Procuring clean and efficient road vehicles

Clean Fleets Guide

Date of Publication: November 2014

Source: Viorel Sima, Dreamstime

Authors: Simon Clement, Natalie Evans (ICLEI – Local Governments for Sustainability)

Contributions & acknowledgements: Clean Fleets project partners (TTR, City of Stockholm, City of Bremen, Transport for London, City of Rotterdam, City of Palencia, TÜV Nord, URTP, Zagreb Holding, VAG Freiburg, ISIS, City of Sofia), Giles Liddell (Bristol City Council), Orlando Redondo Alvarez (EREN), Mike White (Birmingham City Council), Geert Wijnen (EV Consult), Helena Hečimović (City of Koprivnice), Luis Manuel Echaniz Gil (Province of Alava), Esmeralda Llanos Martín (EMT Madrid), Ruben van Doorn (INNIMO)

Contents

Glossary

BEV	Battery electric vehicle
CNG	Compressed natural gas
CoC	Certificate of Conformity
CVD	Clean Vehicles Directive (Directive 2009/33/EC on the Promotion of Clean and Energy Efficient Road Transport Vehicles)
GPP	Green public procurement
GWP	Global Warming Potential
HDV	Heavy duty vehicle
HEV	Hybrid electric vehicle
HVO	Hydrogenated vegetable oil
ICE	Internal Combustion Engines
ILUC	Indirect land use change
LCC	Life cycle costing
LDV	Light duty vehicle
LPG	Liquefied petroleum gas
NEDC	New European Driving Cycle
NMHC	Non-methane hydrocarbons
NO_x	Mono-nitrogen oxides, which includes both NO (nitric oxide) and NO_2 (nitrogen dioxide)
OEM	Original equipment manufacturer
OLC	Operational lifetime cost
PHEV	Plug-in hybrid electric vehicle
PM	Particulate matter
TCO	Total cost of ownership
TTW	Tank to wheel
VED	Vehicle Excise Duty
WHTC/WHSC	World harmonized transient cycle/stationary cycle
WTW	Well to wheel

1. Introduction – why procure clean vehicles?

Local governments and public transport operators across Europe are increasingly looking at alternatives to traditional petrol and diesel vehicles for their fleets – whether vehicles are directly owned, or operated by subsidiaries or other private companies that carry out public services (such as public transport or waste collection). Hybrid, full electric, gas or biofuel-driven vehicles, for example, are being considered for a range of reasons:

- **Climate change** – The transport section is responsible 25% of total greenhouse gas emissions. [1] Meeting CO_2 reduction targets requires local governments to reduce the emissions of public fleets.

- **Air quality** - Vehicles also have a major impact on local air quality in Europe's towns and cities – they emit significant quantities of NO_x, NMHC, and PM which have been linked to a range of health and environmental problems. In 2012, 11 Member States breached limits set under the National Emission Ceilings Directive - the most common pollutant being NO_x, with nine Member States exceeding designated levels[2] At the city level, NO_x is repeatedly cited as a particular local air pollution issue.

- **Creating a market for alternatively-fuelled vehicles** – Policy makers at the European and national level recognise the importance of public sector demand in helping to boost the market for cleaner and more energy efficient vehicles. At the European level, the **Clean Vehicles Directive** (CVD)[3] has been introduced to encourage the broad market introduction of more environmentally friendly vehicles. It obliges public authorities to take certain environmental factors into account when purchasing road vehicles.

- **Example setting** – Public authorities play an important role in setting an example for private citizens and companies. Employing alternatively fuelled vehicles for public transport and other highly visible public services can help encourage others to think of this option

- **Fuel security** – There is growing concern about European reliance on oil imports, and the vehicles sector is amongst the most dependent of all. Finding large scale alternatives to petrol and diesel is a political priority.

Purpose of the guide

This guide is designed to assist public authorities and public transport operators in purchasing clean and energy efficient vehicles in full compliance with European legislation – in particular the Clean Vehicles Directive (CVD)[4]. It is primarily targeted at procurers and fleet

---

[1] http://ec.europa.eu/clima/policies/transport/index_en.htm

[2] http://www.eea.europa.eu/highlights/eleven-countries-exceed-air-pollutant

[3] Directive 2009/33/EC on the Promotion of Clean and Energy Efficient Road Transport Vehicles

[4] Directive 2009/33/EC on the Promotion of Clean and Energy Efficient Road Transport Vehicles

managers, but will also be of relevance to policy makers and others involved in the transport sector.

The guide presents how environmental criteria can be introduced into the different stages of procurement procedures, together with information on life cycle costing (LCC) and other relevant topics. The information presented is complemented by various real-life examples from European public authorities.

It has been produced by the Clean Fleets project (www.clean-fleets.eu) – Clean Fleets is funded by the Intelligent Energy Europe Programme of the European Union which assists public authorities and fleet operators with the procurement or leasing of clean and energy-efficient vehicles and the implementation of the Clean Vehicles Directive (CVD).

For further advice on clean vehicle procurement please write to info@clean-fleets.eu.

2. Compliance with the Clean Vehicles Directive

The Clean Vehicles Directive (CVD)[5] requires public purchasers and private companies operating public transport services to consider energy consumption and environmental impacts when purchasing and leasing road vehicles. The Directive is transcribed into the national legislation of all EU member states.

To comply with the Directive purchasers must take the all of the following aspects into account as part of their purchasing decision[6]:

- Energy consumption
- CO_2 emissions
- NO_x[7]
- NMHC (non-methane hydrocarbons)
- Particulate matter (PM)

2.1. Scope of application

The Directive applies to contracts for the purchase of road transport vehicles by:

a) contracting authorities or contracting entities obliged to follow the procurement procedures set out in the old Public Procurement Directives (2004/17/EC and 2004/18/EC[8]). For example:

- A public authority tendering for vehicles for their employees car fleet
- A public authority directly purchasing waste trucks and other utility vehicles

b) private operators of public transport services, which are performing public service obligations under a public service contract (as those terms are defined in Regulation (EC) No 1370/2007) ("public service operators"). This group will primarily be bus operators purchasing vehicles to provide a service under contract with a public authority.

---

[5] Directive 2009/33/EC on the Promotion of Clean and Energy Efficient Road Transport Vehicles

[6] Emissions of CO_2, NO_x, NMHC and PM are considered in relation to the operation of the vehicle only – i.e. emissions from fuel combustion in the vehicle ("tank to wheel"). The origin of the fuel (for example biogas or biodiesel rather than natural gas or diesel) is not considered (as it would be in a "well to wheel" approach), see section 2.4.

[7] Mono-nitrogen oxides, which includes both NO (nitric oxide), NO_2 (nitrogen dioxide) and NO_3 (nitrogen trioxide)

[8] In January 2014, the European Parliament adopted new public procurement directives:

- Directive 2014/24/EU (which replaces the 'Classic' Procurement Directive 2004/18/EC)
- Directive 2014/25/EU (which replaces the 'Utilities' Procurement Directive 2004/17/EC)
- Directive 2014/23/EU on the award of concession contracts

"Road transport vehicles" include cars and light commercial vehicles, buses, and heavy vehicles such as trucks or refuse trucks. Vehicles running on tracks (such as trams and trains) are excluded.

Certain specialist road vehicles are excluded from the Directive. The precise vehicles excluded will vary according to Member State, and so national legislation implementing the CVD should be checked. This may include for example vehicles designed for use by the armed services, civil defence, or fire services, vehicles designed for use on construction sites, or mobile machinery.

Whilst not specifically covered by the Directive, public authorities may wish to additionally apply a similar approach where vehicles will be operated on behalf of the purchasing authority by a third party under a contract for services other than public transport – for example highway maintenance or transport for vulnerable groups such as the elderly. See section 2.4 below.

