective instrument to fix the base level of consumption before, and to continuously maintain skills of drivers after, a fuel efficient training program has been introduced and to save money spent on the training program. As it is well known that the eco-driving skills of drivers tend to degrade over time, this instrument has been shown to help maintain them continuously over a longer period.

Since the real fuel consumption of a vehicle varies in very wide range it is not realistic/possible to establish a single constant fuel consumption value for a base of interaction between companies (owners) and drivers. In contrast, the use of adjustment/correction factors in a proper designed fuel rationing system provides a much more flexible instrument that automatically gives confidence for owners that they can make effective use of fuel resources in wide range of vehicle operating conditions, and also gives confidence for drivers in the fairness of the system.

Modern on-time vehicle control systems, including GPS based navigation and fleet remote control, are often able to provide actual fuel consumption numbers. These figures can be used by the system to provide high-quality input data for the rationing system to enhance its effectiveness. However, at this point in time they are not able to replace it, since the actual fuel consumption data by themselves do not include all the associated factors that should still be controlled to make more efficient use of resources. In the future it is possible that more sophisticated software might be able to provide the basis for a similarly complex assessment, but until then this system provides a useful and cost-effective approach.

This unified “Rationing system of fuel and lubricants for road transport” is very popular in Ukraine between organizations and enterprises of all forms of ownership, and is also actively used by tax and regulatory authorities within its relationships with legal entities. It is also used as the basis for the establishment of tariffs for passenger transportation, as well as the base for assigning state budgets and for planning and allocation for organisations in terms of their automotive fuel expenses.

5.10 Other instruments spread in Ukraine

There are no other significant instruments in-use in comparison to EU experience, other than those already mentioned in the previous report sections.

5.11 National road transport GHG emission reporting issues

Reliable national scale reporting of GHG emissions by road transport is important to enable effective monitoring and control of the effectiveness of measures on reducing the negative consequences transport activity in Ukraine. Although at present the level of motorization in Ukraine is relatively small, there is an expected increase in the contribution of transport to total GHG emissions of the country in the future. At this time the national system of reporting GHG emission from road transport in Ukraine faces considerable challenges.

The main problems can be briefly considered as:

1. Significant under-funding of activities in this area;
2. The current statistical data that are needed for the road transport sector in the GHG emission inventory are incomplete and do not match well with reality.
3. The is an absence of nationally-specific emission factors that are required for the inventory.

The development of national data sources on the actual carbon content of different types of fuel is a strong (obligatory) requirement of the 2006 IPCC Guidelines as the base for CO_2 emission factors, especially in the road transport sector. As a result, the national GHG inventory system in Ukraine has had strong criticism by the international community due to the lack of this national (specific) data for the fuels used by road transport as key category. In addition, various fuel additions, including renewable components, consumption of oils and other auxiliary liquids (e.g. those used for reducing toxicity as AdBlue) should be taken in to account. Furthermore, CH_4 and N_2O emissions are related to combustion technology, as are the precursors of greenhouse gases and other toxic pollutants, and it should be noted that default IPCC EFs are not suitable for the specific conditions of Ukraine.

At the current time there are a number of pre-planned activities to improve the situation, including the project CEEF2015-041-UA *"Capacity building of the national GHG inventory system in terms of the development of methodological recommendations for determining national GHG emission factors from the use of motor fuels in the transport sector"* and the project for the creation a common information system including data processing center for transport with subsequent development of National Transport Model of Ukraine (SE SRTRI of the Ministry of transportation of Ukraine is responsible for this). It is expected that the latter project will also help to improve the situation with regards to input data for the national GHG inventory, as well as providing an effective instrument to facilitate the planning and monitoring of a wide set of measures for reducing GHG emissions (as done in other countries).

5.12 Gap analysis of missing elements and obstacles to implementation in Ukraine of measures similar to the EU experience

The missing elements and obstacles to implementation in Ukraine of measures consistent with those utilized in the EU / EU member states experience can be can be briefly ranked as follows:

1. The current legislative background is currently weak, insufficiently coherent and transparent as well as practically not yet connected with the solution of the problem.
2. There is an acute shortage of public resources available for the implementation of practical measures to tackle the problem.
3. The strategic documents as well as state and sectoral scale programs with planned measures and stated goals to reduce CO_2 emission and fuel consumption in transportation sector do not have practical mechanisms for actual implementation.
4. There is currently deep-rooted corruption in the bodies of conformity assessment, which is a major fundamental obstacle in Ukraine to any technical regulation and/or combination with fiscal measures, including harmful emissions, greenhouse gases and the fuel efficiency of vehicles.
5. The economic instruments in use are not clearly related to the solution of the problem and declared targets, and also do not involve all the options already used in EU countries.
6. There is shortage of suitable testing facilities (laboratories and ground test facilities) that would be required to ensure conformity to certification procedures (the standards) needed to enable regulation of CO_2 emissions and energy consumption of newly registered vehicles.
7. Research and development and other instruments to stimulate innovation and new technologies introduction are currently neglected by the State.
8. There is a lack of a common and sufficiently complete information system in the transport sector – there needs to be a central vehicle database governed by the State.

9. Lack of requirements regarding MVC (monitoring, verification and certification) of new vehicle performance as well as the absence of instruments to implement it at the time being.
10. The current regulatory framework on the use of biofuels does not take into account the sustainability aspects that have been considered and implemented in EU legislation in recent years.
11. Driver training (Eco driving) potential and other educational and awareness raising instruments are currently ignored due to a lack of knowledge about of the potential ways for implementation.

5.13 Overall conclusions

The current situation for the Ukraine road transport system may be summarised as follows:

- The system for the regulation of emissions in the transport sector is currently not well developed;
- The structure of the road vehicle fleet contains a significant proportion of older vehicles, with few incentives to shift to more efficient vehicles, and Ukraine's transport infrastructure needs further development;
- There is significant potential for the future application of newest information and logistics technologies and numerous other opportunities; but
- There are also significant issues with regards to financial resources, and corruption in Ukraine.

It can be concluded, therefore, that Ukraine has a big potential for the reduction of specific GHG emissions in transport sector in comparison to the current policy situation. However, at the same time there are currently significant barriers to the implement the majority of the available options likely needed to realise this potential. In the following report sections, a number of recommendations are therefore presented to develop a potentially optimal approach, taking in to account the available resources in the country and the other national circumstances.

6 Proposals and recommendations for the improvement and development of a national policy (Task 5)

6.1 Outline of the proposed approach

The objective of this task is to identify and describe concrete actions that could/should be undertaken in order to enhance Ukraine's national policy with regards transport CO_2 emissions. The national policy is to be in line with national global GHG emissions reduction targets and the Association Agreement between the Ukraine, the European Union and the European Atomic Energy Community.

For this purpose, the first subtask was to identify and list (global) targets and agreements that are relevant for the Ukraine to ensure a common understanding of CO_2 policy requirements in the global context. The second subtask has referred to the findings from earlier tasks in order to develop concrete proposals on what actions should be taken to improve national policy and to align it with the targets as identified in the previous subtask. These recommendations have been built upon:

a) The findings in earlier tasks
b) The recommendations and proposals expressed by stakeholders during the first coordination meeting (see Section 1)

The aim was also to provide indicative timescales for the introduction of the actions by setting priority levels for each action, potentially reflecting the "ease" of implementation of certain policy actions.

The following report sections provide a discussion and summary of the project's proposals and recommendations for Ukraine.

6.2 Identification of global CO_2 reduction targets and agreements

In this section a discussion is provided below on the global targets and agreements identified that the Ukraine aims to align with or improve on. Principally, these include the following:

In the European Union, Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date.

The Association Agreement between Ukraine, on the one hand, and the European Union, European Atomic Energy Community and their Member States on the other hand has an objective to improve and develop an appropriate Ukrainian policy on the regulation of CO_2 emissions and energy consumption by road transport. As it was said in Chapter 2 (Background) the provisions of the Directive 2006/32/EC (that is repealed by the Directive 2012/27/EU) regarding road transport should be reflected in the legislation of Ukraine for 5 years and implemented within 8 years from the date of entry into force of the Agreement.

Looking further forwards, in the EU, Green Paper "A 2030 framework for climate and energy policies" (European Commission, 2013) was issued with the aim to consult stakeholders to obtain evidence and views to support the development of the 2030 framework. The European Union's 2030 climate and energy framework was adopted in October 2014 and established an aggregated (for whole economy) binding target for GHG emissions of 40% below 1990 levels by 2030. This target is split between the ETS (EU emissions trading scheme) and non-ETS sectors and translates to a reduction objective of 30% for non-ETS sectors by 2030 (compared to 2005). Whilst there is currently not a specific objective set for the contribution to this reduction from the non-ETS transport sector (which excludes aviation and maritime shipping), PRIMES modelling carried out for the European Commission has suggested

that for cost-effective reductions, GHG emissions from road transport should be reduced by at least 21-25% versus 2005 levels. However, recent modelling work has shown that reductions in the order of 30% from non-ETS transport by 2030 may be necessary to be compatible with the EU's longer term GHG reduction objective of 60% reduction in GHG emissions from transport compared to 1990 (Ricardo Energy & Environment, 2016).

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the universal legally binding global climate deal. Intended Nationally Determined Contributions (INDC) of Ukraine to New Global Climate agreement declared as will not exceed 60% of 1990 GHG emissions level in 2030. It is said "Ukraine's INDC will be revised after the restoration of its territorial integrity and state sovereignty as well as after the approval of post-2020 socio-economic development strategies with account of investment mobilization". For the European Union, the longer term perspectives were laid out by the European Commission in 2011 in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050, and the Transport White Paper. These documents include a sector-wide target of reducing GHG emissions from the EU by at least 80% by 2050 (compared to 1990), and an objective of reducing GHG emissions from transport by 60% (European Commission, 2016).

In relation to these medium- to long-term objectives, the Global Fuel Economy Initiative (GFEI) has initiated the "100 countries for 50 by 50" campaign in order to promote greater fuel economy, with a target to double fuel economy of the global passenger vehicle fleet by 2050, and for new passenger vehicles by 2030. In addition to this the GFEI is already engaging with stakeholders in Ukraine in order to further this objective in the country: a summary of this activity is provided in Box 1 below. Similarly, the International Transport Forum (ITF) at the OECD on 19 May 2016 officially launched a major global initiative towards carbon-free transport "the Decarbonising Transport project" on response to the COP 21 Paris Agreement.

As a result of the above, it seems clear that the declared targets for reduction of Ukrainian road fleet GHG emissions and energy consumption (as listed in Section 5.3.2) should be revised to take into account the above mentioned global trends and translated to clear national action plans with corresponding funding. The development of forecasts for GHG and toxic pollutants emissions from the Ukrainian road transport sector as functions of different scenarios of economy growth and regulation options are a subject of further research that started in 2015. This work is being conducted by the State Enterprise *"State Road Transport Research Institute"* for the Ministry of Infrastructure of Ukraine. It is expected that this research will help to develop short-, medium- and long-term national targets for GHG emissions and energy consumption based on an appropriate set of measures and timescales, taking in to account the major factors and the potential for the country, as well as the available resources for its optimal allocation to different sub-sectors.

Whilst the current research within this Clima East project has aimed to develop proposals for the optimal set of priority policy options to be implemented in Ukraine, the above mentioned research has focused on developing numerical forecasts (estimates) of fuel consumption and emissions within different scenarios. The objective here has therefore been to understand what reasonable potential limits of GHG reduction for Ukraine might be within different scenarios of economic growth and policy measures to substantiate the allocation of financial funds and other resources, and to understand what national GHG reduction targets might be set in the future to meet Ukraine's international obligations in this area.

The policy options for Ukraine recommended in the next report sections take into account the main national circumstances and best practice examples from around the world. These recommendations have been developed with the objective of achieving significant GHG reductions within the available resources and country conditions, and are based on a qualitative analysis by the project's expert team of information gathered from a combination of stakeholder feedback and information from the literature. Taking into account the existing plans and considering economic situation in Ukraine, it is possible to recommend the development and implementation of policies that will contribute to ensuring that medium and long term GHG emissions from road transport at least will not exceed the following indicative targets:

- **by 2030:** a reduction of 40% compared to the 1990 level;
- **by 2050:** a reduction of 50% compared to the 1990 level.

These goals at the first approach seem to be more then realistic in the context of transport's GHG emissions -being compared to 1990 emissions levels (in accordance with study of SE SRTRI, 2015):

- at 72% in 2007;
- at 63.5% in 2010;
- at 54.4% in 2014.

Figure 5.1 gave a representation of the trends in Ukraine year by year during 1990-2014 period as well as Figure 4.9, which also showed forecasts in accordance with different scenarios. The total emissions of GHG in the road transport sector are based not only on technological level, but also to a large extent on the overall economic activity in the region. For Ukraine, there has been a sharp decline in economic activity since 1990, which is especially important. The reduction of energy consumption in the sector and GHG emissions since then is likely to a significant extent due to this economic decline rather the result of actions directed at improving energy efficiency and sustainable transport development to meet the needs of the economy and society. Therefore, given also the significant uncertainty in the future economic outlook, it may be useful to consider not only absolute targets, but potentially also specific (per unit of transport work) indicators of energy consumption and GHG emissions and the adoption of appropriate targets (e.g. as indicated in earlier Section 4.7). It is expected that such approach may better stimulate the implementation of innovative solutions in the sector also, and could encourage the setting of more advanced (or ambitious) goals at the state level too. However, the establishment of such objectives, based on the set of measures that could be implemented Ukraine in the short-, medium- and long-term, would require a separate/further much more detailed study than can be provided here. Such an analysis should also ideally be based upon a detailed quantitative assessment using a Ukraine national transport model (which is currently still under planning and development).

Box 1: Information on the Global Fuel Economy Initiative (GFEI) in Ukraine

Ukraine Launches National Fuel Economy Initiative with GFEI

The Global Fuel Economy Initiative (GFEI) exists to assist governments and transport stakeholders promote greater fuel economy, and has an overall aim to improve fuel economy of all LDVs by 50% globally by 2050. In Ukraine, GFEI launched a new project focused on developing a national auto fuel economy baseline in November 2015. So far, the work has focused on the formation of a national working group and securing auto registration data for the calculation of a national auto fuel economy baseline. The project working group consists of the Ministry of Ecology and Natural Resources, the Consumers Union of Ukraine, the State Agency on Energy Efficiency and Energy Saving**,** the Ministry of Energy and Coal, the Ukrainian Scientific Research Institute of Oil Refining, Main Service Center of the Ministry of Internal Affairs.

The Ukrainian implementing partner of the GFEI, the International Standardisation Academy (ISA), participated in the recent GFEI Network Meeting in Paris on 9-10 June. The ISA has managed to established cooperation with the Main Service Center of the Ministry of Internal Affairs of Ukraine, which in turn ensured access to vehicle registration data for 2014. The ISA is working on access to additional years of data; GFEI baselines are usually calculated from 2005 and trends for subsequent years where data is available.

A kick-off meeting presenting data and finding is planned for August/September 2016; ISA is also facilitating a memorandum of cooperation between UNEP and the Ministry of Ecology that will help establish the foundation for further policy-making for automotive energy efficiency.

According to information currently available to GFEI, improvements to new vehicle efficiency have lagged behind other parts of Europe in recent years, as illustrated in the Figure below:

Source: Source: Global Fuel Economy Initiative (GFEI/UNEP, 2016)

Further information is also available on the GFEI and UNEP websites at:
http://www.globalfueleconomy.org/
http://www.unep.org/transport/gfei/autotool/about.asp

6.3 Prioritisation and recommended policy actions

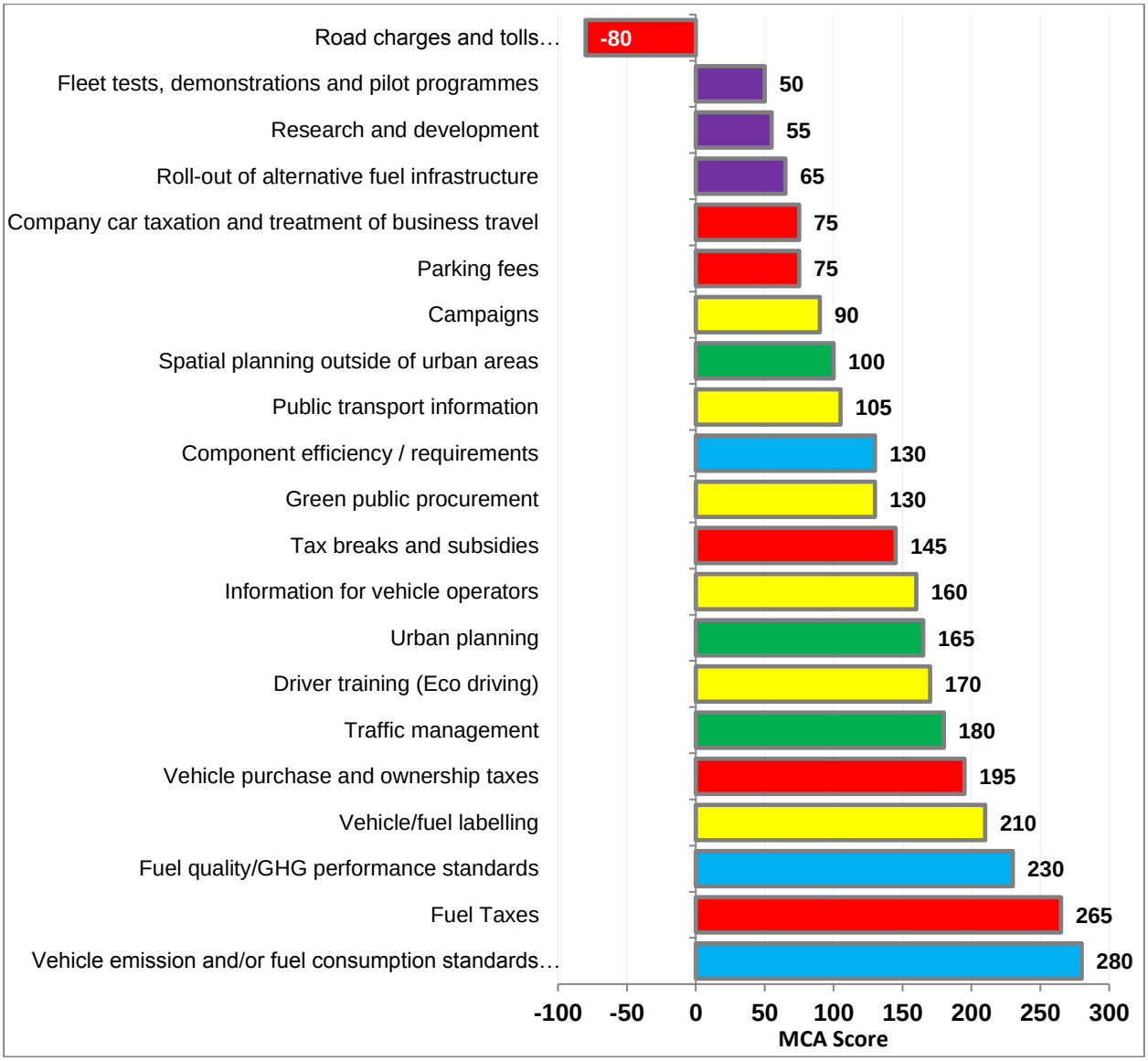
The prioritisation and recommendation of policy actions has been informed in this project by a combination of qualitative and semi-quantitative analysis by the project expert team, and discussion with/feedback from a range of Ukrainian stakeholder experts. These elements are further discussed in the next report sections.

6.3.1 The Multi-Criteria Analysis based ranking of policy options

The review as well as qualitative assessment and ranking of policy options identified in the EU and its Member State (MS) countries for the case of the Ukraine has been based on the Multi-Criteria

Analysis (MCA) presented in earlier Chapter 0. Within this MCA all the policy options identified and considered were originally ranked by the project team experts as is presented in the following Figure 5.1 (with the final score presented next to the column).

Figure 6.1: Representation of the policy options ranking from the Multi-Criteria Analysis



Notes: In the above figure, the groups of policy options are marked according to the following colour key:

- **Red** = *"Economic instruments"* group (comprises 24.2 % of total score sum);
- **Blue** = *"Regulatory instruments"* group (comprises 22.9 % of total score sum);
- **Green** = *"Enhancement of infrastructure"* group (comprises 15.9 % of total score sum);
- **Yellow** = *"Education and awareness raising"* group (comprises 31 % of total score sum);
- **Purple** = *"Stimulation of innovation and development"* group (comprises 6 % of total score sum).

In assessing the attractiveness of different options/groups of options, it might also useful to also consider the overall MCA scores achieved as a whole (e.g. as a percentage of the total). The total scores from the top 5 options (from emission standards to purchase and ownership taxes) account for about 42 % of the sum of all MCA scores for the range of options under consideration. Correspondingly, for the first 7 options (ending with 'eco-driving'), the share is approximately 55 %, and for the first 9 (ending with Information to vehicle operator) it is around 66 %. Such kind of an analysis does not represent actual CO_2 reduction potential of combined groups of options or something similar, but it gives some indicative information about the formal distribution of the options scores. It is important to note also that all options should be considered as complementary in a

common policy framework. Moreover some of them may be fully effective only if they are implemented alongside other supporting measures: for example, linking regulatory vehicle emission standards, vehicle labelling and vehicle taxes within a common system. Whist the stimulation of innovation and development comprises only 6 % of total score sum within the applied MCA approach, which focuses on direct impacts on delivering GHG emissions reductions, it is clearly important in the broader overall considerations, as agreed by the experts community.

The research carried out for this project has only been able to provide a detailed review a selection of the policy options that were ranked the highest according to the multi-criteria analysis. Only top 5 ranked options were therefore considered in more detail, and these were proposed to stakeholders for prioritisation during the consultation, in order to focus their attention to them in this project. Nevertheless, this limitation does not mean that the other options have been withdrawn from set considered in the recommendations for implementation. The MCA here therefore provides only a first-order instrument for first approach prioritisation with the restricted resources available for this project to help develop and put in practice appropriate policy measures in the first place.

The qualitative assessment and ranking of the different policy options by the expert team using the MCA approach covered a clear and agreed set of criteria, and it was naturally necessary to try to keep this assessment clear and focused to a limited set from a practical point of view. Whilst it was therefore not possible to account for all significant factors/the full complexity of the situation using this simplified approach, it is useful to help screen/prioritise options for further investigation. It should be noted, however, that the appropriate assignment of individual scores can be considered to some extent subjective. The final scores therefore represent a compromise between different points of view of the project experts, so an analysis including a wider number of points of view could yield slightly different results. Therefore, the study team also requested the consulted stakeholders to provide feedback on the MCA scoring, and the opportunity to propose amendments to this, and the policies recommended. This is discussed in the next section.

However, a further important consideration in any decision-making about option prioritisation is the relative potential for GHG reduction each option might make to national GHG emissions. Research in this area has recently been conducted for the EU28, and is presented in later Section 6.3.3 to provide an indication of what the relative importance of different options might be (although the specific potentials will be different for Ukraine).

6.3.2 The Stakeholder feedback results

Stake holder feedback was gathered through a combination of direct feedback during the project's first coordination meeting, feedback to questions posed at/after the project meeting (via the distribution of a questionnaire to relevant stakeholders), and informal discussions with the project team.

Analysis of the feedback received shows that there are very different points of view with regards to the prioritisation of the top five policy options. It was not possible to fully combine into one system the very different points of view provided on the policy priorities and their ranking according to importance. In particular, it is perhaps not surprising that the prioritisation proposed by the different stakeholders was closely related to their individual sphere of activity and responsibility. In addition, many of the proposed alternative views option prioritisation were not based on proposed revisions to the MCA nor justified by other formal instruments or analysis. However, the stakeholder representatives' proposals are of course grounded in their practical knowledge and experience, and therefore require careful analysis and consideration in the process of further formation of an integrated state policy. A summary of the key feedback received from different stakeholders is provided below:

Written feedback was received from the following stakeholders, with summary of the proposed prioritisation of options by the different stakeholders also provided in Table 6.1:

- ✓ The State Agency on Energy Efficiency and Energy Saving of Ukraine (Mr. Andrey Frolov, the Deputy chief of Division of monitoring and energy of Management monitoring and information Unit of the Department of strategic development)
- ✓ The Budget Institution "National center accounting greenhouse gases" (Mr. Sergey Shmarin, Chief specialist);
- ✓ The National Ecological Centre of Ukraine (Mrs. Maria Storchilo, Expert on climate change);

- ✓ The National Technical University of Ukraine "Kyiv Polytechnic Institute" (Mrs. Oksana Vovk, Professor, Department of environmental engineering);
- ✓ Association of automotive manufacturers of Ukraine "Ukrautoprom" (Vice-President - Executive Director Yefim Hazan).

Table 6.1: Summary of the proposed prioritisation of different policy measures from the stakeholder consultation exercise

	Top 5 Ranking of Options by Source						
Options	**Project Team**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**Total**
Vehicle regulation/MRV	**[1]**		**[3]**		**[4]**	**[1]**	**3**
Fuel taxes	**[2]**	**[1]**		**[2]**		**[5]**	**3**
Fuel quality/GHG standards	**[3]**		**[4]**		**[1]**	**[3]**	**3**
Vehicle/fuel labelling	**[4]**				**[5]****	**[2]**	**2**
Vehicle purchase /ownership taxes	**[5]**	**[2]**		**[1]**		**[4]**	**3**
Urban planning			**[1]**	**[4]**	**[2]**		**3**
Traffic management			**[2]**	**[3]**			**2**
Green public procurement			**[6]**		**[3]***		**2**
Tax breaks and subsidies		**[3]**					**1**
Research and development		**[4]**					**1**
Roll-out of alternative fuel infrastructure		**[5]**					**1**
Parking fees				**[5]**			**1**
Road charges and tolls			**[5]**				**1**
Basis of prioritisation:	MCA	Expert view	Expert view	Expert view	Expert view	Expert view	

Notes:
1) State Agency on Energy Efficiency and Energy Saving of Ukraine
2) Budget Institution "National center accounting greenhouse gases"
3) The National Ecological Centre of Ukraine
4) The National Technical University of Ukraine "Kyiv Polytechnic Institute"
5) Association of automotive manufacturers of Ukraine "Ukrautoprom"

* "The replacement of old fleet of vehicles travel in Metropolitan areas to a new, environmentally friendly"
** "The creation of a transparent and open procurement system and import into the territory of Ukraine of fuels and lubricants" – it cannot be associated within the prescribed options directly. Indirectly it can be in some extent considered again within Fuel quality/GHG performance standards option and Vehicle/fuel labelling option.

In order to have balanced set of recommendations on national level as a whole, and to take into account opinion of each stakeholder, the results of the above mentioned Multi-Criteria Analysis were considered together with the main comments from stakeholders' responses. These are presented in Table 6.1 above in aggregated form (following those from the initially proposed prioritisation list). They have been ordered in the table according to the degree of coherence between the different correspondents and their prioritisation (in square brackets). In accordance with the stakeholders' responses received, these additional options have also been given further consideration (i.e. in addition to the five priority options based on the MCA) in the development of the recommended prioritisation of actions later in this chapter. The most interesting additional proposals of the stakeholders include (but are not limited to) the following:

A. To focus more attention on R&D activities in Ukraine in order to significantly increase the share of alternative energy sources in the total energy consumption of transport, especially renewable

energy, as well as electric vehicles, including the development of appropriate infrastructure (The State Agency on Energy Efficiency and Energy Saving of Ukraine).

B. As a part of urban planning option it is proposed to concentrate on a comprehensive set of measures including public transport development program (to make it more competitive in relation to the use of private cars, including the level of comfort and other benefits), the development of high-speed suburban and regional transport, cycling infrastructure building, the introduction of park and ride parking lots at the entrance to the city, comprehensive parking policy. It is proposed to develop a comprehensive transport strategy of the city and the program of development of public transport, which should be based on transport models and taking into account the best world experience (National Ecological Centre of Ukraine).

C. National Ecological Centre of Ukraine also supports the introduction of a differentiated CO_2 tax on the purchase of new cars, which is to be paid at the first registration, and provided specific suggestions for appropriate levels relative to the effective scale (size) of such a tax.

D. National Ecological Centre of Ukraine also suggested to pay due attention to the administrative measures on the fixing and adequate punishment of drivers for infringement of traffic regulations. Many of these violations are connected with excess of speed limits, or with improper parking. Ensuring compliance with speed limits has significant potential to reduce the consumption of fuels. Compliance with the established parking regulations will reduce congestion.

E. National Ecological Centre of Ukraine stressed that the Transport Strategy of Ukraine for the period up to 2020 should be revised to take into account the objectives and conclusions of the recent Paris climate agreement. This strategy should reflect the goal of reducing CO_2 emissions, energy efficiency in transport and appropriate directions for their implementation.

F. In particular, Kiev signed the Covenant of mayors, but still has not yet developed the SEAP (Action Plan for sustainable economic development), which would provide for the reduction of CO_2 emissions by 20% by 2020. Transportation should also be included in this plan (National Ecological Centre of Ukraine).

G. The National Technical University of Ukraine "Kyiv Polytechnic Institute" suggested to pay due attention to R&D activities (including stimulation of the creation (extension) of independent research laboratories) and believes the most important long-term policy of reducing GHG emissions by increasing the share of alternative fuels in the total fuel mix used by transport and improvement of road infrastructure.

H. Monitoring of emissions should be implemented by the relevant unit of the so-called environmental police directly during the vehicle operation (The National Technical University of Ukraine "Kyiv Polytechnic Institute").

I. At the stage of ranking and selection of optimal criteria it would be appropriate to use the principle of life-cycle assessment for all processes, which characterise the vehicle and the infrastructure from the point of view of environmental impacts and to build appropriate environmental matrix (The National Technical University of Ukraine "Kyiv Polytechnic Institute").

J. "...the tax on fuel we believe - it is necessary to consider the latest in the list of five priorities, given the current socio-economic situation in the country. Also marking the level of energy efficiency proposed to consider together with the standards of emissions and/or energy consumption" (Association of carmakers of Ukraine "Ukravtoprom").

K. "Taxes on the purchase and/or possession of vehicles should be applied differentially to different categories of vehicles, primarily for economic reasons" (Association of carmakers of Ukraine "Ukravtoprom").

