CVD Operational Lifetime Cost Methodology

Clean Fleets Factsheet (July 2014)

The Operational Lifetime Cost (OLC) method outlined in the Clean Vehicles Directive (CVD)[1] 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. It is one of three options allowed by the CVD when purchasing road vehicles. 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)

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

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).

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.[2]

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.

[2] 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*).

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.

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 emissions (g/km) x cost per gCO_2 (€) 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[3]
NO_x	0.0044 €/g
NMHC	0.001 €/g
PM	0.087 €/g

[3] 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.

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 chart representation in the Annex). 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 – Worked example of the OLC

The information in this Annex is all taken from the Clean Vehicle Portal.[4] *The models compared where 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[5]	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

[4] Data obtained on 10 Sept 2013

[5] 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[6]	**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**

[6] 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

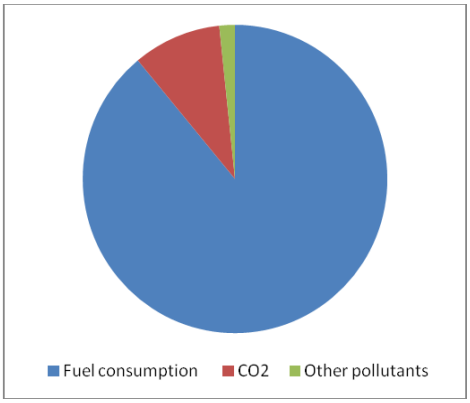
Vehicle type	**Lifetime costs (€)**					**Total OLC (€)**
	Fuel consumption	CO_2 emissions	NO_x emissions	NMHC emissions	Particulate emissions	
Diesel	5.827,30	612	107,80	0	0,191400	**6.547,29**
Petrol	6.242,35	654	36,61	11,040	0,292320	**6.944,29**
Electric	2.584,93	0	0	0	0	**2.584,93**
Hybrid	5.047,01	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.

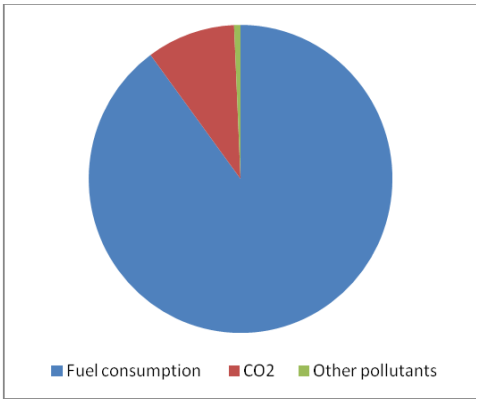
The pie charts below demonstrate the breakdown of OLC costs between fuel consumption, CO_2 emissions and other pollutants:

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

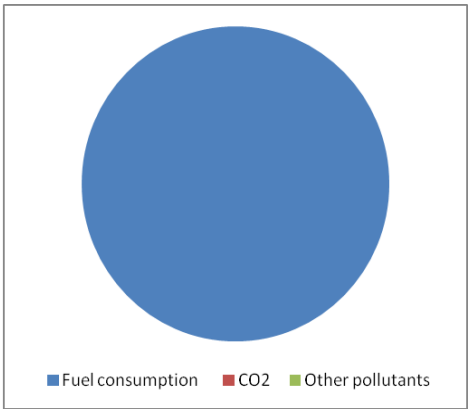
Diesel:



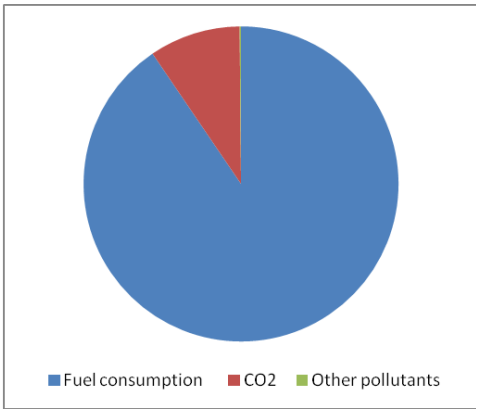
Petrol:



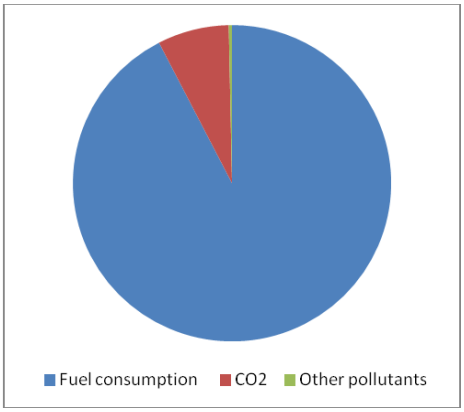
Electric:



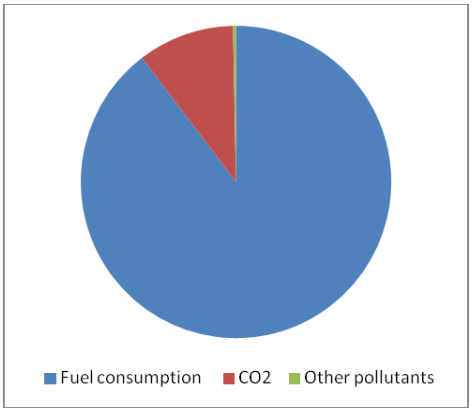
Hybrid:



CNG:



Ethanol:



Clean Fleets Factsheet series

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.

The Factsheet series aims to provide concise information on topics of relevance to clean vehicle procurement. If you wish to propose a topic for a new factsheet please email procurement@iclei.org

Clean Fleets project partners

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