2.2. Options for implementation

Organisations required to take energy and environmental impacts into account under the CVD can do so in three ways[9]. They can either use:

- **Option 1** – Set **technical specifications** for energy and environmental performance in the documentation for the procurement of road transport vehicles;
- **Option 2** – Include energy and environmental impacts in the purchasing decision by using these impacts as **award criteria** as part of a procurement procedure;
- **Option 3** – Include energy and environmental impacts in the purchasing decision by monetising them and calculating an "**operational lifetime cost**" (OLC) in accordance with set methodology provided within the Directive (also known as the "harmonised methodology").
- A combination of these options

When using option 1 or 2, the CVD does not set any specific minimum specifications for environmental performance, or minimum weighting for the award criteria – these may be determined by the individual purchasing organisation. When using option 3, the precise methodology of the CVD must be followed.

The following sections present more in-depth information on how to use these options in vehicle procurement. Annexes 1 and 2 provide a detailed description of how to apply option 3 (OLC) together with a full worked example.

[9] Some EU countries have restricted which of the above methodologies may be used - Sweden allows only options 1 and 3, the Czech Republic allows only options 1 and 2, Slovenia only allows option 2.

2.3. Notes on CVD application:

- Although fuel consumption and CO_2 emissions are very closely linked, they need to be addressed separately to ensure full compliance with the Directive.

- If an authority specifically requests a zero or very low tailpipe emissions technology (e.g. full electric or hydrogen), then emissions of CO_2 and other harmful emissions would not need to be assessed again when tendering, as these are implicitly being considered. Energy consumption would still need to be addressed however. Furthermore, although not necessary for compliance with the Directive, when purchasing an electric or hydrogen vehicle the purchasing authority must also take into account how the electricity or hydrogen is produced to be sure of the full well to wheel CO_2 benefits (see section 2.4).

- It is possible to consider the environmental aspects in the CVD either at the individual vehicle level or as an average for the whole number of vehicles being purchased. If, for example, an authority is replacing a large number of fleet vehicles, it may set a maximum CO_2 emissions level (or fuel consumption level, or Euro standard) as an average for the whole purchase – i.e. some vehicles may have higher emissions, and some lower, but the average does not exceed the maximum level set.

- Specifying minimum Euro Emissions Standards (for Light Duty Vehicles[10] or Heavy Duty Vehicles[11]) does not in itself constitute compliance with the CVD, as neither CO_2 emissions nor energy consumption levels are considered.

If you have questions about the applicability of the Directive or options for implementation in your case, please send an email to info@clean-fleets.eu.

2.4. Service providers not covered by the CVD

Many services operated on behalf of a public authority by a private company involve the significant use of vehicles in their provision, for example:

- Highway maintenance,
- Waste collection,
- Taxi/transportation services for groups such as the elderly or disabled.

Public authorities may also play a role in licensing companies, for example, providing private taxi services.

Although none of these activities are specifically covered by the CVD, they provide the public authority responsible with a significant opportunity to promote the use of clean and energy efficient vehicles within their jurisdiction.

[10] www.dieselnet.com/standards/eu/ld.php

[11] www.dieselnet.com/standards/eu/hd.php

When tendering for service contracts, where vehicle usage is a key element in service delivery, public authorities may select to set conditions for, or establish competition around the vehicles used in carrying out the service, as well as conditions relating to driver training, maintenance and fuel consumption monitoring. When licensing taxi operations minimum environmental performance conditions may also be set.

An example of such a tender for waste collection services, translating council-wide carbon reduction targets effectively into a procurement procedure can be found here.

2.5. Well to wheel (WTW) vs tank to wheel (TTW)

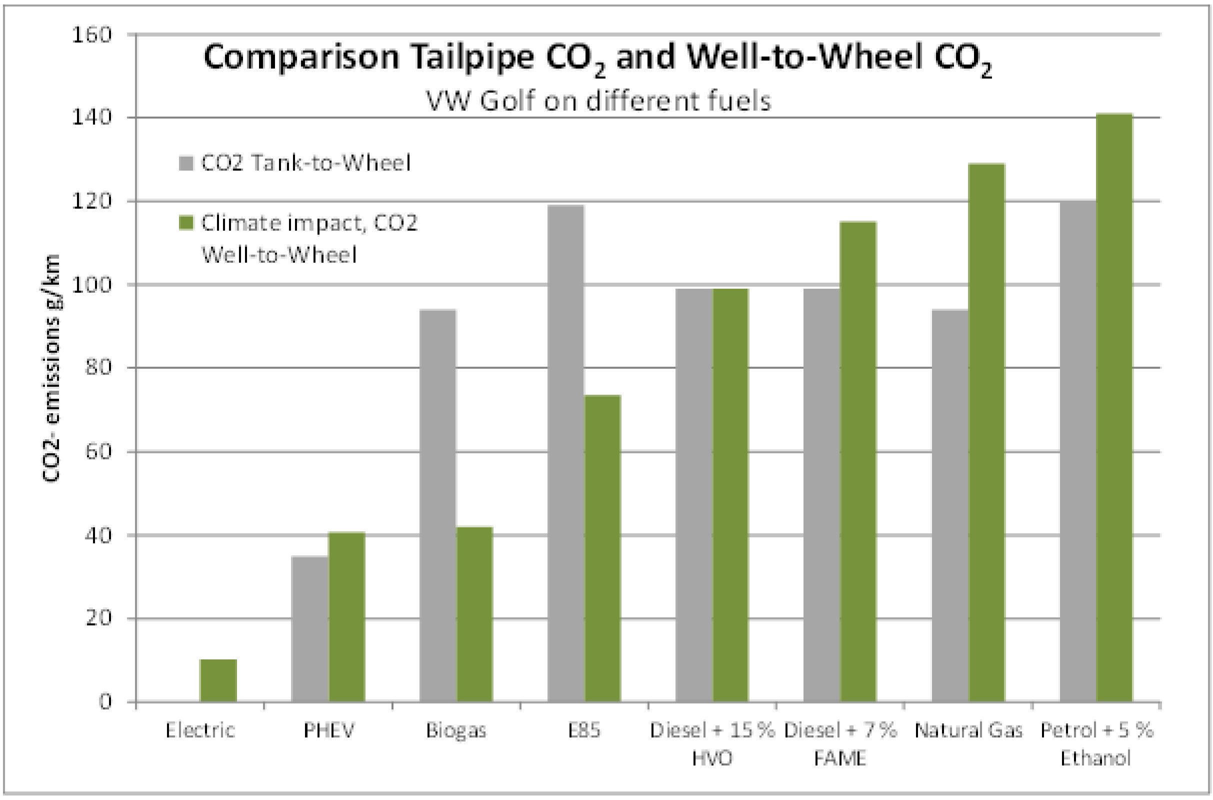
European legislation requires the tailpipe emissions of CO_2 to be measured during the type approval procedures for new vehicles. This approach, known as *tank to wheel* (TTW) only counts the CO_2 emissions produced when fuel is burned by the vehicle engine. This however is a poor indicator of climate impact as much of that impact actually occurs during the production of the fuel – especially for alternative vehicle fuels.

This is obvious in the case of electric and hydrogen vehicles which don't have tailpipe emissions. For these fuels the climate impact occurs when the electricity or hydrogen is produced. If the electricity used to run the car is generated from coal or natural gas power stations the overall climate impact of the vehicle will still be high. If the electricity is generated from renewable sources, such as wind, solar or hydro power, then the overall impact may be close to zero.

For biofuels like ethanol, FAME, HVO or biogas the CO_2 emitted from the tailpipe is actually the same CO_2 which was absorbed from the atmosphere when the plant was growing. Theoretically biofuels can therefore be climate neutral However, energy is required to produce the fuel, and other emissions such as methane can be released during production – these factors must also be considered when assessing climate impact.

A comprehensive assessment of vehicle climate impact needs therefore to consider both fuel consumption and the climate performance of the fuel used – this approach is known as *well to wheel* (WTW). The graph below shows a comparison of the TTW and WTW impact of a VW Golf operating on eight different fuels.

Fig. 1: Comparison between the Tailpipe CO2-value, shown in the vehicle register and the real climate impact CO2 Well-to-Wheel, (based on Swedish biofuels sustainability values 2012)



3. Cars and vans

Almost 75% of the EU's total road transport emissions come from light duty vehicles (LDVs), which include cars and vans, and make up a significant proportion of public sector vehicle purchases[12].