L. "To improve the situation with the aim of establishing more transparent and fair conditions of competition in the market, it would be appropriate to develop put in place new more sophisticated methods for the determination of CO_2 emissions and fuel consumption of transport vehicles, which will minimise the negative effects of issues of "off cycle" emissions problem (Association of carmakers of Ukraine "Ukravtoprom").

M. Technical and financial regulation of CO_2 emissions and energy consumption by automobiles must take into account the economy and promote job creation in the domestic high-tech products with high added value. The desire to reduce CO_2 emissions and energy consumption road transport should not be considered in isolation from the aspects of structural safety of vehicles (which to

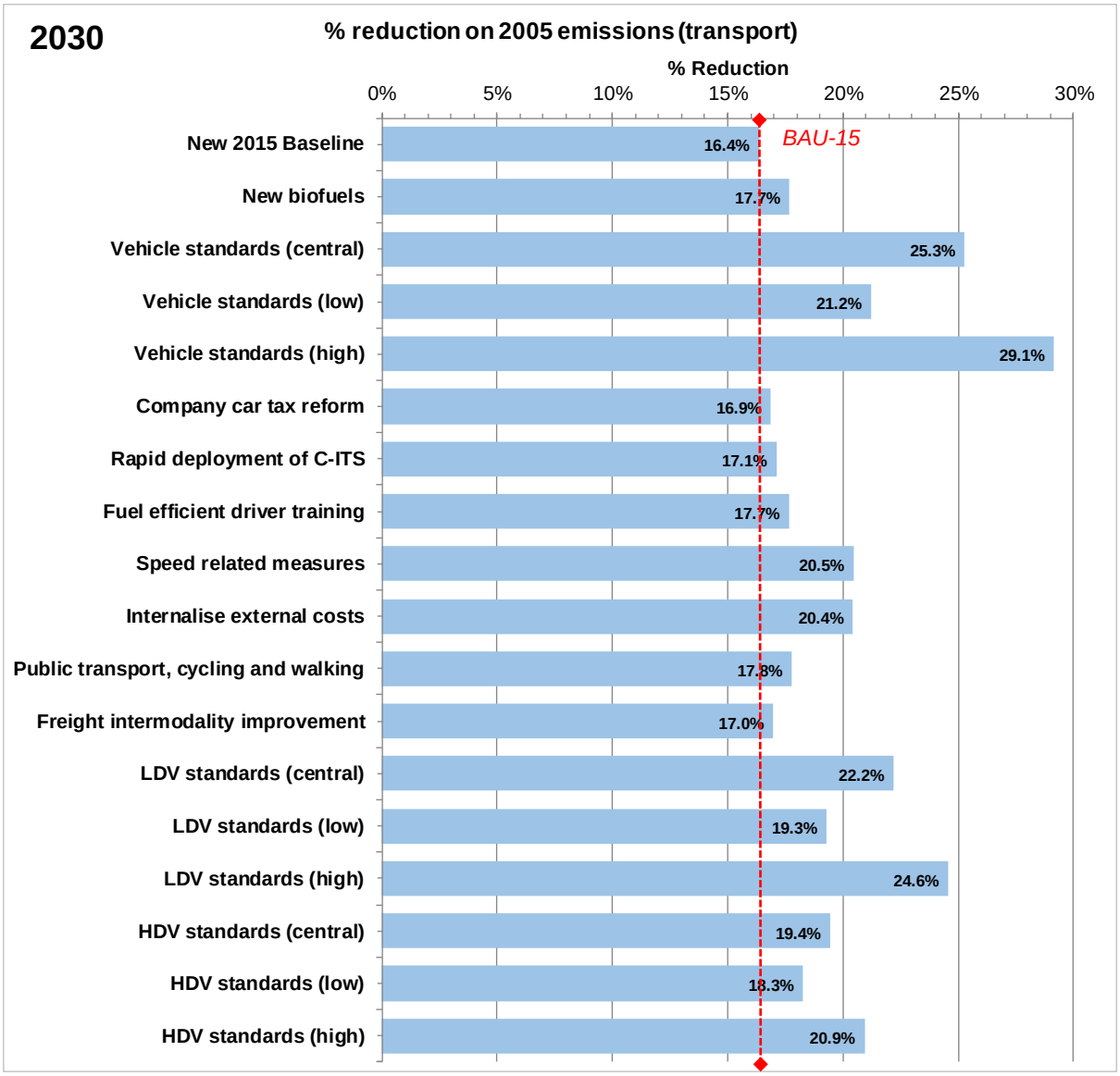
some extent are in conflict). Activities in this area should be considered in the set of vehicle requirements, capabilities of the industry, commercially available technologies and their costs, etc. (motor vehicle manufacturers Association "Ukrautoprom")

6.3.3 Other analysis on the effectiveness of GHG reduction options

It is also useful to consider other quantitative indications on the relative potential of different options to reduce GHG emissions from transport to help inform the case for prioritisation of different options for Ukraine. The following Figure 6.2 provides a summary of modelling analysis from (Ricardo Energy & Environment, 2016) illustrating the assessment of the potential for reduction in GHG emissions at the 2030 timeframe for a range of different policy options for the European Union. Whilst the potential magnitudes of the GHG reductions for Ukraine would clearly be different based on the current situation (i.e. economics, fleet characteristics and overall transport structure), it does provide a useful indication of the potential relative magnitude different options might contribute to reductions.

In the figure a range of different options are explored in terms of overall GHG reductions relative to 2005 levels from transport, and compared to the situation in the baseline scenario (red-dashed BAU-15 line), where no further policies are introduced other than those already in place (i.e. includes existing commitments on biofuels, and regulation of CO_2 emissions up to 2020/21 only). The analysis illustrates that the potential GHG savings are by far the greatest for different levels of ambition for road vehicle CO_2 regulation standards (high = stricter standards, low = weaker standards). Whilst the potential impacts for improving new vehicle efficiency may be lower in Ukraine, due to much higher levels of imported vehicles, supporting actions such as vehicle labelling and CO_2-based ownership taxes and fuel taxes can also have an important impact on the selection of/demand for more efficient second-hand vehicles.

Figure 6.2: Potential reduction in non-ETS transport direct GHG emissions for 2030 in the European Union, for different policy scenario options



Source: SULTAN modelling analysis for the European Union presented in (Ricardo Energy & Environment, 2016)

6.3.4 Proposals and recommendations in aggregated form

The final proposals and recommendations have been based primarily on the MCA and on the stakeholders discussions and feedback, whilst taking into account the complementarity of different options as well as the relative potential for GHG reduction and the existing legislative framework in Ukraine. The economic instruments considered here need to be integrated (and supported) by appropriate non-fiscal measures. Individual options have been grouped into a number of supporting 'themes' below which include a suite of complimentary measures. These themes are listed below in order of priority and are further split into **Primary Prioritisation Options** and **Secondary Prioritisation Options**. The primary options should be taken forward/addressed as a top priority in order to maximise benefits/GHG savings. The secondary options are a lower priority, that should ideally also be further developed once progress has been started on the primary list. In the list below, the MCA based score is presented in rectangular brackets at the front and individual options are arranged accordingly to the proposed development/implementation order.

Primary Prioritisation Options

I. Measures to improve fleet renewal and enhance fleet structure:

- [280] Vehicle emission and/or fuel consumption standards and MRV (for LDVs only initially).
- [210] Vehicle labelling (all categories of road vehicles).
- [195] Vehicle purchase and ownership taxes (to be based on CO_2 specific emission and progressive tax scale, with more shift to ownership (or even operation) tax modes).
- [145] Tax breaks and subsidies (to stimulate fleet renewal with more efficient vehicles).
- [130] Green public procurement to stimulate investments in innovation and development.
- [130] Component efficiency / requirements (including tyre efficiency rating, etc.).
- [75] Company car taxation and treatment of business travel (to force a more positive fuel economy policy at a company level).
- *[75] Parking fees – being highly differentiated on GHG / toxic pollutants emission ("Euro" vehicles environmental standard/classification), potentially with also a variation by size for very small (e.g. micro/urban cars like the Smart ForTwo) and/or very large vehicles (e.g. SUVs).**

*** Note**: This could be considered a secondary priority, as it has mainly a supporting role in urban environments and overall direct impacts seem likely to be small. Parking fees also can be considered in some extant within groups IV and V below to optimise fleet usage and to enhance/renew transport infrastructure within Urban planning option. In broader sense it can be considered as instrument to force car drivers not only chose public or another fuel efficient mode of transportation within city but to force favour to more fuel efficient vehicles purchase and usage in city areas, if parking fees will be differentiated in a proper way.

These options provide a policy pathway to improved fuel economy of new vehicles based on such measures as fuel economy labelling and standards, linked with appropriate fiscal measures presented in Section 4.7. It is also recommended that following this project there is ongoing positive engagement with the GFEI (see Box 1), to help facilitate the development and implementation of policy in this area.

Why is this important/included in the list at this prioritisation level?

- The implementation of these measures is a priority from the point of view of potential to reduce energy consumption in the sector as a whole in the medium- to long-term. It is crucial to incorporate energy efficiency standards in the sector and relevant patterns of behaviour of consumers, since taking into account the intensity of the renewal and duration of operation of vehicles in Ukraine, by today's standards for newly purchased vehicles will continue to determine the overall efficiency of the entire fleet of the country over a long period of time.
- The implementation of this package of measures does not necessarily require large-scale investments, with the exception of the establishment of a research and test center in Ukraine, and can be performed in a relatively short time.
- The effect of this set of measures is highly cumulative if we consider the fleet as a whole. However, individual consumers and business entities – the owners of new, more efficient vehicles will receive net benefits resulting from lower fuel costs.
- Such policies are highly consistent with the general policy approaches of the European Union countries, USA, Japan, China and many other countries. Therefore, Ukraine could earn considerable progress in improving the energy efficiency of the transport sector in a relatively short timescale.
- Energy efficiency standards and the whole combination of measures aimed at improving the structure of the Ukraine fleet, are of course only one part the available measures to reduce GHG emissions in the transport sector. However, early implementation these will likely help Ukraine to reduce GHG emissions to meet international obligations at a lower cost than other options since, for example, areas such as optimization of transport infrastructure, and the planning of cities require significant investment of resources in terms of their acute shortage in Ukraine.
- The introduction of a CO_2 or energy consumption regulation in Ukraine would be best manages in as staged approach, as has been implemented elsewhere, i.e. with early introduction of less challenging standards to bring Ukraine closer to other regions (like the EU), followed by more challenging regulations to bring further into line with ambition levels elsewhere (e.g. as being done in Ukraine for the Euro standards for air quality pollutants). It is expected that such an approach would also have a positive impact on the competitiveness of the transport sector and the whole economy of Ukraine.

What is the current Ukraine approach in Ukraine?

None of the above mentioned package of measures has yet been established in Ukraine.

How could these options fit into the existing legislative framework?

To implement above mentioned package of measures it is need to modify in appropriate way at least the following existing legislative acts in Ukraine:

- the law of Ukraine "On some issues of import to the customs territory of Ukraine and registration of vehicles";
- order of the Ministry of infrastructure of Ukraine dated 17.08.2012 No. 521 "On approval of Procedure for approval of design of vehicles, their parts and equipment and the Procedure for maintaining the register of certificates type of vehicles and equipment issued by the manufacturers certificate of conformity of vehicles or equipment" registered in the Ministry justice of Ukraine 14.09.2012 No. 1586/21898;
- the Law of Ukraine “On Motor Vehicle Transport” The Law of Ukraine “On Traffic”;
- the Tax Code of Ukraine;
- the Law of Ukraine "On Customs tariff of Ukraine", and other similar legislative acts.

There is therefore a need to establish new special Law to amend the above mentioned (and other) legislative acts and set out all the measures taken forward in a linked and clear way.

II. Measures to enhance fuel/energy infrastructure for road transport sector:

- [230] Fuel quality/GHG performance standards (to increase use of share of low carbon fuels in the total energy consumption of transport).
- [210] Fuel labelling (for proper information of the customer and as the base for differentiated taxes).
- [265] Fuel Taxes (considered here as to be differentiated on Fuel quality/GHG performance).
- [65] Roll-out of alternative fuel infrastructure (based on stimulation of innovation and development and included as renewable energy resources as 100% electricity vehicles infrastructure development).

Why is this important/included in the list at this prioritisation level?

- Similarly to vehicle efficiency/CO_2 regulation, improvements to the GHG intensity of fuels has the ability to allow significant and relatively rapid reductions to emission levels, and can often be implemented by governments in a relatively simple and cost-effective way.
- The measure also compliments the measures recommended to improve fleet renewal and enhance fleet structure, since some of the technical options will require improved or alternative fuels and new refuelling infrastructure provision.
- Ukraine also has big potential for growth in renewable energy production and its consumption by road transport.
- Appropriately set fuel taxes factoring in transport external costs are also considered a powerful universal instrument to encourage transport mode shifts (as they more fairly distribute the costs of different options) as well as the implementation of measures to optimise fleet usage, stimulate fuel economy related R&D and appropriate choices of the customer, etc.

What is the current Ukraine approach in Ukraine?

The current approach in Ukraine is not yet well established regarding this set of measures, and there are currently significant issues with the way biofuels are sold/marketed in Ukraine. An overview was included in Section 5.4.

How could these options fit into the existing legislative framework?

There is a need to establish a new special Law to amend the legislative acts mentioned in Section 5.4.3 into a common system.

Secondary Prioritisation Options

III. Stimulation of innovation and development:

- [55] Research and development (“Stimulation of innovation and development” group).
- [50] Fleet tests, demonstrations and pilot programmes (“Stimulation of innovation and development” group).

Why is this important/included in the list at this prioritisation level?

Despite the relatively low the MCA based score assessment, these options are considered key supporting medium- and long-term measures (as technological development is an important component of many of these), as described in detail in Chapter 7.

R&D support is a key measure necessary to facilitate sustainable development in any field of the economy, including road transport efficiency enhancement, even though it's impact is felt mostly over the longer term and it is not easy to link such support through to direct benefits. In addition, fleet tests, demonstrations and pilot programmes can also play an important role in bringing greater attention of sustainable options to society in general. They also help to improve the understanding of how to overcome barriers and obstacles to new technologies in specific conditions (which can vary from region-to-region and country-to-country) and in furthering their technical development through real-world application.

What is the current Ukraine approach in Ukraine?

R&D activities in Ukraine have experienced a significant decline the last two decades, due to a significant lack of funding and demand for research. As a result, there is something of a crisis in science, technology and production in Ukraine, with obsolete R&D base (infrastructure), aging scientific personnel (i.e. with insufficient numbers of new graduates coming through), as well as other negative consequences (e.g. on wage levels versus national averages).

How could these options fit into the existing legislative framework?

This problem is systemic, very complicated and a detailed examination of the reasons and development of recommendations for overcoming the difficulties is far beyond the scope (limits) of this study.

IV. Measures to optimise fleet usage:

- [170] Driver training (Eco driving).
- [160] Information for vehicle operators.
- Potential further development the existing Fuel Rationing system (Ukraine benefits from a unique and effective system of fuel rationing for commercial and municipal road transport).
- [90] Campaigns.

Why is this important/included in the list at this prioritisation level?

It is expected that with the development of technology, the problem of optimizing the usage of the transport increasingly will be addressed by automation and the role (importance) of the human factor will decrease with time. Nevertheless, optimizations in-service vehicles fleet can have significant combined potential to reduce GHG emissions in the sector in the short- and medium- term, at least from commercial vehicles where they can be more readily applied. These options can also be considered as being very efficient from the point of view of overall costs and benefits.

What is the current Ukraine approach in Ukraine?

A national level programme for widespread dissemination of eco-driving techniques is currently under development by SE SRTRI at the time of this report's preparation. Ukraine already benefits from a (in part voluntary) state fuel rationing system for road transport, which has proven an effective instrument to control and lower fuel expenses where it is taken up. However, there are currently a lack of appropriate campaigns in this area. New information technologies such as C-ITS (communicating intelligent transport systems and semi-/autonomous vehicles are under development in Europe and the US (and other regions), however there is currently no clear and consistent policy for the development and deployment of these technologies in Ukraine.

How could these options fit into the existing legislative framework?

As a first step, it is recommended to develop amendments to the existing legislative framework to:

- Include eco driving techniques and examples of economical behaviour into the initial driver training programs (i.e. when obtaining a driver's license) and further training of drivers (including the introduction of periodic revalidation first commercial vehicle drivers, and then further to private p drivers of passenger vehicles, as far as practical). The application of fuel efficient driver training techniques have also been shown to provide significant safety benefits.

- Begin to spread state fuel rationing system experience (currently obligatory only for state enterprises belonging to the Ministry of infrastructure) to all companies that operate road transport.
- It could also be helpful to require the provision of an appropriate amount of public information provision/campaigns by the government which would aim to promote energy saving behaviours within the population regarding transport choices. A special legislative act could be developed to require such mass-media communications (i.e. via the Ministry of Information Policy of Ukraine) to include the provision of appropriate scientifically based content with the participation of the State Agency on Energy Efficiency and Energy Saving of Ukraine, the Ministry of Infrastructure of Ukraine (for the transport sector), and other related institutions.

V. Measures to enhance/renew transport infrastructure:

- [180] Traffic management.
- [165] Urban planning.
- [105] Public transport information.
- [100] Spatial planning outside of urban areas.

Why is this important/included in the list at this prioritisation level?

Some traffic management options to force drivers to more closely respect speed limits could be introduced in relatively short time (i.e. through improved enforcement measures) with significant GHG emission reduction. However, in general measures to enhance/renew transport infrastructure require huge investments and time, but have significant potential for reducing energy consumption, extending to the entire fleet of vehicles in service. As a whole this set of measures is focused on obtaining positive results in the medium- to longer-term.

What is the current Ukraine approach in Ukraine?

Traffic management policy in Ukraine currently has the potential for significant improvement. Urban sprawl is currently forced rather by local business interests than by comprehensive planning and optimisation.

How could these options fit into the existing legislative framework?

It can be proposed first of all improve speed limit enforcement in urban and other areas (focusing first on areas with higher accident rates) to result in lower actual speed limits in cities (which are currently relatively high) and on other roads where speeding is an issue. This could include both stationary and mobile speed cameras, which have been shown to be effective in other regions. Revisions also the severity of punishments for speed related offences by amendment the Law of Ukraine “On Traffic” and other legislative acts should also be considered.

Development of national strategy for sustainable development of urban and transport infrastructure with an appropriate state programme based on leading worldwide experience could be considered as first step on the way to enhance/renew transport infrastructure. This should also include improving (or creating) appropriate legislation to ensure the optimisation of transport/environment considerations in urban planning (and the development of interurban transport links) is better taken into account/is given greater priority.

The prioritisation outlined above (or sequence of implementation of policy options) can be considered to some extent as a compromise between the different criteria and different points of view of the consulted stakeholders discussed above as well as the economic situation in Ukraine. However, the underlying basis of the prioritisation has been presented MCA approach, which provides a clear and agreed set of criteria and, in general, also aligns with the experience/implementation of EU countries.

6.4 High-level policy implementation plan

Presented below is a proposed high-level policy implementation plan in first approach:

I. The first step is to develop and approve an appropriate national strategy, targets, an implementation schedule for these and a legislative base as well.

II. The second step is the development of the appropriate national capacity required for implementation in practice the recommended policy actions, including the institutional aspects and R&D infrastructure identified and described below in the next Chapter 7.

III. The third step is to put into practise the measures to realize the proposals and recommendations, as outlined in aggregated form in paragraph 6.3.3 and in accordance with the established sequence (or prioritisation of policy actions) and taking in to account the proposals and recommendations made in the relevant sections above.

IV. Then there is strong need to monitor and control the implementation of the national strategy in this area in order to make necessary, and timely, amendments and improvements to ensure the end objectives are reached. Reliable national-scale reporting of GHG emission by road transport is a key feature to enable the monitoring and control of the effectiveness of the implemented measures.

The above elements are not strictly sequential (i.e. there will need to be some overlaps and ongoing development/update) and only provides an outline of the general approach. Different kinds of options will of course need different levels of support, and different amounts of resources and time for preparation and implementation in practice. The main actions can be considered to be taken for implementation over different timescales, as summarised below:

Short term implementation actions (1-2 years) include:

- Develop and approve the appropriate national strategy, targets, the implementation schedule and the legislative base as well.
- Include the national strategy into the field of legislation and sub-legislative acts.
- Establish a base for phased further development of a transport common information system – i.e. a state Data processing center to operate the data needed for National Transport Model creation.
- Develop the most critical (urgent) R&D infrastructure, including first stage of vehicle and engine test facilities.
- Implement the first stage of measures to improve fleet renewal and enhance fleet structure regarding LDVs (which include passenger cars and light commercial vehicles) and P2W.
- Implement measures to optimise fleet usage.
- Measures to enhance/renew transport infrastructure for traffic management (in the framework of initiatives that can be quickly implemented without significant capital investment).

Medium term implementation actions (3-5 years) include:

- Development of appropriate national capacity required for implementation of the recommended policy actions, including institutional aspects and complete R&D infrastructure (which is necessary) to research and to regulate vehicle emission and fuel efficiency.
- Implement a second stage of measures to improve fleet renewal and enhance fleet structure regarding HDVs.
- Implement measures to enhance fuel/energy infrastructure for the road transport sector.
- Measures to enhance/renew transport infrastructure concerning public transport information as well as traffic management (i.e. medium term projects including infrastructure elements).
- The National transport model of Ukraine should be developed as an effective instrument for forecasting and policy optimization in this and other fields.
- Improvements to the national emissions inventory system based on the above developments including improved data sources.
- Establish well-grounded long-term national obligations (targets) to reduce GHG emission from road transport (and if it is needed to correct the appropriate national strategy, its implementation schedule and legislative base taking in to account results of first 3-4 years of national GHG emission reduction policy implementation).

Longer term implementation (5-10 years) include:

- Implement complete set of measures to enhance/renew transport infrastructure (priority projects within a specified time period and given available resources).
- Further continuation, development and improvement of the measures described above.

All of the actions listed above should be continuously monitored and evaluated, so that timely corrective measures can be taken where necessary, to ensure that the end objectives are met, and

according to the planned overall timescales. In addition, they undoubtedly require the creation in Ukraine of stable, timely and sufficient public funding instruments to allocate on a continuous basis budget funds for scientific research and development projects nearer the beginning of each budget year than is currently the practice.

In the next Chapter 7, the proposals on the development of capacity required for the implementation of the national policy are outlined, based on the recommendations made in this chapter.

7 Proposals on the development of capacity required for the implementation of the national policy (Task 6)

7.1 Outline of the approach

The objective of this Task was to identify and assess the capacity required to implement the actions proposed in the previous Task (see Chapter 6). Again, this Task refers to the outputs from earlier tasks and especially the stakeholder inputs obtained in the first coordination meeting.

In a first subtask the current capacities that are already in place/available in the Ukraine in the context of road transport policy development have been assessed. The main focus here is on institutional aspects (i.e. What institutions exist? How do they function? What are their responsibilities? What budget is available to them?) and R&D infrastructure (i.e. What research institutions exist? What research areas do they cover? How are the organisations financed?).

In the second subtask a gap-analysis is provided by comparing Ukraine's current capacities with the required capacities as evidenced by the policy options that were prioritised, as well as case study examples of specific Member States that have shown to have successfully implemented the relevant policy measures, as discussed in Chapter 0. This gap analysis provides a series of proposals for which capacities/institutions should be created, re-organised or expanded to allow for the successful implementation of the policy actions recommended in the previous task.

The results of this analysis is presented in the report sections below.

7.2 Assessment of current capacity

The following sections provide a brief overview of the key bodies in the Ukraine that are concerned with road transport policy development. Also their main capacities and responsibilities are shown.

7.2.1 Overview of key stakeholders and their responsibilities relevant to road transport policy

This subsection provides a summary of the main stakeholders that are directly or indirectly related to policy making or to providing scientific support in the field of road transport. Their key responsibilities are briefly summarised in the text below.

(A) National Ministries and key authorities:

- ✓ The Ministry of Infrastructure of Ukraine
- ✓ The State Enterprise "State Road Transport Research Institute"
- ✓ The Ministry of Ecology and Natural Resources of Ukraine
- ✓ The Ministry of Internal Affairs of Ukraine
- ✓ The Ministry of Economic Development and Trade of Ukraine
- ✓ The Ministry of Incomes and Fees of Ukraine
- ✓ The Ministry of Energy and Coal Industry of Ukraine
- ✓ The State Agency on Energy Efficiency and Energy Saving of Ukraine
- ✓ The Ministry of Regional Development, Building and Housing and Communal Services of Ukraine
- ✓ The State Agency of Highways of Ukraine
- ✓ The Ministry of Agrarian Policy and Food of Ukraine
- ✓ The State Statistics Service of Ukraine
- ✓ The State Fiscal Service of Ukraine
- ✓ The State Border Guard Service of Ukraine
- ✓ The Budget Institution "National centre for accounting for greenhouse gases"

(B) Public nongovernmental organizations and industry associations:

- ✓ The National Ecological Centre of Ukraine
- ✓ The Association of international road carriers of Ukraine

- ✓ The All-Ukrainian Association of automobile carriers
- ✓ The Association of transport forwarding organizations of Ukraine “Ukrzovnishtrans”
- ✓ The Ukrainian Motor Vehicle Manufacturers Association
- ✓ The All-Ukrainian Association of Automobile Importers and Dealers

(C) Science & Research institutions:

- ✓ The Transport Academy of Sciences of Ukraine;
- ✓ The National Transport University;
- ✓ The State Enterprise “State Road Transport Research Institute” (SRTRI);
- ✓ The National Technical University of Ukraine "Kyiv Polytechnic Institute";
- ✓ Other scientific organizations and institutions of Ukraine;

(D) Local authorities:

- ✓ The city administration of Kiev;
- ✓ Other local authorities.

(A) National Ministries and key authorities:

The Ukrainian **Ministry of Infrastructure** is responsible for the transport sector, including its infrastructure. More specifically, the Ministry’s responsibilities relevant to this study include:

- Prioritisation, development and implementation of state policy in the transport sector, including development of transport infrastructure;
- Provision of forecasts and program documents on developments in the transport sector;
- Participation in the development and implementation of economic, tariff, investment, credit and social policy in the field of transport and road infrastructure, as well as development of science and technology and innovation policy in the fields of transport;
- Development and implementation of public policies to reduce the environmental impacts of transport.

Furthermore, the Ministry is responsible for the technical regulation of wheeled vehicles, while being provided scientific and technical support from the “State Road Transport Research Institute”. In accordance with the Status of the Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958, Ukraine is represented (including the fields of vehicle pollution and fuel consumption regulation) by:

- 46/A (a) Ministry of Infrastructure;
- 46/A (b) State Enterprise State Road Transport Research Institute (Executive Body of the Ministry of Infrastructure);
- 46/B State Enterprise State Road Transport Research Institute ("Road Vehicle Testing Centre").

The **State Enterprise “State Road Transport Research Institute” (SRTRI)** is the leading scientific institution in the sphere of road transport. It is falls into the responsibility of the Ministry of Infrastructure. The institute provides scientific and technological decision support to the Ministry, and also delivers support for the development of projects of normative-legal documents in the field of transport and related fields. The Institute also serves as the main vehicle test and R&D centre in Ukraine and is therefore the executive body of the Ministry of Infrastructure in line with the above mentioned Geneva agreement (46/A(b)) and as responsible technical service of Ukraine (46/B).

The research areas and activities of the SRTRI cover almost all elements considered in this report, i.e. they cover road transport CO_2 emissions regulation, energy consumption, alternative fuel and energy sources, fuel rationing, vehicle testing and conformity assessment (certification), etc.

For the time being no state budget is available for the Ministry to provide or support R&D activities in the field of road transport.

The SRTRI is, as a scientific organization, self-supporting (i.e. it receives almost no financing from the state, with the exception of rare state-funded scientific research projects). For many years the SRTRI has occupied a leading position in a number of key performance indicators in the official rankings among all the state enterprises of Ukraine.

The SRTRI has already created unique capacities and vehicle test facilities in the Ukraine. Its further development is under process. However, the institute does not have its own financial resources to create a full-scale information infrastructure on transport or fully-fledged vehicle testing infrastructure that would be needed for regulating the energy efficiency of vehicles. Such facilities (infrastructure capacity) would also allow to perform tasks for industry, such as related to maximizing vehicles' energy efficiency as well as improving the overall efficiency of the transport sector.

The Ukrainian **Ministry of Ecology and Natural Resources** is responsible for environmental protection and for Ukraine's international obligations in this field. This includes climate policy, national GHG inventories, etc. In the areas of transport, infrastructure, motor fuels and related environmental protection, the Ministry cooperates with the Ministry of Infrastructure, the State Road Transport Research Institute, the Ministry of Energy and Coal Industry and others.

The Ukrainian **Ministry of Internal Affairs** is responsible for road vehicle registration procedures and the maintenance and processing of the road vehicle registration database. The vehicle registration procedure ensures that vehicles comply with the legal requirements in terms of vehicle safety, environmental impact, and energy efficiency. The latter requirements are set by the state in line with experience that was gained by other countries. The current version of the road vehicle registration database is considered to be in the need of significant improvements. It is seen to be incomplete, of insufficient quality and not comprehensive enough to sufficiently cover all the data needed for policy development and monitoring. For instance, it is difficult to support national inventory preparation in line with the international IPCC requirements. Required improvements would necessitate the involvement of all key stakeholders.

The Ukrainian **Ministry of Economic Development and Trade** is responsible for economic policy making.

The Ukrainian **Ministry of Incomes and Fees** is responsible for fiscal measures including the setting of vehicle taxes, fuel taxes and respective incentive levels. The Ministry's functions can be seen as key for encouraging and supporting a low carbon transport system.

The **Ukrainian Ministry of Energy and Coal Industry** & the **State Agency on Energy Efficiency and Energy Saving** is responsible for issues related to traditional motor fuels supply and alternative motor fuels propagation. This can be considered to be a key function of policy/regulation regarding policy options such as Fuel quality/GHG performance standards and Fuel labelling, as well as the roll-out of alternative fuel infrastructure.

