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Environmental Impact Assessment of a Residential Light: An Approach system-product

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Summary— **This article presents the environmental** impact according **to** Eco **indicator 95 of a** residential luminaire from a product system **approach. This paper evaluates the environmental impact of the materials used in the luminaire, the energy consumed during the** production **stage,** the **materials used for** the **distribution and** marketing of the **product, the energy consumption during** the life of the luminaire and **the impact on the waste stage of** the **product. For the evaluation of the**environmental impac**to of the materials and processes, the Eco-it software was used** for the **simplified CVS life cycle of the product. Based on the results, we propose some ecodesign strategies to reduce** the environmental impact of **the product-system.**

Keywords— Ecodesign, Product life cycle management, LED lamp.

***Abstract*—This paper presents the environmental impact according to Eco indicator 95 of a residential luminaire from a product system approach. This work evaluates the environmental impact of the materials used in the luminaire, the energy consumed during the production stage, the materials used for the distribution and commercialization of the product, the energy consumption during the useful life of the luminaire and the impact at the product disposal stage. For the evaluation of the environmental impact of the materials and processes in the simplified CVS life cycle of the product, the Eco-it software was used. Based on the results, we propose some ecodesign strategies to reduce the environmental impact of the product- system.**

Keywords—Ecodesign, Product life cycle management, LED lamp.

I. Introduction

It is generally accepted that environmental considerations that span the entire life cycle of a product provide a holistic view and provide a better way to reduce the environmental impact associated with product-process systems [1]. Ecodesign considers environmental aspects that relate to a product throughout its life cycle, while seeking that the functions of the product are the most efficient. In addition to the benefits offered by ecodesign with respect to the reduction of impacts on the environment, other results of this practice are the reduction of costs, obtaining improved functions in the products and greater presence of the product in the market due to greater customer acceptance of environmentally friendly products [2].

In the last decade of the twentieth century, sustainable design focused on the product emerged [3]. Green design seeks to redesign the product to reduce its environmental impact, such as adopting the use of renewable energy. On the other hand, ecodesign by focusing on the entire life cycle of the product achieves a more significant environmental impact than green design. One of the strategies of ecodesign is to increase the life time of the products, however this time can be shortened by factors that are not technological and that are related to the psychological obsolescence of the product, that is, when the user perceives that the product no longer satisfys a desire, a need, a trend or a style. Emotionally durable design is another product-focused proposal, which seeks to extend the user-product relationship through strategies such as the search for user authenticity through product personalization, that is, the product shows affiliation. from the user to a social group or that the product is associated with a memory of the user. Ecodesign does not affect the behavior of the user regarding the consumption, use and disposal of products, for this reason the concept of a design for a sustainable behavior that is based on principles, to design so that the user wants and easily adopts a desired behavior or to design so that the user does not want or find it difficult to adopt a behavior contrary to the care of the environment. At the beginning of the XXI century, new methods of sustainable design inspired by the processes of nature are proposed, so the Cradle-to-Cradle design proposes that waste be biological nutrients for an open cycle or technological nutrients for a closed cycle, in such a way that society can continue to produce and consume in an economy that grows indefinitely. Another method is the biomimetic design that is inspired by nature and proposes to find the solution to human problems in the solutions that nature has already created, is based on the mimetic of forms, processes and ecosystems, where waste are the resources in a closed system of production and with sumo, similar to the Cradle-to-Cradle proposal [3].

However, the above methods arise in industrialized societies; far from the reality in which the majority of the human population lives, that is, in conditions of poverty and access to products and production systems that are unsustainable and in many cases economically unviable. For this reason, there is a need to innovate in sustainable design for the base of the socioeconomic pyramid, which seeks to provide solutions to the basic needs of access to services and products, in conditions of social exclusion, cultural and political, where companies make profits while bringing prosperity to society, but base-of-the-pyramid design should not be linked as a strategy to solve poverty problems and social inequality.

Innovation in design is crucial to reduce the environmental impact of products and their production processes, however it is not enough, because they do not modify business models. On the contrary, innovation based on an efficient ecological design of product-service systems changes the business model by proposing a mixture of tangible products and intangibl services is that they meet the needs of the customer, where the consumer ceases to be the owner of the product to one where he has access to the product and shares its use with other people when his needs have already been met.