The application of the CVD and selection of the appropriate option for implementation is strongly dependent on the availability and reliability of data from manufacturers on fuel consumption and emissions of CO_2, NO_x, NMHC and particulates. Box 1 below provides an overview of relevant legislation and data availability for cars and vans.

3.1. Technical specifications (Option 1 under the CVD)

The most straightforward approach to compliance with the CVD is by setting minimum environmental performance standards in the **technical specifications** which address the required issues (fuel consumption, CO_2, NO_x, NMHC and PM emissions), such as:

- *Maximum fuel consumption per vehicle: xx l/km*[13]
- *Maximum CO_2 emissions per vehicle: xx g/km*
- *Euro emissions standard X or higher*

All Member States should also have in place a labelling system for fuel economy and CO_2 emissions for passenger cars (see Box 1). The nature of these labels vary from country to country but are often structured by efficiency classes (e.g. A-G) like the standard EC energy efficiency label. As such public authorities can specify the energy class to be met instead of a specific emissions/consumption limit (e.g. *Cars must have energy class B or higher*)[14].

Another alternative approach is to use a third party environmental performance points system, such as ecoscore (Box 2 below). This gives vehicles a score based on an assessment of their environmental performance, including all of the aspects covered by the CVD. This score can therefore be used to either set minimum specifications.

Emissions of NO_x, NMHC and particulates should be addressed by specifying the relevant Euro standard (see Box 1). **Reminder:** Specifying minimum Euro standards for all vehicles is not enough to comply with the CVD requirements, as the Euro standards do not address either fuel consumption or CO_2 emissions.

---

[12] http://ec.europa.eu/clima/policies/transport/vehicles/index_en.htm

[13] For pure electric and plug-in electric hybrid vehicles fuel consumption is expressed in kWh/km. CNG and biogas are measured in m3/km and hydrogen in kg/km. Conversion formula based on MJ content of the different fuels can be applied in order to allow a direct comparison.

[14] It is important to bear in mind that that these labels are often comparative – comparing vehicles within the same vehicle category only. As such, a medium sized car with an A label can have higher emissions than a small car with a C rating for example. It is therefore also of critical importance to define the size of vehicle which best suits your needs (see section 7.1).

Box 1. European regulations and data availability[15] – cars and vans[16]

CO_2 & fuel economy:

- Maximum CO_2 emissions for a manufacturer's fleet average (i.e. the average of all of the vehicles they produce) is 130g CO_2/km by 2015 for cars, and 175g CO_2/km by 2017 for vans
- Data on CO_2 emissions and fuel economy is recorded in the Certificate of Conformity (CoC) which must be provided when a vehicle is purchased.
- All passenger cars (category M1) sold on the European market must be additionally accompanied by a label indicating the car's fuel economy and CO_2 emissions.[17]

NOx, NMHC and PM - the Euro standards:

- The Euro emissions standards set limits for a series of harmful emissions for all new vehicles placed on the market – including NOx, NMHC and PM, but not CO_2. They are becoming progressively stricter over time[18].
- All light passenger and commercial vehicles currently required to meet the Euro 5 standard. The stricter Euro 6 standard will become compulsory for new models from September 2014 and for existing models from September 2015.

Testing procedure:

- Tested in a laboratory using the New European Driving Cycle (NEDC). A new worldwide harmonized cycle (WLTP) and test procedure is currently being developed which will offer more realistic, modern-day testing conditions. However it is not clear when this will be finalised.

[15] More detailed information can be found in a Clean Fleets factsheet on this topic, available on the project website – www.clean-fleets.eu

[16] Vehicle categories M1, M2, N1 and N2 with a reference mass of less than 2,610kg

[17] In many EU countries the label follows the familiar EU energy labelling design, however this is not compulsory and other countries have adopted their own specific design.

[18] Although exact figures on NOx, NMHC and PM are provided on vehicle's CoC, these are tested in laboratory conditions and should not be used directly to compare vehicles. Vehicles should be compared on the Euro standard the achieve only.

Snapshot: Setting minimum specifications in Bristol, UK

Values on CO_2 were set under Bristol City Council's (UK) most recent LDV framework contract after consulting the EU GPP Core Criteria on transport. The criteria stipulate that cars have to emit <130g CO_2/km and vans <175g CO_2/km. However, Bristol went further than this and asked for cars and car-derived vans to be Vehicle Excise Duty (VED) Band C (111-120g CO_2/km) or better (*this is a UK system to determine road tax according to emissions*). In practice, Bristol usually goes below this and asks for cars emitting 100g/km or less when calling off the contract. In practice this restricts them to hybrids and small cars for most of their vehicles and the VED band C limit still allows departments who require larger cars to procure them if necessary. Devolved departments do have to seek special permission if they want over and above what is described in the limits of the framework contract. These technical specifications were complimented by award criteria for sustainable working practices and measures to reduce environmental impacts in a practical and positive manner.

Snapshot: Minimum vehicle standards in Växjö, Sweden

In 2010, it was decided that Växjö would be a fossil free municipal organisation by 2020. Transport was an extremely important area to tackle in order to achieve this. Växjö established a maximum emissions threshold as part of its tendering procedures of 110gCO_2/km, which at that time was even lower than the Swedish national “environmentally friendly” limit of 120gCO_2/km (this has now been updated). In terms of the minibus and car fleet in 2013, Växjö had 77% of vehicles classified as “environmentally friendly” and 65% running on biofuels. This has been achieved despite a highly decentralised procurement structure due to a clear overarching target, supported by a systematic implementation of GPP within the organisation.

3.2. Award criteria (Option 2)

Alternatively, these aspects can be assessed as **award criteria**, by awarding points for vehicles according to their performance in each of the three areas. These two approaches can also be combined by setting both minimum standards in the technical specifications and then awarding additional points for even better performance at the evaluation stage. If such award criteria are applied it is important to make potential suppliers aware of the evaluation scheme in the tender documents.

3.3. Operational Lifetime Cost (Option 3)

The **Operational Lifetime Cost (OLC)** methodology outlined in the CVD can also be applied using the data provided on car and vans CoC and will produce a monetary cost which should be added to other life cycle cost parameters.

Some authorities have used the OLC calculation methodology, but have used this to award points in tender evaluation (i.e. using a standard award criteria approach – option 2), rather than using the monetary value in a cost calculation.

See Annexes 1 & 2 for guidance on the correct use of the OLC methodology.

Box 2. Ecoscore

Ecoscore is a Belgian system which assesses the overall environmental performance of vehicles, and awards them an *ecoscore* of between 0 and 100 (with 100 being the best).

The ecoscore takes into account the most important pollutants emitted by the vehicle. The emissions are divided into three categories: emissions with impacts on global warming, emissions with impacts on air quality (divided into impacts on human health and impacts on ecosystems) and noise emissions. The weighting of the different emissions in the final score is:

- Global warming: 50%
- Air quality (health impacts): 20%
- Air quality (ecosystem impacts): 20%
- Noise: 10%

Ecoscore takes a well to wheel approach in its assessment. This means that emissions from both the driving phase (exhaust emissions) and from the production and distribution phase of the fuel (fuel cycle emissions) are considered.

Several public authorities in Belgium use the ecoscore system when setting minimum technical specifications for vehicle purchases, or as an award criterion in tendering.

For more information please visit: www.ecoscore.be

3.4. Fleets

In most cases, public authorities or transport operators will not be purchasing individual vehicles, but rather a number of vehicles, or setting up multi-year framework contracts which the procuring authority can then buy off as needed over the course of the contract. As explained in section 2.3, purchasers can also apply the requirements of the CVD to the group of vehicles being purchased rather than each individual vehicle, and this provides for alternative procurement approaches, e.g.:

- Setting minimum environmental performance requirements as an average value for the whole group of vehicles to be purchased
- Requiring a minimum percentage of non-petrol/diesel vehicles (or a specific fuel/technology type such as electric) to be included in the offer

These measures are often more robust when supported by an overarching environmental, sustainable procurement or transport policy.