The **Ukrainian Ministry of Regional Development, Building and Housing and Communal Services** is responsible for regional development and spatial policy of local authorities. The Ministry's functions can be seen to be key for policy development in the areas of green public procurement to stimulate investments in innovation and development, parking fees, the roll-out of alternative fuel infrastructure, and also for options such as fleet tests, demonstrations of energy efficient technologies and pilot programmes, information for vehicle operators, traffic management, urban planning, public transport information, etc.

The **Ukrainian State Agency of Highways** is responsible for road transport infrastructure support and development. The agency's functions are key for developing policies such as spatial planning outside of urban areas, road infrastructure maintaining and enhancement, etc.

The **Ukrainian Ministry of Agrarian Policy and Food** is interested in issues relating to production of feedstock for biofuels. The Ministry's functions are essential to support the development (and introduction) of low carbon fuels.

The **Ukrainian State Statistics Service** is responsible for statistical data processing. Ukraine is currently experiencing significant problems with a lack of detailed quality data in the field of transport and transport fuel. In order to develop consistent dataset that are comparable with the respective datasets of EU members, strong improvements would be necessary that would require an active involvement of all institutions that hold relevant data.

The **Ukrainian State Fiscal Service of Ukraine and State Border Guard Service** is responsible for customs and control of the movement of goods and people across the border. This is a key function for ensuring that the movement of road vehicles and fuels is line with legal requirements.

The **Budget Institution "National center accounting greenhouse gases"** is responsible for the preparation of the national GHG inventory– a key function to monitor and control the overall efficiency of the options being considered.

(B) Public non-governmental organizations and industry associations:

The **Ukrainian National Ecological Centre** is a public organisation that takes a vital role in the development of ecologically balanced policy of the state.

The **Ukrainian Association of international road carriers**, the **All-Ukrainian Association of automobile carriers** and the **Ukrainian Association of transport forwarding organizations (the "Ukrzovnishtrans")** represent business associations or road transport operators.

The **Ukrainian Motor Vehicle Manufacturers Association** represents the national automotive industry.

The **All-Ukrainian Association of Automobile Importers and Dealers** represents the business community in the field of road vehicles imports.

(C) Science & Research institutions:

The Ukrainian Transport Academy of Sciences, **the National Transport University**, **the State Enterprise "State Road Transport Research Institute", National Technical University of Ukraine "Kyiv Polytechnic Institute",** as well as many other scientific organizations and institutions (not explicitly cited within this report) represent the scientific and wider academic community in the field of transport. The National Transport University furthermore provides education programmes directly relevant for the transport industry.

(D) Local authorities:

The city administration of Kiev represents one of the local authorities in Ukraine that may have interest in pilot projects that could test innovative transport solutions in the Ukraine. The involvement of other local authorities would also help the spread of innovative solutions across the country.

7.2.1.1 General remarks

In general, it can be said that the budget available for all state bodies at present is low and insufficient for supporting the implementations of the recommended options considered in Chapter 6.

Generally speaking, a CO_2 reduction policy that is similar to that established in European Union Member States is not yet integrated into national policy. Appropriate functions need to be defined and responsibilities need to be assigned between key stakeholders. Also appropriate budgets for the respective activities would need to be made available.

As described in Section 6.3.4, all the recommended policy actions were divided into primary and secondary options. A summary of the main institutions and the actual or proposed responsibilities and interests in the different policy options (or in main support functions) is presented in Table 7.1 and Table 7.2.

While the first table focuses on Primary Prioritisation Options the second Table then provides an overview of Secondary Prioritisation Options respectively.

The primary responsibility of an institutions (marked '**R**' in the tables) may be combined with 'Interest or secondary/supporting responsibility' (marked '**I**') (or other) given the sometimes complex nature of policy options and respective relevant functions that are required. Scientific support is marked with '**S**' and *Proposed* primary responsibilities are marked with '**PR**'. These latter *proposed* activities are then further described in Section 7.4.

Table 7.1: Actual and proposed responsibilities and interests of institutions regarding Primary Prioritisation Options and its key supporting functions

	Primary Prioritisation Options									Key supporting functions							
Organisation	Vehicle emission / component standards	Vehicle labelling	Vehicle taxes	Company car taxation	Fuel quality, alternative fuels labelling	Fuel taxes	Alternative fuel infrastructure	Parking fees	Green public procurement	Vehicle regulation	Vehicle testing	Vehicle certification	Vehicle registration	Data Vehicle Base	Vehicle statistics	Transport statistics	Customs
Ministry of Infrastructure	R	PR	I	I	I	I	I	I	PR	R	R	PR	I	I	I	I	I
SRTRI	S/R	S/I	S/I	S	S/I	S	S	S	S/I	S/R	R/S	R/S	I/S	PR	PR	PR	I
Ministry of Ecology	I	I	I		I	I	I		I		I			I	I	I	
Ministry of Economic Development	I	I	R	R	I	R	I	R/I	I	I	I	R/I	I	I	I	I	I
Ministry of Incomes and Fees	I	I	I/R	R/I	I	I/R		I/R					I	I	I	I	I
Ministry of Energy	I	I	I		R	I	R		I						I	I	
Ministry of Internal Affairs	I	I											R	R/I	R/I	I	I
Ministry of Regional Development, Building and Housing and Communal Services		I	I				I	I	I						I	I	
The State Agency of Highways															I	I/R	
Ministry of Agrarian Policy and Food					I	I	I		I						I	I	
State Agency on Energy Efficiency and Energy Saving	I	I	I		R/I	I	I		I						I	I	
State Statistics Service	I														R	R	
State Fiscal Service	I	I	I	I	I	I											R
State Border Guard Service	I																R
Budget Institution "National centre accounting greenhouse gases"	I	I												I	I	I	
National Ecological Centre	S	S	S		S	S		I	I	S					I	I	
Association of international road carriers	I		I	I	I	I	I	I	I	I				I	I	I	
All-Ukrainian Association of automobile carriers	I		I	I	I	I	I	I	I	I				I	I	I	
Association of transport forwarding organizations “Ukrzovnishtrans”							I								I	I	I
Ukrainian Motor Vehicle Manufacturers Association	I	I	I		I				I	I	I	I		I	I	I	
All-Ukrainian Association of Automobile Importers and Dealers	I	I	I		I				I	I	I	I		I	I	I	

	Primary Prioritisation Options									Key supporting functions							
Organisation	Vehicle emission / component standards	Vehicle labelling	Vehicle taxes	Company car taxation	Fuel quality, alternative fuels and labelling	Fuel taxes	Alternative fuel infrastructure	Parking fees	Green public procurement	Vehicle regulation	Vehicle testing	Vehicle certification	Vehicle registration	Vehicle Data Base	Vehicle statistics	Transport statistics	Customs
Transport Academy of Sciences	S	S	S	S	S	S	S	S	I/S	S	S	S		I/S	I/S	I/S	
National Transport University	S	S	S	S	S	S	S	S	I/S	S	S	S		I/S	I/S	I/S	
National Technical University "Kyiv Polytechnic Institute"	S	S	S	S	S	S	S	S	I/S	S	S	S		I/S	I/S	I/S	
The city administration of Kiev	I	I	I	I	I	I	I	I/R	I/R						I	I	
Others	I	I	I	I	I	I	I	I/R	I/R						I	I	

Notes:

R = Primary responsibility; **I** = Interest or secondary/supporting responsibility; **PR** = proposed primary responsibility (e.g. where no clear leading responsibility exists currently); **S** – Scientific support.

Table 7.2: Summary of the main institutions and the actual / proposed responsibilities and interests regarding Secondary Prioritisation Options and key supporting functions

	Secondary Prioritisation Options								Key supporting functions			
Organisation	R&D	Driver training	Information for vehicle operators	Campaigns	Traffic managem't.	Urban planning	Public transport information	Spatial planning outside of urban areas	National Transport Model	Fleet tests (stimulation of R&D)	National GHG inventory	Fuel Rationing System
Ministry of Infrastructure	PR	PR	PR	I	I	I	I	I	R	I	I	R
SRTRI	R/S	I	I	PR	I	I	I	I	R/S	PR	S/I	I/S
Ministry of Ecology and Natural Resources	I	I		I		I		I	I	I	R	
Ministry of Economic Development and Trade	I			I		I		I	I	I	I	I
Ministry of Incomes and Fees									I			I
Ministry of Energy and Coal Industry	I								I	I	I	
Ministry of Internal Affairs		R		I	R	I		I	I			
Ministry of Regional Development, Building and Housing and Communal Services	I		I	I	I	R	I	I	I	I	I	

	Secondary Prioritisation Options								Key supporting functions			
Organisation	R&D	Driver training	Information for vehicle operators	Campaigns	Traffic managem't.	Urban planning	Public transport information	Spatial planning outside of urban areas	National Transport Model	Fleet tests (stimulation of R&D)	National GHG inventory	Fuel Rationing System
The State Agency of Highways of Ukraine	I	I	I	I	I	I	I	R/I	I	I	I	
Ministry of Agrarian Policy and Food	I								I	I	I	
State Agency on Energy Efficiency and Energy Saving	I	I							I	I	I	
State Statistics Service									I		I	
State Fiscal Service									I			
State Border Guard Service												
Budget Institution "National center accounting greenhouse gases"	I								I		R	
National Ecological Centre	S/I	I	S	I	S	S	S	S	S/I	S/I	S	
Association of international road carriers												
All-Ukrainian Association of automobile carriers	I	I	I	I			I	I	I	I		I
Association of transport forwarding organizations of Ukraine “Ukrzovnishtrans”	I		I						I	I		I
Ukrainian Motor Vehicle Manufacturers Association	I			I					I	I		
All-Ukrainian Association of Automobile Importers and Dealers	I			I					I	I		
Transport Academy of Sciences	S/I	S/I	S	S/I	S	S	S	S	S/I	S/I	S	S
National Transport University	S/I	S/I	S	S/I	S	S	S	S	S/I	S/I	S	S
National Technical University of Ukraine "Kyiv Polytechnic Institute"	S/I	S/I	S	S/I	S	S	S	S	S/I	S/I	S	S
The city administration of Kiev	I	I	I	I	I	I	I	I	I	I		I
Others	I	I	I	I	I	I	I	I	I	I		I

Notes:

R = Primary responsibility; **I** = Interest or secondary/supporting responsibility; **PR** = proposed primary responsibility (e.g. where no clear leading responsibility exists currently); **S** – Scientific support

7.2.2 Information infrastructure in the transport sector

This subsection provides a summary of the current status of the information infrastructure that is available in the Ukraine and that is relevant for the recommended policy actions.

Currently, transport sector statistics and administrative information are inadequate to understand and address transport sector challenges. For example, the State Road Transport Research Institute (SRTRI) provides detailed quantifications of Ukraine's road vehicle stock, including activity levels, fuel consumption levels, GHG and air pollutant emissions for the period 1990-2014 on the basis or a mathematical model. However, the model uses partly incomplete and/or controversial sources of data.

In general the model is based on inputs stemming from:

- **Various data sources, including:**
  - The State Statistical Report Form # 4T3 [incomplete[32]];
  - The State Automotive Inspection Database [incomplete[32]];
  - The database of the Ukrainian Motor Transport Bureau;
  - COPERT IV (EEA) averaged data;
  - Road vehicle price assessor's bulletin of the Ukraine;
  - Road traffic research data and related data sources;
  - The Ukrainian Road Transport Fuel Consumption Rationing
  - Administrative data sources;
  - Various substituted data sources (for instance – economic activity related to transport activity);
- **Various institutions, including:**
  - Road Vehicle Insurance Companies operated in the Ukraine;
  - Road vehicle commodity research organizations in the Ukraine;
  - Road vehicle maintenance companies in the Ukraine;
  - Data of other countries (various sources),including data for countries with similar road infrastructure and/or fleet data;
  - Institutions and universities; and
- **Other inputs, such as:**
  - Scientific literature;
  - Vehicle tests;
  - Experts inputs;
  - Mathematical simulation.

In 2015, SRTRI initiated a project to develop and create a national transport data processing centre. The centre has the capabilities that are needed for the creation of a National Transport Model (NTM). As a result, the Institute has developed project proposals for the NTM (see Section 7.3.3.1 below) including a plan of priority actions, for external coordination between the ministries and further approval. The proposal also contains a concept for a common data processing centre to support the NTM, which would involve the creation of a common information system for the whole transport sector. The NTM would be relevant for the practical implementation of policy options considered in this study, such as vehicle CO_2 emission/fuel consumption regulation database or road transport emission inventory support as well in accordance with international requirements. The proposals for the NTM have been approved at the level of official plan by the Ministry of Infrastructure of Ukraine and the Ministry of Finance of Ukraine. However, there are still further steps necessary before the project can move forwards into the implementation stage.

7.2.3 R&D infrastructure

This subsection provides a brief summary of the current status of Ukraine's R&D capacity in the transport sector that is relevant for the policy options recommended in this study.

[32] It was necessary to use a complex mathematical model to estimate data values to fill data gaps

The R&D infrastructure that is currently available/suitable for technical regulation is mainly concentrated in the SRTRI. However, SRTRI has obtained almost no state budget during the past two decades and is funding itself at the expense of the numerous types of activities performed in the interests of the transport and other sectors of the national economy.

The R&D infrastructure at the institute includes a road vehicle test centre (E46) with three laboratories conducting research and testing in the fields of emission and energy efficiency standards, alternative motor fuels, active, passive and general vehicle safety. However, at the moment only a very limited amount of tests that can be performed due to a lack of funding. Testing facilities include, for example, vehicle test cells to test vehicles' fuel efficiency and emission standards compliance, as well as an obsolete engine test cell.
SRTRI also performs road tests by using certified areas of public roads. However, the types of test that can be performed are very restricted, primarily due to safety reasons.

The above-mentioned R&D infrastructure is, to some extent, suitable for implementing LDV and P2W CO_2 emission/fuel consumption regulation. However, significant improvements would be required - these are discussed in the following Section 7.3.

7.3 Capacity gap analysis of the required capacity

This section provides a gap analysis by comparing Ukraine's current capacities with the required capacities as evidenced by the defined priority options, as well as by providing examples of other EU Member States. This gap analysis fed into the development of proposals for which capacities/institutions should be created, re-organised or expanded to allow for the successful implementation of the policy actions recommended in the previous task.

It should be noted that this section focuses mainly on the Primary Prioritization Options. It is assumed that Secondary Prioritization Options, such as, for example, set of measures to enhance/renew transport infrastructure, require separate further investigation and detailed planning, as described in Section 6.

7.3.1 Brief overview of the situation of specific Member States

In general, from looking at EU Member States' experience, the following generalisations concerning institutions and capacities for regulating CO_2 emissions in road transport can be made:

1. Institutional aspects of EU Members States cover state budget, public–private partnerships and other mechanisms to finance activities in the sector, as well as comprehensive and well financed R&D activities and R&D infrastructure.
2. R&D infrastructure in the EU is provided by numerous research and test centers, with high demands for their services, and includes significant national and EU-level research funding.
3. Information infrastructure is provided in the EU to support regulation, including certification and registration data as well as numerous other data sources, including standardised aggregated transport statistics used for the purpose of inventories (reporting under CO_2 regulation to EEA, etc.) or national transport models and forecasts, as well as EU-level modelling.

The following sections provide a gap analysis and include case study examples from the UK and Germany where appropriate. We concentrated on UK and Germany experience as these countries are believed to have comparatively well-tested and founded approaches to policy development and supporting research. Other EU countries would of course also be of interest and would likely show slightly different approaches, where responsibilities are assigned to different organizations in accordance to the countries' internal functioning.
The gap analysis is divided on two sections. The first section contains specific institutional aspects related to the implementation of specific policy options. The second section contains general institutional aspects related to information and R&D infrastructure, as well as to key supporting functions that are considered to be vital to implement/support certain policy options.

7.3.2 Gap analysis: specific institutional aspects

The following Table 7.3 provides a summary of the proposals to fill the identified gaps from the analysis with regards to specific institutional aspects for the primary prioritisation options recommended by this study. In the following paragraphs a summary is provided of the recommended actions taken to address these gaps, illustrated with some EU case study examples of how the specific requirements have been coped with in the UK and Germany. This also includes recommendations as to where it may be appropriate to reassign current responsibilities to other organisations or to strengthen its institutional ability to establish and support appropriate policy options. It should be noted that the experience and responsibilities as observed in EU Member States cannot be directly implemented in Ukraine as there are significant differences in the organisational structures, economic models etc. Proposals to cover institutional gaps therefore need to be foremost based on understanding the appropriate Ukrainian government bodies, agencies and other institutions as well as their current fields of activity, their responsibilities, potential capacities and relations. Also the existing national legislation that is currently place needs to be well understood.

Table 7.3: Proposal to fill the main gaps and institutional requirements regarding Primary Prioritisation Options

Area	Proposals to fill institutional gaps and requirements
I. Measures to improve fleet renewal and enhance fleet structure:	
Vehicle emission and/or fuel consumption standards and MRV	These measures would need to be implemented by the Ministry of Infrastructure with the support of SRTRI R&D, technical and informational capacities. The Ministry of Internal Affairs could be responsible for key supporting functions, such as first vehicle registrations in line with legal requirements (e.g. including emission and/or fuel consumption standards). The State Border Guard Service could be responsible for ensuring that only vehicles in line with legal requirements enter the Ukraine. The Ministry of Economic Development and Trade, the Ministry of Incomes and Fees, the State Fiscal Service could be responsible for supportive fiscal policy development and implementation, based on the proposals of the Ministry of Infrastructure and taking in to account national Climate Policy under the responsibility of the Ministry of Ecology and Natural Resources , as well as national energy efficiency saving policy under the responsibility of The Ministry of Energy and Coal Industry and the State Agency on Energy Efficiency and Energy Saving respectively. **Examples/practices in EU Member States:** In the EU, vehicle emissions standards are set by the European Commission. The standards apply to all vehicles newly registered in the EU – irrespective of the country or the origin of the vehicle. National authorities need to report characteristics and vehicle emission levels of newly registered vehicles to the European Commission. For example, in the UK it is the Vehicle Type Approval Authority (VCA) that collects and maintains a central database of registered vehicle data including CO_2 performance (made available also through a data portal), however the industry (via SMMT in the UK) is responsible for providing the dataset/database for new car CO_2 regulation to the European Environmental Agency, EEA (who collate and monitor/report on this at the EU-level). In Germany, the Kraftfahrt-Bundesamt (KBA) approves vehicles types and parts, monitors the work of test centres for the periodic examination of vehicles and quality control at manufacturing plants, accompanies recall actions by manufacturers of vehicles and vehicle parts, and also manages the Central Vehicle Register and provides information from this Register, and

Area	Proposals to fill institutional gaps and requirements
	produces and publishes statistics on its. The KBA is within the scope of the Federal Ministry of Transport and Digital Infrastructure.
Vehicle labelling	Also this measure would be best implemented by the Ministry of Infrastructure, based on the SRTRI's support and the direct implication of other stakeholders. The Ministry of Internal Affairs (which is currently responsible for the national vehicle registrations database) should provide institutional support for vehicle registration and other events. The Ministry of Economic Development and Trade, the Ministry of Incomes and Fees, the State Fiscal Service could be responsible for supportive fiscal policy development and implementation, based on the proposals of the Ministry of Infrastructure and taking in to account national Climate Policy under the responsibility of the Ministry of Ecology and Natural Resources , as well as national energy efficiency saving policy under the responsibility of The Ministry of Energy and Coal Industry and the State Agency on Energy Efficiency and Energy Saving respectively. The Ministry of Regional Development, Building and Housing and Communal Services of Ukraine could be responsible for introducing promotional policy measures, that support vehicle labelling measures. **Examples/practices in EU Member States:** As described earlier, the EU vehicle labelling directive (see Section 3.4.4) provides guidelines on how vehicle labelling is to be introduced, monitored and enforced in the EU Member States. In the UK, In the UK, the VCA's database underpins the implementation of the car CO_2 labelling in the UK. There used to be also a used car labelling system provided by the VCA, but this was stopped due to lack of funding in 2012, and is now provided by independent service providers. In Germany, the labelling (according to the EU directive) became responsibility of The Federal Ministry for Economic Affairs and Energy. An appropriate website has also been set up by the German Energy Agency (Dena) to provide additional information for consumers and dealers about the revised implementation of the Directive in Germany – the work of Dena is funded by the Ministry.
Vehicle purchase, ownership tax	The Ministry of Economic Development and Trade and the Ministry of Incomes and Fees (with support of the State Fiscal Service) should be responsible for fiscal policy development and implementation with regards to vehicle purchase and ownership taxes. Tax development should be based on proposals from the Ministry of Infrastructure and take into account national climate policy that lies within the responsibility of the Ministry of Ecology and Natural Resources. Also national energy, energy efficiency and energy saving policy (under the responsibility of The Ministry of Energy and Coal Industry and the State Agency on Energy Efficiency and Energy Saving should be taken into account. **Examples/practices in EU Member States:** In the UK, whilst transport policies, like fuel and vehicle taxes, are mainly researched by the Department for Transport, (or also the Department for Energy and Climate Change), the Treasury has the final say in decision making related to fiscal/economic policy (e.g. including vehicle grants/subsidies), and will directly set measures like car registration/road vehicle taxes, fuel duties, etc.
Tax breaks and subsidies	Policy development in the area of tax breaks and subsidies should be dealt with similarly to vehicle purchase and ownership taxes (see above).

Area	Proposals to fill institutional gaps and requirements
Green public procurement	Green public procurement measures should be implemented by the Ministry of Infrastructure, with the scientific, technical and informational support from the SRTRI. Other national and non-governmental institutions should directly participate in green procurement programmes, including authorities like: • The Ministry of Ecology and Natural Resources; • The Ministry of Economic Development and Trade; • The Ministry of Energy and Coal Industry; • The State Agency on Energy Efficiency and Energy Saving; • The Ministry of Regional Development, Building and Housing and Communal Services of Ukraine (and local authorities), Key non-governmental organizations as the National Ecological Centre and Science & Research institutions should also be involved.
Component efficiency /requirements	Policy development in the area of component efficiency/requirements should be dealt with similarly to vehicle emission and/or fuel consumption standards (see above).
Company car taxation and treatment of business travel	Policy development in the area of company car taxation and treatment of business travel should be dealt with similarly to vehicle purchase and ownership taxes (see above).
Parking fees	Also parking fees should be dealt with similarly to vehicle purchase and ownership taxes. In addition, The Ministry of Regional Development, Building and Housing and Communal Services should be responsible for promoting/ encouraging differentiated parking fees in, for example, city areas. Local authorities should however be the key responsible stakeholders to implement such policies.
II. Measures to enhance fuel/energy infrastructure for road transport sector:	
Fuel quality/GHG performance standards/ biofuels	These measures should be implemented by the Ministry of Energy and Coal Industry & the State Agency on Energy Efficiency and Energy Saving. The implementation of such measures should furthermore take into account • Fuel requirements and fuel quality needs given the country's vehicle fleet structure (by getting support from the Ministry of Infrastructure and SRTRI) and • National climate policy (under the responsibility of the Ministry of Ecology and Natural Resources of Ukraine). The Ministry of Agrarian Policy and Food should furthermore participate in policy development to ensure the sustainability of biofuel production. The Ministry of Economic Development and Trade, the Ministry of Incomes and Fees and the State Fiscal Service should furthermore implement fiscal policy that accounts for differences in fuel type (and in components used for fuel production), fuel quality/GHG performance standards and appropriate fuel`s labelling also. **Examples/practices in EU Member States:** In the UK, the Department for Transport is responsible for fuel quality and biofuel policy, though other departments (like DECC and Defra) also have interest/support in this area. Regarding biofuels, the Renewable Transport Fuel Obligation (RTFO) requires suppliers of fuel for use in road transport and certain other mobile machinery to ensure that a proportion of the fuel they supply comes from renewable sources. This was originally administered (including setting methods for assessing sustainability) by a separate UK Government non-departmental body called the Renewable Fuels Agency (RFA), but in 2011 the responsibility for this was moved into the Department for Transport (DfT), which has the responsibility for transport fuel policies

Area	Proposals to fill institutional gaps and requirements
	(with some overlaps with the Department for Energy & Climate Change).
Fuel labelling	Policy development in the area of fuel labelling should be dealt with similarly to measures regarding fuel quality (see above).
Fuel Taxes	The Ministry of Economic Development and Trade and the Ministry of Incomes and Fees should modify fuel taxes by taking into account proposals of the Ministry of Energy and Coal Industry, the State Agency on Energy Efficiency and Energy Saving and the Ministry of Infrastructure. The taxation concept should be based on an approach that differentiates different transport fuels – an approach that should ensure both stable transport operations and the achievement of climate policy goals. Scientific support of policy in this area to make use of simulation results stemming from transport models is highly recommended. **Examples/practices in EU Member States:** In the UK, whilst transport policies, like fuel and vehicle taxes, are mainly researched by the Department for Transport, (or also the Department for Energy and Climate Change), the Treasury has the final say in decision making related to fiscal/economic policy (e.g. including vehicle grants/subsidies), and will directly set measures like car registration/road vehicle taxes, fuel duties, etc.
Roll-out of alternative fuel infrastructure	Measures that support the roll-out of alternative fuel infrastructure should be implemented by the Ministry of Energy and Coal Industry with support from the State Agency on Energy Efficiency and Energy Saving, and taking in to account: • Fuel requirements and fuel quality needs given the country's vehicle fleet structure (by getting support from the Ministry of Infrastructure and SRTRI) and • National climate policy (under the responsibility of the Ministry of Ecology and Natural Resources of Ukraine). Also the direct participation of the Ministry of Regional Development, Building and Housing and Communal Services and local authorities are recommended. **Examples/practices in EU Member States:** In the UK, the Office for Low Emission Vehicles (OLEV) is a cross Government, industry-endorsed, team combining policy and funding streams to simplify policy development and delivery for ultra-low emission vehicles. OLEV currently comprises people and funding from the Departments for Transport (DfT), Business, Innovation and Skills (BIS), and Energy and Climate Change (DECC). The core purpose is to support the early market for electric and other ultra-low emission vehicles (ULEVs). OLEV is located within the Department for Transport, and has responsibility for the plug-in vehicle and infrastructure grant schemes (though it commissions other organisers to administrate them for it – i.e. Ricardo Energy & Environment administers the plug-in vehicle scheme for OLEV).

7.3.3 General institutional aspects (informational and R&D infrastructure) and other key supporting functions

This section provides a summary of information and R&D infrastructure requirements – the key supporting functions that are required to support the implementation of primary prioritisation options that are recommended in this study.

It should also be taken in to account that a high level of competence is needed for the development of required capacities and functions, for developing both, information and R&D infrastructures. An

appropriate program for the recruitment, support and retention of personnel of a suitably high qualification and expertise is therefore required.

The following sections discuss the specific proposals in more detail.

7.3.3.1 Infrastructure for gathering and exchanging information

The development of a detailed and robust data source is essential for the effective planning of implementation measures, and for technical and fiscal regulation as well as attracting financial resources on the way to reducing road transport fuel dependence, CO_2 emissions, and to improve the efficiency of the national transportation sector and the national economy as a whole.

The general requirements for infrastructure for gathering and exchange of information that are needed for regulation are briefly discussed in earlier Section 4.2.2.3 “A central vehicle database governed by the State”. This database is necessary to feed recommended policy options. It is therefore strongly recommended to establish sufficient infrastructure for the gathering and exchange of information by establishing:

1) A detailed and more effective central database of vehicle certification, registration and other statistics, such as licensing information (that can also be used to generate aggregated information for modelling/inventory DB, etc.)
2) A general transport and energy database that includes more aggregated data relevant to the development of inventories and for transport modelling (including transport activity, economic data, etc.).

It is recommended to follow European best practices regarding vehicle certification/registration statistics (e.g. as managed by the VCA in the UK) and licensing information. Also common European approaches regarding the provision of aggregated transport statistics that allow to integrate national statistics into international monitoring systems should be adopted. This type of data is very important for the development of a National Transport Model (NTM) - a vital instrument for ensuring policy commitments and attracting investments in transport infrastructure.

An appropriate project is currently under development by SRTRI. The project results from the implementation of article 369 of the Association Agreement EU-Ukraine, i.e. to the order of the Cabinet of Ministers of Ukraine dated 17.09.2014, No. 847 "On the implementation of the Association Agreement between Ukraine and the EU, the European atomic energy Community and its member States, on the other hand" that requires the Ukraine to

1) (item 277) develop, implement and use a national transport model in the planning and implementation of the strategic development of transport infrastructure;
2) (item h 278) create automated information systems for collecting and analysing data related to passenger and freight transport, including transit;
3) (item h 286) create a single state electronic register of road carriers;
4) (item 275) to collect baseline data for the analysis and development of nationally integrated development plan for logistics, to ensure the development of logistics centres that optimise transport operations, etc.;
5) (item 274) collect baseline data for the analysis and justification of the implementation Ukraine’s transport strategy up until 2020;
6) (item 279) to strengthen the institutional capacity of the Ministry of Infrastructure, in particular through the implementation of EU best practices in the formation and implementation of state policy that ensures the stable and efficient functioning of the transport industry;
7) (item 272) develop, improve and update the development programme for the build of a National (priority) transport network.

However, currently this project has been assigned very limited finding within Transport strategy of Ukraine for the period until 2020 and though also a support program by the European Commission, involving the first stage of IT-infrastructure development. Also the practical implementation of this project still remains questionable due to the lack of state budget, the uncertainty of the future financing of the whole project, and because of delays in dealing with organisational matters. Now the Ministry of Infrastructure has recently finally decided not to finance this project in 2016, in favour of the

implementation of other emergency measures. It is therefore recommended that this project is given higher priority and an appropriate level of state funding is allocated to ensure its successful and timely completion.