In this paper, we present the evaluation of the environmental impact of a residential luminaire from a system-product approach. Currently lighting products consume a large amount of resources, about 15% of electricity and generate a considerable amount of toxic emissions, about 4.6% of greenhouse gas emissions [20]. The ECO-it software was used to measure the impact according to Eco indicator 95 considering the stages of the CVS Simplified Life Cycle of theproject. Unlike the common approach of assessing the environmental impact of a product only with respect to its energy consumption, over its lifetime. The main contribution of this work is to show the environmental impact also from the materials used, the stage of production, distribution, marketing and disposal of the product. Finally, based on the results of this evaluation and under the principles of ecodesign, we propose some strategies to reduce the environmental impact for the object of evaluation.

This document is structured as follows: shape: Section 1 provides an introduction to design of products sustainable; in the section 2 herself ago one revision of sustainable innovation, eco-design and lighting residential; in the section 3 are described the residential luminaire materials; in Section 4 describe the methodology of agreement of the Cycle of Life Simplified product CVS; in section 5 are displayed the results of the environmental impact of the product and on the section 6 herself Present the Conclusions.

II. LA SUSTAINABLE INNOVATION

A. *Sustainable innovation*

Sustainable innovation is an academic research topic that explores the relationship between ecodesign and sustainable business models that create value for all *stakeholders,* in as opposed to the traditional model that seeks a benefit exclusively for customers and shareholders of the company [4]. Sustainable business models are based on a set of four requirements: 1. A value proposition that provides measurable ecological and social value to economic value. 2. A supply chain with suppliers taking responsibility for their processes and products. 3. Customers motivated to a responsible consumption, use and disposal of the products and 4. a financial model that promotes a fair distribution of ecological and social costs and benefits.

Disruptive technologies will only be successful if they are accompanied by new business models; however, sustainable innovation and ecodesign does not only involve the use of new technologies, but a way to reflect on the need to achieve economic growth, while reducing the negative impact on the environment. environment and society; this concept is particularly importantwhenconsidering trends in population growth in cities, economic growth and environmental degradation [5]. For developing countries, adopting ecodesign methodologies opens up new possibilities for entrepreneurship based on sustainable business models.

The electronic equipment industry is a growing sector with a wide presence in global manufacturing, however it is also one of the industries that generates one of the largest environmental impacts in all stages of the life cycle of the product, from mineral extraction, production, use, energy consumption and even the disposal of equipment. An effective tool to prevent the environmental impact of electricaland electronic equipment is eco-design [6]. Some benefits of adopting ecodesign are compliance with standards and legal requirements that allow the manufacturer to access important markets, for example, in the European community there is the directive of waste electrical and electronic equipment WEEE, the restriction of certain hazardous substances in RoHS electrical and electronic equipment and the directive on the use of energy in EuP products. In addition, environmental certifications such as IPC Lead Free, EMAS, ISO 14001, ISO 14006, ISO 50001 and LEED are strengths that distinguish suppliers in supply chains. Finally, a product based on ecodesign is a mandatory value proposition to access the market of ecologically and environmentally responsible consumers that shows an upward trend [7].

Sustainable innovation goes hand in hand with the use of ecodesign tools and creative methods in collaborative work groups that generate new ideas [8], however this practice is little known for electronic equipment manufacturers. Innovation in sustainable products and production processes have a positive impact on business finances such as the reduction of operating costs, reduction of energy consumption, compliance with environmental regulations and the recycling of parts of disposal during operation, for example, the use of electronic product packaging is an area of opportunity to promote consumer participation in reducing environmental impact [9]. The World Business Council for Sustainable Development [10] proposes to companies sevenpractices to achieve eco-efficiency in their operations: 1. reduction of the intensity of the material used in production, 2. reduction of the intensity of the energy used in production, 3. reduction of the generation and dispersion of toxic substances, 4. promote recycling, 5. maximize the use of renewable natural resources, 6. extend the life time of the products and 7. raise the quality of the level of service. .

B. Ecodesign

Engineering plays a significant role in reducing the risks associated with the use and generation of toxic chemicals. It can contribute if the design of products, processes and systems does not include toxic chemicals in their production, repair, processing and maintenance. In addition, engineering can contribute to understanding the fate and transport of these chemicals, so that the damage they cause to ecosystems and human health can be eliminated or minimized [11].