Snapshot: Minimum fleet standards in Germany

The Federal German requires that from 2013 onwards at least 10% of all new or leased cars must emit less than 50g CO_2/km.

http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue27_Case_Study58_Berlin_clean%20vehicles.pdf

3.5. Other environmental factors to consider

The CVD does not limit the consideration of other environmental aspects beyond those listed. Some other aspects which may be taken into account in either technical specifications or award criteria include[19]:

- Air conditioning gases with a high global warming potential (GWP)
- Hazardous hydraulic fluid and lubricant oils
- Use of recycled or renewable materials in vehicle construction
- Fuel economy displays, gear change indicators and tyre pressure monitoring systems
- Low rolling resistance tyres[20]
- Driver behaviour monitoring equipment
- Anti-drunk driving devices

3.6. Information sources

The most important issue when applying minimum specifications is knowing what performance levels to set.

Although European regulation has helped introduce 130g CO_2/km as a regularly used benchmark for cars, in reality there are many vehicles available with emissions of less than 100g CO_2/km. Public authorities and transport operators can typically afford to be more ambitious in setting criteria for cars and vans without risk of cost increases or restricting the market.

The key to successful procurement of clean vehicles is to be properly aware of what the market is able to provide. Carrying out effective market research is therefore one of the most important steps in the procurement process. There are a number of sources of information which can help here:

[19] Taken from the European Commission's Green Public Procurement (GPP) criteria for transport: http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm

[20] Noise emissions are also an aspect of key concern in terms of local impacts, however there is very little difference between engine noise emissions, and would therefore likely not be relevant to consider in tendering.

- Clean Vehicle Portal – A database run by the European Commission, which contains a comprehensive searchable database of all vehicle models available on the market. This includes information on the CO_2 emissions, fuel consumption and harmful local emissions for each, which can serve as a useful reference tool for identifying appropriate maximum limits.

- National databases, such as www.miljofordon.se, or http://carfueldata.direct.gov.uk also provide detailed information, also on prices.

- Euro Topten Max provides a European wide searchable database of the best available models together with selection criteria and sample tender documents for the cleanest, most energy efficient vehicles on the market. 19 national Topten websites are also available.

Other information sources can also be useful in helping to define specifications or award criteria:

- EU GPP (Green Public Procurement) criteria – a voluntary guideline for any public authority in Europe to apply. The “Transport” criteria set provide recommended CO_2 emissions limits for cars and light-duty vehicles, depending on vehicle size. The criteria are also split into “Core” and “Comprehensive” to reflect different levels of ambition. Although these criteria include all environmental factors listed in 3.4, they do not currently consider energy consumption, which must be addressed separately to CO_2 in the criteria documents.

- National GPP criteria sets– several countries have obligatory or voluntary environmental standards for vehicle procurement (e.g. Italy, the Netherlands, Spain, Sweden, and the UK).

- Clean Fleets case studies – the project is producing a series of case studies from across the EU which provide specific information on criteria used and results achieved. As this resource continues to grow it can help to provide a benchmark for others to follow.

4. Heavy duty vehicles[21]

Over 25% of EU road traffic emissions are generated by HDVs[22], which present a more complex situation for clean and efficient vehicle procurement. The HDV sector encompasses a huge range of vehicle types: delivery vehicles (from vans to large trucks), buses (from minibuses to coaches), as well as specialist vehicles such as waste collection trucks or maintenance vehicles.

Although the CVD applies to HDVs in the same way as for cars and vans the complexity of the sector makes it very challenging to provide generic advice in the same way as in section 3 above.

Usage patterns vary hugely from vehicle to vehicle, as do local conditions and driver behaviour; all of these factors can have a significant impact on environmental performance. Buses may run with high capacity on dense flat urban routes, with very regular stops and starts, or they may run at low capacity on rural, mountainous routes, with long distances between stops. Delivery vehicles may make many, short trips around town, or fewer, long-distance trips. Vehicles may operate 18 hours a day, or once every 3 days. They may operate in high temperatures with a need for cooling, or at very low temperatures with a need for heating.

A major challenge in the procurement of clean and efficient HDVs is that testing procedures and data reported do not and cannot reflect this complexity, and therefore cannot be readily used by procurers. This is because the engine rather than the vehicle is tested and it is very difficult to present emissions for engines which have such a wide variety of usages, (see Box 3 below).

Minimising fuel consumption and finding the optimal efficiency requires identifying the most suitable engine technology and correct engine size for your specific needs, together with the correct size and design of your compartment, and cooling technology or add-on auxiliary power etc., where applicable. A laboratory test, based on engine power output does not provide realistic data for reflecting these real-life driving conditions.

Very few real life test cycles exist, however[23]. One exception is for urban buses, where the SORT cycles (standardised on-road test cycle) produced by UITP,[24] provide three different test cycles (heavy urban, easy urban, and suburban) – these are real-life tests, e.g. not an engine test but a test with a full-size bus on a test track. Given the widespread industry acceptance of these standards, most manufacturers would have data on emissions for these cycles and so can be demanded by procurers in order to assess vehicles. No SORT cycle for out-of-town bus operation currently exists.

---

[21] More detailed information in relation to buses can be found in the Clean Fleets bus report, available at www.clean-fleets.eu

[22] http://ec.europa.eu/clima/policies/transport/vehicles/index_en.htm

[23] Some authorities have developed their own, such as the Millbrook London Transport Bus (MLTB) Drive Cycle, however such an approach will likely only be appropriate for very big authorities.

[24] International Association of Public Transport

The presentation of data in terms of emissions per kWh, also means that the operational lifetime cost methodology outlined in the CVD (Option 3) is not useable, as this requires the calculation to be carried out based on emissions/consumption per kilometre[25].

It is therefore difficult to take a technology-neutral approach, based on setting environmental performance specifications or award criteria as outlined above. Instead, most purchasing organisations will decide which fuel/technology to use in the planning phase, based on a careful analysis of their usage patterns and local conditions. This was the case, for example, for the purchase of London's diesel hybrid bus fleet and Vienna's full electric bus fleet.

Section 5 provides more information on selecting vehicle technology types.

Box 3. European regulations and data availability[26] – heavy duty vehicles[27]

CO_2 & fuel economy:

- No CO_2 emissions limits set
- CO_2 emission and fuel economy tested for the engine, rather than for the vehicle, measured in kWh (i.e. gCO_2/kWh, instead of gCO_2/km).
- Data on CO_2 emissions and fuel economy not recorded in the Certificate of Conformity (CoC), but would be available if demanded by procurer.

NOx, NMHC and PM - the Euro standards:

- All new heavy duty vehicles must already meet the Euro VI standard.[28]

Testing procedure:

- Engines tested with the new WHTC/WHSC (world harmonized transient cycle/stationary cycle), since the introduction of the Euro VI standards

Some of the information and guidance sources presented in section 3.6 above may also be relevant for heavy duty vehicles, although less data is available.

For buses a comprehensive review of current European city experiences with alternative fuels and technologies can be found in a special Clean Fleets report here.

[25] Figures provided in the Clean Vehicle Portal are based on generic figures for the vehicle class, rather than for the specific model

[26] More detailed information can be found in a Clean Fleets factsheet on this topic, available on the project website – www.clean-fleets.eu

[27] Vehicle categories M2, M3, N2 & M3 with a reference mass of above 2,610 kg

[28] The Euro standards for heavy vehicles are often presented in Roman numerals to avoid confusion with the Euro standards for light vehicles.

5. Determining the appropriate vehicle technology

When planning for the procurement of new vehicles, an authority must first decide whether to:

a) Determine in advance the type of vehicle technology/fuel to be purchased (e.g. electric, hybrid, biofuel-driven, diesel etc., or a combination)

b) Make the tender **technology neutral** – where different vehicle types compete against a common set of specifications and award criteria

Currently, in the large majority of cases, authorities will already make the decision on vehicle technology/fuel at the planning stage, based on a detailed comparison of the options available and their suitability given their particular context. A shift in vehicle technology will often have a number of important consequences which need to be taken into account in planning – not least, refuelling options and infrastructure, and vehicle usage profiles. Some of the main considerations facing fleet managers are listed below.

