Product Life Cycle Assessment - LCA

Signal lamps for cars – P21W 7506

This life-cycle assessment of an ORIGINAL signal lamp with metal bases feature for cars comprises the entire life of a product, from raw material extraction and acquisition, through material production and manufacturing, to use and end of life treatment including recycling and final disposal.

The method for these analyses was an assessment following principally the international standards ISO 14040 and 14044. Apart from the primary energy consumption, the impact on the environment was evaluated in specific categories. The LCA was calculated with the life cycle modelling software GaBi.

Product description

The ams OSRAM P21W 7506 is an ams OSRAM OEM (Original Equipment Manufacturer) incandescent signal lamp used in different applications in car lighting, like stop light, rear light, direction indicators etc. The assessed lamp is assumed to be a for the automotive industry to be built into new cars. Nonetheless, ams OSRAM signal lamps are also available in the automotive aftermarket as replacement lamps.

Electrical and optical data

Signal lamp - P21W 7506	Unit	Value
Nominal wattage	W	21
Nominal voltage	V	12
Luminous flux	lm	460
Lifespan (Tc*)	h	500
Weight	g	8.10
Dimensions	mm	52.5 x 26.5

*Tc lifetime value shows the failure rate of 63.2% of the lamps according to standard IEC 60810

Material composition

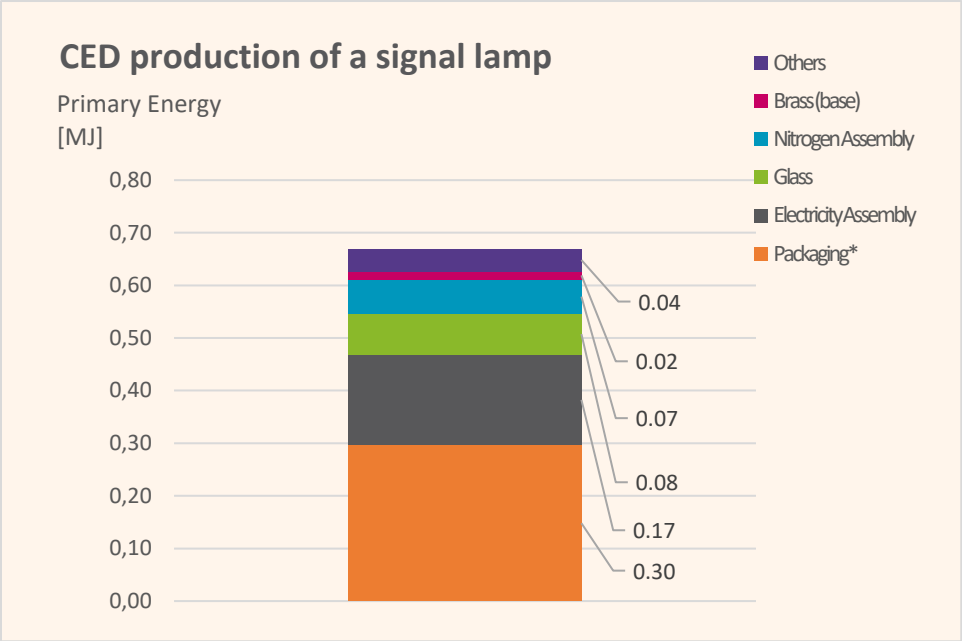
The table below shows the material composition of a signal lamp including the packaging.

MATERIAL	WEIGHT	PERCENTAGE
GLASS	5.63 g	38.59 %
NON-FERROUS METAL	1.91 g	13.09 %
CEMENT	0.58 g	3.98 %
FILLING GAS	0.10 g	0.69 %
PACKAGING*	6.37 g	43.66 %
TOTAL	**14.59 g**	**100.0 %**

*Tray for OEM customer (approximated considering the packaging of H4 lamp)

Determining the CED (Cumulative Energy Demand) during the production phase

To determine the amount of energy needed in the manufacturing phase, all the materials used, their masses and production steps are considered. During this phase, transportation of the major components is also taken into account. The cumulative energy demand during the production phase of a signal lamp is shown in the diagram below.



*Tray for OEM customer (approximated considering the packaging of H4 lamp)

Calculating CED during the usage phase of one signal lamp

Since cars use alternators driven by the engine to generate electricity, the CED of a car headlight lamp during the usage phase is calculated by considering the fuel consumption of the car respectively the combustion engine. In this way CO_2 emissions can also be considered. For this calculation an effectiveness of the alternator (0.75) as well as the effectiveness of the combustion engine (0.30) was assumed. As car fuel the gasoline mix of the German automobile stock was considered.

As operating time of the signal lamp, we calculate with a scenario considering usage for 100,000 km. Within this scenario the average run-time of a signal lamp is 360h. This value was assessed in an internal study by a German car manufacturer and communicated to ams OSRAM. ams OSRAM is not aware of other publicly available studies/data revealing further usage scenarios for car lighting.