The life cycle assessment method, one of the first tools developed for the assessment of environmental loads of products and processes, allows engineers to identify and quantify both direct and indirect environmental impacts, as well as energy and resource consumption. On the other hand, the correct application of the evaluation of the life cycle of a product requires a large amount of information about the product and its process, for this reason, in recent yearssome workshave focused on carrying out environmental assessments in stages prior to design activities, on the other hand the Eco Indicator 95 is one of the most used methods by designers for the evaluation of the life cycle of a product, usually used to evaluate the environmental impact of a system-product that exists in the market and that is desired redesign or create a new similar product from the previous one [12]. Some proposed strategies for the ecodesign of the s-product system are shown in Fig 1.

C. Residential lighting systems

In the ecodesign of lighting systems, the operation of the luminaire and the type of lamp used must be analyzed. The use of LED lamps achieves energy savings of up to 50% and in synergy with lighting controls, the savings can reach up to 93%. European regulations such as Reg. 874/2012 on the ecodesign of lighting systems of extended products, not only considers the efficiency of the lamp, that is, the amount of light radiated between the power consumed, it also considers the durability, maintenance, requirements of functionality, numbers of ciclos before presenting a failure and compatibility with energy saving systems [14].

Fig. 1. Ecodesign strategies System-product. Source: Own Elaboration

In residential lighting, LED lamps have a better efficiency of 73 lm/W compared to 22 lm/W of halogen lamps, Fig. 2, in addition the life time of an LED lamp can be up to 25 times that of a halogen lamp, Fig. 3. On the other hand, indirect CO2 emissions between LED and halogen lamps are similar; the units of indirect CO2 emissions in Fig. 4 in Mt CO2/Plmh represents the metric tons of CO2 on Petalumenes-hour associated with the extraction of materials and the manufacturing process of the lamps regarding the life cycle for case studies between 2009 and 2016 [14].

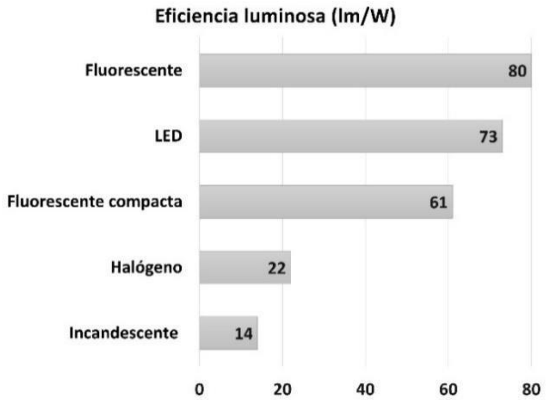


Fig. 2. Efficiency in residential lighting lamps. Source: Own Elaboration

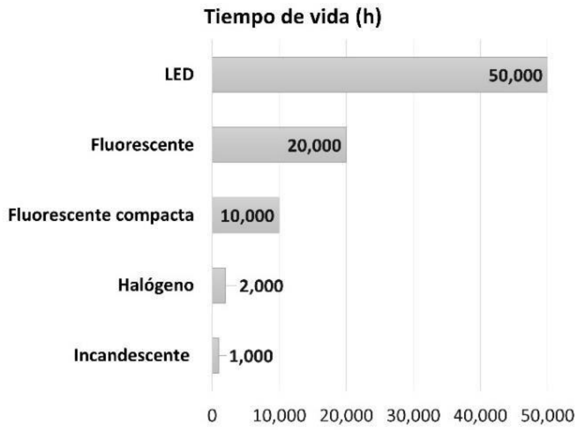


Fig. 3. Life time of residential lighting lamps. Source: Own Elaboration

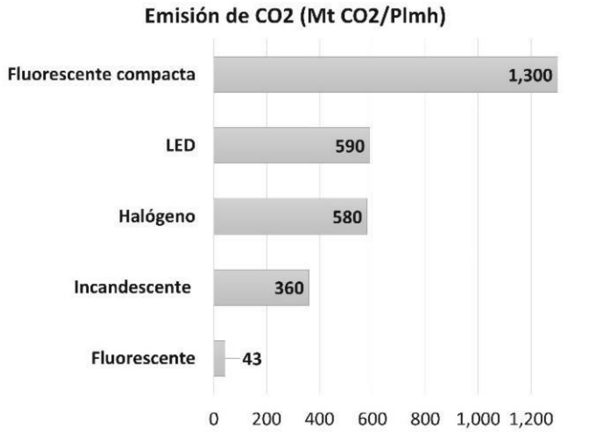


Fig. 4. Indirect emission of CO2 in residential lighting lamps. Source: Own Elaboration