Concerning the matter of a national transport model (NTM), it is worth considering the case study examples from the UK and Germany:

- In the UK, it is the Department for Transport develops/maintains the national transport model (and other models for other modes). The model is used in policy analysis/development and forecasting, and also provides activity data that is used in the development of the national atmospheric emissions inventory (NAEI, by Ricardo Energy & Environment) – but this latter NAEI uses its own models for the specific detailed inventory purposes.
- In Germany, the Federal Environmental Agency commissioned **TREMOD** (the Transport Emissions Model) in the early 1990ies to design a suitable tool that covered the current state of knowledge for emission calculation in Germany at the time. It is constantly updated for the use in the GHG inventory reports and the projection of past trends and future scenarios. Road transport in TREMOD is divided by vehicle category. In principal, these are 2- wheelers, passenger cars, light commercial vehicles and heavy duty vehicles. For each category the transport performance and the fleet composition are calculated separately. TREMOD is currently used by the following institutions: German Federal Environmental Agency, Federal Highway Research Institute and several federal ministries, Association of the German Automotive Industry VDA (since 1996), Association of the German Petroleum Industry MWV (since 1996), Deutsche Bahn AG (since 1997), Deutsche Lufthansa (since 2006) and TUI (since 2006). These partners conceptually and financially support the enhancement of the model and its continuous updating to state-of-the-art scientific knowledge as well as new legislation and technology.

7.3.3.2 Road vehicle testing facilities to be created in Ukraine to support regulation in relevant areas (as well as R&D)

The general R&D infrastructure requirements for vehicle measurements and testing has been briefly discussed in earlier Section 4.2.2.2.

Concerning the matter of **vehicle testing** specifically, it is to be noted that a 'National Research and Testing Centre of Prospective Technologies of Safe, Environmentally-Sound and Energy-Efficient Road Transport' has been planned and planned at the present time according to numerous national scale transport sector documents. These include the Action Plan for the implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand for the period 2014-2017 (that was approved by the decree of the Cabinet of Ministers of Ukraine dated 17.09.2014 No. 847-R). These documents set out that the testing centre should be created on the base of existing facilities of SRTRI, with sufficient funding to establish an appropriate institution that could operate in full conformance with the scope of EU requirements in the field of i) emission and fuel consumption regulation of wheeled vehicles and ii) in support of alternative energy sources technologies development and utilization by transport. The Ministry of Infrastructure approved in particular (on 30 December 2013) the concept and detailed specification for designing of the domestic Automotive Proving Ground test facilities as part of the test centre.

Given the limited financial resources, the test centre is built and run on the basis of the economic solutions, high standardization and universally applicable capabilities (unification and the use of universal (multifunctional) equipment). This creates certain restrictions on the test cells and proving ground performance, including the available types of tests and/or throughput of the test facilities. However, it is expected that this will significantly reduce the cost of creating and operating the research centre, and also allow international cooperation in research.

The total necessary investment has been estimated to amount to EUR 79 million (EUR 33.64 million in the first phase and EUR 45.36 million in the second phase to fulfil most of the requirements of 1958 Geneva Agreement. To ensure full compliance with the environmental standards of "Euro-5" and "Euro-6" and for supporting new initiatives to overcome "off-cycle" emission problems as well as to allow for fiscal regulation linked to vehicles' energy efficiency performance, it would be necessary to

invest in more complex test equipment (at a cost of around EUR 9.4 million). Environmental laboratories for this complex project have been designed for Ukraine with the support of several global companies, specialized in designing and manufacturing high-tech test equipment and test facilities for the automotive industry.

A representation of the estimated macroeconomic effects resulting in the medium term from the introduction of the above mentioned research centre are shown on Figure 7.1. Here the "red" row with negative signs represent estimations of the annual macroeconomic losses (in billion euros) due to road accidents, pollution of environment, and energy dependence of the Ukraine. The corresponding "blue" row with positive signs represent estimations of the value for which annual macroeconomic losses can be reduced in the medium term due to the introduction of more effective vehicle environmental, safety and fuel efficiency regulations, on the basis of the deployment of modern technologies.

It can be seen that, altogether, local environmental impacts, together with the energy dependence of Ukraine, constitutes annual costs of around EUR 6.5-8.5 billion. However, the introduction of modern technologies can reduce economic losses by around EUR 1.7-2.8 billion in the medium term. The cost of the initial investment in the test facilities and their operation represents only a very small percentage of the overall macroeconomic costs caused by the activities of transport.

Besides the reduction in annual macroeconomic losses, such investments (in accordance to international experience) has the potential for other significant positive effects. These include the development of new technologies in the sphere of alternative energy sources and increases in the fuel efficiency of the vehicle fleet, etc.

The test centre project envisages the involvement of public resources and is seen to be very cost-efficient if considering the above-mentioned macroeconomic factors.

Figure 7.1: Representation of macroeconomic effect which will be obtained in the medium term from the introduction the "National Research and Testing Centre of Prospective Technologies of Safe, Environmentally-Sound and Energy-Efficient Road Transport"

The decision-making on the development of the test centre is mainly determined by:

- P. 268 action Plan for the implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, the European atomic energy Community and their

member States, on the other hand, for 2014 – 2017, approved by the decree of the Cabinet of Ministers of Ukraine dated 17.09.2014 No. 847-R.

- Transport strategy of Ukraine for the period until 2020 approved by the decree of the Cabinet of Ministers of Ukraine from 20.10.2010 № 2174-R ("Priorities of development of road transport").

This project is generally supported on the high policy level and is provided for in numerous state programs at national and regional scale. However, its practical implementation remains questionable due to a lack of funding.

It is strongly recommended to make available funding for research activities in the field of vehicle testing, emissions of pollutants, energy efficiency and alternative energy sources. This should include the establishment of a research and testing base.

7.3.3.3 Scientific staff operation conditions

There is a need to improve the capacity for technical/research personnel to deliver valuable inputs to the implementation of the policy actions. One of the key components of this is to equip research laboratories with modern instruments and introduce global best practices to manage research in line with international standards. The creation of demand for innovation in the country and, accordingly, state and business orders for R&D is necessary (and will provide an opportunity to improve the rewards for work in this field). It is also recommended to improve and broaden international cooperation in this area.

To facilitate this, it is recommended that measures are implemented that aim at improving the working conditions and reputation of technical staff and researchers. This would help to ensure that technical experts that are needed to implement the recommended policy actions can be recruited and retained.

7.4 Overall recommended actions for capacity development for Ukraine

In summary, the following main actions are recommended:

- Create an interdepartmental coordination/working group (and maybe several sub-groups) to i) work on the further development of relevant policy and draft legal acts that require the coordination of positions of various institutions and ii) consolidate efforts towards the adoption of an appropriate institutional framework. The working group(s) should be empowered to work effectively, must have a clear timetable and clear responsibilities.

- (Re-) assign responsibilities regarding the recommended Primary and Secondary Policy Prioritisation Options, as presented in this report. However, more detailed planning should be undertaken to take into account also aspects that were beyond the scope of this current research project.

- Develop, corresponding to modern requirements, informational and R&D infrastructure (both are key capacities required for the implementation of many policy measures that can curb road transport CO_2 emissions and energy consumption in the sector) with the acceleration of the implementation of such key projects as the creation of a National transport model (NTM) and appropriate computer center (data processing center) for the collection and processing of data needed for transport modelling and solving practical problems in optimization and increase of efficiency of activity of the industry, and the project of creating a "National scientific-research testing center of advanced technologies of safe, environmentally friendly and energy-efficient road transport." This is likely to require a significant amount of time and resources. It is therefore recommended to start this process as soon as possible, considering the prioritisation dictated by the high-level policy implementation plan (see earlier report Section 6.4) to support the timely implementation of relevant policy options.

- Provide financing to create and maintain the necessary infrastructure and the above mentioned activity the area of road transport. It could also be beneficial to create a specialized

State Fund for Sustainable Transport Development. Further work would need to be carried out to establish the appropriate budget that should be set aside for this purpose.

8 Meetings and Workshops (Tasks 7-9)

8.1 Outline of the approach

There were two key meetings to be delivered as part of this project, which included:

1. *Meeting 1:* Coordination meeting:
2. *Meeting 2:* Final presentation and discussion to relevant governmental structures, and to experts from the community and civil society at a workshop

Further information on the objectives of the two meetings is provided below, with a summary of the results of the two meetings provided in Section 8.2 and Section 8.3.

8.1.1 Meeting 1: Coordination meeting

This meeting was planned to present initial findings from the work in the first three technical tasks, discuss our draft initial thoughts on what to recommend for Ukraine. The invitee/attendance list for the first meeting included the following organisations:

- Ministry of Infrastructure of Ukraine
- Ministry of Ecology and Natural Resources of Ukraine
- Ministry of Economic Development and Trade of Ukraine
- Ministry of Incomes and Fees of Ukraine
- Ministry of Energy and Coal Industry of Ukraine
- *Ministry of Agrarian Policy and Food of Ukraine (proposed here regarding biofuels)*
- State Agency on Energy Efficiency and Energy Saving of Ukraine
- Budget Institution "National center accounting greenhouse gases"
- National Ecological Centre of Ukraine
- *Association of international road carriers of Ukraine*
- *All-Ukrainian Association of automobile carriers*
- *Association of transport forwarding organizations of Ukraine "Ukrzovnishtrans"*
- Ukrainian Motor Vehicle Manufacturers Association
- All-Ukrainian Association of Automobile Importers and Dealers
- *Transport Academy of Sciences of Ukraine*
- *State Enterprise "State Road Transport Research Institute"*
- National Transport University
- *National Technical University of Ukraine "Kyiv Polytechnic Institute"*
- *The city administration of Kiev*

8.1.2 Meeting 2: Final presentation and discussion to relevant governmental structures, and to experts from the community and civil society at a workshop

The objective of this final meeting was to present the final results of the research and analysis and our full draft recommendations to a similar community of experts, taking into account the feedback/proposals received from/after the first meeting, and discuss with participants. There was a particular focus on planning implementation of the recommendations in this meeting. The invitee/attendance list for the second meeting therefore included the same organisations as that of the first meeting and other organisations additionally.

8.2 Meeting 1: Coordination meeting between the Ministry of Infrastructure, Ministry of Ecology and Natural Resources, Agency on Energy Efficiency and Energy Saving and other interested governmental bodies (Task 7)

The first coordination meeting took place on 25 May 2016 at the Ministry of Infrastructure in Kiev. The objective of the meeting was to engage with all relevant stakeholders by

i) Providing an introduction to the project, its objective and methodology,
ii) Presenting first project results,
iii) Seeking stakeholder feedback on the work that has been carried out so far and on future actions, and
iv) Encouraging continued interaction between the stakeholders and the study team throughout the time of the project.

The meeting was attended by a wide range of stakeholders. In addition to the policy-makers from the Ministry of Infrastructure and representatives of the National Ecological Centre of Ukraine (NECU) – the direct beneficiaries of the project – participated included representatives of the Ministry for Regional Development, Construction and Housing, Ministry of Agricultural Policy, State Fiscal Service, State Agency on Energy Efficiency and Energy Saving, Kyiv City Administration, professional associations of car importers and carriers, National Transport University and Kyiv Polytechnic Institute.

After presenting the proposed work plan and methodological approaches to the study, the study team provided an overview of possible policy options that contribute to a reduction in fuel consumption in road transport and that have been implemented to varying degrees across the European Union. The national expert also provided an overview of the respective current policy situation in Ukraine.

The meeting was then mainly dedicated to

i) the presentation of possible methods and procedures for vehicle testing in terms of CO_2 emissions and fuel consumption labelling and regulation
ii) the presentation of a Multi Criteria Analysis (MCA) of available policy options for Ukraine - the participants were provided with a list of policy measures aimed at CO_2 emission reductions in the road transport sector and an initial assessment and priority ranking of each policy option according to the expert's experience and judgement.

The participants were invited to provide their view and input to the policy assessment with the aid of the proposed matrix that was provided as hand-outs to each participant. The experts could collect first useful feedback to the policy assessment during the meeting. They also encouraged all participants to provide further feedback electronically until the 17th of June 2016 and to respond to stakeholder-specific questions concerning the policy assessment and ranking, as well as concerning possible ways and necessary actions for implementing any potential policy options. The questions were disseminated to all participants via email after the meeting, together with all relevant presentation material of the coordination meeting.

8.3 Meeting 2: Presentation and discussion of results and submission them to relevant governmental structures, and to experts from the community and civil society at the workshop (Task 8/9)

This meeting was held at 28 October 2016 in the Ministry of Infrastructure of Ukraine in a form of roundtable "National policy on CO_2 emissions and energy consumption by road transport: European experience and prospects for Ukraine".

The invitee/attendance list for the last (final) meeting included the following organisations divided on several subgroups:

(1) National Ministries and key authorities:

- The Ministry of Infrastructure of Ukraine;
- The State Enterprise "State Road Transport Research Institute";

- The Ministry of Ecology and Natural Resources of Ukraine;
- The Ministry of Internal Affairs of Ukraine;
- The Ministry of Economic Development and Trade of Ukraine;
- The Ministry of Incomes and Fees of Ukraine;
- The Ministry of Energy and Coal Industry of Ukraine;
- The State Agency on Energy Efficiency and Energy Saving of Ukraine;
- The Ministry of Regional Development, Building and Housing and Communal Services of Ukraine;
- The State Agency of Highways of Ukraine;
- The Ministry of Agrarian Policy and Food of Ukraine;
- The State Statistics Service of Ukraine;
- The State Fiscal Service of Ukraine;
- The State Border Guard Service of Ukraine;
- The Budget Institution "National centre for accounting for greenhouse gases";

(2) Profile committees of the Verkhovna Rada of Ukraine (the Parliament):

- The Committee on transport;
- The Committee on environmental policy, nature resources utilization and elimination the consequences of Chernobyl catastrophe;
- The Committee on fuel and energy complex, nuclear policy and nuclear safety;
- The Committee on economic policy;
- The Committee on taxation and customs policy;
- The Committee on industrial policy and entrepreneurship.

(3) Public nongovernmental organizations and industry associations:

- The National Ecological Centre of Ukraine;
- The Association of international road carriers of Ukraine;
- The All-Ukrainian Association of automobile carriers;
- The Association of transport forwarding organizations of Ukraine “Ukrzovnishtrans”;
- The Ukrainian Motor Vehicle Manufacturers Association;
- The All-Ukrainian Association of Automobile Importers and Dealers;

(4) Science & Research institutions:

- The Transport Academy of Sciences of Ukraine;
- The National Transport University;
- The State Enterprise “State Road Transport Research Institute” (SRTRI);
- The National Technical University of Ukraine "Kyiv Polytechnic Institute";
- Other scientific organizations and institutions of Ukraine;

(5) Local authorities:

- The city administration of Kiev;

(6) Representatives of other projects and programs aimed at reducing CO_2 emissions and energy consumption by road transport, namely from:

- «Global Fuel Economy Initiative» (GFEI), UNEP;
- USAID project «Municipal energy reform in Ukraine»;
- Heinrich Böll Foundation in Ukraine;

(7) Experts community in the field of environment protection, fuel market.

(8) The press.

The meeting was mainly dedicated to presentation and discussion of the project final results. In addition, other related projects were reported and next steps considered.

The final meeting agenda included the following items:

- Introduction. Overview of the Clima East project ‘National policy on regulation of CO_2 emissions and energy consumption by road transport’;

- Overview of relevant EU Member State policies and their multi-criteria assessment. Analysis of selected priority policies;
- Suggestions and recommendations for the improvement and development of national policy in the sphere of regulating CO_2 emissions and energy consumption in the road transport sector;
- Proposals for the development of the capacities needed to implement national policy for reducing energy consumption and carbon emissions in road transport, reducing energy dependence and increasing the economic competitiveness;
- Next steps discussion;
- The presentations of other projects and programs aimed at reducing CO_2 emissions and energy consumption by road transport;
- Closing remarks and collecting wishes of the participants (stakeholders) of the project results further implementation.

The participants paid special attention to questions about the comprehensiveness of the proposed activities list (i.e. policy measures set) and the extent of their compliance with the practices of European countries. To this extent, it was stressed by the project's team of experts that the project has addressed all the main areas of policy in this field considered or implemented by European countries. However, in accordance with the objectives and the results of the project, the report provides more focused proposals on an appropriate strategy and implementation plan based on policy measures ranking according to priority and taking into account the resource constraints of the country and other specific national circumstances. This will allow the Ukraine to achieve the best effect based on the most efficient allocation of limited resources.

Other projects and programs that were also presented during the meeting, which also aimed at reducing CO_2 emissions and energy consumption by road transport, may further develop and build upon the recommendations of the project outlined in this report.

Participants of the meeting stressed that the issue of transport emissions should be addressed more widely from the point of view of sustainable mobility, including planning city infrastructure and encouraging cycling and walking (not only focusing on cars), and reducing the overall need to travel for long distances. (It was also noted by of the project team experts that such considerations are also considered in this report as part of the Secondary options group, including group V "Measures to enhance/renew transport infrastructure", and including the "Urban planning" policy option).

The participants generally endorsed the results of the project with the following aggregated wishes regarding implementation of the project results:

- To implement in Ukraine the project proposals outlined in the report regarding the strategy for National policy on regulation of CO_2 emissions and energy consumption by road transport;
- To forward the final report of the project to high-level authorities in Ukraine for political decision-making and further relevant practical steps of the country on this field.

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10 Annexes

10.1 Annex I: Supporting information on the EU / Member State policy review

Multi-criteria assessment of the long-list of policy options

Assessment criteria category	Policy Benefits				Impl. Costs		Coherence/ Acceptability			Other		
Assessment criteria	1.1. Long term CO2 reduction potential	1.2. Congestion co-benefits	1.3. Air pollutant co-benefits	1.4 Other co-benefits (social/economic/energy security)	2.1. Cost to implement and run the measure	2.2. Time required to implement the policy	3.1. Coherence with EU legislation and practice	3.2. Coherence with Ukrainian legislation and practice	3.3. Public acceptability	4.1. Time lag until CO2 reduction materialises	Final score	Final rank
Weight	10	3	3	4	5	5	10	5	5	4		
Policy options												
Economic instruments												Rank
Fuel Taxes	10	0	5	-5	10	10	10	0	-10	5	265	2
Road charges and tolls	5	5	0	-5	-5	-10	0	0	-10	0	-80	21
Vehicle purchase and ownership taxes	5	0	5	-5	5	10	10	0	-5	0	195	5
Parking fees	-5	5	5	0	0	5	5	5	-5	5	75	16
Company car taxation and treatment of business travel	-5	0	0	0	5	10	5	0	0	0	75	16
Tax breaks and subsidies	5	-5	5	5	-10	5	5	5	5	0	145	10
Regulatory instruments												
Vehicle emission and/or fuel consumption standards and MRV	10	0	5	5	0	0	10	0	5	5	280	1
Component efficiency / requirements	0	0	5	5	0	0	5	0	5	5	130	11
Fuel quality/GHG performance standards	5	0	5	5	0	0	10	0	5	5	230	3

Assessment criteria category	Policy Benefits				Impl. Costs		Coherence/ Acceptability			Other		
Assessment criteria	1.1. Long term CO2 reduction potential	1.2. Congestion co-benefits	1.3. Air pollutant co-benefits	1.4 Other co-benefits (social/economic/energy security)	2.1. Cost to implement and run the measure	2.2. Time required to implement the policy	3.1. Coherence with EU legislation and practice	3.2. Coherence with Ukrainian legislation and practice	3.3. Public acceptability	4.1. Time lag until CO2 reduction materialises	Final score	Final rank
Weight	10	3	3	4	5	5	10	5	5	4		
Enhancement of infrastructure												
Urban planning	10	10	5	10	-10	-10	5	0	10	-5	165	8
Spatial planning outside of urban areas	5	5	5	10	-10	-10	5	0	10	-5	100	14
Traffic management	10	10	5	5	-5	-5	0	0	5	10	180	6
Education and awareness raising												
Campaigns	-10	0	5	5	5	10	5	0	10	-5	90	15
Public transport information	-10	5	5	5	5	10	5	0	10	-5	105	13
Information for vehicle operators	-5	0	5	5	5	10	5	0	10	0	160	9
Driver training (Eco driving)	0	5	5	10	0	5	5	0	5	0	170	7
Vehicle/fuel labelling	-5	0	5	5	10	5	10	0	10	0	210	4
Stimulation of innovation and development												
Green public procurement	0	0	5	5	0	0	5	0	5	5	130	11
Research and development	0	0	0	5	-5	-5	10	0	5	-10	55	19
Fleet tests, demonstrations and pilot programmes	-5	0	0	0	0	5	5	0	5	0	50	20
Roll-out of alternative fuel infrastructure	0	0	5	5	-10	-5	10	0	5	-5	65	18

10.2 Annex II : Description of GHG projection scenarios for transport

10.2.1.1 Description of proposed policies and measures for different scenarios

The scenario I. The first ("Stagnation") scenario is in conformity to forecast of economy stagnation till 2020 (in general as for a whole period 2014-2020) in spite of current crisis.

It is included:

- "Stagnation" scenario of economic activity with approximately the same in comparison to 2014 level of transportation activity due to 2017-2020 slow growth after 2015-2017 decline;
- gasoline consumption in 2020 will approximately reach 2014 level in spite of 2015-2017 crisis;
- diesel oil consumption in 2020 will approximately reach 2014 level in spite of 2015-2017 crisis;
- LPG consumption in 2020 will be increased approximately on 25% in comparison with 2014 level as a result of expensive gasoline substitution (mainly drivers with a strong need for private routes on relatively long annual mileage);
- CNG consumption in 2020 will be approximately decreased on 2.6 times in comparison with 2014 level as a result of Natural Gas related political issues.
- slow renewal of fleet (about 50% of the average level for 2010-2014 period);
- low actual (in spite of formal (i.e. legislative) restrictions) requirements for a newly registered vehicles.

It is considered the following policies and measures within the first scenario within the available resources:

i. ecology "Euro" standards to newly registered vehicles gradual implementation in accordance to current national legislation;

ii. ecology "Euro" standards to motor fuels gradual implementation in accordance to current national legislation.

So, it is mean (within the first scenario) that no other wide-scale measures considered beside of the vehicle and fuel Euro standards formal and gradual implementation (as it is prescribed in current and above mentioned national legislation).

The scenario II. The second ("Negative") scenario is conform to forecast of permanent economic decline till 2020 (in comparison to 2013).

It is included:

- - "Negative" scenario of economic activity for entire 2015-2020 period with permanent decline of transportation activity;
- - gasoline consumption in 2020 will be decreased to approximately 65% of 2014 level;
- - diesel oil consumption in 2020 will be decreased to approximately 45% of 2014 level;
- - LPG consumption in 2020 will be decreased to approximately 90% of 2014 level;
- - CNG consumption in 2020 will approximately decreased on 10 times in comparison with 2014 level as a result of Natural Gas related political issues.
- - very slow renewal of fleet (about 25% of the average level for 2010-2014 period);
- - low actual (in spite of formal (i.e. legislative) restrictions) requirements for a newly registered vehicles.

It is considered mainly the following policies and measures within this scenario within the available resources:

i. - ecology "Euro" standards to newly registered vehicles gradual implementation in accordance to current national legislation (as is situation));

ii. - ecology "Euro" standards to motor fuels gradual implementation in accordance to current national legislation.

So, it is mean (within the second scenario) that no other wide-scale measures considered beside of the vehicle and fuel Euro standards formal and gradual implementation (as it is prescribed in current and above mentioned national legislation).

The scenario III. The third ("Positive") scenario is considered to have opportunity for moderate economic growth in general for a whole period 2014-2020 in spite of current crisis.

The scenario IIIA. "Low Requirements Grows and Fulfilment";

It is included:

- - "Positive" scenario of economic activity with transportation activity increase (and in particular further grows of number of car per capita since this indicator is still far from eastern countries of EU);
- - gasoline consumption in 2020 will increased approximately on 60% in comparison to 2014 level in spite of 2015-2016 crisis, but reach level of 2007;
- - diesel oil consumption in 2020 will increased approximately on 25% in comparison to 2014 level in spite of 2015-2016 crisis, and will slightly exceed level of 2011 about on 5%;
- - LPG consumption in 2020 will be increased approximately on 80% in comparison with 2014 level as a result of expensive gasoline fast substitution;
- - CNG consumption in 2020 will be approximately decreased on 70% in comparison with 2014 level as a result of Natural Gas related political issues (but not so significant fall as in scenarios I-II due to demand on transportation on already existed CNG vehicles that cannot be converted to other fuels in economically acceptable way).
- - middle rate renewal of fleet;
- - middle actual (in spite of formal (i.e. legislative) restrictions) requirements for a newly registered vehicles.

It is considered mainly the following policies and measures within this scenario:

i. - ecology "Euro" standards to newly registered vehicles gradual implementation in accordance to current national legislation;

ii. - ecology "Euro" standards to motor fuels implementation in accordance to current national legislation.

So, it is mean (within the first scenario) that no other wide-scale measures considered beside of the vehicle and fuel Euro standards formal and gradual implementation (as it is prescribed in current and above mentioned national legislation). Middle rate renewal of fleet here (within third scenario is natural effect since economic activity growth).

The scenario IIIB. "High Requirements Grows and Fulfilment";

It is included:

- - "Positive" scenario of economic activity with transportation activity increase (and in particular further grows of number of car per capita since this indicator is still far from eastern countries of EU);
- - gasoline consumption in 2020 will increased approximately on 60% in comparison to 2014 level in spite of 2015-2016 crisis, but reach level of 2007;
- - diesel oil consumption in 2020 will increased approximately on 25% in comparison to 2014 level in spite of 2015-2016 crisis, and will slightly exceed level of 2011 about on 5%;
- - LPG consumption in 2020 will be increased approximately on 80% in comparison with 2014 level as a result of expensive gasoline fast substitution;
- - CNG consumption in 2020 will be approximately decreased on 70% in comparison with 2014 level as a result of Natural Gas related political issues (but not so significant fall as in scenarios I-II due to demand on transportation on already existed CNG vehicles that cannot be converted to other fuels in economically acceptable way).
- - fast rate renewal of fleet;

- - high actual (in spite of formal (i.e. legislative) restrictions) requirements for a newly registered vehicles.

It is considered mainly the following policies and measures within this scenario:

i. **-** economical ***and other measures to encourage fast fleet renewal on cars with high ecological class;***
ii. - ecology "Euro" standards to newly registered vehicles fast implementation in accordance to current national legislation (with stringent control);
iii. - ecology "Euro" standards to motor fuels implementation in accordance to current national legislation.

The scenario IIIC. "High Requirements Grows and Fulfilment plus Optimization of transportation".

It is included:

- - "Positive" scenario of economic activity with transportation activity increase (and in particular further grows of number of car per capita since this indicator is still far from eastern countries of EU). But due to set of measures in average specific fuel consumption, total mileage and total fuel consumption will be decreased in average (for all fuels) approximately on 15% in comparison to scenario IIIB;
- - fast rate renewal of fleet;
- - high actual (in spite of formal (i.e. legislative) restrictions) requirements for a newly registered vehicles.

It is considered mainly the following policies and measures within this scenario:

i. - a set of measures to decrease average specific fuel consumption, total mileage and total fuel consumption, including:
ii. - public transport fast development and increase its attractiveness;
iii. - economical and other measures to force private car drivers to use more often public transport;
iv. - cargo transportation wide-scale optimization due logistic and informational technologies fast development and implementation, etc.
v. - national wide-scale eco-driving programme establishment
vi. - reducing maximum permissible speed limits in some ways and areas (as well as the road rules infringement punishment);
vii. - economical and other measures to encourage fast fleet renewal on cars with high ecological class;
viii. - ecology "Euro" standards to newly registered vehicles fast implementation in accordance to current national legislation (with stringent control);
ix. - ecology "Euro" standards to motor fuels implementation in accordance to current national legislation;
x. - establishment of in-use vehicle proper maintenance wide-scale programmes to maintain proper technical condition, including condition of emission control systems;
xi. - moderate (within restricted resources) investments to road infrastructure (only to the most actual projects, related to the most important congestion problems solutions).

10.2.1.2 Analysis of the feasibility of policies and measures for different scenarios

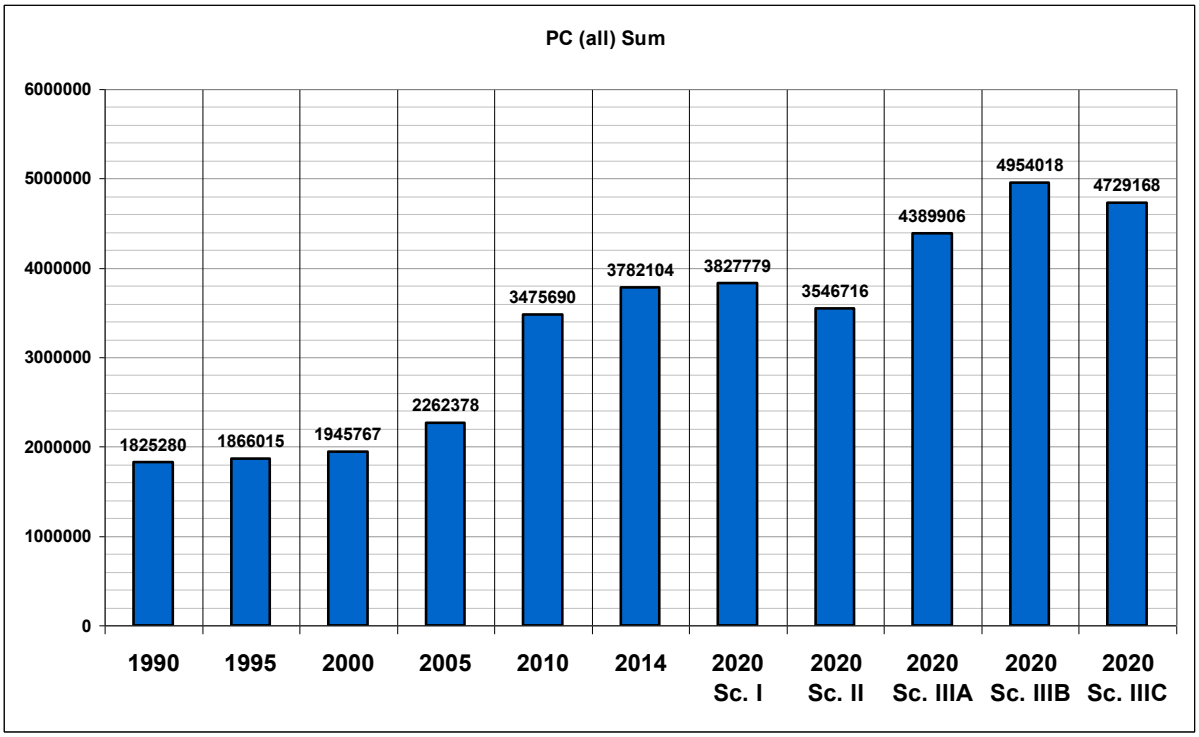
The discussed policies and measures for different scenarios are in conformance with above mentioned national plans for road transport development (that were planned taking in to the account feasibility of policies and measures).

