Electronics: LED Lighting
Case study Proton Electronica

PROTON ELECTRONICA, settled in Bizkaia (Basque Country) in 1981, is specialist in the design, supply, installation and maintenance of electrical and electronic equipment related to the quality and efficiency of electric power: uninterruptible power supply systems (UPS), voltage stabilizers, lighting controllers, power supplies AC/DC, inverters, etc. In addition, PE carries out energy audits in the areas of electric power, efficiency, lighting and safety in the power supply.

Supported by Gaia, the Association of Electronic and Information Technologies of the Basque Country, PE participated in the training provided by Fraunhofer technicians on how to use the LCA to go tool and therefore, how to apply life cycle thinking to their businesses model and how to improve the environmental performance of products.

In particular, the goal of PE was to assess the environmental impacts throughout the whole lifecycle of spherical luminaires optimizing the economic and environmental results according to the standard of Eco design ISO14006.

One of the major disadvantages of this type of lighting is the low luminous efficiency, as well as, that the warming produced by gas lamps causes the deterioration of the watertight joints, causing leakage of moisture, internal dirtiness and shorten lifetime. Additionally, many luminaries do not have top reflectors producing light pollution, disturbing neighbours, breaching regulations and wasting energy.

On the basis of seven years operational life, an assessment through the LCA to go tool was carried out with the following objectives: rehabilitate the existing luminaires reusing environmentally sustainable parts, glass spheres, sockets of cast aluminum and often tops, rods and rings, which make up the bulk of the weight and volume of the luminaire; reduce the consumption of the luminaire; avoid the environmental impact of manufacturing reused elements, their transport and packaging; reuse obsolete items that are removed in good conditions; reduce maintenance i.e. increase lamps lifetime and improve the quality of the light, safety and light pollution.

The assessment of LED lamps with the LCA to go tool faced the challenge that the embedded data models in the tool are made for computer products, and lighting products were not considered in the specification phase of the tool. Consequently, the tool does not provide datasets for LEDs and drivers, which had to be generated in the course of the mentoring as supplementary data for the assessment.

Data models for the LED have been derived from a publication by OSRAM (LCA of Illuminants, a comparison bulbs fluorescent lamps LED, 2009), scaled by the number of LED components. According to OSRAM data the manufacturing of each packaged LED chip comes with a carbon footprint of roughly 100 g CO_2-eq.. From industry insights in the lighting sector Fraunhofer IZM could derive a carbon footprint KEPI for a typical driver board assembly, which is 56 g CO_2-eq. per 1 g of assembled board, i.e. including semiconductors, diodes, capacitors and coils, other passive components, connector clamps and a single or double-sided printed circuit board. Scaling the board by mass is not fully accurate, but can give at least an approximation of the production impact of the LED driver board.

The results of the assessment with the LCA to go tool are shown in the following table:

	CF	Cu	Au	Ta	oREm	In	Co	Al	Stl	Nd	Pt,Ru,Pd	DQI
	kg CO_2-eq	g	g	g	g	g	g	g	g	g	g	
TOTAL per product lifecycle	391.29	-	-	-	-	-	-	432.00	172.80	-	-	
MANUFACTURING	98.20	-	-	-	-	-	-	660.00	264.00	-	-	
Housing & internal structural elements	89.27	-	-	-	-	-	-	600.00	240.00	-	-	
aluminium	6.21	-	-	-	-	-	-	600.00	-	-	-	
steel	2.84	-	-	-	-	-	-	-	240.00	-	-	
PVC	0.72	-	-	-	-	-	-	-	-	-	-	
Glass	8.30	-	-	-	-	-	-	-	-	-	-	
Drivers	11.20	-	-	-	-	-	-	-	-	-	-	
LED	60.00	-	-	-	-	-	-	-	-	-	-	
Display	-	-	-	-	-	-	-	-	-	-	-	
Printed Circuit Board Assemblies	-	-	-	-	-	-	-	-	-	-	-	
Tantalum capacitors	-	-	-	-	-	-	-	-	-	-	-	
Memory	-	-	-	-	-	-	-	-	-	-	-	
Processor	-	-	-	-	-	-	-	-	-	-	-	
Storage	-	-	-	-	-	-	-	-	-	-	-	
Optical Disc Drive	-	-	-	-	-	-	-	-	-	-	-	
Connectivity	-	-	-	-	-	-	-	-	-	-	-	
Power supply	-	-	-	-	-	-	-	-	-	-	-	
Cables	-	-	-	-	-	-	-	-	-	-	-	
Battery	-	-	-	-	-	-	-	-	-	-	-	
Overhead miscellaneous parts	8.93	-	-	-	-	-	-	60.00	24.00	-	-	
DISTRIBUTION	2.14	-	-	-	-	-	-	-	-	-	-	
Packaging	0.87	-	-	-	-	-	-	-	-	-	-	
Transport	1.26	-	-	-	-	-	-	-	-	-	-	
USE	294.15	-	-	-	-	-	-	-	-	-	-	
Power consumption	294.15	-	-	-	-	-	-	-	-	-	-	
Replacement	-	-	-	-	-	-	-	-	-	-	-	
END-OF-LIFE	-3.20	-	-	-	-	-	-	-228.00	-91.20	-	-	
Reuse	-	-	-	-	-	-	-	-	-	-	-	
Recycling	-3.20	-	-	-	-	-	-	-228.00	-91.20	-	-	

Clearly, the manufacturing of the LEDs dominates the production related carbon footprint.

Taking into account that spherical luminaires consume around 170kWh per year, the highest carbon footprint belongs to the use phase, but is much lower than with conventional lighting technology. Over 7 years lifetime the impact of manufacturing the LED lamps is roughly 25% of the total carbon footprint. It should be kept in mind that according to Proton Electronica, their aim is not only to save energy but also to avoid the generation of waste coming from the key components in the weight of the luminaire and manufacture new ones.

PE also seeks to achieve these objectives among the Circular Economy project, launched by the World Economic Forum and the Ellen MacArthur Foundation with support from McKinsey & Company. It is considered that the glass sphere, as well as, the closing system could be reused for more than 7 years, replacing only the LED during this period. According to the assessment by LCA to go such a reuse or life extension of bulk material parts can save almost 20 kg CO_2-eq. per lamp. Life Cycle Assessment results perfectly underpin Proton Electronica's product strategy.