III. MATERIALS

The product evaluated in this article is a residential outdoor luminaire model MX-JR008, manufactured in China and distributed in Mexico by the company MAXXIAMERICA S.A. de C.V. its price is 200 Mexican pesos in retail outlets. The product is distributed in an individual corrugated cardboard packaging, includes a tied sulf board packagingfor the halogenlamp and a polyethylene bag. Fig. 5 shows the explosion diagram of the parts of the luminaire, it should be noted that the plug is a component that does not include the supplier, but is necessary for its operation and that the user must purchase separately. Stake E is a product accessory that can be used to insert the luminaire above ground or can be discarded, rather than fixing the lamp with taquete and screw on the floor or wall. Table I shows the components of the luminaire.

The life time of the product according to the distributor's warranty is 2 years. The product uses a 2,800K light halogen lamp model MR16 with reflector that has an electrical power consumption of 35 W / 127 V / 60 Hz / 0.27 A. According to the manufacturer's information, its life time is 2,000 hours, it does not contain mercury and can be disposed of as household waste because it complies with EC standards for marketing in the common market of the European Union and RoHS on material restrictions dangerous in the manufacture of electrical equipment. The halogen lamp that includes the product must be replaced by the user up to 4 times over the course of the two years of the luminaire's lifetime. Assuming that an average of 10 daily hoursisused, the calculation of bimonthly electricity consumption is shown in (1).

Fig. 5. Explosion diagram of the outdoor parts of the luminaire. Source: Own Elaboration

TABLE I. COMPONENTS AND LUMINAIRE MATERIALS. FUENTE: ELABORACIÓN PROPIA

Id	Description of the material
In	Common glass window Sodium-Calcium, recyclable material.
SV	Flexible silicone window seal, it is a NON-recyclable material.
SC	Seal for flexible silicone cable, in a NON-recyclable material.
T	Galvanized steel screws, 35% carbon steel ANSI 1035 with Zn coating, ASTM ɣclable or reusso material.
TB	Injected aluminium base cover for assembly to the B base of the luminaire.
B	Injected aluminum base, recyclable material.
F	Halogen lamp of common Sodium-Calcium glass structure, tungsten filament W, and encapsulated Bromine Br gas, for impact calculations n mPt the presence of W and Br is omitted.
S	Cold rolled steel bracket, carbon steel 24% ASTM A283, material reciclable.
And	Stake for inserting the lamp on the ground, piece of lene made of recyclable material.
A	Galvanized steel washers, 35% ANSI 1035 carbon steel with Zn coating, ASTM A153, or reusing material.
AND	Bronze threaded insert 88% Cu and 12% Sn for the ɪe base of the luminaire, recyclable material.
D	Carbon steel disc 24% ASTM A283 rolled joined inside the base.
BSC	Contact base, dielectric ceramic piece (50% clay, 25% SiO3 and 25% feldspar) to support the lamp contact. The part is attached to a disk D and an LC contact sheet. It consists of copper terminals inside attached to a cable segment.
LC	Galvanized sheet of 24% carbon steel and Zn coating ASTM A153, joined by screws to contact base and disk D.
AND	PVC cable insulation. Usually discarded in burning.
C	Copper electrical conductor cable, recyclable material.
BC	PVC material, consists of 3 parts that are assembled by screws.
EC	Copper spikes recessed in the peg. The cable fixed by screw to 3 spikes.

$$
\begin{aligned}
&Consumo\ Electrico\\
&= (35\,[W])\,(10\,[\frac{horas}{dia}])\,(\frac{1\,kWh}{1000\,W})\,(\frac{60\,dias}{Bimestre})\\
&= 21\,[\frac{kWh}{Bimestre}]
\end{aligned}
\qquad (1)
$$

The cost bimonthly in Pesos Mexican MXP What herself Sample in (2), Corresponds to the case of one consumption basic in a 75kWh household, where the energy supplier's tariffelectric CFE it of 0.799 MXP/kWh since March 2019.

$$
\begin{aligned}
costo &= (21\,[\frac{kWh}{Bimestre}])\,(0.799\,\frac{MXP}{kWh})\\
&\approx \$\,18\,MXP
\end{aligned}
\qquad (2)
$$

Considering the two years of the life of the luminaire, the total electricity consumption will be 252 kWh and the cost of electrical energy without considering inflation and additional increases, would be approximately $ 216 MXP

.