Many authorities will also establish large **framework contracts** with several vehicle suppliers, covering a range of different vehicle types, and also potentially vehicle technologies. In these cases, the final decision of which vehicle is purchased will often be made by the end user department, based on their individual requirements and preferences, rather than through a procurement activity.

Where a technology/fuel new to the procuring authority is under consideration, many authorities opt to carry out **testing and pilot actions** to assess their performance under on-road conditions, and then base their decision on the results achieved. Trials and demonstrations can help to not only identify any unforeseen issues related to the new technology, but can also help to increase acceptance of new technologies if end users are involved in testing actions.

5.1. Factors affecting procurement decisions

There are a variety of factors which public authority or transport operator will take into account when determining their vehicle procurement approach, as well as which fuel/technology option(s) to select:

Subsidies, tax incentives, funds etc.: The availability of financial support for the introduction of alternative fuels and technologies, including tax incentives (reduced vehicle tax for cleaner vehicles, lower tax on cleaner fuels etc.) and subsidies/grants, varies substantially from country to country. This is often the most important factor in determining whether such technologies are cost-effective, and which fuel/technology to choose.

Total cost of ownership (TCO):[29] Many alternative fuel/technology options have higher upfront investment costs, both in terms of the vehicles, the infrastructure required, and potentially driver and maintenance training, but can demonstrate cost savings over the life cycle of the vehicle due to lower fuel consumption/prices, and potentially longer lifespans and

[29] Also often referred to as life cycle costing (LCC), although definitions do differ

lower maintenance costs. TCO comparisons can be complex, and are heavily dependent on usage patterns, as well as available subsidies and tax incentives. For some authorities the split in budgetary responsibility between Capex (capital expenditure) and Opex (operational expenditure) can also make it problematic to base decisions on a TCO approach. More on this can be found in Section 6.

Prioritisation of air pollution or CO_2 emissions: A major determining factor in fuel/technology selection is your priority in terms of environmental performance. If local air pollution has higher political priority than CO_2 reductions, this may lead to a different choice of technology/fuel.

Low emission zones: An increasing number of cities are introducing low emission zones or emissions-based congestion charging schemes. The type of emissions which are restricted, and the limits set will have a significant impact on the choice of vehicle.

Availability of fuel and refuelling infrastructure: The highly differentiated availability of a refuelling infrastructure for alternative fuel types has a major impact on the practicality of selecting certain vehicle types. Often a decision to invest in a new form of vehicle fuel/technology will need to go hand in hand with investment in refuelling or charging stations, or a wider programme of incentivisation for vehicle uptake in the private sector. This in turn will depend on the overarching national or regional commitment to renewable energy.

Availability of spare parts: Where considering the introduction of new fuels and technologies, ensuring the availability of spare parts is an important factor in the procurement process.

Usage patterns, topography & climate: Where and how the vehicles will be operating can also have a major impact on the right choice of fuel/technology, and possibilities for new infrastructure developments – for example how hilly an area is, the length of trips, the distance between stops, load volumes, the density of passenger occupation, conditions of extreme heat and extreme cold, narrow access or historical districts, rough road surfaces and many other factors.

Scope of replacement activities: The extent to which a new technology may be introduced will also be in part determined by the approach to replacement within the fleet. The introduction of a new refuelling infrastructure will likely only be cost effective where a major fleet overhaul is occurring. Where individual vehicles are being replaced, different fuel/technology choices may be most appropriate.

Time and expertise available for procurement exercise: Shifting to new vehicle/fuel technologies can require both a longer procurement process and additional technical expertise within the procurement team. Support and advice from similar organisations offered through established relationships or relevant networks may prove to be of significant benefit in this respect, especially in terms of sharing experiences.

Training requirements: Where fleet maintenance takes place in house, procurement decisions may have implications for staff training when considering the introduction of new fuels and technologies.

Influence on the market: How important a customer are you on the market? For passenger cars, any public authority is likely to represent only a very small market share, and consequently will have little power to move the market, so instead will need to base procurement around existing options. For other vehicle categories, such as buses or waste collection trucks, public authorities may be the most significant, or even only customer on the market. In these cases there may be considerably more scope to work with suppliers to develop cleaner alternatives. Joint procurement, where authorities combine their procurement activities is another way to increase attractiveness to the market.

5.2. Alternative fuels/technologies – an overview

Recent years have seen huge advances in alternative vehicle technologies and increasing penetration in commercial vehicle markets. The picture is complex, however, with a very wide range of different fuels and technologies, all with different advantages and challenges, appropriate for different usage patterns, and at different stages of development. This section can only provide a very cursory overview of the main trends and types of alternative fuel vehicles.

Hybrids and electric vehicles

Many consider the full electrification of vehicle fleets to represent the most likely development path in vehicle propulsion – due to absence of exhaust emissions and the technology for implementation being relatively available. However questions remain around the additional electricity demand and ability of batteries to replicate the simplicity of liquid fuels, especially in large, heavy vehicles.

Hybrid electric vehicles (HEVs), which combine a conventional internal combustion engine with an electric motor, are already well-established on the passenger car market. The first plug-in hybrid electric vehicles (PHEVs) are also now commercially available. PHEVs can be recharged by being plugged in to the electricity grid, and can travel further in electric only mode, giving significantly higher reductions in CO_2 and harmful local emissions in comparison to standard hybrids. Greater reductions in CO_2 from PHEV and HEVs occur when operating them in urban and semi urban, stop/start conditions. HEVs and PHEVs currently on the market are B, C and D segment cars.

Most car manufacturers now offer full battery electric vehicles (BEVs) as part of their standard offering. These are available in the A to D car segments as well as small vans. Larger vans are also becoming available. These provide zero tailpipe emissions, and are increasingly becoming available in different segments of the van and heavy-duty vehicle market. The principle challenge still faced with this technology is the cost, range and time taken to charge the vehicles. Also, when using energy intensive elements of the vehicle, such as heating and headlights, the range can be substantially reduced.

Biofuels

Biofuels are renewable transport fuels derived from organic materials. The term biofuels encompasses an ever-increasing number of different fuel types – differentiated by the source material, the manufacturing process and the type of fuel ultimately created (gaseous, petrol or diesel equivalent, suitable for blending).

- **Biogas (biomethane)** is produced from organic materials are broken down by a microbiological activity to produce methane. CO_2 Well-to-Wheel benefit can be significant from bio waste, however the availability of this fuel is limited. Biogas can be used as a direct substitute for natural gas in CNG engines.

- **Biodiesel** exists in two main forms:

  a) FAME, which can be used in 5% in all diesel vehicles. Higher blends can be used in some vehicles, however vehicle manufacturers should be consulted regarding warranties. From 2014 it will be possible to type approve HDVs on FAME

  b) HVO, which can be used in 80% blend in all diesel vehicles. Higher blends can be used, however vehicle manufacturers should be consulted regarding warranties.

- **Bioethanol** is produced by the fermentation of starch, sugar and cellulose plants. It can be used with, or as a direct substitute for petrol. Bioethanol at a concentration higher than 5% in petrol can be used in all existing petrol vehicles. Vehicle manufacturers should be consulted before bioethanol is used. Flex-fuel vehicles are available which are capable of operating on any concentration of petrol and ethanol up to 85% ethanol.

Assessing the CO_2 impact of biofuels is complex. When burned in vehicle engines biofuels emit greenhouse gases, just like burning fossil fuels. However, as the organic material used to produce these fuels absorbs CO_2 as it grows the overall CO_2 emissions may be very low.[30] Direct CO_2 impacts are heavily impacted by the processing and manufacturing methods (including what by-products are produced and how these are dealt with), the use of artificial fertilisers, and the efficiency of the fuel produced. Concerns have also been raised relating to land use change, and the impact on food prices (often called ILUC[31]), with critics claiming that demand for land to grow crops for biofuels leads to both virgin land being turned into fields, and to biofuel crops replacing food crops. Others point out that there are more than 50 million hectares of abandoned land in the EU alone (Eurostat) available for cultivating fuel crops, helping to both reduce CO_2 emissions and oil dependency, as well as creating rural jobs. This debate is a complex one, with little consensus yet reached, and cannot be explored in detail here.

