Product Life Cycle Assessment - LCA

LED signal lamps for cars – XLS

This life-cycle assessment of Standard Signal Light sources 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 XLS (e**X**changable **L**ED **S**ignal) is a standardized LED light sources for signal light applications in the automotive industry. It is available in four variants/colors to cover the full range of car signal applications (Brake, tail light and rear fog light / Reverse and daytime running light / Rear and front indicator / Front fog). This allows simple replacements, reduces complexity and overall costs for car manufacturers and leads to faster development processes thanks to adapted standards. Further information can be found here: XLS product family

Electrical and optical data

Signal lamp – XLS LW5	**Unit**	**Value**
Nominal wattage	W	5.2
Nominal voltage	V	13.5
Luminous flux	lm	350
Lifespan (L70B10)	h	>5000
Weight	g	17.65
Dimensions	mm	D 38 / H 34

Material composition

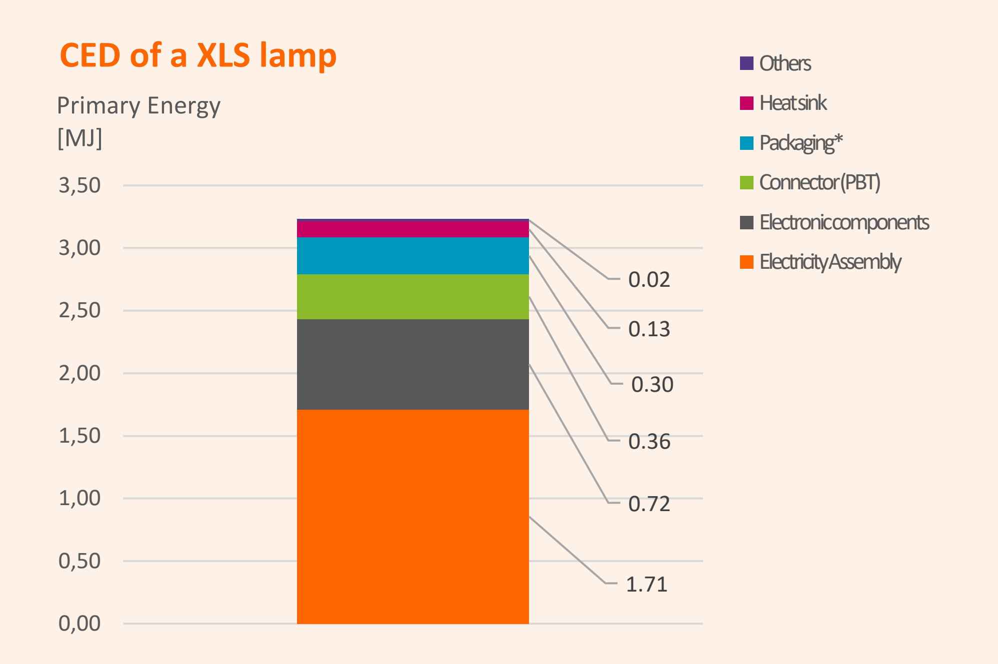
The table below shows the material composition of a XLS lamp including the packaging.

MATERIAL	WEIGHT	PERCENTAGE
ALUMINIUM PARTS	12.00 g	48.54 %
PLASTICS (PBT)	4.76 g	19.25 %
SILICONE RUBBER	0.84 g	3.40 %
ELECTRONIC COMPONENTS	0.60 g	2.42 %
OTHER	0.15 g	0.62 %
PACKAGING*	6.37 g	25.77 %
TOTAL	**24.72 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 XLS 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 an XLS lamp – Scenario stop light

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 taken into account. 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 as stop light for 100,000 km. Within this scenario the average run-time of a 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**	**5.2 W_{El} * 360 h = 1.87 kWh_{El}**
2.)	Effectiveness	1.87 * 3.6 MJ_{El} * 4.44 = 29.95 MJ_{El}
3.)	Fuel consumption for lighting per 100,000 km	29.95 MJ_{El} : 32 MJ/l = 0.94 l/ 100,000 km (or 0.94ml/100km)

The CED within the usage phase of one LW5 lamp considering the described assumptions above is 36.9 MJ_{Prim}.