IV. METHODOLOGY

The system-product analysis for the outdoor garden luminaire was elaborated taking into account the stages of the CVS Simplified Life Cycle [2] of a product, Fig. 8, which consists of: 1. obtaining the materials, 2. production, 3. distribution and marketing, 4. use and 5. End of life of the product. Version 1.4 of the ECO-it software [15], Fig. 6, which is based on the methodology of Eco indicator 95 for thecalculation of the environmental impactin milliPoints. A 1 Pt = 1,000 mPt and a 1 Pt represents one hundredth of the annual environmental burden of an average European citizen.

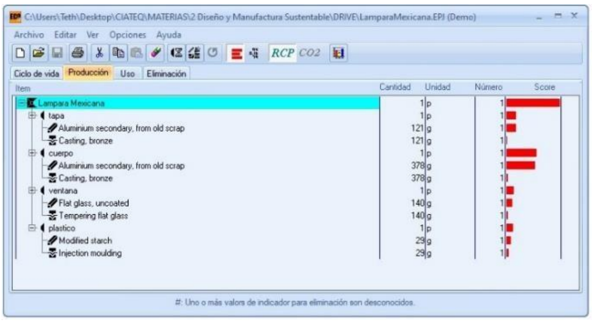


Fig. 6. Eco-it software user interface. Source: PRé Consultants and Ihobe

Tables II, III and IV summarize the environmental impact by material resources, by energy consumption in processes in the production stage and in the distribution stage of the product life cycle, respectively.

BOARD II. IMPACTO ENVIRONMENTAL BY RESOURCES MATERIALS.FUENTE: ELABORACIÓN PROPIA

Material	Impact of toxic emissions
Pe Polyethylene	The additive bisphenol-A is an endocrine disruptor that affects the hormonal system, it is used in the manufacture of many plastic products that leach as the plastic ages. In
Polypropylene PP	The decomposition of PP and PE produces hydrocarbon gases such as methane.
Vinyl	Vinyl chloride is a human carcinogen, which
Silicone	Low toxicity, low chemical reactivity synthetic polymer with thermal stability d 250°C.
Cardboard	Emission of dioxins derived from the use of compounds with chlorine and emission of contaminants of sodium hydroxide NaOH and sulfates SO_{4-2} that are used for treatments of wood chips in the production of paper.
Electric porcelain	Composed of clay, silicon dioxide and feldspar. Emission of volatile substances during drying, and generation of dust. In the production, wastewater is generated with the presence of suspended solids, heavy metals and bromine compounds.
Glass	Sodium-Calcium glass is made from non-toxic raw materials such as sodium carbonate, limestone and dolomite. Its volatile pollutants such as$_{CO2,SO2,}$ OnCl and F come from the decomposition of these materials and their impurities.
Copper	Acidic soils from pyrite waste. Contamination in water sources by sulfuric acid H_2SO_4 and cyanide. Atmospheric emission of sulfur dioxide SO_2,nitrogen oxides NO_X carbon monoxide CO and non-metallic volatile organic compounds. Emission of 10µm particles of heavy metals Cr, Pb and Cd.
Five	
Aluminium Bronze	
Steel	
Galvanized sheet	They come from the NaOH alkaline degreasing process, HCL H_2SO_4 acids and cleaning

TABLA III. IMPACTO BY PROCESSES IN THE PRODUCTION STAGE. FUENTE: ELABORACIÓN PROPIA

Parts production	weight	Environ mental impact
Frosted cutting of part V	4 g	0.111 mPt
Cold pressing of S, D, LC and A parts	6 g	1.048 mPt
Manufacture of part F by injection of glass	25 g	14 mPt
Manufacture of part E by PP injection	3 g	1.5 mPt
Manufacture of parts B and TB by injection of Al	60 g	8.7 mPt
Application of electrostatic paint in parts B and TB	9.5 mm^2	0.0048 mPt
Application of electrostatic paint on S and D parts	500 mm^2	0.5 mPt
Machining IR bronze threaded insert	10 g	17 mPt
Machining of T and TC parts	11 g	7.1 mPt
Galvanizing of T and TC parts	100 mm2	0.00079 mPt
Molding of SV and CV silicone seals	7 g	3.1 mPt
BSC molding in electric ceramics	1.5 g	0.24 Pt

TSISTER IV. IMPACTO IN THE STAGE DISTRIBUTION. FUENTE: ELABORACIÓN PROPIA

Packaging	weig ht	Environ mental impact
Box	200 g	7.8 mPt
Bag	5 g	1.8 mPt
Label	1 g	0.38 mPt
Maritime container	2300 medical history	14 mPt

At the stage of use of the product, the highest environmental load is 18,000 mPt and is due to the emission of greenhouse gases associated with the consumption of electrical energy in the two years of the life of the halogen lamp. In the Eco-it software, the *Use → Energy → Non renewable electricy → Electricity, oil 101 mpt kWh*option was selected, because in Mexico 62% of the energy is obtained by burning oil according to information from SENER. At the end of life stage of the product the environmental impact is 34 mPt.