Such measures are considered as available and feasible in practice (at least majority of them). Nevertheless, the feasibility of measures, like fast fleet renewal and especially sufficient investments to road infrastructure, is a big question (taking in to the account current crisis and big level of vagueness).

The above mentioned scenarios and measures were therefore focused on a restricted set of measures and they are the object of further research based on the results of this study.

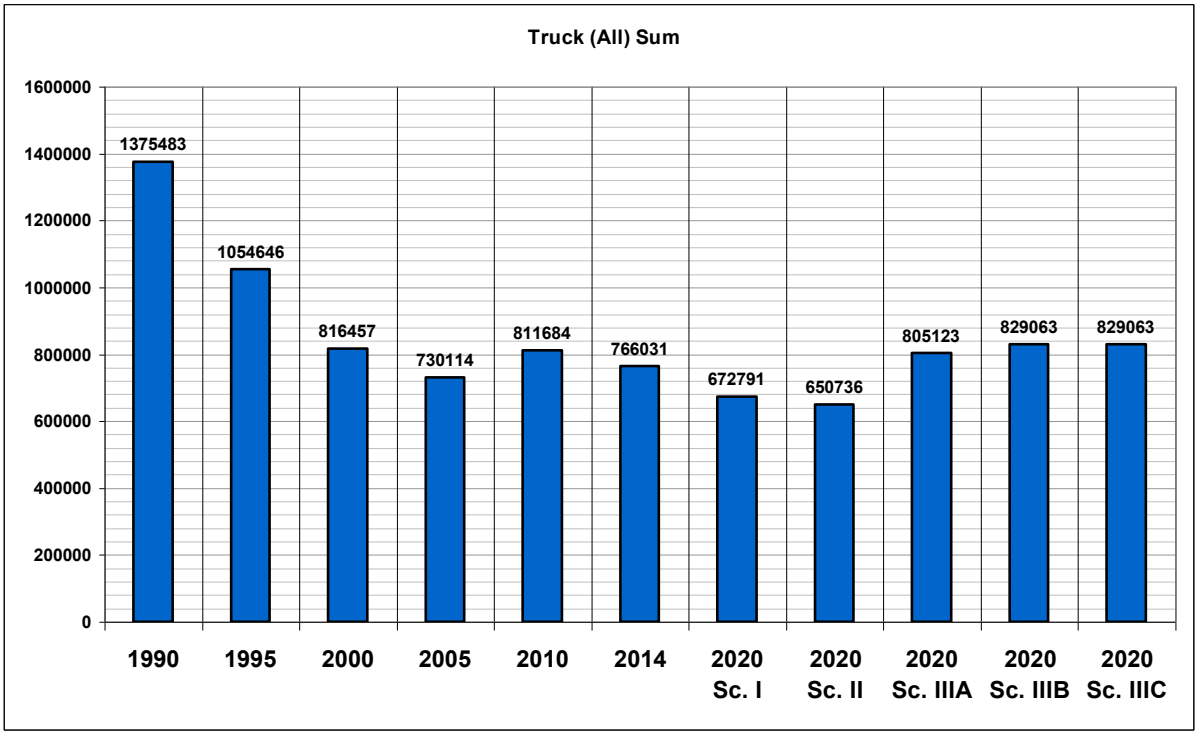
Fleet structure by vehicle type trends and projections within different scenarios are shown on Figure 10.1 to Figure 10.5.

Figure 10.1: PC total amount trends



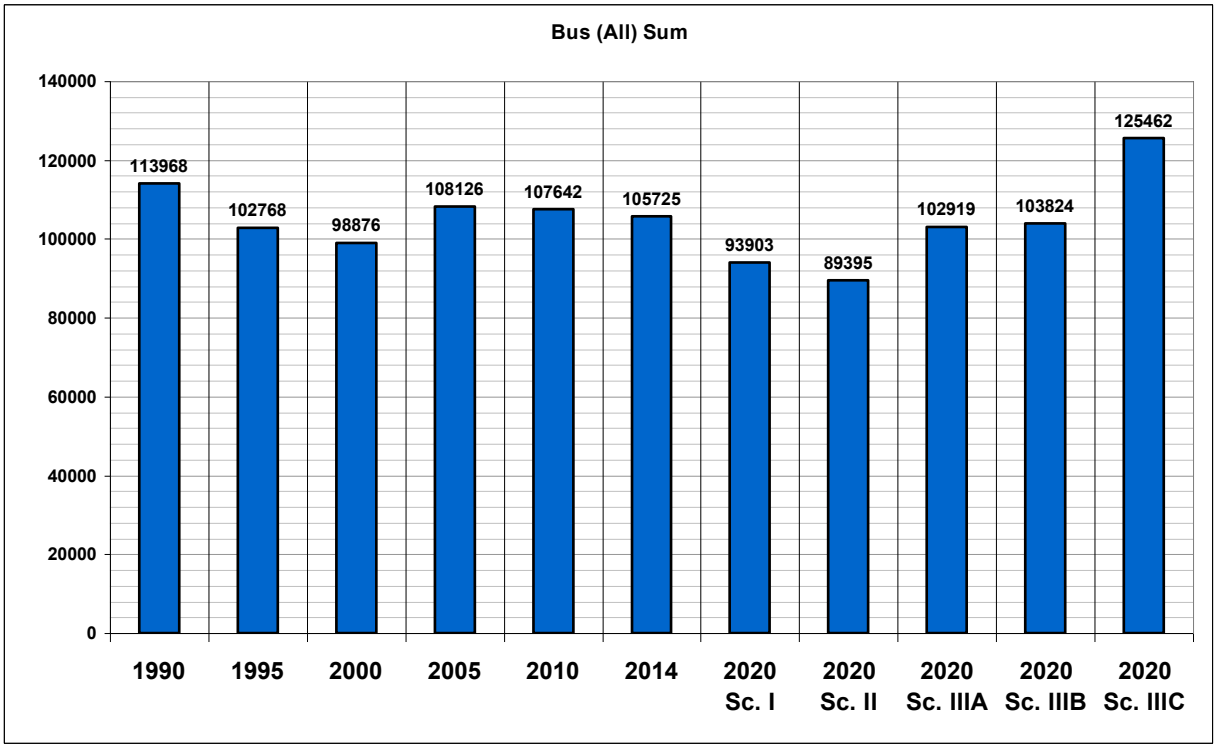
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.2: Truck total amount trends



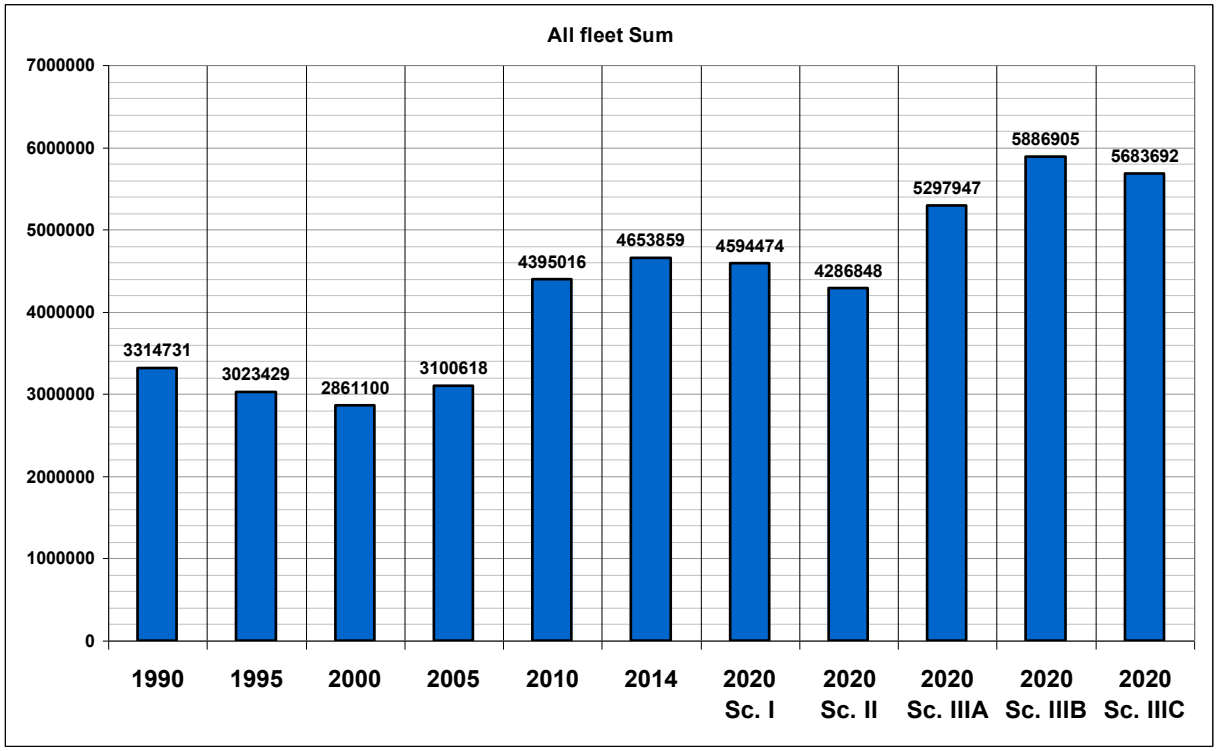
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.3: Bus total amount trends



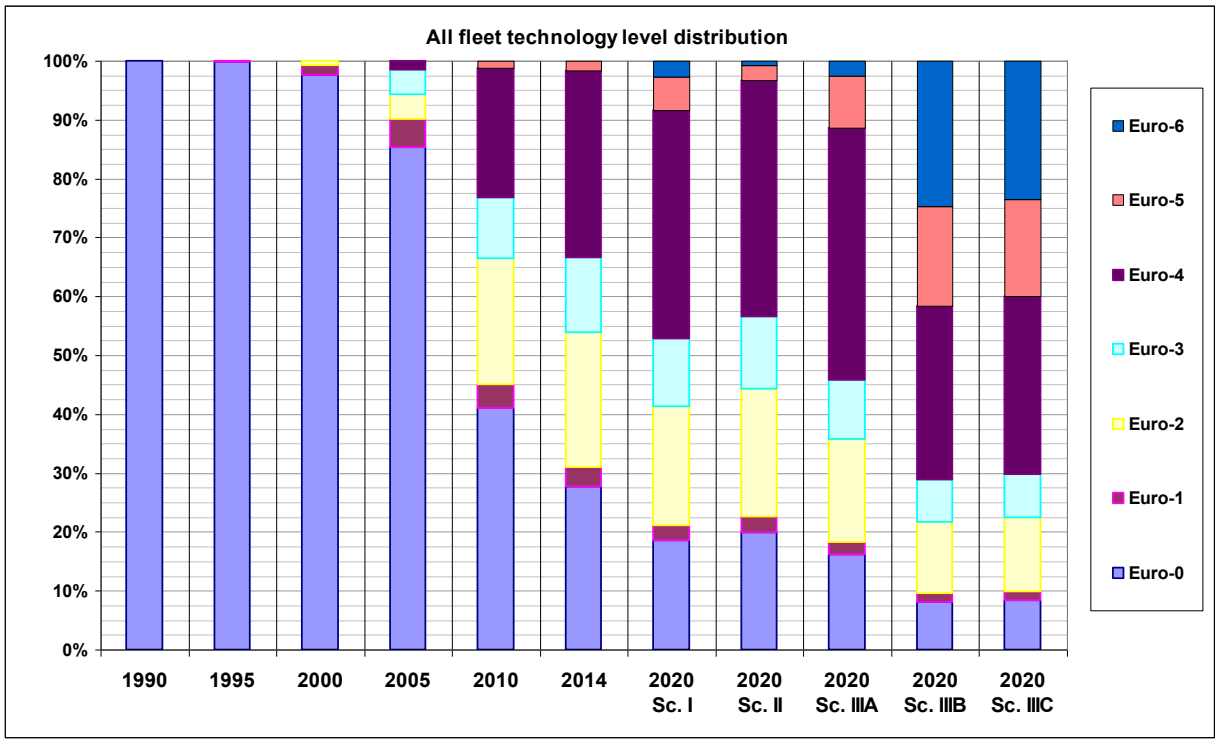
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.4: All fleet total amount trends



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

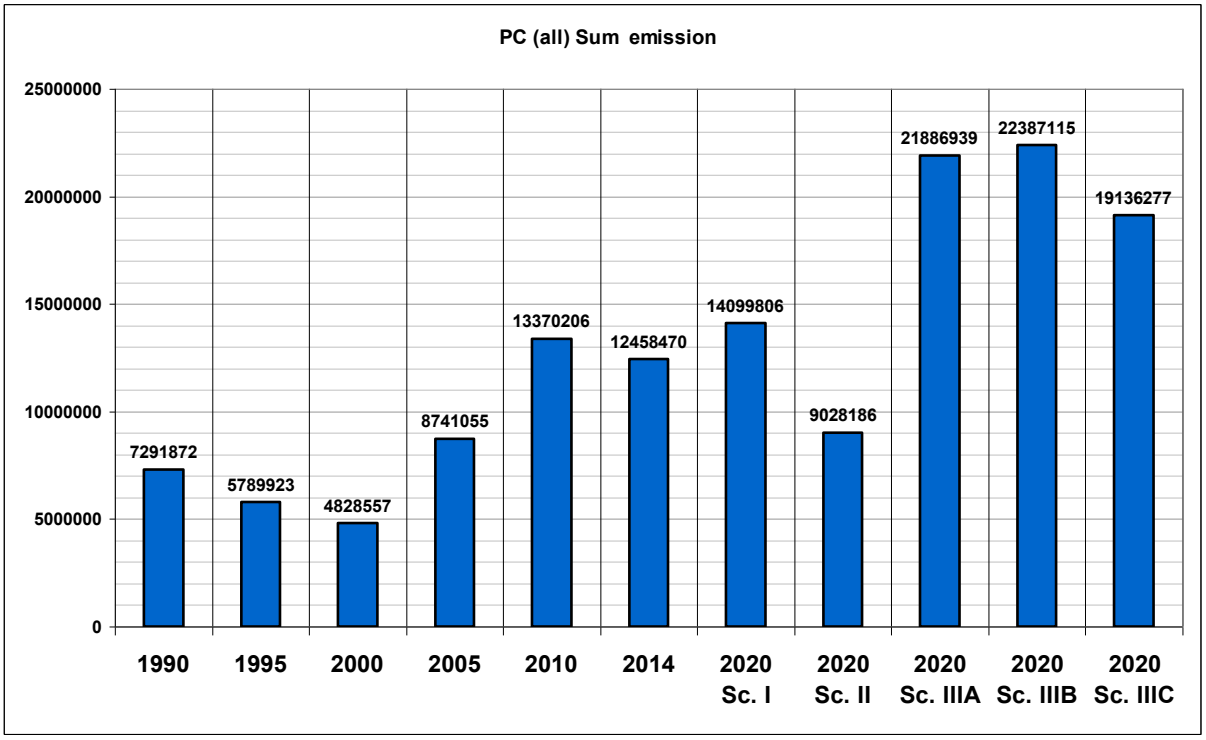
Figure 10.5: All fleet in average technology level distribution



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

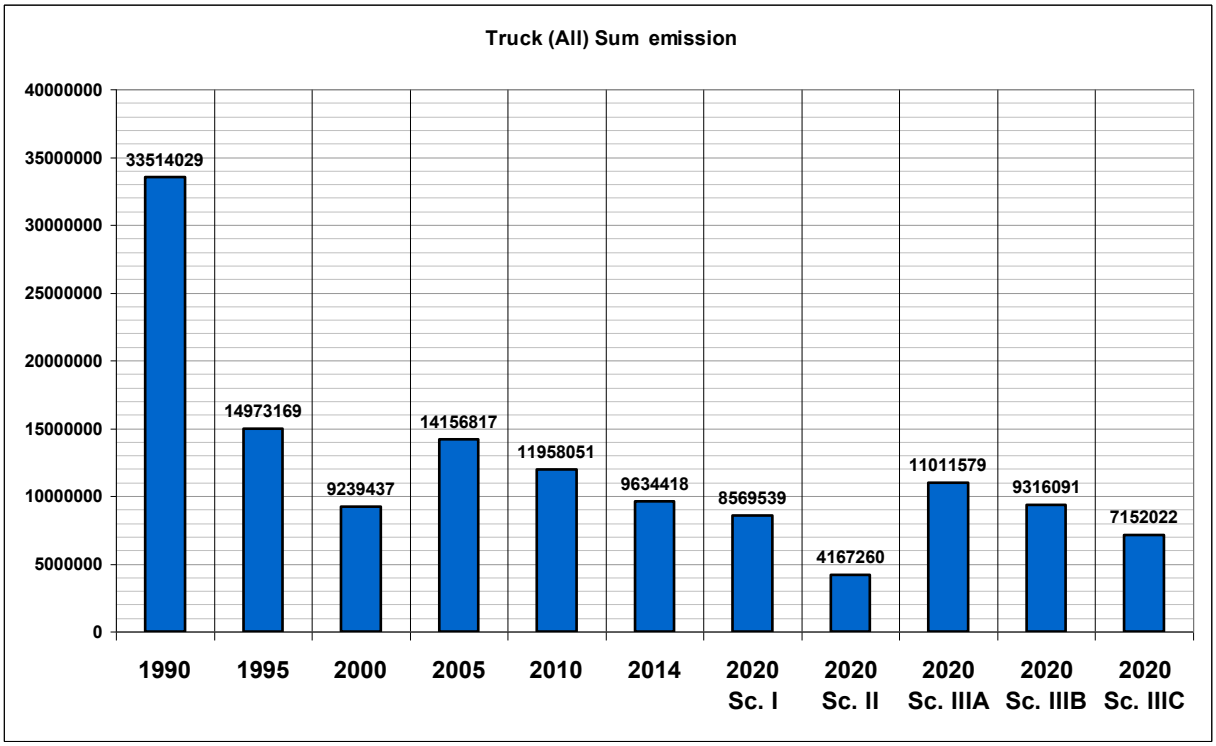
CO_2 emission trends and projections within different scenarios are shown on the Figure 10.6-Figure 4.10.

Figure 10.6: CO2 emission (t) trends (PC sum)



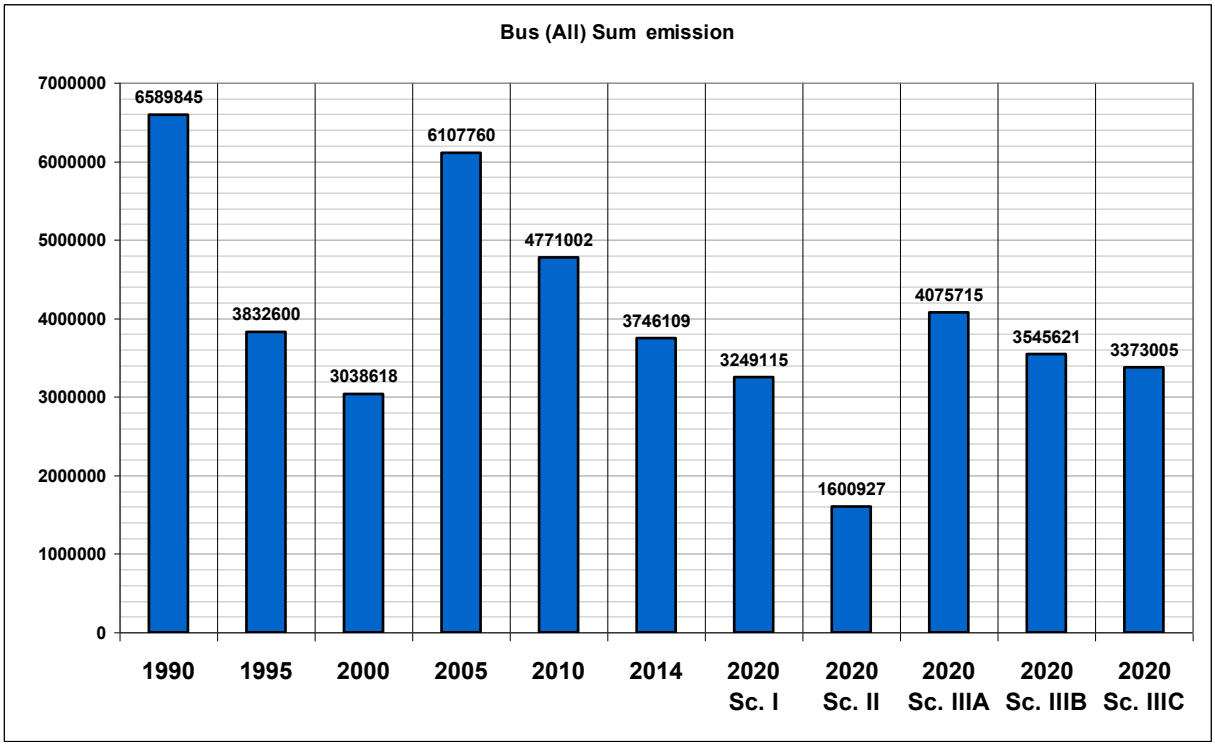
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.7: CO2 emission (t) trends (Truck)



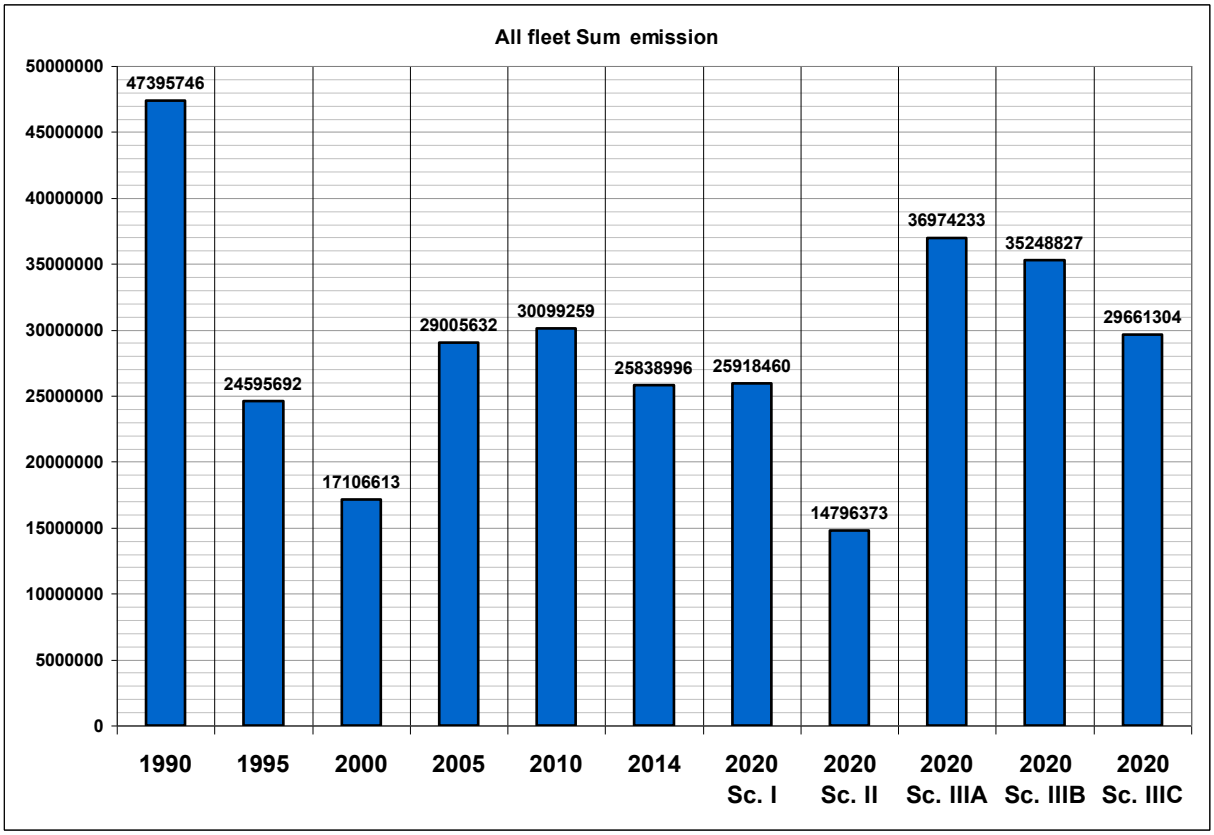
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.8: CO2 emission (t) trends (Bus)



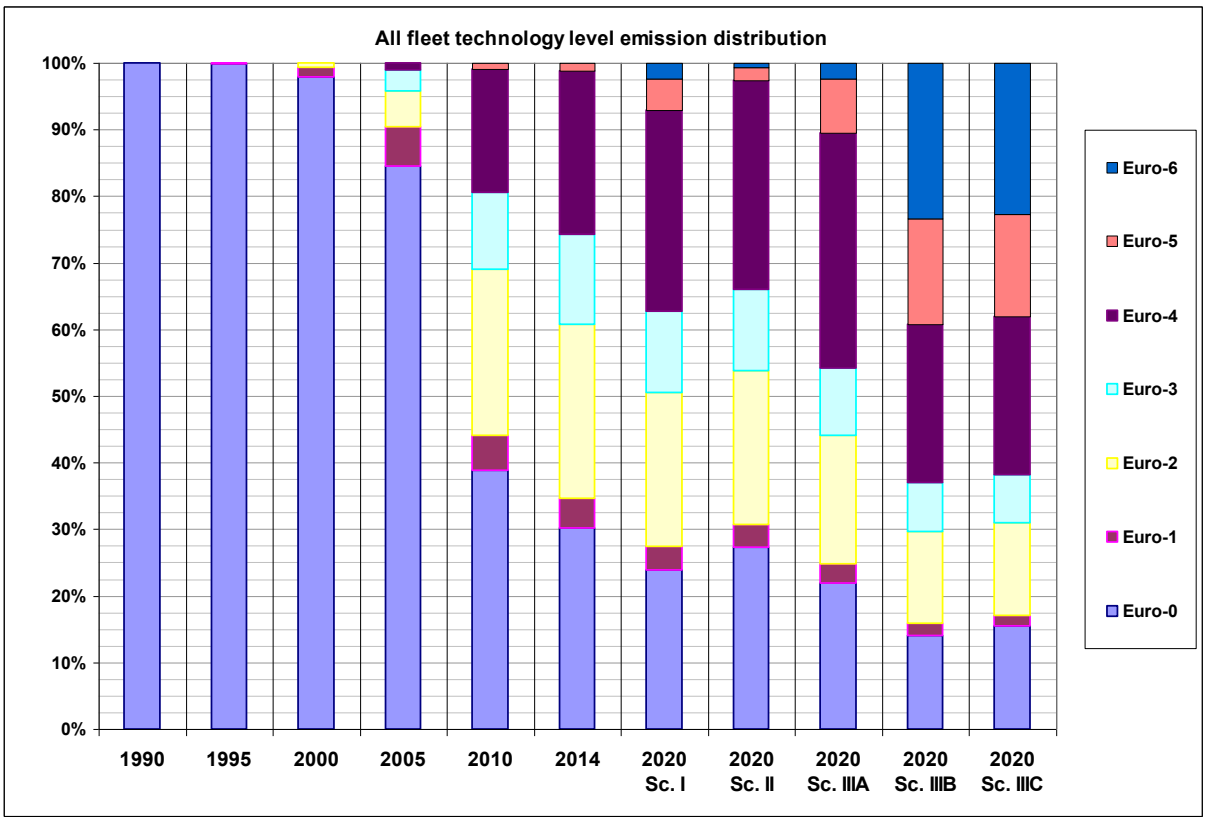
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.9: CO2 emission (t) trends (All fleet)



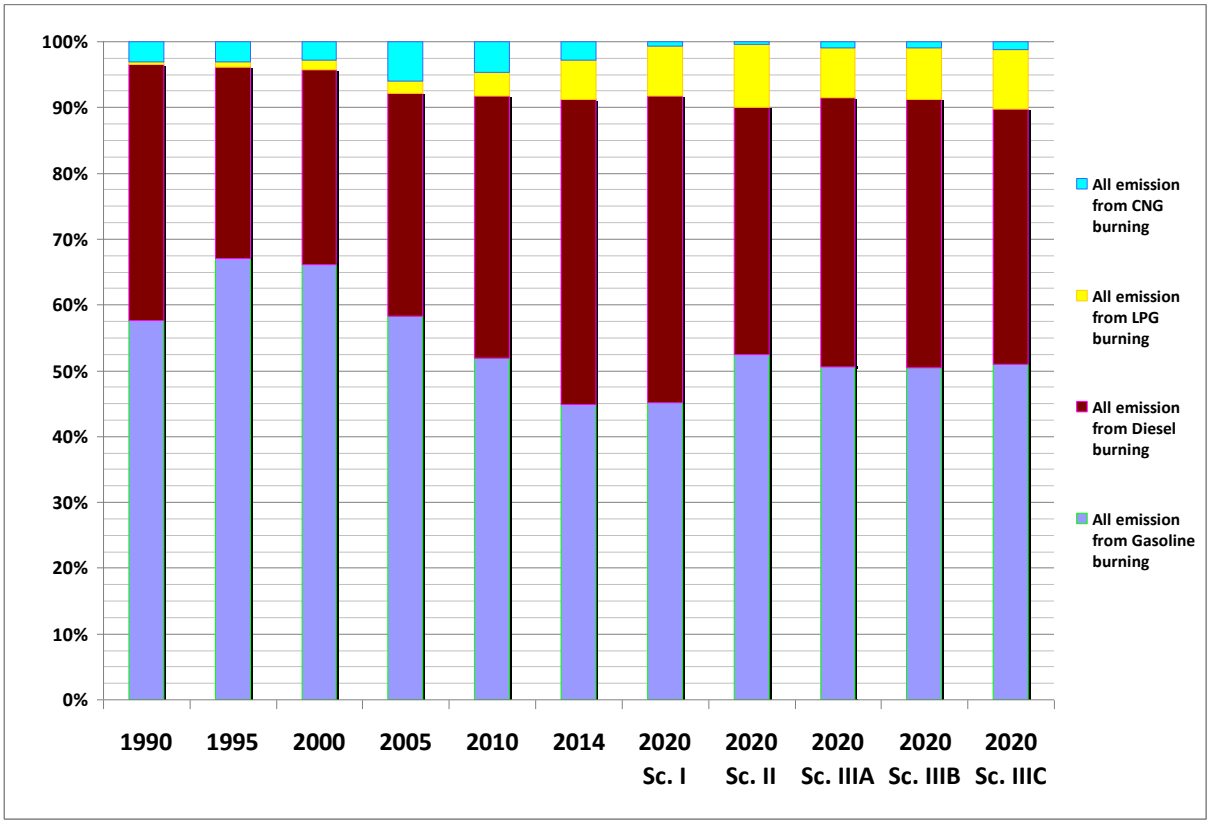
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.10: CO2 emission trends (All fleet) (% distribution of emission from different ECO-level vehicles)