CNG and LPG

There are several gaseous fuels available on the market, deriving from fossil fuels. The two main examples are:

- **CNG (compressed natural gas)** – methane derived from oil and gas fields, stored under pressure for use as a vehicle fuel,

---

[30] It is important to again note that the CVD requires public authorities to consider tailpipe emissions only in relation to CO2 and other pollutant emissions. This therefore discourages the use of biofuels.

[31] Indirect land use change

- **LPG (liquefied petroleum gas) –** a mixture of butane and propane, a by-product of the petrol refinement process.

In Europe, CNG is more typically used in HDVs and buses, whereas LPG is usually used in cars and light vans. Other less widespread examples include liquefied natural gas (LNG) and gas-to-liquid (GTL). Fossil fuel based gaseous fuels don't offer significant CO_2 reductions in comparison to traditional fuels, however they can provide major reductions in emissions of PM, NO_X, and noise. In terms of HDVs this difference was more pronounced when comparing CNG to Euro V diesel models; compared to Euro VI models emissions are more similar. In some cases CNG cars are available with smaller motor sizes than available diesel engines, and as such may in some cases offer a lower CO_2 solution.

Hydrogen

Hydrogen fuel cell vehicles, which generate electricity to power vehicles by combining hydrogen with oxygen, remain largely at the demonstration stage. They are however considered a promising zero local emission technology in the longer term given their greater potential range than BEVs.

The use of Hydrogen within internal combustion engines (ICEs) is a more developed technology because the engines are reasonably similar to standard ICEs, but this is a significantly less efficient way of using Hydrogen compared to fuel cell technology.

A major challenge for hydrogen-powered vehicles remains the production of hydrogen itself. Using current techniques this is an energy-intensive process – so although local emissions are zero, the overall CO_2 impact in relation to traditional engines may not be that positive, or even negative.

5.3. Alternative fuels/technologies per vehicle sector

Cars

Hybrid cars are already well established on the mass market in Europe, and there has been a significant increase in the offer of PHEVs and full electric vehicles from the major car manufacturers. Both present a viable alternative to standard petrol/diesel vehicles for public authority fleets, depending on the usage patterns of the vehicles concerned and on local climatic, topographical and congestion conditions. A cost comparison between electric, hybrid and traditional vehicles can heavily depend on available subsidies and/or tax incentives.

Vans

There are some, smaller, full electric vans on the market. Some larger 3.5 tonne vans are becoming available although the weight of the battery can cause issues related to load capacity, Aftermarket retrofit hybrid systems are available for 3.5 tonne vans. In some parts of Europe vans and associated refuelling infrastructure for Biofuels and CNG are available.

Minibuses

Full electric minibuses are available from conversion companies, but not from OEMs. In some parts of Europe minibuses and associated refuelling infrastructure for Biofuels and CNG are available.

Buses

As with all HDVs, buses have traditionally run on diesel, however a wide variety of alternatives exist at different levels of market maturity today. A significant number of CNG buses can be found today in the cities of Europe, due to the lower local emissions of PM and NOx. Hybrid buses are also increasingly well established on the market, and many cities are piloting the use of full electric buses.

A comprehensive review of current European city experiences with alternative fuels and technologies for buses can be found in a special Clean Fleets report here.

Other HDVs

Due to vehicle size, weight and recharging speeds, electric propulsion is not a significant option for other HDVs currently. CNG is already well established on the market for HDVs in certain European countries, and biogas offers an attractive alternative where refuelling infrastructure is in place. Hydrogen may offer a longer term solution, but remains too expensive currently for commercial operation. Electric and hybrid vehicles are being introduced for some specialist vehicle types with an appropriate usage pattern (regular stop-start, and recharging time) such as street cleaning and waste collection trucks.

6. Life cycle costing/total cost of ownership (LCC/TCO)

When considering the total cost of ownership (TCO) of a vehicle to an organisation, several specific costs must be taken into account:

- Purchase price
- Fuel costs
- Maintenance and repairs
- Taxes
- Disposal/resale

Where new technologies are being introduced, then refuelling infrastructure and training for drivers and/or mechanics may also need to be added to this list.

Although traditionally public authorities have often focused on purchase price only, increasingly organisations are comparing different vehicle options based on their TCO – either at the planning stage, when assessing different fuel/technology options, or directly in tendering by assessing the TCO of competing bids.

Several authorities have developed their own tools for assessing TCO in procurement. The Swedish Environment Council (SEMCo) has also developed a simple tool that can be used by any public authority to compare the costs listed above. It is currently only available in Swedish but an English version is due to be released shortly.[32]

6.1. Costing externalities

In many cases, though certainly not all, alternative fuels/technologies may be cheaper over the vehicle's lifetime than traditional diesel/petrol vehicles (particularly considering relevant tax incentives and subsidies) This is even more likely to be the case if environmental externalities are taken into account in a TCO calculation – i.e. giving a cost to the emissions of CO_2, NO_x etc, and considering this alongside normal financial costs.

The Operational Lifetime Cost (OLC) methodology outlined in the CVD (option 3) is designed to do precisely this. It defines a specific method for giving values for each of the environmental impacts the CVD considers: CO2, fuel consumption, NOx, NMHC and PM. This methodology is outlined in detail in Annex 1.

The Clean Fleets project is currently developing an LCC tool which directly combines a standard TCO calculation with the OLC methodology from the CVD. This will shortly be available on the Clean Fleets website: www.clean-fleets.eu.

---

[32] As of April 2014. Swedish version available here: www.msr.se/sv/Upphandling/LCC/Kalkyler/Personbilar

7. Fleet management and working with service providers

Improving the environmental performance of the vehicles used to carry out public services does not only relate to the type of vehicles purchased, leased or used. The way in which vehicles are driven and the fleet managed plays an important role. Furthermore, many of the vehicles used in carrying out public services are increasingly operated by private operators – from bus operators, to waste collection and road maintenance companies. Although public authorities do not typically own the vehicles used to carry out such services they may still influence the vehicles used considerably.

7.1. Fleet management

A number of measures can help to reduce fuel consumption and the environmental impact of your transport operations, such as:

- **Driver training** – providing drivers with training in eco-driving skills can prove to be one of the most effective ways of reducing fuel consumption, for example by reducing sudden acceleration/braking, idling, lowering speed, and carrying unnecessary weight. Collecting monitoring data on driver performance can help to assess the effectiveness of such training. Various organisations have put effective schemes in place to monitor and incentivise eco-driving amongst staff members.

- **Reducing wasted mileage** – more sophisticated route-planning, and real-time monitoring systems can help reduce the overall distance which vehicles travel. Planning out-of-hours deliveries and service schedules can also help to reduce congestion and allow more efficient driving.

- **Tyre and engine maintenance** – ensuring tyres are properly inflated, and engines are correctly tuned will help to improve fuel efficiency. Low noise and low rolling resistance tyres should also be considered.

- **Retrofitting** – substantial improvements in environmental performance, particularly local emissions, can be achieved through retrofitting vehicles with new technologies such as hybrid systems or with particle filters. This may be considered as a less costly approach than buying new alternative vehicles. Two examples of this from Berlin and Barcelona were presented at the Clean Fleets London Workshop.

- **Selecting appropriate vehicle size** – after vehicle technology, vehicle weight has the highest impact on fuel economy. It is therefore important to select the smallest, lowest power vehicle that meets your needs. Any potential customisations and ancillary equipment which may need to be fitted (such as disabled adaptations, refrigeration) must also be considered when assessing the base vehicle requirements.

- **Car-sharing** - As many fleets of administrations and companies are in use only during workdays, making use of public car sharing schemes, where usage tends to be high outside working times, may be worth considering. It may also be a way of raising the profile and visibility of newer technology types, such as electric vehicles. An example of this in Paris can be found here.

- **Encouraging BEV use** – The gradual introduction of BEVs into vehicle pools should be carefully managed to ensure their use – for example obliging drivers to use a BEV if range allows, and ensuring vehicles are charged when not in use.