V. RRESULTS

According to the CVS Simplified Life Cycle Assessment [2], Fig. 7 shows the environmental impact in mPt per part at the production stage. The piece with the highest score is the bronze IR threaded insert with 17 mPt,followed by the halogen lamp F and the parts of the base B and cover of the aluminum TB base that make up the body of the luminaire. The individual cardboard packaging of the luminaire also generates a significant environmental impact of 7.8 mPt. It should be noted that the bronze insert is not an essential piece for the operation of the luminaire and can be manufactured in another material that has a lower environmental impact.

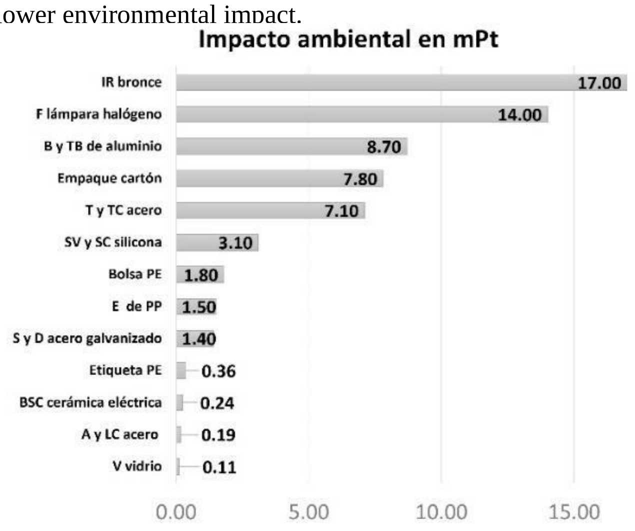


Fig. 7 Score by production parts. Source: Own Elaboration

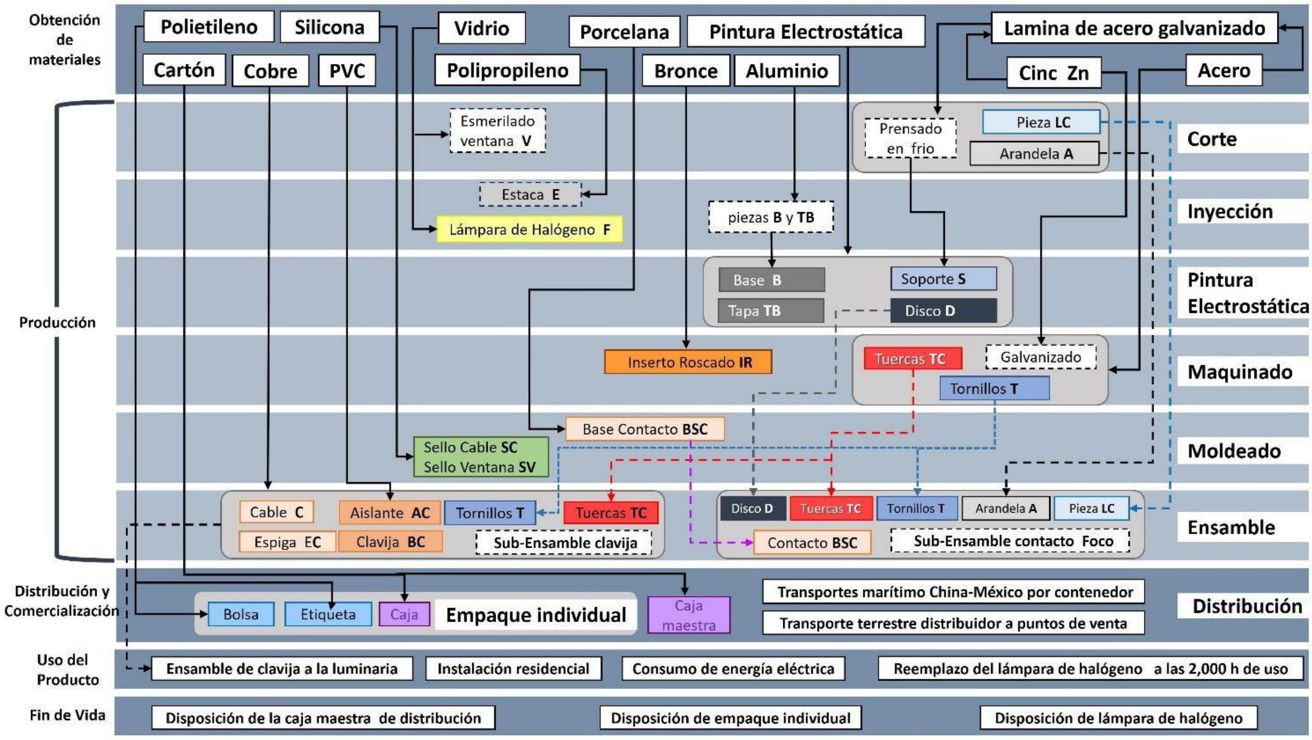
Table V shows a comparison between three possible product use cases. Case 1 considers the electricity consumption of 252 kWh for two years in the option of generating electricity by burning fuel oil. Case 2 corresponds to the use of the lamp for a consumption of 21 kWh during a two-month period; under the same criterion of electricity consumption from non-renewable sources, described in case 1. It is favorably observed that the highest score corresponds to the use of the product above its production and disposal.