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

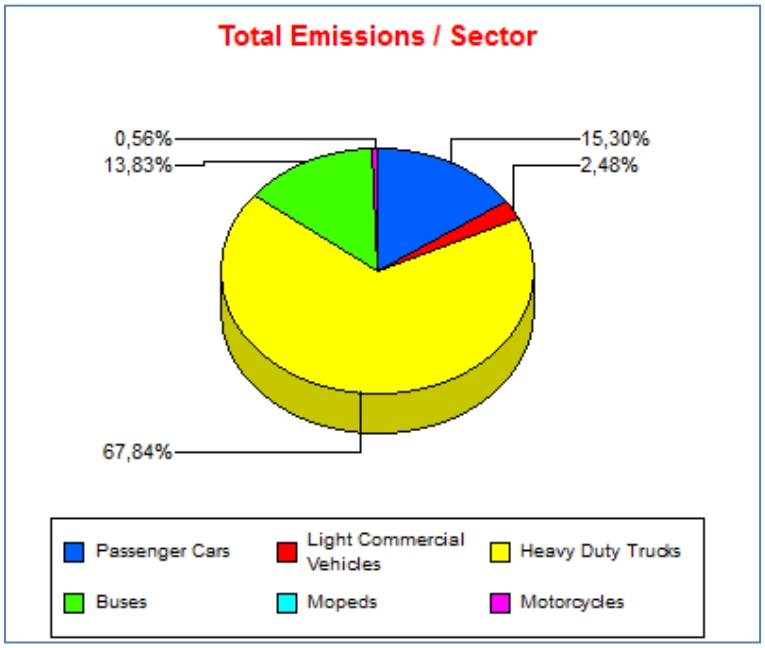
Figure 10.11: CO2 emission trends (% distribution of emission from different fuels powered vehicles)



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

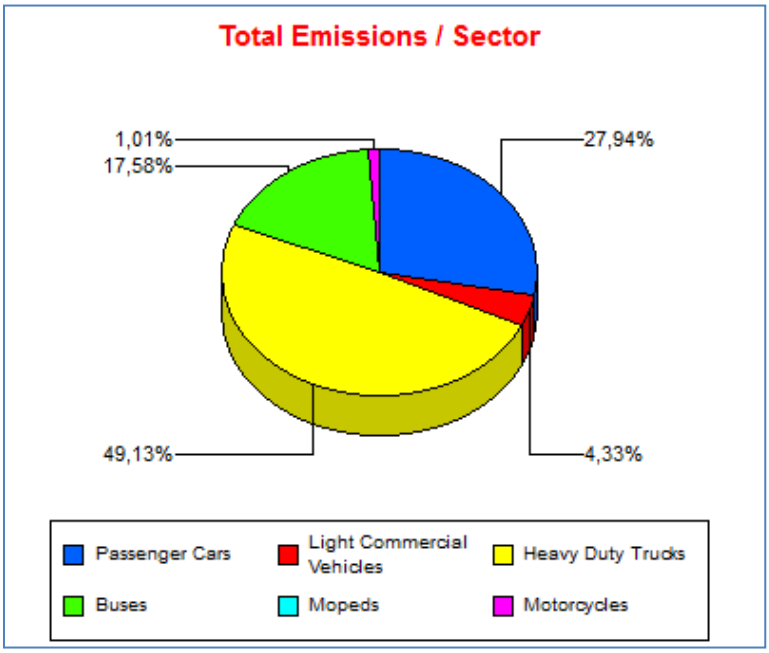
Different road vehicle type's share of CO2 emission in Ukraine in 1990, 2000, 2010 and 2014 respectively showed on the Figure 10.12 to Figure 10.15.

Figure 10.12: Different road vehicle types share of CO2 emission in Ukraine in 1990



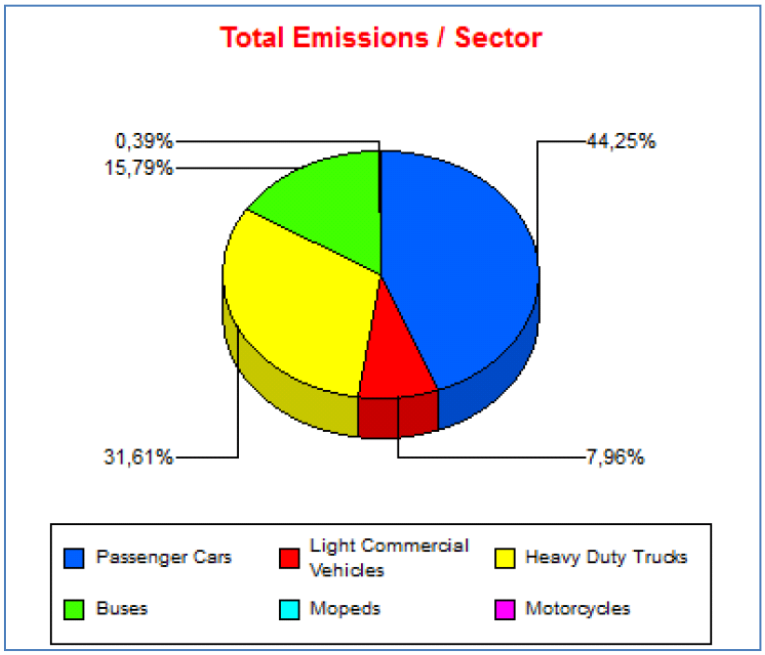
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.13: Different road vehicle types share of CO2 emission in Ukraine in 2000



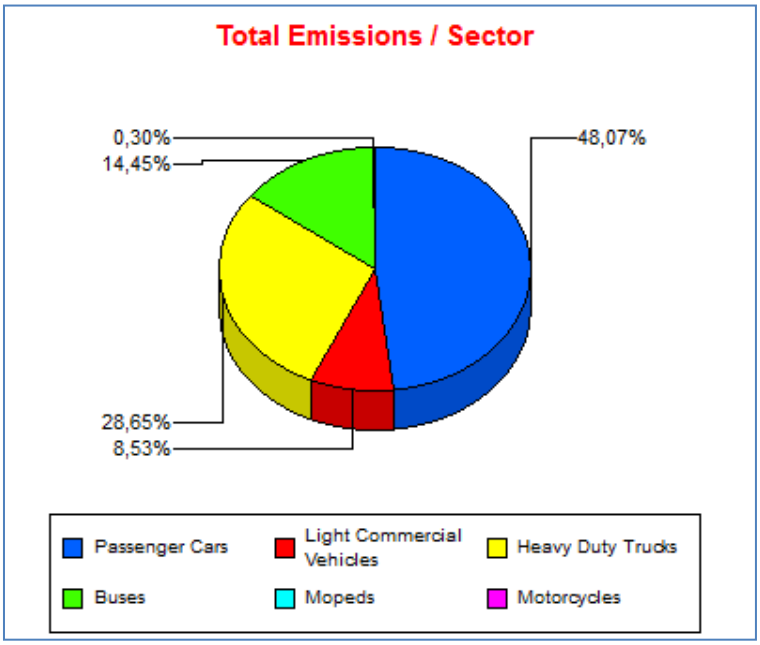
Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.14: Different road vehicle types share of CO2 emission in Ukraine in 2010



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

Figure 10.15: Different road vehicle types share of CO2 emission in Ukraine in 2014



Source: Report "Study of the effect on emissions harmful substances in atmospheric air the structure of the vehicle fleet of Ukraine", state registration No. 0115U006027, State Enterprise "State Road Transport Research Institute", Ukraine, 2015.

As it is shown on the Figure 10.12 to Figure 10.15 share of Passenger Cars and LDV had a tendency for rapid significant growth from 1990 to 2010 in Ukraine, while 2010-2014 period gives much slower tendency of mode shift.

10.3 Annex III : Supporting material on methods and procedures for testing road transport vehicles

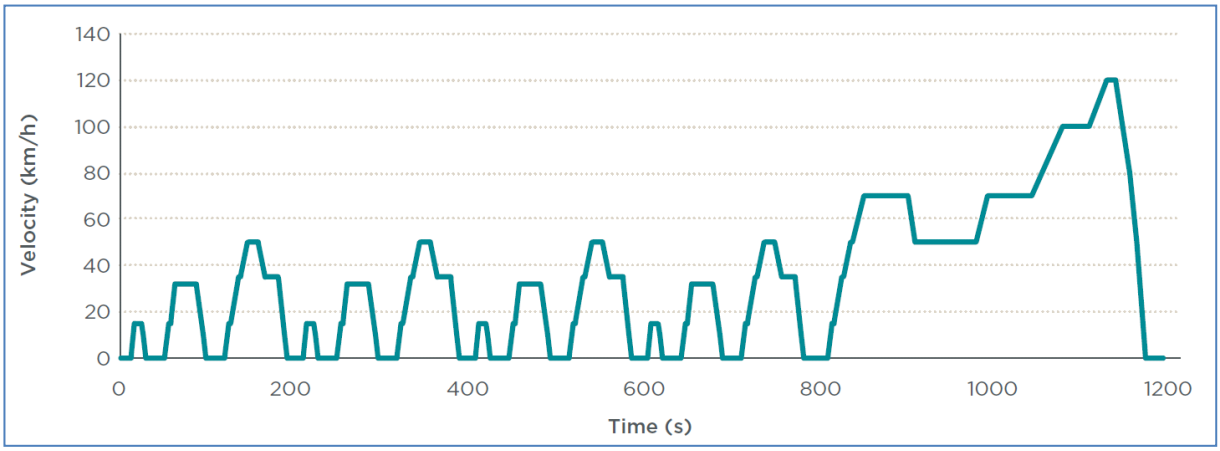
10.3.1.1 LDVs

Remarks regarding driving cycles graphical representation below:

1. Below for NEDC, FTP75, HWFET and JC08 test cycles the provided representation is taken from (ICCT, 2014a)
2. For US06 and SC03, the test cycles are taken from the Delphi Worldwide Emissions Standards. Passenger Cars and Light Duty Vehicles. 2015/2016 booklet (Delphi, 2015)
3. For the Worldwide harmonized Light-duty Test Cycle (WLTC), the cycle schematics are from (Dieselnet, 2016)

10.3.1.1.1 European Union

Figure 10.16: Driving schedule of the NEDC cycle (EU)

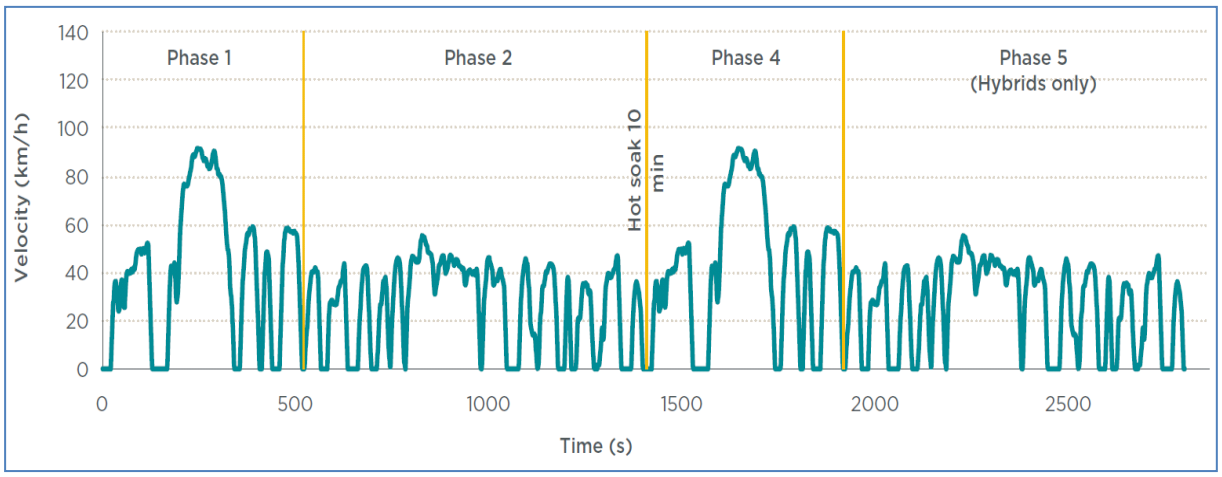


The NEDC some selected parameters:

- Start condition: cold
- Total duration (ECE + EUDC): 1180 s
- Distance: 11.007 km
- Average speed: 33.6 km/h
- Maximum speed: 120 km/h
- Maximum acceleration: 1.04 m/s2
- Mean positive acceleration: 0.59 m/s2
- Stop time / share: 280 s / 23.7%

10.3.1.1.2 North America

Figure 10.17: Driving schedule of the FTP75 cycle (US)



The FTP75 some selected parameters:

- Start condition: 43% cold / 57% hot
- Total duration: 1874 s (plus hot soak: 540 s min; 660 s max)
- Distance: 17.77 km (11.04 mi)
- Average speed: 34.2 km/h (21.19 mph), stop excluded
- Maximum speed: 91.2 km/h (56.68 mph)
- Maximum acceleration:1.48 m/s2
- Mean positive acceleration: 0.5 m/s2
- Stop time / share: 241 s / 17.6%

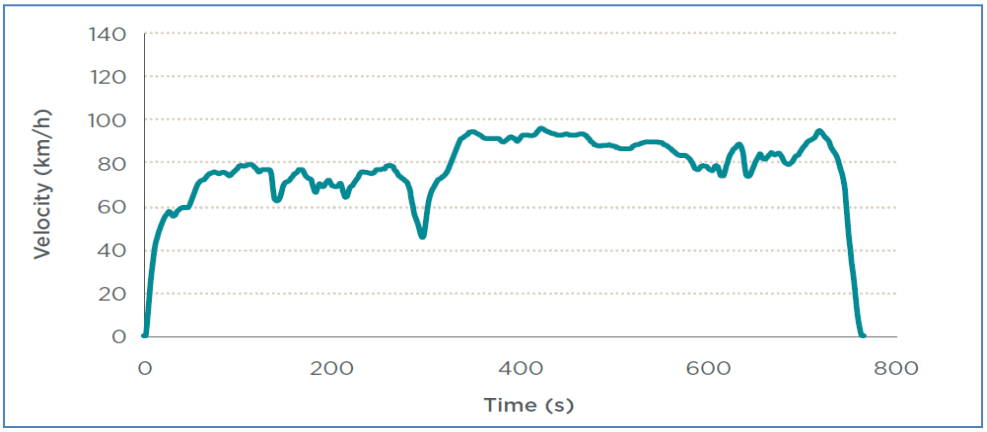
Emissions from all phases excluding hot soak are collected and analysed separately.

Total emissions are calculated as a sum of cycle phases` results using the weighting factors:

- 0.43 for the cold start transient phase 1;
- 1.0 for the stabilized phase 2;
- 0.57 for the hot start transient phase 4 for non-hybrids.
- For hybrids, phase 2 is weighted at 0.43 and phase 5 at 0.57, resulting in the same total weighting of 1.0 for the stabilized phase.

The Highway Fuel Economy Test (HWFET or HFET) cycle is a chassis dynamometer hot start driving schedule developed by the U.S. EPA for the determination of the highway fuel economy rating (the Figure 10.18)

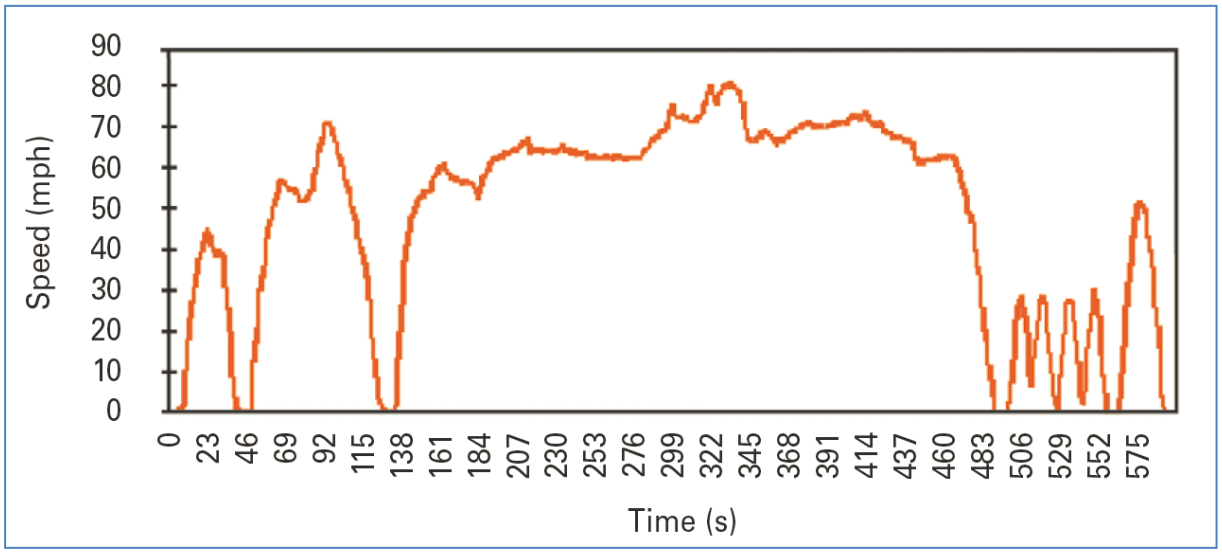
Figure 10.16: Driving schedule of the HWFET cycle (US)



The HWFET some selected parameters:

- Start condition: hot
- Total duration: 765 s (hot start driving schedule)
- Distance: 16.5 km (10.26 mi)
- Average speed: 77.7 km/h (48.3 mph), stop excluded
- Maximum speed: 96.4 km/h (59.91 mph)
- Maximum acceleration: 1.43 m/s2
- Mean positive acceleration: 0.19 m/s2
- Stop time / share: 4 s / 0.5%

Figure 10.19: Driving schedule of the US06 cycle or Supplemental FTP Driving Schedule (high speed/high load cycle) (US)



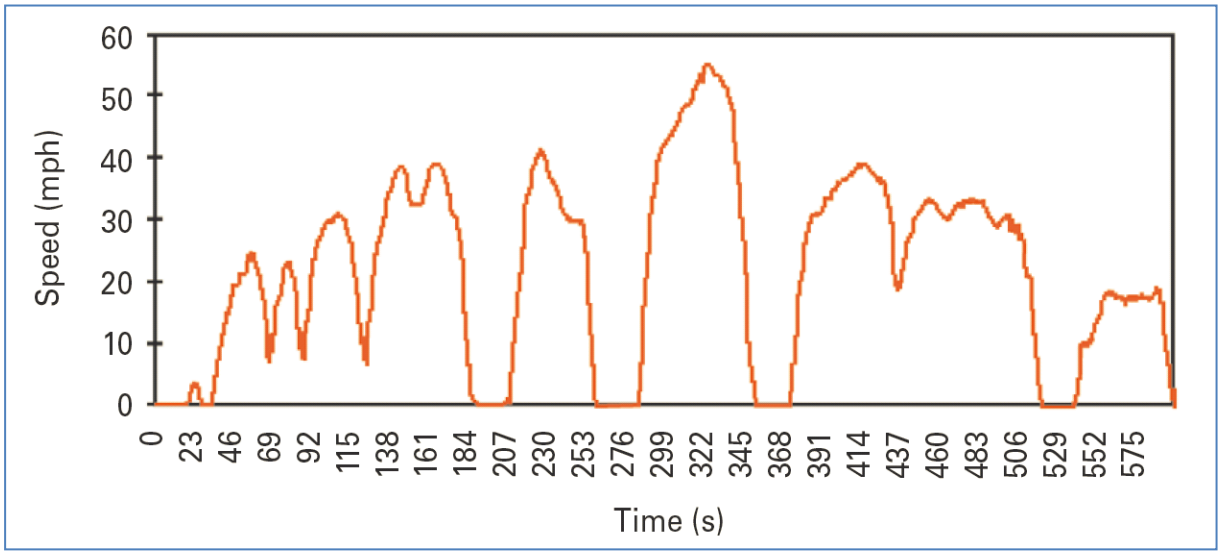
The US06 some selected parameters:

- Start condition: hot (5 s initial idle)
- Total duration: 596 s
- Distance: 12.86 km (8.01 mi)
- Average speed: 77.2 km/h (48.37 mph)
- Maximum speed: 129 km/h (80.3 mph)
- Stop time / share: 13 s / 2.2%

SC03 Air conditioning cycle

Driving schedule of the SC03 Air conditioning cycle is presented on the Figure 10.20.

Figure 10.20: SC03 Air conditioning cycle (US)

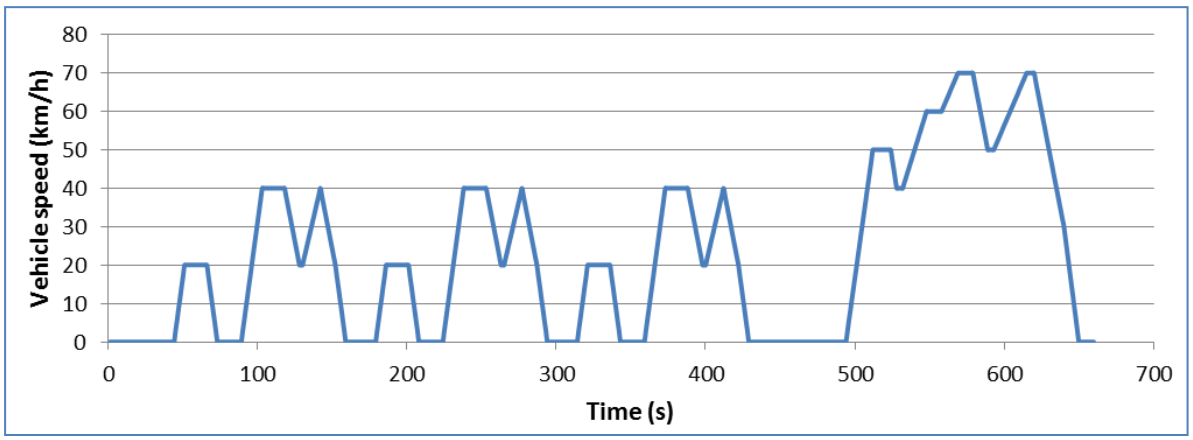


The SC03 some selected parameters:

- Start condition: hot (18 s initial idle)
- Total duration: 598 s
- Length: 5.76 km (3.58 mi)
- Average speed: 34.9 km/h (21.55 mph)
- Maximum speed: 88 km/h (54.8 mph)
- Stop time / share: 82 s / 13.7%

10.3.1.1.3 Japan

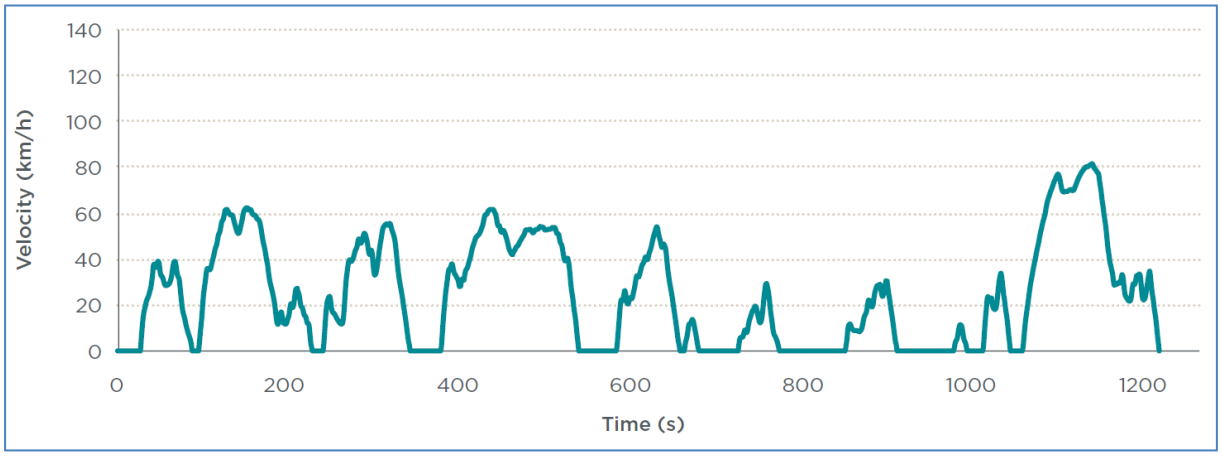
Figure 10.21: The 10-15 mode driving cycle (Japan)



The 10-15 driving cycle some selected parameters:

- Start condition: hot
- Total duration: 660s
- Distance: 4.16 km
- Average speed: 22.7 km/h
- Maximum speed: 70.09 km/h
- Mean positive acceleration: 0.37 m/s2
- Stop time / share: 172 s / 26%

Figure 10.17: The JC08 driving cycle (Japan)



The JC08 some selected parameters:

- Total duration: 1205 s
- Length: 8.2 km
- Average speed: 24.4 km/h
- Maximum speed: 80 km/h

10.3.1.1.4 Worldwide harmonisation

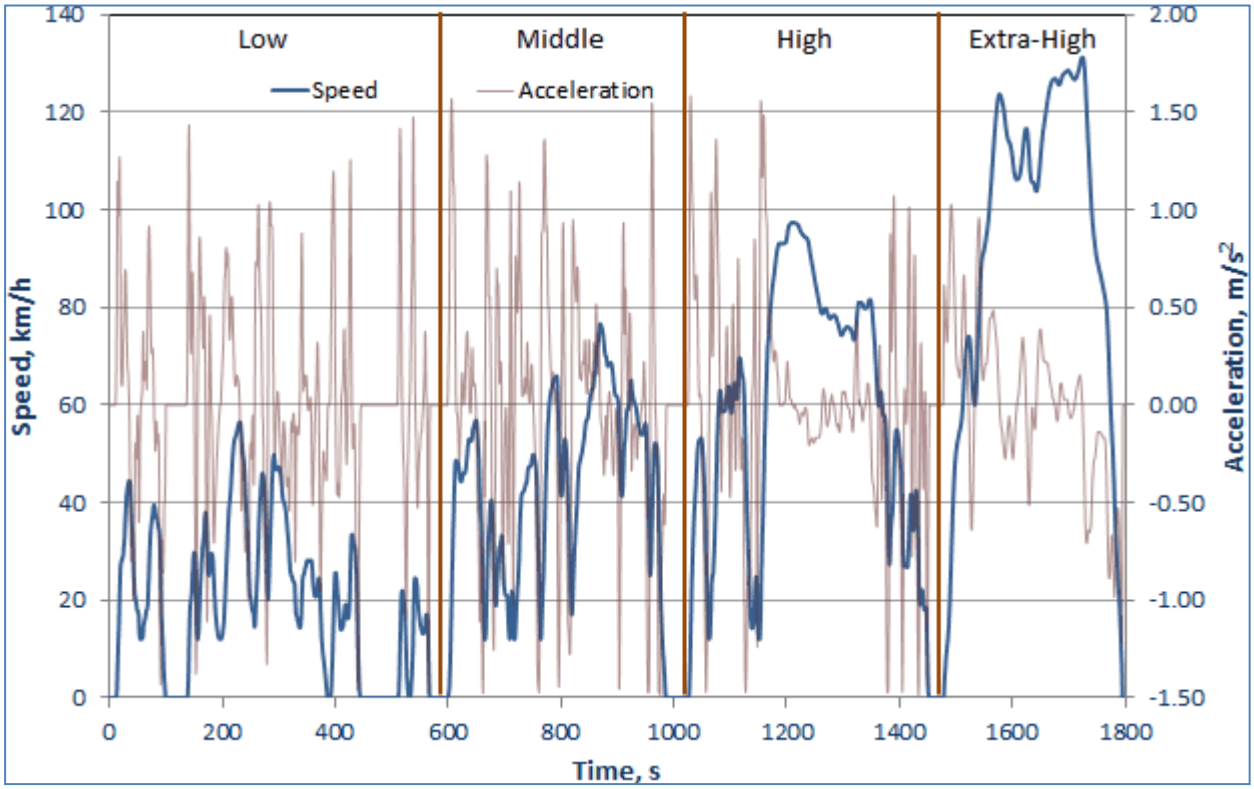
Class 3 cycle category (the Figure 10.23) is designed for vehicles with highest PMR and is declared as a representative of vehicles driven in Europe, US and Japan.

The class 3 WLTC in its current version (#5) consists of four parts:

1) Low load (representative of urban driving);
2) Middle (suburban driving);
3) High (extra-urban driving);
4) Extra-high load (highway zone).

Emissions from these four sub-cycles are collected and analysed separately.