1.)	**Electrical power consumption, 100,000 km, 360h**	**21 W_{El} * 360 h = 7.56 kWh_{El}**
2.)	Effectiveness	7.56 * 3.6 MJ_{El} * 4.44 = 120.84 MJ_{El}
3.)	Fuel consumption for lighting per 100,000 km	121 MJ_{El} : 32 MJ/l = 3.78 l/ 100,000 km or 3.78ml/100km)

Considering the above fuel-to-power conversion efficiency of a car, fuel consumption and fuel production and distribution, the modelling software calculated the CED within the usage phase of a signal lamp as 149 MJPrim.

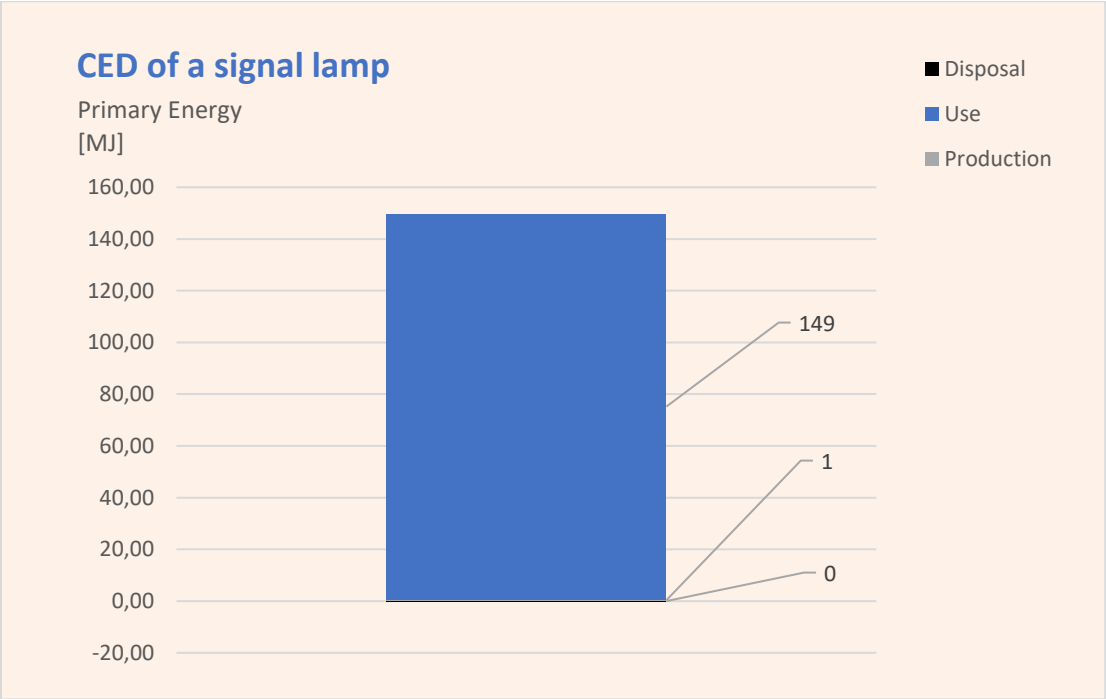
CED in the disposal phase

In this assessment, incineration of the packaging of signal lamps in a municipal waste-to-energy plant and disposal of the glass components, solder and cement in landfill are assumed. This represents the worst-case scenario. Nonetheless, during the incineration process, a small amount of energy can be

recovered. A higher amount of energy recovery and further environmental benefits can be obtained by recycling the copper parts of the product.

The CED of the entire lifecycle of signal car lamps

The following diagram shows the results of the entire lifecycle assessment of a signal lamp. Analysis shows that over 99% of the energy is consumed during the usage phase. In the end-of-life phase, there is in relation to the overall CED a negligible benefit (-0.002%) from energy recovery through the re-use of metal components and waste incineration.



Environmental impacts of all lifecycle phases of one signal lamp

Impact Category	Unit	Production	Usage	Disposal
Cumulative Energy Demand (CED)	MJ	0.67	149.00	0.00
Global Warming Potential (GWP)	kg CO_2 eq.	0.03	10.81	0.02
Acidification Potential (AP)	kg SO_2 eq.	7.5E-05	1.3E-02	-3.6E-07
Eutrophication Potential (EP)	Kg PO_4 eq.	1.0E-05	2.6E-03	7.8E-07
Photochemical Ozone Creation Potential (POCP)	Kg Ethane eq.	7.1E-07	1.6E-03	1.4E-07
Human Toxicity Potential (HTP)	Kg DCB eq.	3.8E-03	3.5E-01	-1.2E-04
Abiotic Depletion Potential (ADP) (fossil)	MJ	0.49	141.0	0.00