TABLA V.COF THE SCORE FOR TWO POSSIBLECASES REGARDING THE USE OF THE HALOGEN LAMP. FUENTE: ELABORACIÓN PROPIA

	CASE 1 **Use 2 years**	CASE 2 **Use 1 bimestre**
Life cycle	18,000 mPt	2,300 mPt
Production	130 mPt	130 mPt
Use	18,000 mPt	2,100 mPt
Elimination	34 mPt	34 mPt

EN FIG.9 THE CASE 2 SCORE GRAPH FOR PRODUCTION, USE AND DISPOSAL OF THE LUMINAIREIS SHOWN. SE NOTES THAT THE ENVIRONMENTAL IMPACT AT THE PRODUCT DISPOSAL STAGE IS LOWER THAN THE PRODUCTION STAGE, BECAUSE MOST METAL PARTS CAN BE RECYCLED OR REUSED, WITH THE EXCEPTION OF THE HALOGEN THAT IS DISPOSED OF IN LANDFILL AND PRODUCES 14 MPT OFENVIRONMENTAL IMPACT. CON BASE IN THE ABOVE ANALYSIS THE FOLLOWING IMPROVEMENTS ARE PROPOSED TO THE SYSTEM-PRODUCT ACCORDING TO THE STAGES OF THE CVS OF THE FIG.8

Fig. 8. Simplified CVS life cycle of the system-product.
Source: Own Elaboration



D. Proposals for *improvements to the CVS of the product-system.*

At the stage of *obtaining materials*, it is suggested to avoid the use of toxic materials such as vinyl chloride [17] that end their life cycle in landfills or incinerators. By comparison of environmental indicators, the use of recycled metals, plastics and cardboard on new materials is preferable.

At the *production* stage, it is suggested to avoid energy consumption bypartnering the machining of parts not essential for the operation of the product such as the threaded insert IR bronze. Replace galvanized parts with stainless steel to increase the life of the product, plus stainless steel does not degrade during the recycling process [18].

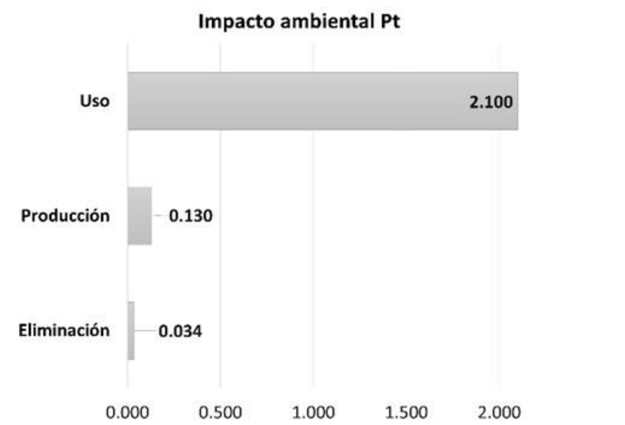


Fig. 9. Graph score of Production 130 mPt, Elimination 34mPt and Use 2,100 mPt for a consumption of 21 kWh during 1 bimestre of electrical energy generated by the burning of fuel oil. Source: Own Elaboration

At the *distribution and marketing* stage of the product, it is suggested to prefer a local supplier of the product to avoid the use of maritime transport and reduce greenhouse gas emissions [19]. And use recycled material for individual packaging and replace the master box with reusable pallets for the distribution of the product to the points of sale.