Figure 10.18: WLTP Cycle for Class 3 Vehicles



The class 3 WLTC some selected parameters:

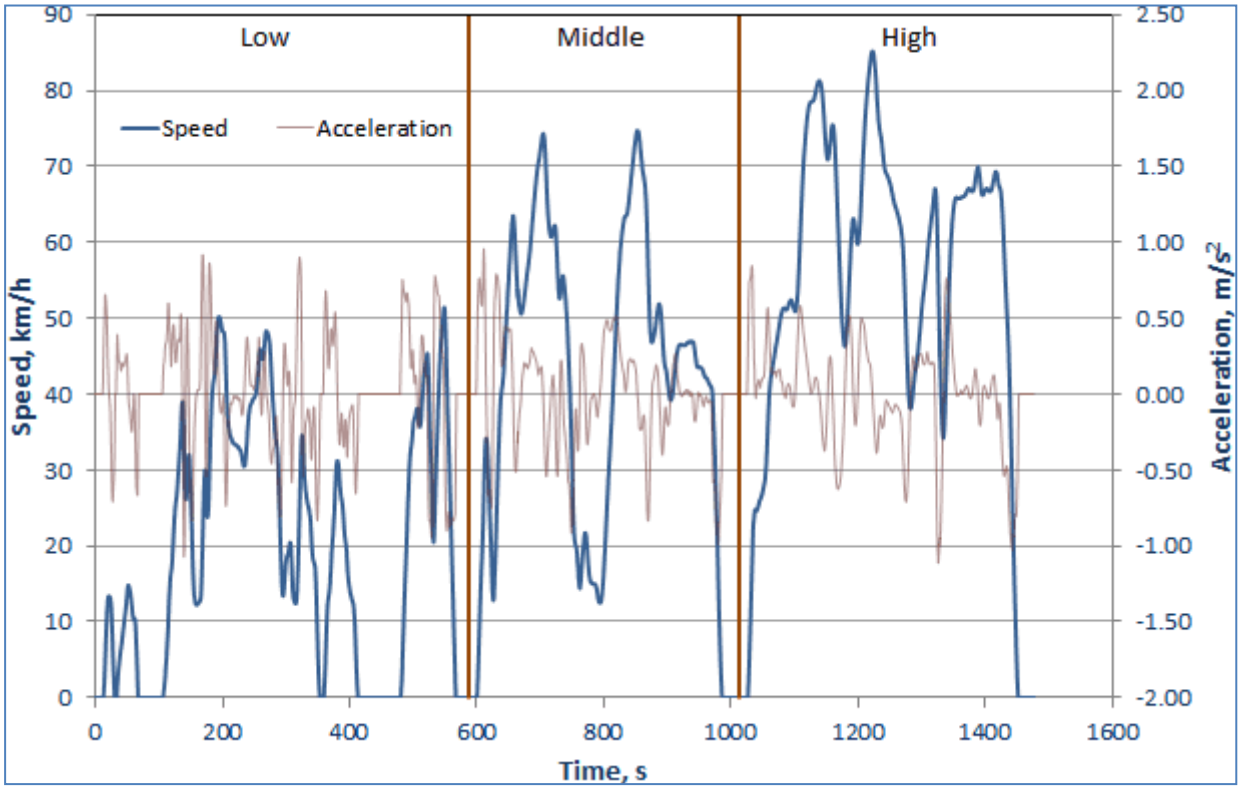
- Start condition: cold
- Total duration: 1800 s
- Distance: 23.262 km
- Average speed: 46.5 km/h
- Maximum speed: 131.3 km/h
- Maximum acceleration: 1.67 m/s2
- Mean positive acceleration: 0.41 m/s2
- Stop time / share: 226 s / 12.6%

Class 2 cycle category (the Figure 10.24) is designed for vehicles with medium PMR and is declared as a representative of vehicles driven in India and of low power vehicles driven in Japan and Europe.

The class 2 WLTC consists of three parts:

1) Low load (representative of urban driving);
2) Middle (suburban driving);
3) High (extra-urban driving).

Figure 10.19: WLTP Cycle for Class 2 Vehicles



The class 2 WLTC some selected parameters:

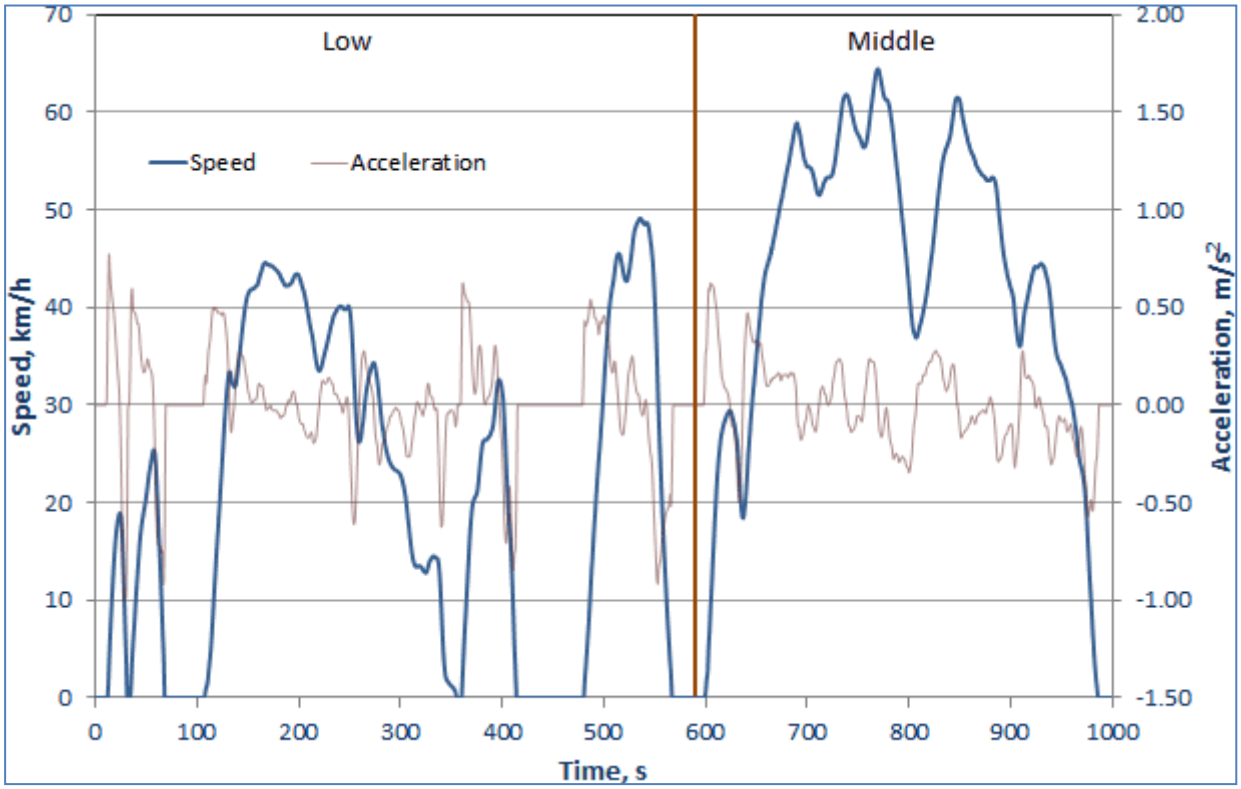
- Start condition: cold
- Total duration: 1477 s
- Distance: 14.664 km
- Average speed: 35.7 km/h
- Maximum speed: 85.2 km/h
- Maximum acceleration: 0.96 m/s2
- Stop time / share: 233 s / 15.8%

Class 1 cycle category version 1.4 (the Figure 10.25) is designed for vehicles with lowest PMR and is declared as a representative of vehicles than can be found in India.

The class 1 WLTC consists of two parts:

1) Low load (representative of urban driving);
2) Middle (suburban driving).

Figure 10.20: WLTP Cycle for Class 1 Vehicles



The class 1 WLTC some selected parameters:

- Start condition: cold
- Total duration: 1022 s
- Distance: 8.091 km
- Average speed: 28.5 km/h
- Maximum speed: 64.4 km/h
- Maximum acceleration: 0.76 m/s2
- Stop time / share: 203 s / 19.9%

The different cycles have quite different levels of velocity and of acceleration. Thus the engine load distribution for a vehicle is also quite different in these cycles. The differences in the engine load distribution between the cycles are not constant but depend on the vehicle specifications (e.g. ratios between mass, C_d x A, the rolling resistance coefficient and engine rated power, etc.). Table 10.1 to Table 10.3 summarise the main cycle parameters for NEDC and WLTC based on recently completed work for the European Commission (Ricardo Energy & Environment et al, 2016 (forthcoming)). Load and engine speed related values are shown for the petrol base car from EU car segment C (e.g. VW Golf, Ford Focus, etc.). The average vehicle speeds increase from the NEDC to WLTC, and consequently the engine speed levels also increase since the high speed phases are generally driven in the highest gear in all cycles. The average power demand is for the C-segment car is only 4% of the rated power in the NEDC, while in WLTP it is 8%.

Table 10.1: road category shares of the cycles

	Share in mileage		
	Urban	Rural	Motorway
NEDC	37%	34%	29%
WLTC	34%	31%	36%

Source: (Ricardo Energy & Environment et al, 2016 (forthcoming))

Table 10.2: Parameters from the test cycles simulated (engine speed and power shown for the base petrol lower medium car)

	dist	velocity	pos. acc	$v*a_{neg}$	relat. pos. acc.	pos grad	n_{norm}	Pe_{norm}
	[km]	[km/h]	[m/s^2]	[m²/s³]	[m/s²]	[%]	[-]	[-]
NEDC	3.69	33.65	0.53	-4.48	0.107	0.00	0.22	0.043
WLTC	8.15	46.53	0.45	-5.16	0.147	0.00	0.24	0.081

Source: (Ricardo Energy & Environment et al, 2016 (forthcoming))

Notes:
pos grad… average positive road gradient
$v*a_{neg}$….average product of velocity (m/s) and acceleration [m/s²]. Only counted if a<0….
n_{norm}….engine speed normalised between idling and rated engine speed
P_{norm}….engine power normalised between idling and rated engine power

Table 10.3: Share of total power demand in the test cycles simulated (engine speed and power shown for the base petrol C-segment car)

	$P_{auxiliaries}$	P_{transm}	P_{roll}	P_{air}	P_{grad}	P_{brake}
	[% from avg. engine power demand]					
NEDC	1%	8%	30%	34%	0%	26%
WLTC	5%	6%	30%	38%	0%	22%

Source: (Ricardo Energy & Environment et al, 2016 (forthcoming))

10.3.1.2 HDVs

10.3.1.2.1 Further information on Ukraine's GOST 20306-90 and GOST P 54810-2011

The figures below show the on road track driving cycles used for different types of vehicles, with a travelled distance scale, rather than a time scale.

- The test is run as a hot test with a vehicle pre-running/warm-up phase carried out before the main test.
- The vehicle accelerates at full fuel delivery until the desired speed is achieved on each part of cycle.
- Gear shift rules and deceleration as well as vehicle loaded weight are also regimented.
- Special requirements are settled for road track and valid atmospheric conditions and as well as measured results eligibility also.

Figure 10.26: Extra-urban driving cycle on road track, used for vehicles with loaded mass less than 3500 kg and coaches (GOST 20306-90, GOST P 54810-2011)

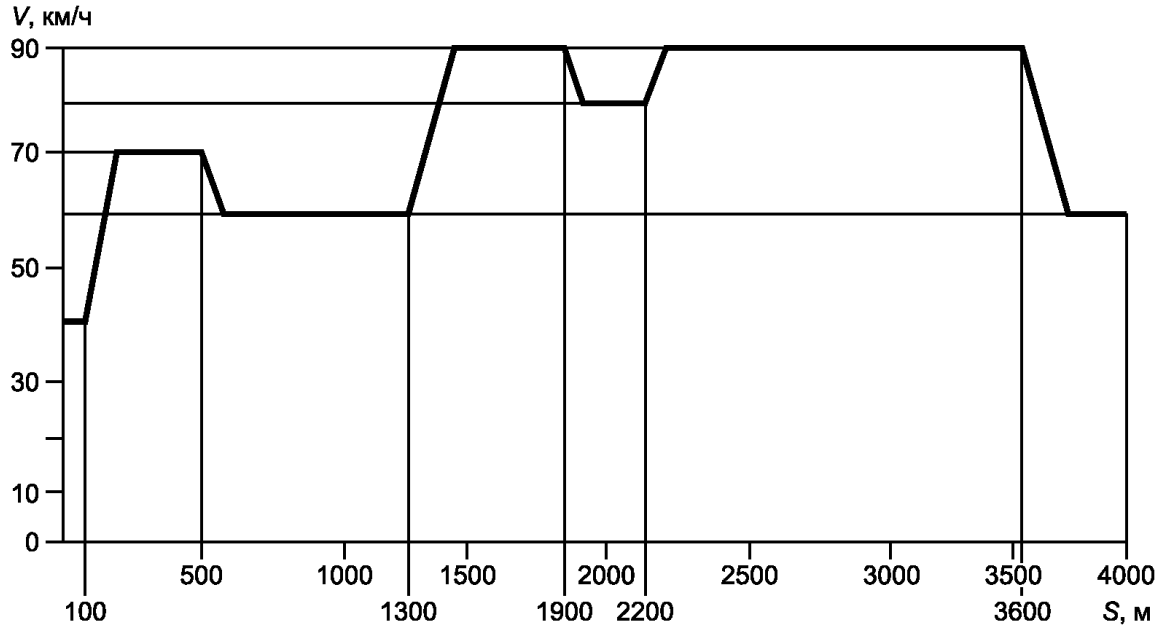


Figure 10.21: Extra-urban driving cycle on road track, used for cargo vehicles with loaded mass more than 3500 kg and inter-city buses (GOST 20306-90, GOST P 54810-2011)

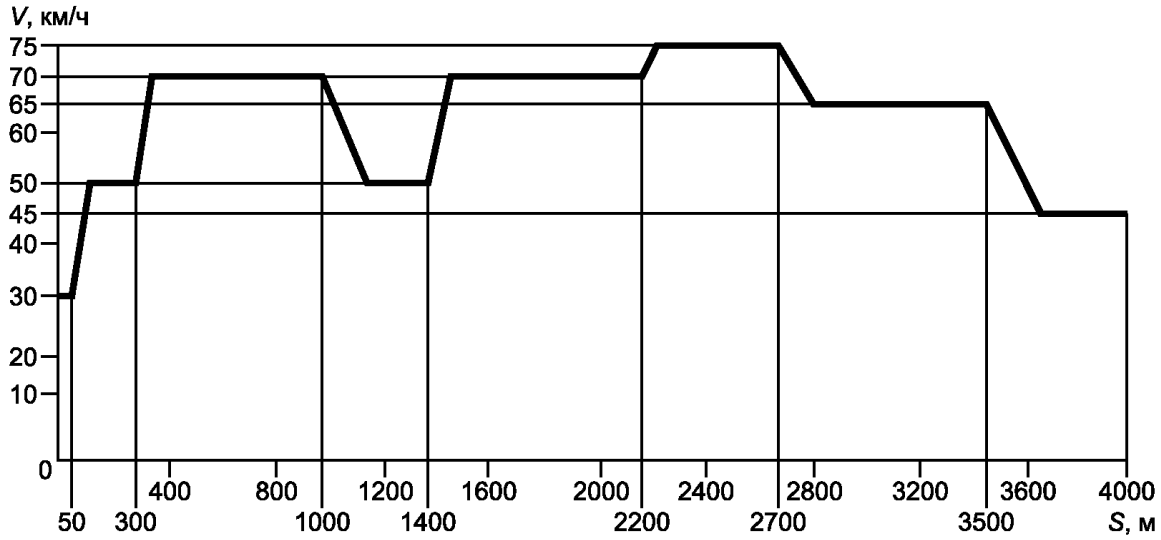


Figure 10.22: Urban driving cycle on road track, used for vehicles with loaded mass less than 3500 kg (GOST 20306-90, GOST P 54810-2011)

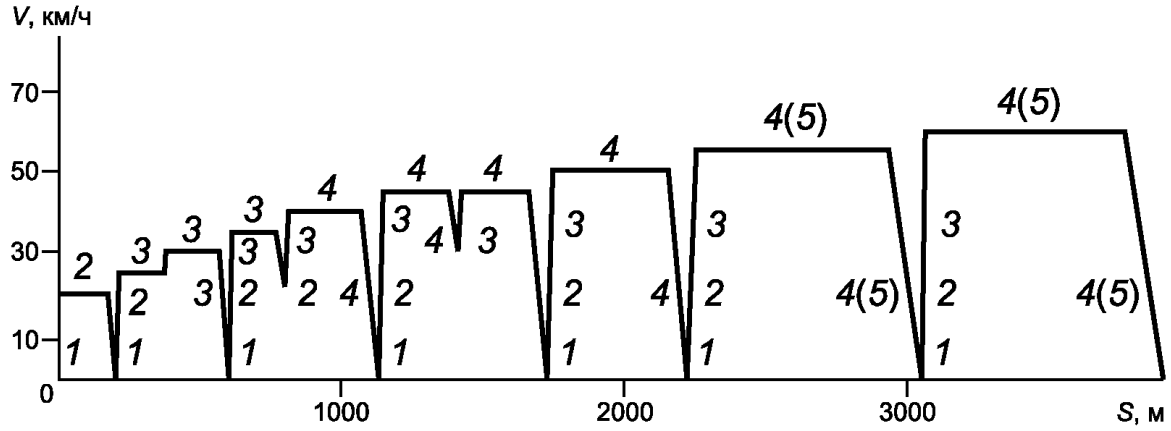


Figure 10.23: Urban driving cycle on road track, used for cargo vehicles with loaded mass more than 3500 kg (GOST 20306-90, GOST P 54810-2011)

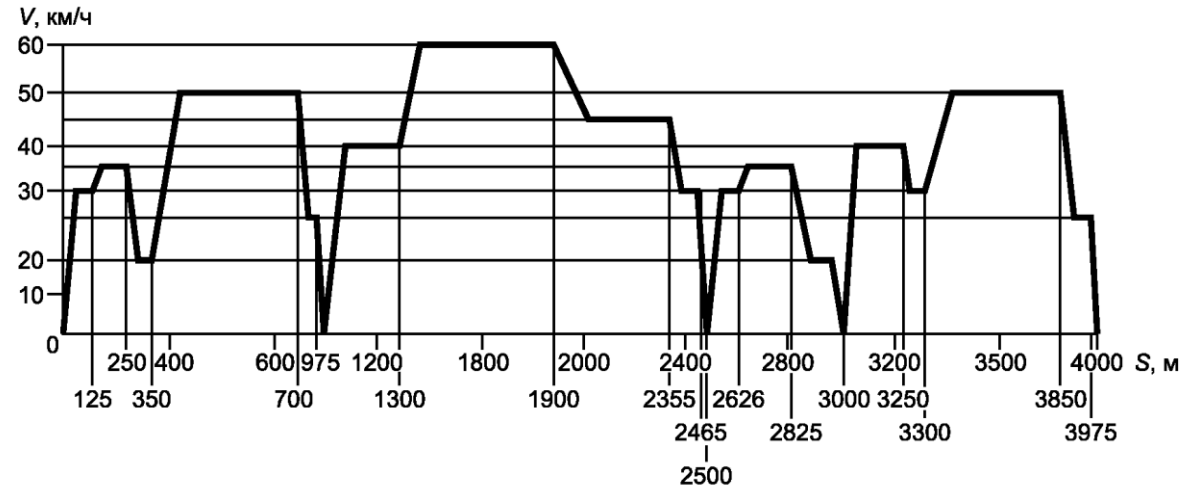


Figure 10.30: Urban driving cycle on road track, used for city buses (GOST 20306-90, GOST P 54810-2011)

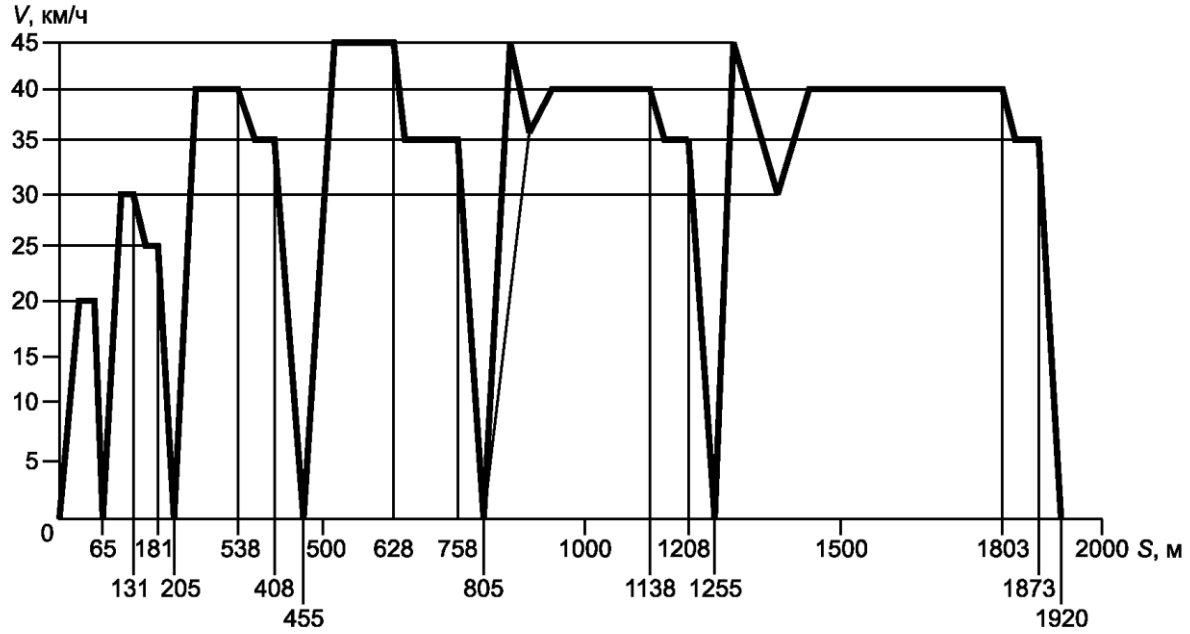
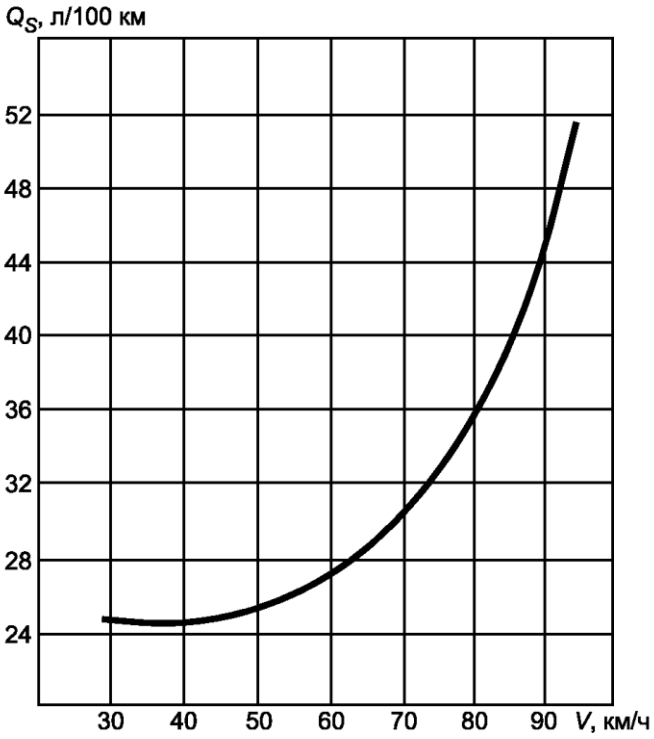


Figure 10.31: Steady-speed fuel consumption curve (on road track test) typical view (GOST 20306-90, GOST P 54810-2011)



10.3.1.3 P2Ws

Figure 10.24: Cycle part 1 of WMTC

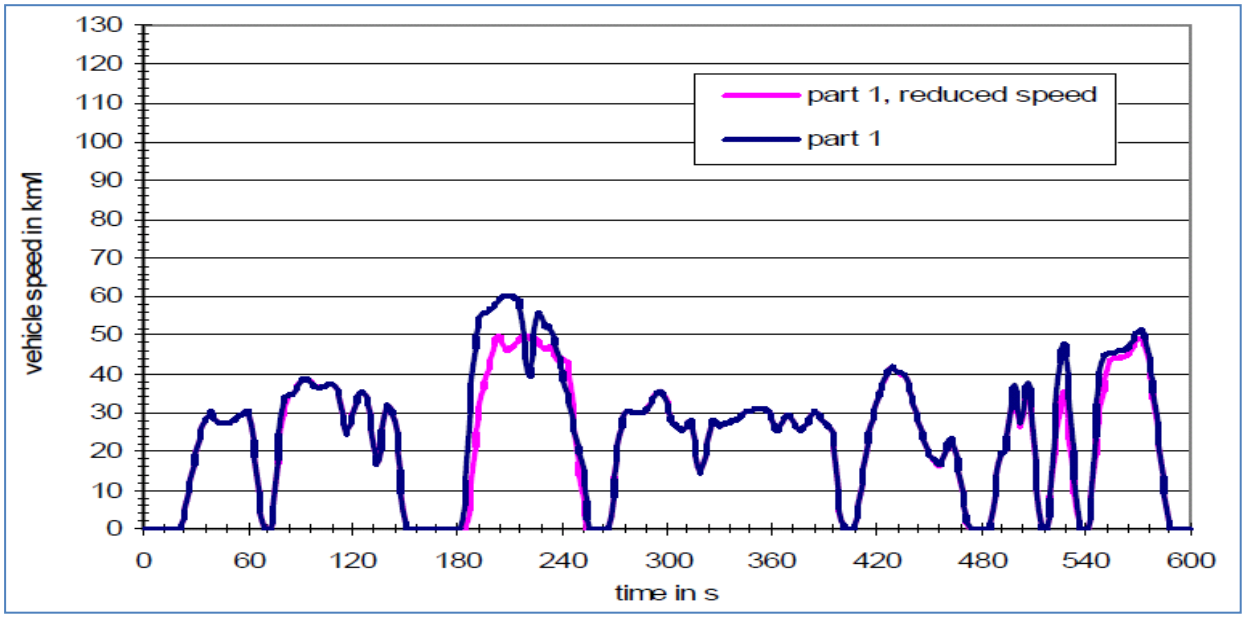


Figure 10.25: Cycle part 2 for vehicle classes 2 and 3 of WMTC

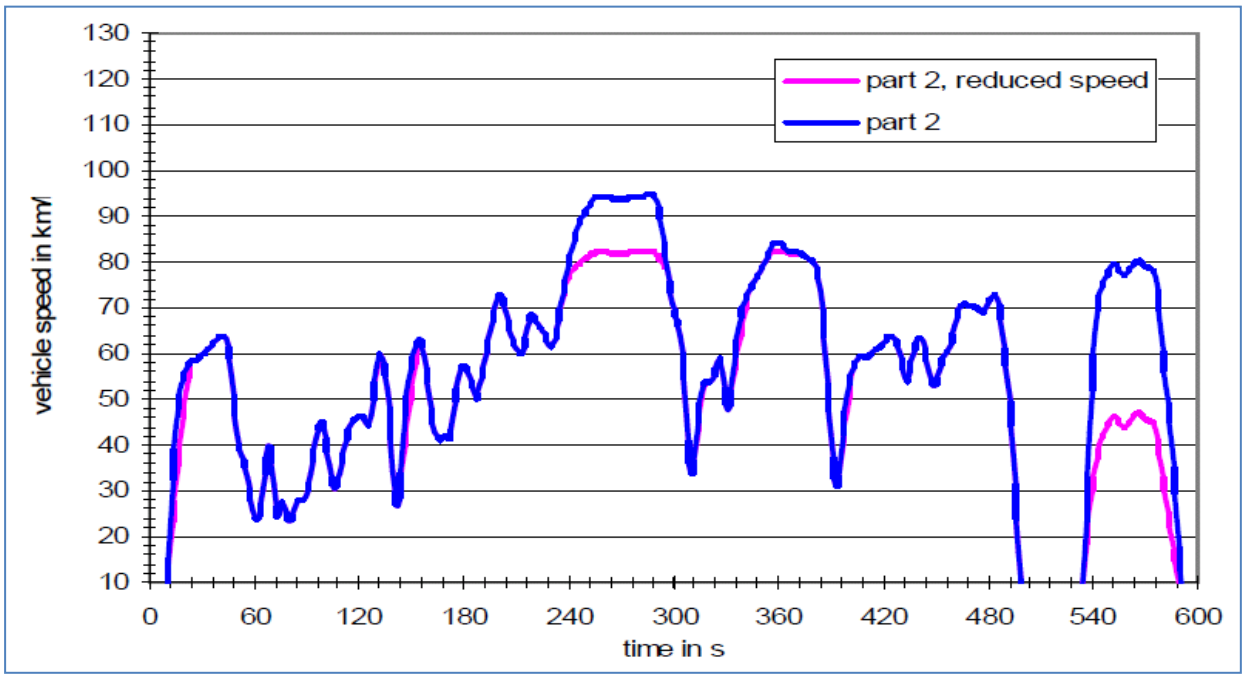
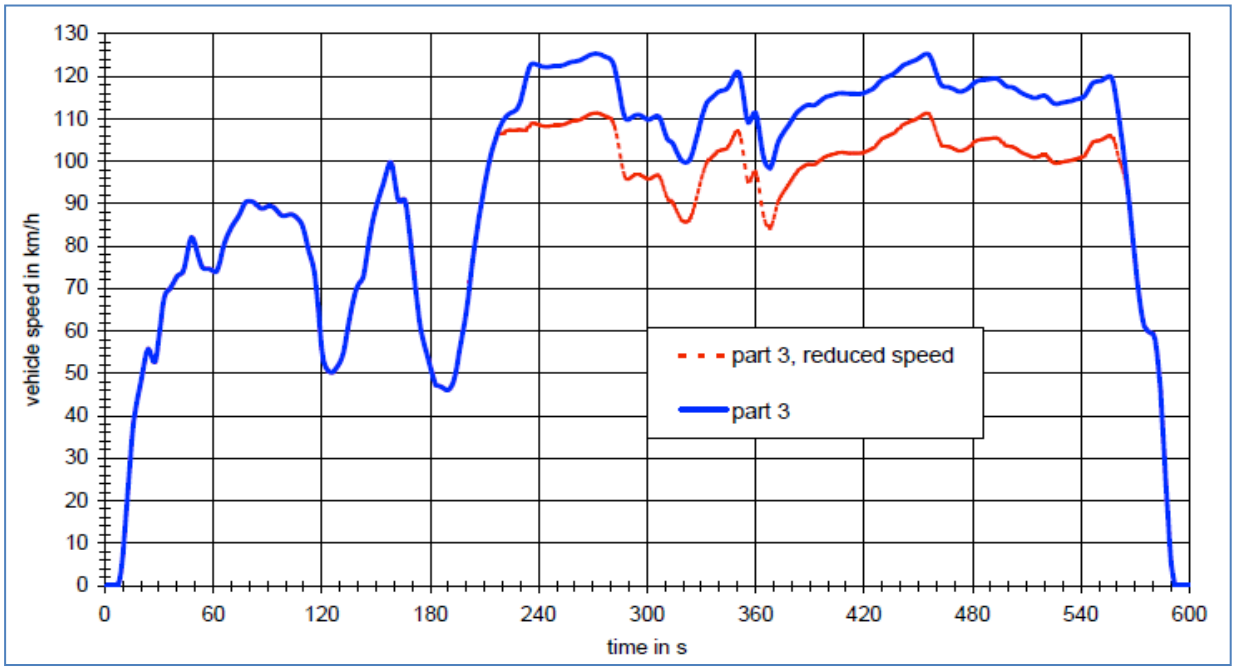


Figure 10.26: Cycle part 3 for vehicle class 3 of WMTC



10.4 Annex IV : Supporting material on the review of Ukraine legislation experience

Below is presented more detailed information regarding the excise duty and Customs tariff (import duty) in Ukraine.