An excellent guide on sustainable fleet management has been produced by Transport for London, and can be found here: www.tfw.org.uk/documents/fuel-and-fleet-management-guide.pdf .

Annex 1: Using the "operational lifetime cost" option

The OLC method outlined in the CVD[33] is designed to allow the comparison of the environmental impacts of different vehicles in monetary terms, and thus include them directly in overall cost evaluations. The methodology is designed to be technology neutral, allowing different technologies to be compared against the same evaluation framework.

If emissions and fuel consumption are to be monetised during a procurement process the methodology presented in the CVD must be followed exactly. The methodology is outlined in Article 6 of the Directive, together with the Annex. The European Commission's Clean Vehicle Portal (www.cleanvehicle.eu) provides calculated OLC values for all vehicles in its database.

To determine total OLC you must add the following costs:

- Lifetime energy consumption costs
- Lifetime CO_2 emission costs
- Lifetime NO_x emission costs
- Lifetime NMHC emission costs
- Lifetime PM emission costs

The Clean Vehicle Portal presented above is designed to directly support the OLC option. It provides a direct Calculation of the Operational Lifetime Costs for each of the vehicles within its database (www.cleanvehicle.eu). This value can then be used directly by procurers.

Calculating energy consumption costs

Lifetime energy consumption cost is calculated according to the following formula:

LECC (€) = EC per km (MJ/km) x cost per unit of energy (€/MJ) x lifetime mileage (km)

(LECC = lifetime energy consumption cost; EC = energy consumption)

a) Energy consumption (EC)

Energy consumption must be calculated in terms of MJ/km. As consumption for most fuel types is expressed differently (e.g. litres or cubic metres per km), the Directive provides a table of conversion factors for all fuel types (see Table 1). Consider also that fuel consumption is typically given in l/100 km not l/km. For a correct calculation this figure should therefore be first divided by 100 (see worked example in Annex 2).

[33] Directive 2009/33/EC, Article 5(3)(b), second indent

Table 1: Fuel conversion factors for energy consumption calculation

Fuel	Energy content
Diesel	36 MJ/litre
Petrol	32 MJ/litre
Natural Gas/Biogas	33 – 38 MJ/Nm^3
Liquified Petroleum Gas (LPG)	24 MJ/litre
Ethanol	21 MJ/litre
Biodiesel	33 MJ/litre
Emulsion Fuel	32 MJ/litre
Hydrogen	11 MJ/Nm^3

b) Cost per unit of energy

Calculating the **cost per unit of energy** (€/MJ) requires two steps:

1) Determine which is the lower of the cost of a single unit of either petrol or diesel *before tax* when used as a transport fuel.[34]

2) Divide this cost by the energy content fuel conversion factor from the table above (either 36 if diesel is the cheapest, or 32 if petrol is the cheapest)

Please note, the fuel type (petrol or diesel) used in this calculation is independent of the type of fuel the vehicle being assessed actually uses – this calculation is designed to assess the efficiency of the vehicle in turning a certain amount of primary energy into vehicle power NOT to assess the actual financial cost of the fuel consumption. If you wish to consider the costs your organisation will bear for fuel over the lifetime of the vehicle, this must be calculated and evaluated separately during tendering.

c) Lifetime mileage

The lifetime mileage can be determined by the purchasing authority directly, or they may use the reference values which are provided in the Annex to the Directive, as set out in Table 2 below. Some member states may set reference mileages at the national level.

[34] The European Commission provides a weekly bulletin here: http://ec.europa.eu/energy/observatory/oil/bulletin_en.htm. This provides both an EU-wide average, and individual country figures (Note, make sure you select the file containing *prices without taxes*).

Table 2: Lifetime mileage of road transport vehicles

Vehicle	Lifetime mileage
Passenger cars (M1)	200,000 km
Light commercial vehicles (N1)	250,000 km
Heavy goods vehicles (N2, N3)	1,000,000 km
Buses (M2, M3)	800,000 km

Calculating CO_2, NO_x, NMHC and PM costs

Lifetime costs of CO_2 emissions are calculated according to the following formula:

$$LCCO_2\ (€) = CO_2 \text{ emissions (g/km) x cost per g}CO_2\ (€) \text{ x lifetime mileage (km)}$$

($LCCO_2$ = lifetime cost of CO_2 emissions)

Lifetime costs for NO_x, NMHC and PM are calculated in exactly the same way.

The **cost for emissions** is provided in the Annex of the Directive as outlined in Table 3 below. Contracting authorities may apply higher costs for emissions, but not higher than double those included in the table.

Table 3: Cost for emissions

Emission	Cost
CO_2	0.03 – 0.04 €/kg[35]
NO_x	0.0044 €/g
NMHC	0.001 €/g
PM	0.087 €/g

Criticisms of the OLC method

Whilst the OLC method provides a welcome focus on assessing the cost of environmental impacts, there are certain criticisms that have been mentioned by public authorities interviewed by the Clean Fleets project. These include:

a) **Weighting and inflexibility in OLC method** – Some concerns have been raised over weighting given to the different environmental impacts by the OLC method – with energy consumption typically massively outweighing the other impacts in the final calculation, and NO_x, NMHC and PM having an almost negligible impact (see the pie

[35] Please note, it is critical that you take into account the unit being used. The CVD gives a cost for *kilogrammes* of CO_2 emissions. Data on CO_2 emissions will normally be provided by manufacturers in *grammes* of CO_2.

chart representation in Annex 2). Typically, this calculation will strongly favour efficient diesel vehicles over other types of fuel/technology. Considering the importance of local air quality to many European cities, some feel that there should be more flexibility in setting the weighting.

b) **Tank to wheel assessment** - The OLC method assesses emissions from tank-to-wheel only (i.e. emissions related to the operation of the vehicle only) instead of well-to-wheel, which also takes into account the production of the fuel (see section 2.4).

c) **Confusion between OLC and LCC** – The OLC method does not assess the costs of ownership borne by the purchaser over the lifetime of the vehicle, but rather assesses the external costs of environmental impacts. This even applies to fuel consumption as the cost here is based on the same cost per unit of fuel/energy (the cheaper of petrol or diesel) regardless of the actual fuel used by the vehicle. To assess financial costs a separate life cycle cost/total cost of ownership evaluation would need to be carried out alongside the OLC approach.

Annex 2 – Worked example of the OLC

The information in this Annex is all taken from the Clean Vehicle Portal.[36] *The models compared are those with the lowest operational lifetime cost (OLC) for their fuel/technology type within the* compact car *classification, with an engine power of between 50 – 100 kw.*

Please note, these figures are not intended to provide a meaningful comparison of different fuel/technology options, as the vehicles are not similar enough in size/performance to do so. It is intended simply to demonstrate the practical application of the OLC methodology.

Vehicle data – passenger cars (compact class)

Vehicle	Power (kW)	Fuel consumption (l/km)	CO_2 emissions (g/km)	NO_x emissions (g/km)	NMHC emissions (g/km)	PM emissions (g/km)
Diesel	77	3,9	102	0,1225	0	0,000011
Petrol	74	4,7	109	0,0416	0,0552	0,0000168
Electric	80	17,3 (kWh/km)	0	0	0	0
Hybrid	73	3,8	87	0,0033	0,0251	0
CNG[37]	69	7.7 (Nm^3/km)	138	0,043	0	0
Ethanol	90	7,1	116	0,012	0,0564	0,0000026

- **Lifetime mileage: 200,000km**

1) Fuel consumption costs

a) Cost per unit of energy

Cheapest fuel	Cost of fuel (€/l)	Conversion factor for diesel (MJ/l)	Cost per unit of energy (€/MJ)
Diesel	0,74709	36	0,0207525