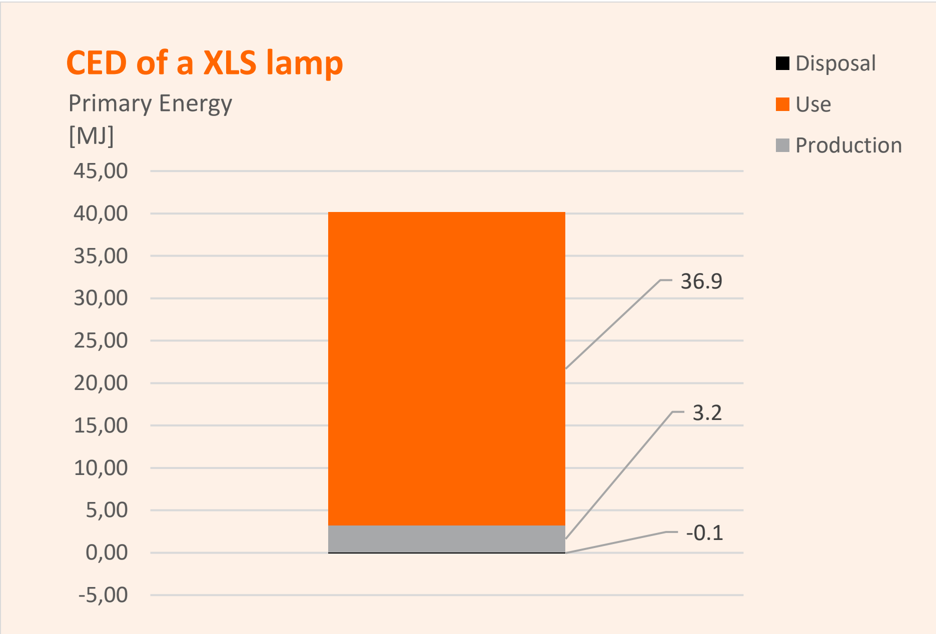
Considering the above fuel-to-power conversion efficiency of a car, fuel consumption and fuel production and distribution, the modelling software calculated the CED within the usage phase of the XLS lamp as 36.9 MJPrim.

CED in the disposal phase

In this assessment, incineration of the packaging, plastics, printed circuit board, adhesives and ferro metals of XLS lamps in a municipal waste-to-energy plant 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 aluminium parts of the product.

The CED of the entire lifecycle of XLS lamps

The following diagram shows the results of the entire lifecycle assessment of a LW5 lamp. Analysis shows that over 92% 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 (-0.21%) from energy recovery through the re-use of aluminium components and waste incineration.



A potential measure to reduce the primary energy consumption of signal lamps in cars is the replacement of the incandescent lamp technology with LED technology. Compared to a traditional signal lamp (P21W – 7506) savings up to 73% can be achieved.

Environmental impacts of all lifecycle phases of one signal lamp

Impact Category	**Unit**	**Production**	**Usage**	**Disposal**
Cumulative Energy Demand (CED)	MJ	3.23	36.90	-0.08
Global Warming Potential (GWP)	kg CO_2 eq.	0.18	2.68	0.03
Acidification Potential (AP)	kg SO_2 eq.	8.51E-04	3.10E-03	-5.53E-06
Eutrophication Potential (EP)	Kg PO_4 eq.	6.71E-05	6.35E-04	-6.00E-07
Photochemical Ozone Creation Potential (POCP)	Kg Ethane eq.	5.44E-05	3.99E-04	-7.31E-07

Human Toxicity Potential (HTP)	Kg DCB eq.	1.73E-02	8.66E-02	-5.11E-05
Abiotic Depletion Potential (ADP) (fossil)	MJ	2.25	34.90	-0.05