10.4.1.1 Excise duty

The article 215 “Excisable goods and rates of tax” includes fuel and vehicles (the cars, exterior (body) to them, trailers and semi-trailers, motorcycles, vehicles designed to transport 10 or more persons, vehicles for the transport of goods – LDV as well as HDV).

The tax rate in fixed amount from the unit of the realized goods (products) for a motor vehicle designed for transportation of 10 persons and more, including the driver (except of motor vehicles noted in the commodity item code 8702 90 90) are:

- 0.003 Euro / per 1 cubic cm of the engine volume for all types;
- 0.007 Euro / per 1 cubic cm of the engine volume for all PI second-hand vehicles and also second-hand vehicles with diesels with engine volume less than 2500 cubic cm and more than 5000 cubic cm.

The tax rate in fixed amount from the unit of the realized goods (products) for passenger cars and other motor vehicles intended mainly for transportation of people (except motor vehicles, mentioned in the commodity position code 8702), including station wagons, racing cars, including cars which in accordance with legislation submitted to the bodies of internal affairs of Ukraine for the registration or renewal in connection with change of the vehicle model, which before conversion when importing answered code 8704, and after the conversion corresponds to commodity item code 8703 are stated in the Table 10.4.

Table 10.4: The tax rate for passenger cars and other motor vehicles intended mainly for transportation of people

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
8703	Cars and other motor vehicles intended mainly for transportation of people (except motor vehicles of code 8702), including station wagons and racing cars:	
8703 10	- vehicles specially designed for travelling on snow; special cars for transporting athletes to venues for golf and similar vehicles:	
8703 10 11 00	- special-purpose vehicles for travel on snow, with internal combustion engine with compression ignition or with the internal combustion engine with spark ignition	0.653 Euro per 1 CC of the engine volume
8703 10 18 00	- others	0.653 Euro per 1 CC of the internal combustion engine volume or 109.129 Euro for one piece of vehicle equipped with electric motor
	- other vehicles with internal combustion engine with spark ignition and crank mechanism:	
8703 21	- with a cylinder capacity of engine not more than 1000 CC:	
8703 21 10 00	- - - new	0.102 Euro per 1 CC of the engine volume
8703 21 90	- - - second-hand:	
8703 21 90 10	- - - - no more than five years	1.094 Euro per 1 CC of the engine volume
8703 21 90 30	- - - - more than five years	1.438 Euro per 1 CC of the engine volume
8703 22	- - with a cylinder capacity exceeding 1000 CC but not	

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
	exceeding 1500 CC:	
8703 22 10 00	- - - new	0.063 Euro per 1 CC of the engine volume
8703 22 90	- - - second-hand:	
8703 22 90 10	- - - - no more than five years	1.367 Euro per 1 CC of the engine volume
8703 22 90 30	- - - - more than five years	1.761 Euro per 1 CC of the engine volume
8703 23	- - with a cylinder capacity exceeding 1500 CC but not exceeding 3000 CC:	
	- - - new:	
8703 23 11	- - - - motor vehicles equipped for temporary accommodation of people:	
8703 23 11 10	- - - - - with cylinder capacity exceeding 1500 CC but not exceeding 2200 CC	0.327 Euro per 1 CC of the engine volume
8703 23 11 30	- - - - - with a cylinder capacity exceeding 2200 CC but not exceeding 3000 CC	1.316 Euro per 1 CC of the engine volume
8703 23 19	- - - - other:	
8703 23 19 10	- - - - - with cylinder capacity exceeding 1500 CC but not exceeding 2200 CC	0.267 Euro per 1 CC of the engine volume
8703 23 19 30	- - - - - with a cylinder capacity exceeding 2200 CC but not exceeding 3000 CC	0.276 Euro per 1 CC of the engine volume
8703 23 90	- - - second-hand:	
	- - - - with cylinder capacity exceeding 1500 CC but not exceeding 2200 CC:	
8703 23 90 11	- - - - - no more than five years	1.643 Euro per 1 CC of the engine volume
8703 23 90 13	- - - - - more than five years	2.441 Euro per 1 CC of the engine volume
	- - - - with a cylinder capacity exceeding 2200 CC but not exceeding 3000 CC:	
8703 23 90 31	- - - - - no more than five years	2.213 Euro per 1 CC of the engine volume
8703 23 90 33	- - - - - more than five years	4.985 Euro per 1 CC of the engine volume
8703 24	- - with a cylinder capacity exceeding 3000 CC:	
8703 24 10 00	- - - new	2.209 Euro per 1 CC of the engine volume
8703 24 90	- - - second-hand:	
8703 24 90 10	- - - - no more than five years	3.329 Euro per 1 CC of the engine volume
8703 24 90 30	- - - - more than five years	4.985 Euro per 1 CC of the engine volume
	- other vehicles with internal combustion engine with compression ignition:	
8703 31	- - with a cylinder capacity of engine not more than 1500 CC:	
8703 31 10 00	- - - new	0.103 Euro per 1 CC of the engine volume
8703 31 90	- - - second-hand:	
8703 31 90 10	- - - - no more than five years	1.367 Euro per 1 CC of the engine volume
8703 31 90 30	- - - - more than five years	1.761 Euro per 1 CC of the engine volume
8703 32	- - with a cylinder capacity exceeding 1500 CC but not exceeding 2500 CC:	
	- - - new:	
8703 32 11 00	- - - - motor vehicles equipped for temporary accommodation of people	0.327 Euro per 1 CC of the engine volume

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
8703 32 19 00	- - - - other	0.327 Euro per 1 CC of the engine volume
8703 32 90	- - - second-hand:	
8703 32 90 10	- - - - no more than five years	1.923 Euro per 1 CC of the engine volume
8703 32 90 30	- - - - more than five years	2.441 Euro per 1 CC of the engine volume
8703 33	- - with a cylinder capacity exceeding 2500 CC:	
	- - - new:	
8703 33 11 00	- - - - motor vehicles equipped for temporary accommodation of people	2.209 Euro per 1 CC of the engine volume
8703 33 19 00	- - - - other	2.209 Euro per 1 CC of the engine volume
8703 33 90	- - - second-hand:	
8703 33 90 10	- - - - no more than five years	2.779 Euro per 1 CC of the engine volume
8703 33 90 30	- - - - more than five years	4.715 Euro per 1 CC of the engine volume
8703 90	- other:	
8703 90 10 00	- - vehicles equipped with electric motors	109.129 Euro for 1 piece
8703 90 90 00	- - other	109.129 Euro for 1 piece

NOTE: The Law of Ukraine dated on May 31, 2016 No. 1389-VIII “On amendments to subsection 5 of section XX "Transitional provisions" of the Tax code of Ukraine concerning stimulation of development of the market of used vehicles” completely change tax rate in favour of used vehicles.
http://zakon3.rada.gov.ua/laws/show/1389-19
These changes make inefficient and impossible on practice almost any kind of energy efficiency or/and GHG emission regulation for mentioned categories of vehicles, taking in to account current economy situation in the country.

The tax rates for motor vehicles for the transport of goods are shown on the Table 10.5.

Table 10.5: The tax rates for motor vehicles for the transport of goods

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
8704	Motor vehicles for the transport of goods:	
8704 10	- dump trucks intended for use on the off-road:	
8704 10 10	- - with the internal combustion engine with compression ignition or with the internal combustion engine with spark ignition:	
8704 10 10 10	- - - the capacity over 75 t	0.016 Euro per 1 CC of the engine volume
8704 10 10 90	- - - other	0.016 Euro per 1 CC of the engine volume
8704 10 90	- - other:	
8704 10 90 10	- - - dump trucks weighing up to 5 t	0.01 Euro per 1 CC of the engine volume
8704 10 90 90	- - - other	0.01 Euro per 1 CC of the engine volume
	- other with the internal combustion engine with compression ignition:	
8704 21	- - with a gross vehicle weight not exceeding 5 t:	
	- - - - with a cylinder capacity exceeding 2500 CC:	
8704 21 31 00	- - - - - new	0.01 Euro per 1 CC of the engine

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
		volume
8704 21 39 00	- - - - - second-hand	0.02 Euro per 1 CC of the engine volume
	- - - - with a cylinder capacity of engine no more than 2500 CC:	
8704 21 91 00	- - - - - new	0.01 Euro per 1 CC of the engine volume
8704 21 99 00	- - - - - second-hand	0.02 Euro per 1 CC of the engine volume
8704 22	- - with gross vehicle weight over 5 tonnes but not exceeding 20 t:	
8704 22 91 00	- - - - new	0.013 Euro per 1 CC of the engine volume
8704 22 99 00	- - - - second-hand	0.026 Euro per 1 CC of the engine volume
8704 23	- - with gross vehicle weight over 20 tons:	
8704 23 91 00	- - - - new	0.016 Euro per 1 CC of the engine volume
8704 23 99 00	- - - - second-hand	0.033 Euro per 1 CC of the engine volume
	- other with the internal combustion engine with spark ignition:	
8704 31	- - with a gross vehicle weight not exceeding 5 t:	
	- - - - with a cylinder capacity exceeding 2800 CC	
8704 31 31 00	- - - - - new	0.01 Euro per 1 CC of the engine volume
8704 31 39 00	- - - - - second-hand	0.02 Euro per 1 CC of the engine volume
	- - - - with a cylinder capacity not exceeding 2800 CC:	
8704 31 91 00	- - - - - new	0.01 Euro per 1 CC of the engine volume
8704 31 99 00	- - - - - second-hand	0.020 Euro per 1 CC of the engine volume
8704 32	- - with gross vehicle weight over 5 tons:	
8704 32 91 00	- - - - new	0.013 Euro per 1 CC of the engine volume
8704 32 99 00	- - - - second-hand	0.026 Euro per 1 CC of the engine volume

Note: Tax rates for vehicles of code 8704 shall be applied for vehicles that have been used:

- with 5 to 8 years with a factor of 40;
- for vehicles that have been used for more than 8 years with a factor of 50

Tax rates for the car bodies (code 8707), noted in the product item code 8703 are:

- 218 Euro for 1 piece of new;
- 872 Euro for 1 piece of second-hand.

The tax rates for motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them are shown on the Table 10.6.

Table 10.6: The tax rates for motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them

Commodity position code	Goods description	The tax rate in fixed amount from the unit of the realized goods (products) (specific)
8711 10 00 00	Motorcycles (including mopeds) and bicycles with internal combustion engine with a crank mechanism and a cylinder capacity not exceeding 50 CC	0.062 Euro per 1 CC of the engine volume
8711 20	Motorcycles (including mopeds) and bicycles with internal combustion engine with a crank mechanism and a cylinder capacity exceeding 50 CC but not exceeding 250 CC	0.062 Euro per 1 CC of the engine volume
8711 30	Motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them; side-cars: with an internal combustion engine with a crank mechanism and a cylinder capacity exceeding 250 CC but not exceeding 500 CC	0.062 Euro per 1 CC of the engine volume
8711 40 00 00	Motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them, with piston engine ignition with a crank mechanism and a cylinder capacity exceeding 500 CC but not exceeding 800 CC	0.443 Euro per 1 CC of the engine volume
8711 50 00 00	Motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them, with piston engine ignition with a crank mechanism and a cylinder capacity over 800 CC	0.447 Euro per 1 CC of the engine volume
8711 90 00 00	Motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them, except those with a piston engine ignition with the crank gear; strollers	22 Euro for 1 piece

Customs tariff (import duty)

Annex to the Law of Ukraine "On Customs tariff of Ukraine" dated 19 September 2013 No. 584-VII contains Group 87 “Vehicles other than railway or tramway rolling stock, parts and equipment”.

Import duties are differentiated on different aspects in relatively complicated manner and showed in the Table 10.7.

Table 10.7: Import duties (April 2016 status)

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8701	Tractors (excluding tractors of code 8709):			
8701 10 00 00	- tractors, controlled by the driver, who goes next		10	10
8701 20	- road tractors for semi-trailers:			
8701 20 10 00	- - new		0	0
8701 20 90 00	- - second-hand		10	10
8701 30 00 00	- crawler tractors		0	0
8701 90	- other:			
	- - tractors for agricultural work (in addition to tractors, controlled by the driver, who goes next) and forestry tractors, wheeled:			
	- - - new, with the power of the engine:			
8701 90 11 00	- - - - no more 18 kW		0	0
8701 90 20	- - - - more 18 kW, but no more 37 kW:			
8701 90 20 10	- - - - - more 18 kW, but no more 25 kW		10	10
8701 90 20 30	- - - - - more 25 kW, but no more 37 kW		0	0
8701 90 25 00	- - - - more 37 kW, but no more 59 kW		10	10

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8701 90 31 00	- - - - more 59 kW, but no more 75 kW		10	10
8701 90 35 00	- - - - more 75 kW, but no more 90 kW		0	0
8701 90 39 00	- - - - more 90 kW		0	0
8701 90 50 00	- - - second-hand		10	10
8701 90 90 00	- - other		0	0
8702	A motor vehicle designed for transportation of 10 persons and more, including the driver:			
8702 10	- with the internal combustion engine with compression ignition :			
	- - with a working volume of cylinders of the engine more 2500 CC:			
8702 10 11	- - - new:			
8702 10 11 10	- - - - with a working volume of cylinders of the engine no more 5000 CC		10	10
8702 10 11 30	- - - - with a working volume of cylinders of the engine more 5000 CC		20	20
8702 10 19	- - - second-hand:			
8702 10 19 10	- - - - with a working volume of cylinders of the engine no more 5000 CC		10	10
8702 10 19 90	- - - - with a working volume of cylinders of the engine more 5000 CC		20	20
	- - with a working volume of cylinders of the engine no more 2500 CC:			
8702 10 91 00	- - - new		10	10
8702 10 99 00	- - - second-hand		10	10
8702 90	- other:			
	- - with the internal combustion engine with spark ignition:			
	- - - with a working volume of cylinders of the engine more 2800 CC:			
8702 90 11 00	- - - - new		10	10
8702 90 19 00	- - - - second-hand		10	10
	- - - with a working volume of cylinders of the engine no more 2800 CC:			
8702 90 31 00	- - - - new		10	10
8702 90 39 00	- - - - second-hand		10	10
8702 90 90	- - with the engine of another type:			
8702 90 90 10	- - - trolleybuses		15	15
8702 90 90 90	- - - other		10	10
8703	Cars and other motor vehicles intended mainly for transportation of people (except motor vehicles of heading 8702), including station wagons and racing cars:			
8703 10	- vehicles specially designed for travelling on snow; special cars for transporting athletes to venues for golf and similar vehicles:			
8703 10 11 00	- - special purpose vehicles for traveling over snow, with the internal combustion engine with compression ignition or with the internal combustion engine with spark ignition		12	12
8703 10 18 00	- - other		12	12
	- other vehicle with the internal combustion engine with spark ignition and with a crank mechanism:			
8703 21	- - with a working volume of cylinders of the engine no more 1000 CC:			
8703 21 10 00	- - - new		10	10
8703 21 90	- - - second-hand:			
8703 21 90 10	- - - - not more than 5 years		10	10
8703 21 90 30	- - - - more 5 years		10	10
8703 22	- - with a working volume of cylinders of the engine more 1000 CC, but no more1500 CC:			

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8703 22 10 00	- - - new		10	10
8703 22 90	- - - second-hand:			
8703 22 90 10	- - - - not more than 5 years		10	10
8703 22 90 30	- - - - more 5 years		10	10
8703 23	- - with a working volume of cylinders of the engine more 1500 CC, but no more 3000 CC:			
	- - - new:			
8703 23 11	- - - - motor vehicles equipped for temporary accommodation of people:			
8703 23 11 10	- - - - - with cylinder capacity more 1500 CC, but no more 2200 CC		5	10
8703 23 11 30	- - - - - with cylinder capacity more 2200 CC, but no more 3000 CC		5	10
8703 23 19	- - - - other:			
8703 23 19 10	- - - - - with cylinder capacity more 1500 CC, but no more 2200 CC		10	10
8703 23 19 30	- - - - - with cylinder capacity more 2200 CC, but no more 3000 CC		10	10
8703 23 90	- - - second-hand:			
	- - - - with cylinder capacity more 1500 CC, but no more 2200 CC:			
8703 23 90 11	- - - - - not more than 5 years		10	10
8703 23 90 13	- - - - - more 5 years		10	10
	- - - - with cylinder capacity more 2200 CC, but no more 3000 CC:			
8703 23 90 31	- - - - - not more than 5 years		10	10
8703 23 90 33	- - - - - more 5 years		10	10
8703 24	- - with a working volume of cylinders of the engine more 3000 CC:			
8703 24 10 00	- - - new		5	10
8703 24 90	- - - second-hand:			
8703 24 90 10	- - - - not more than 5 years		10	10
8703 24 90 30	- - - - more 5 years		10	10
	- other vehicle with the internal combustion engine with compression ignition :			
8703 31	- - with a working volume of cylinders of the engine no more 1500 CC:			
8703 31 10 00	- - - new		10	10
8703 31 90	- - - second-hand:			
8703 31 90 10	- - - - not more than 5 years		10	10
8703 31 90 30	- - - - more 5 years		10	10
8703 32	- - with a working volume of cylinders of the engine more 1500 CC, but no more 2500 CC:			
	- - - new:			
8703 32 11 00	- - - - motor vehicles equipped for temporary accommodation of people		10	10
8703 32 19 00	- - - - other		10	10
8703 32 90	- - - second-hand:			
8703 32 90 10	- - - - not more than 5 years		10	10
8703 32 90 30	- - - - more 5 years		10	10
8703 33	- - with a working volume of cylinders of the engine more 2500 CC:			
	- - - new:			
8703 33 11 00	- - - - motor vehicles equipped for temporary accommodation of people		10	10
8703 33 19 00	- - - - other		10	10
8703 33 90	- - - second-hand:			

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8703 33 90 10	- - - - not more than 5 years		10	10
8703 33 90 30	- - - - more 5 years		10	10
8703 90	- other:			
8703 90 10	- - vehicle, equipped with electric motors:			
8703 90 10 10	- - - vehicle equipped with only the electric motors (one or more)		0	0
8703 90 10 90	- - - other		8	10
8703 90 90 00	- - other		10	10
8704	Motor vehicles for the transport of goods:			
8704 10	- dump trucks intended for use on the off-roads:			
8704 10 10	- - with the internal combustion engine with compression ignition or with the internal combustion engine with spark ignition:			
8704 10 10 10	- - - capacity more 75 t		0	0
8704 10 10 90	- - - other		0	0
8704 10 90	- - other:			
8704 10 90 10	- - - dump trucks weighing up to 5 t		0	0
8704 10 90 90	- - - other		0	0
	- other with the internal combustion engine with compression ignition :			
8704 21	- - with full weight of vehicle no more 5 t:			
8704 21 10 00	- - - designed specifically for the transport of highly radioactive substances		10	10
	- - - other:			
	- - - - with a working volume of cylinders of the engine more 2500 CC:			
8704 21 31 00	- - - - - new		10	10
8704 21 39 00	- - - - - second-hand		10	10
	- - - - with a working volume of cylinders of the engine no more2500 CC:			
8704 21 91 00	- - - - - new		10	10
8704 21 99 00	- - - - - second-hand		10	10
8704 22	- - with full weight of vehicle more 5 t, but no more 20 t:			
8704 22 10 00	- - - designed specifically for the transport of highly radioactive substances		10	10
	- - - other:			
8704 22 91 00	- - - - new		10	10
8704 22 99 00	- - - - second-hand		10	10
8704 23	- - with full weight of vehicle more 20 t:			
8704 23 10 00	- - - designed specifically for the transport of highly radioactive substances		10	10
	- - - other:			
8704 23 91 00	- - - - new		10	10
8704 23 99 00	- - - - second-hand		10	10
	- other with the internal combustion engine with spark ignition:			
8704 31	- - with full weight of vehicle no more 5 t:			
8704 31 10 00	- - - designed specifically for the transport of highly radioactive substances		5	5
	- - - other:			
	- - - - with a working volume of cylinders of the engine more 2800 CC:			
8704 31 31 00	- - - - - new		5	5
8704 31 39 00	- - - - - second-hand		5	5
	- - - - with a working volume of cylinders of the engine no more 2800 CC:			
8704 31 91 00	- - - - - new		5	5

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8704 31 99 00	- - - - - second-hand		5	5
8704 32	- - with full weight of vehicle more 5 t:			
8704 32 10 00	- - - designed specifically for the transport of highly radioactive substances		10	10
	- - - other:			
8704 32 91 00	- - - - new		10	10
8704 32 99 00	- - - - second-hand		10	10
8704 90 00 00	- other		10	10
8705	Motor vehicles for special purpose, except designed primarily for the transport of persons or goods (for example, trucks for emergency repairs, cranes, trucks, fire engines, paints, cars for cleaning roads, watering cars, trucks, vans radiology):			
8705 10 00 00	- cranes		10	10
8705 20 00 00	- auto drilling		10	10
8705 30 00	- fire-fighting vehicles:			
8705 30 00 10	- - with the lift or the stairs		5	5
8705 30 00 90	- - other		10	10
8705 40 00 00	- auto mixer		10	10
8705 90	- other:			
8705 90 30 00	- - the machine is equipped with a concrete pump		5	5
8705 90 80	- - other:			
8705 90 80 10	- - - the special purpose vehicles for mobile television and sound stations		5	5
8705 90 80 90	- - - other		5	5
8706 00	Chassis fitted with engines for vehicles of headings 8701-8705:			
	- chassis for tractors of heading 8701; chassis for motor transportation means of commodity position 8702, 8703 or 8704 with an internal combustion engine with compression ignition, of a cylinder capacity exceeding 2500 CC or with an engine of internal combustion with spark ignition with a cylinder capacity exceeding 2800 CC:			
8706 00 11 00	- - for motor vehicles of heading 8702 or 8704		0	0
8706 00 19 00	- - other		10	10
	- other:			
8706 00 91	- - for motor vehicles of heading 8703:			
8706 00 91 10	- - - for the industrial assembly of motor vehicles		0	0
8706 00 91 90	- - - other		5	5
8706 00 99 00	- - other		0	0
……	……..			
8711	Motorcycles (including mopeds) and bicycles with auxiliary engine, with carriages or without them; strollers:			
8711 10 00 00	- with the internal combustion engine with a crank mechanism and a cylinder capacity of engine no more 50 CC		10	10
8711 20	- with the internal combustion engine with a crank mechanism and a cylinder capacity of engine more 50 CC, but no more 250 CC:			
8711 20 10 00	- - scooters		10	10
	- - other, with cylinder capacity:			
8711 20 92 00	- - - more 50 CC, but no more 125 CC		10	10
8711 20 98 00	- - - more 125 CC, but no more 250 CC		10	10
8711 30	- with the internal combustion engine with a crank mechanism and a cylinder capacity of engine more 250 CC, but no more 500 CC:			

Code	Goods description	Duty rate, %		
		pref.	gr.	full
8711 30 10 00	- - with cylinder capacity more 250 CC, but no more 380 CC		10	10
8711 30 90 00	- - with cylinder capacity more 380 CC, but no more 500 CC		10	10
8711 40 00 00	- with the internal combustion engine with a crank mechanism and a cylinder capacity of engine more 500 CC, but no more 800 CC		10	10
8711 50 00 00	- with the internal combustion engine with a crank mechanism and a cylinder capacity of engine more 800 CC		10	10
8711 90	- other:			
8711 90 10 00	- - bicycles with auxiliary electric motor with a rated capacity of no more 250 W		10	10
8711 90 90 00	- - other		10	10

10.4.1.2 The Concept of the State target economic program of development of road transport

The Concept of the State target economic program of development of road transport for the period up to 2015 has been developed and was finally approved by the decree of the Cabinet of Ministers of Ukraine dated 03.08.2011 No. 732-R. The Concept is focused on the problems identified above, with the following definitions and description of the general situation in the sector.

- *"Road transport plays an important role in the socio-economic development of the country. Today, more than 100 thousand motor carriers provide transportation services 52 percent of passengers and 64 percent of the cargo".*
- *"Road transport as a whole meets the needs of the national economy and population in the transportation, however, the structure of the fleet of buses and trucks is imperfect, most vehicles in its design, capacity, capacity, types of body parameters of comfort, and the specific fuel consumption, environmental indicators do not meet modern requirements".*
- *"The renewal of rolling stock of road transport is slow - almost 70 percent of the rolling stock is technically and/or outdated, and 50 percent of the buses are operated more than 10 years".*
- *"Another outstanding problem is the compensation of revenue loss of motor carriers in connection with the carriage of privileged categories of citizens, as well as the determination of the actual amount of such losses".*
- *"Imperfect is the system of organization of international transport of passengers and goods by road transport".*
- *"In addition, the emissions of harmful substances carried by road transport, is 95 percent of the emissions are from all mobile sources of pollution" (here it is means urban pollution contribution).*

  The main causes of problems in accordance with the Concept are:

  - *the imperfection of the legislation concerning the regulation of motor carriers and other business entities that provide safe transportation of passengers and cargo, as well as the system of state control over compliance with requirements of legislation on road transport;*
  - *insufficient funding of the costs associated with the provision of socially important services, at the expense of budget funds;*
  - *the lack of a systematic approach to ensure the functioning of the road transport, the creation of a competitive environment in the market of transport services.*

  It was stated that this "complex problem can be solved through the development, adoption and implementation of the State target economic program of development of road transport for the period till 2015".

  But such a program do not approved yet with the main reason related to absence of funding sources or funding mechanisms.

  The purpose of such a future Program is defined as "to modernize the provision of road transport services by improving the quality and safety of transportation of passengers and cargo, creating a competitive environment in the market of transport services, improving the sustainability and energy efficiency of vehicles, development of infrastructure road transport".

The main options for solving these problems are also defined as follows within the Concept.

"To solve the problem, we must:

to improve the system of state management in the road transport industry, to improve the quality and level of safety of transportation of passengers and goods by:

- ensuring coordination of the Program with the Transport strategy of Ukraine for the period till 2020;
- determination of the mechanism of provision of socially important services, particularly services for passengers in rural areas;
- settlement of relations between the Executive authorities and road carriers, the owners of the stations, entities engaged in freight forwarding activities;
- development of rules of transportation of passengers in taxi licensing conditions for carrying out such activity, accounting of vehicles equipped to work as a taxi;
- optimization of the structure of buses fleet in major cities and industrial centers;
- the creation of a competitive environment in the market of transport services, the preservation and creation of new jobs;
- optimization of the network of bus routes;
- creation of a system of compulsory insurance against accidents in the transport of passengers and cargo;
- determining mechanism for the admission of entities to the implementation of economic activity on the market of services on transportation of passengers and cargo;

to improve the system of regulation of motor carriers by:

- determining mechanism settlements for the carriage of passengers on the city's bus routes messages;
- development and implementation of a mechanism for separate categories of citizens targeted assistance for concessionary travel by road;
- creation of conditions for renewal of motor carriers rolling stock intended for in the first place, social services and optimizing the structure of the vehicle fleet;
- introduction of new technologies and creation of information systems;
- to improve the security of transportation of passengers and goods by: tightening requirements for motor carriers and ensure control over compliance with requirements of legislation on road safety;
- improving the system of training, retraining and advanced training of personnel of motor transport;
- increased security requirements, design and technical condition of the vehicle;
- development in accordance with the European regulations on the regime of work and rest of drivers of vehicles;

to improve the system of technical regulation of admission to operation of vehicles and the provision of services on transportation of passengers and cargo by identifying with the requirements of international legislation and procedures for the conformity of construction and technical condition of the vehicle, the provision of services for maintenance and repair of vehicles, passengers and cargo;

to increase the level of environmental friendliness and energy efficiency of vehicles by:

- use vehicles alternative fuels;
- based on the experience of EU control over compliance of vehicles and fuel to the established requirements;
- creation of the research and testing centre of motor transport;
- introduction of environmental standards Euro-3 Euro - 5" for vehicles;

- determining mechanism to encourage the use of alternative fuels, in particular biofuels;
- the strengthening of state control over the quality of fuels and lubricants;

to develop regulations on the management of transportation of passengers and cargo, regulation of the transport market, the admission of entities to the market of services on transportation of passengers and cargo, security, traffic, transit traffic, tightening environmental requirements.

The Program should provide:

- "improving the efficiency, quality and safety of transportation of passengers and cargo;
- provision of services on transportation of passengers in rural areas and persons with disabilities;
- *a reduction of 10 percent of the specific consumption of fuel and other energy resources*;
- reducing the harmful effects of road transport on the environment;
- develop of effective competition on the market of services on transportation of passengers and cargo".

The Program is being funded through the state budget and other sources not prohibited by legislation. The estimated funding for the Program is 57,900 million UAH (~€2.05 billion), including: 2500 million UAH (~€88.6 million) at the expense of the state budget , 55400 million UAH (~€1.96 billion) other sources .