At the stage of *product*use, it is suggested to replace the Halogen lamp with an LED lamp of the same MR16 standard to increase the life time of the product and reduce energy consumption [19-20], Fig.10. Include an electronic switch by intensity of sunlight to avoid its use of the product in daytime hours. Avoid accessories for the installation of the product that can be discarded without being used, as is the case of the polyethylene E piece and the polypropylene bag.

At the *end* of *life* stage, it is suggested to promote the recycling of the luminaire when its life cycle ends through an economic incentive at the points of sale.

Fig. 10. MR16 Standard for Halogen Lamp and LED Lamp: Source: Philips

Fig 11. shows a comparative ecological profile between the current product and the proposals for improvement. The ecological profile is a comparative tool where the five etapas of the life cycle of the product plus the improvements in its function are subjectively evaluated on a scale of 0 to 10due to the benefits provided by ecodesign such as: the reduction of toxic waste and greenhouse gases, reduction of the environmental impact by the use of materials recycling andre-use of parts, process improvements and production costs due to the disposal of parts and non-essential operations. It should be noted that the replacement of the halogen lamp by an LED lamp in the same MR16 standard significantly increases the life time of the product, reduces energy consumption at the stage of use of the product and the associated costs to be paid by the user.

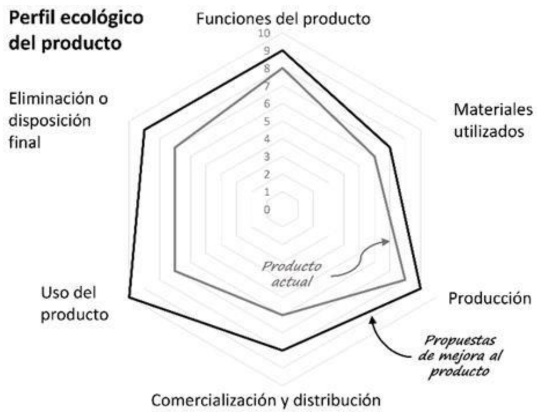


Fig. 11. Comparison of the ecological profile of the current product against the proposals for improvement to the product. Fuente: Own Elaboration

VI. Conclusiones

The greatest environmental impact of the system product of the luminaire is due to its use with 18,000 mPt compared to 130 mPt of production and 34 mPt of elimination, for an electrical energy consumption of 252 kWh of non-energy sources renewables during the life of the product of two years. Consequently, the improvement proposal to replace the halogen lamp with an LED lamp of the same MR16 standard is the first ecodesign strategy to reduce the environmental impact of the luminaire, because it proposes to reduce energy consumption and increase the life of the product.

Replacing the LED lamp with a Halogen lamp can increase the sale price of the product, but its life time is increased, in addition to reducing the consumption of electrical energy and its cost for the final consumer, during the use stage.

Otherstrategies to improve the system-product are the replacement of machined parts, such as the IR bronze threaded insert, which are not essential for the operation of the lamp, but whose operation requires a high energy consumption. It is also advisable to stop producing plastic accessories for the installation of the product that can be discarded unused, this strategy in addition to reducing the environmental burden would have an impact on the costs of production, packaging and transportation. In addition, the manufacture of the luminaire by a local supplier close to the points of sale can reduce the emission of greenhouse gases associated with transport.

The strategy of replacing galvanized steel parts with stainless steel can raise the unit cost of the luminaire, however, it would improve the customer's perception of the quality and durability of the product. On the other hand, the use of recycled materials in the materials of the luminaire and its packaging contribute to the reduction of costs, as well as its ecological footprint. regarding the use of new materials.

The use of toxic materials, such as vinyl chloride, should be avoided because at the end of the life cycle of the product, some parts are discarded in landfills or incinerated to recover valuable materials, such as copper, unfortunately this practice is common in Mexico due to the conditions of poverty of some sectors of society.

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