[36] Data obtained on 10 Sept 2013

[37] As no CNG model in the compact class was included in the database, this model comes from the *multi purpose cars (small)* class

b) Fuel consumption cost

Vehicle type	Fuel consumption (l/100km)	Fuel consumption (l/km)	Fuel conversion factor (MJ/l)	Fuel consumption (MJ/km)	Cost per unit of energy (€/MJ)	Cost per km (€)	**Lifetime fuel consumption cost** (200,000 km) **(€)**
Diesel	3,9	0,039	36	1,404	0,0207525	0,02913651	**5.827,30**
Petrol	4,7	0,047	32	1,504	0,0207525	0,03121176	**6.242,35**
Electric	17,3 (kWh)	0,173	3,6	0,6228	0,0207525	0,012924657	**2.584,93**
Hybrid	3,8	0,038	32	1,216	0,0207525	0,02523504	**5.047,01**
CNG	7,7 (Nm^3)	0,077	33	2,541	0,0207525	0,052732103	**10.546,42**
Ethanol	7,1	0,071	21	1,491	0,0207525	0,030941978	**6.188,40**

2) CO_2 & other pollutant emissions costs

a) CO_2 emissions

Vehicle type	CO_2 emissions (g/km)	CO_2 emissions (kg/km)	Cost (€/kg CO_2)	**Lifetime CO_2 emissions cost** (200,000 km) **(€)**
Diesel	102	0,102	0,03[38]	**612**
Petrol	109	0,109	0,03	**654**
Electric	0	0	0,03	**0**
Hybrid	87	0,087	0,03	**522**
CNG	138	0,138	0,03	**828**
Ethanol	116	0,116	0,03	**696**

c) NO_x emissions

Vehicle type	NO_x emissions (g/km)	Cost (€/g NO_x)	**Lifetime NO_x emissions cost** (200,000 km) **(€)**
Diesel	0,1225	0,0044	**107,80**
Petrol	0,0416	0,0044	**36,61**
Electric	0	0,0044	**0,00**
Hybrid	0,0033	0,0044	**2,90**

[38] The cost allocated in the CVD is 0.03 – 0.04 €/kg CO_2, but purchasers may choose to increase to up to 0.08.

CNG	0,043	0,0044	**37,84**
Ethanol	0,012	0,0044	**10,56**

d) NMHC emissions

Vehicle type	NMHC emissions (g/km)	Cost (€/g NMHC)	**Lifetime NMHC emissions cost** (200,000 km) **(€)**
Diesel	0	0,001	**0**
Petrol	0,0552	0,001	**11,04**
Electric	0	0,001	**0**
Hybrid	0,0251	0,001	**5,02**
CNG	0	0,001	**0**
Ethanol	0,0564	0,001	**11,28**

d) Particulate emissions

Vehicle type	PM emissions (g/km)	Cost (€/g PM)	**Lifetime PM emissions cost** (200,000 km) **(€)**
Diesel	0,000011	0,087	**0,1914**
Petrol	0,0000168	0,087	**0,29232**
Electric	0	0,087	**0**
Hybrid	0	0,087	**0**
CNG	0	0,087	**0**
Ethanol	0,0000026	0,087	**0,04524**

2) Operational lifetime costs

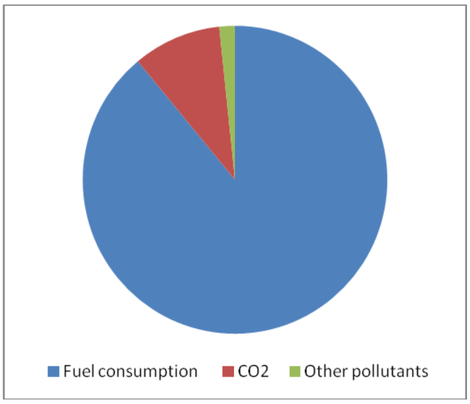
Vehicle type	**Lifetime costs (€)**					**Total OLC (€)**
	Fuel consumption	CO_2 emissions	NO_x emissions	NMHC emissions	Particulate emissions	
Diesel	5.827,30	612	107,80	0	0,191400	**6.547,29**
Petrol	6.242,35	654	36,61	11,040	0,292320	**6.944,29**
Electric	2.584,93	0	0	0	0	**2.584,93**
Hybrid	5.047,01	522	2,90	5,020	0	**5.576,93**
CNG	10.546,42	828	37,84	0	0	**11.412,26**
Ethanol	6.188,40	696	10,56	11,280	0,045240	**6.906,28**

The calculated total OLC can now be evaluated together with the financial costs related to the vehicle to determine the lowest offer.

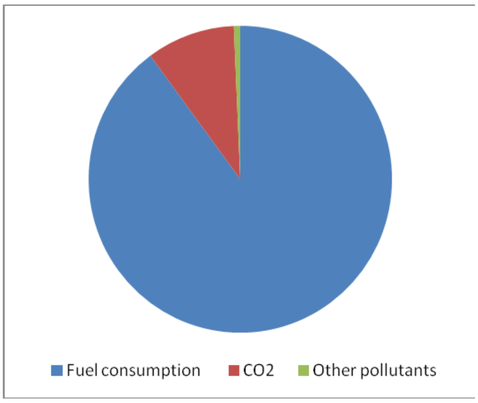
The pie charts below demonstrate the breakdown of OLC costs between fuel consumption, CO2 emissions and other pollutants:

Fig. 2: Relative weight of fuel consumption, CO_2 and other pollutants in overall OLC calculation

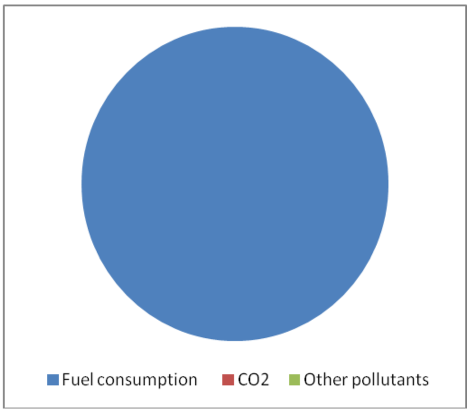
Diesel:



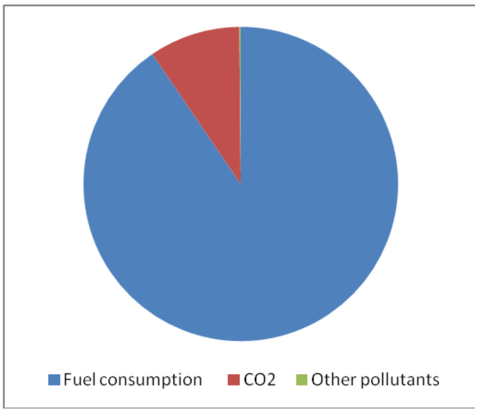
Petrol:



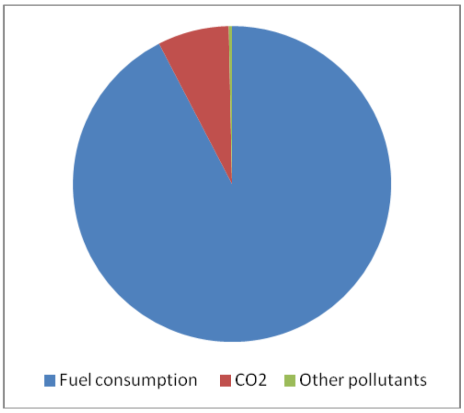
Electric:



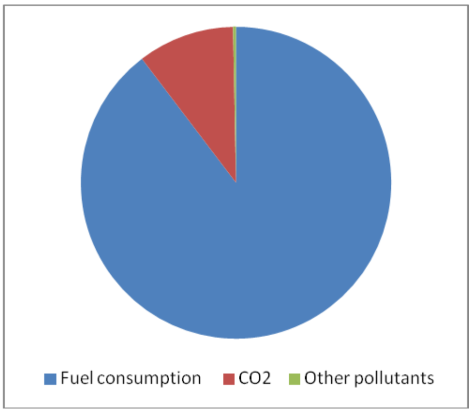
Hybrid:



CNG:



Ethanol:



Clean Fleets – about the project

The Clean Fleets project (www.clean-fleets.eu) assists public authorities and fleet operators with the implementation of the Clean Vehicles Directive and the procurement or leasing of clean and energy-efficient vehicles.

Clean Fleets project partners

Co-funded by the Intelligent Energy Europe Programme of the European Union