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A circular economy approach for lifecycles of products and services

D6.1a On site demonstration of CEBM for industrial and domestic lights

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Summary

The aim of WP6 is to integrate the new Circular Economy Business Models (CEBMs) developed in WPs 1-3, including Co-creation of Products/Services model, Collaborative recycling/reuse model, and Sustainable Consumption model, into the demonstration cases. WP6 will demonstrate the CEBMs to key actors through the value chain of the electrical and electronic products and farming/agri-foods (vegetable food and meats). This WP will test and validate the different CEBM to be developed, in a number of demonstration scenarios, and prepare for up-scaling to other areas.

Deliverable 6.1 is the culmination of this, and the main aim of the deliverable is to demonstrate the CEBMs listed above, within the industrial and domestic lights sector. This has involved the following work:

(1) demonstration of co-creation of lighting products, such as end-user requirement, product design, sustainable production. This has been achieved through various methods for both the domestic and industrial lighting demonstration, including development of a sustainable production approach, development of the product design specification (PDS) following the method developed in WP1, PDS evaluation and further development through Living Lab (LL) approach developed in WP7, Life Cycle Assessment (LCA) studies, and the big data technique developed in WP3.

(2) demonstration of sustainable consumption, such as eco-points method applied, and eco-information in product manual. The eco-points method developed in WP1 was applied to both lighting products. The eco-information included in the product manual/lighting project proposals and provided for consumers together with product's manufacture information. For the domestic lighting, ONA also demonstrated the eco-shopping in their online store using the approach developed in T3.1.

(3) demonstration of collaboratively recycling/reuse, enabling the consumer to recycle their light products when they arrive at the End of Life (EoL) (linked to Task 6.2). For domestic lighting, this has been achieved through both logistic and internet-based recycling manners, incentivised by the eco-credits scheme developed in T2.5. For industrial lighting, a leasing service business model has been developed through the co-creation method to further incentivise and control the reuse and recycle of the developed modular product.

These demonstrations were conducted in both physical and virtual events and involved various key stakeholders in order to capture validation for the work that had been carried out. The events showcased both the industrial luminaires manufactured by Kosnic, and the domestic lights manufactured by Ona. The events also showcased exactly how the new CEBMs have been implemented within and throughout the product life cycles, from initial design, development, manufacture, supply, and EoL.

Task 6.2 has shown how the CEBMs developed in WPs 1-3 can be implemented in real world scenarios. It has also shown that the methods developed, and the structure for the CEBMs, is also transferable to various industries and sectors, and could be very popular with key stakeholders if they were deployed to the market after the project duration.

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Acronyms and abbreviations

Abbreviation	Description
CCT	Correlated Colour Temperature
CEBM	Circular Economy Business Model
CEL	Circular Economy Leasing Company
CO_2	Carbon Dioxide
CRI	Colour Rendering Index
DALI	Digital Addressable Lighting Interface
E-LCA	Environmental Life Cycle Assessment
EoL	End of Life
EPCIS	Electronic Product Code Information Services
EU	European Union
FM	Facilities Management
ICT	Information and Communications Technology
IND	Indumetal
KoM	Kick-off Meeting
KOS	Kosnic Lighting Ltd
LCA	Life Cycle Assessment
LED	Light Emitting Diode
LL	Living Lab
NTU	Nottingham Trent University
OIC	Open Innovation Camp

PCB	Printed Circuit Board
PDS	Product Design Specification
Q&A	Question and Answer
S-LCA	Social Life Cycle Assessment
W	Watt
WP	Work Package

1 Introduction

The aim of Task 6.2 is to demonstrate the Circular Economy Business Models (CEBMs) created in WPs 1-3 through the industrial and domestic lighting markets.

WP1 developed approaches for the implementation of co-creation of products and services with sustainable features, throughout the product development process. This was undertaken by both Kosnic (industrial lighting) and Ona (domestic lighting) by addressing end-user, and key stakeholders, requirements at the beginning of product development. This, coupled with Life Cycle Assessment (LCA) studies, allowed for ongoing development of the product design specification (PDS) following the methodology developed in WP1. In the previous FP7 myEcoCost project (www.ecocost.eu), an eco-cost method (mainly material footprint and carbon footprint) was developed. The eco-cost concept has been further developed by the CIRC4Life project based on the eco-point method (see Deliverable 1.3 for further information), which provides information for three endpoints: human health, ecosystem and resource availability. The CIRC4Life's eco-cost method has been successfully implemented in the demonstration.

WP2 was devoted to the development of business models based on the collaborative recycle and/or reuse of goods and products. For the domestic lighting products produced by Ona, customers recycle their End of Life (EoL) lighting products on demand via the logistic or the Internet-based recycling manners. For the industrial lighting product, Kosnic developed a leasing service eco-system. This allows Kosnic to look after the lights throughout the service life of the product and provide necessary services, such as repair, to enable the product's performance, and take-back the products when they reach EoL, then the recycling, reuse and remanufacture will be implemented with those EoL products.

WP3 aimed to develop methods/approaches to implement the sustainable consumption business model, interacting with the approaches that will be developed within the other two CEBMs. The eco-points method developed in WP1 was applied to the two lighting products. In the case of Ona, the eco-information of the products, including the eco-points, are informed to customers when the product is on sale. This is demonstrated within their online store using the approach developed in T3.1. For Kosnic, the eco-information of the product, or LCA comparison descriptor, is included in prospective project proposals to inform clients of the sustainability of the new modular industrial LED luminaire.

The goal of this task was to demonstrate exactly, and specifically, how these CEBMs were implemented. This section of the Deliverable (6.1a) will focus on the industrial lighting demonstration by Kosnic specifically. Further information on the domestic lighting demonstration by Ona can be seen in Deliverable 6.1b, found later in this document.

2 Co-creation of lighting products

2.1 Objectives

CEBM1, the co-creation of lighting products, has been implemented by both Ona, with domestic lighting, and Kosnic, with industrial lighting. Due to the differences of domestic and industrial end-users, two approaches have been utilised. For Ona, a domestic-consumer focused approach has been utilised. For Kosnic, an industrial-user focused approach has been utilised. The main objective of the CEBM has been the development of both domestic and industrial lighting products by addressing key stakeholders' requirements from the beginning of product development in order to increase product sustainability. To achieve this, and implement this CEBM effectively, the following work was completed:

- For domestic lighting products, ONA applied the big data technique developed in WP3 to mine consumer preferences via large volumes of light products' reviews and comments through social media websites, such as Amazon and eBay, as well as the ONA Website.
- For the industrial lighting product developed by Kosnic, the end-users are specialist industrial users. Due to this, the user-group approach developed in WP7 was applied to address the end-users' requirements. This included end-user workshops, semi-structured interviews, and user feedback via online survey.
- Development of the PDS following the method developed in WP1, which included embedding the eco-constraints into the PDS which helped to govern the product development process.
- The PDS was evaluated and developed further by using the Living Lab (LL) approach developed in WP3, which involved various stakeholders in the value chain of the lighting products.
- LCA studies (both environmental and social) were conducted to evaluate the environmental and social impacts through the product life cycle.
- Development of a sustainable production approach based on the results of FP7 cycLED project http://www.cycled.eu/ (NTU was the leader of the Sustainable Production WP and Ona produced a domestic LED light as a demonstrator of the project) and CIP Ecolights project https://ec.europa.eu/environment/eco-innovation/projects/en/projects/ecolights (ONA was the project co-ordinator and NTU was the key technology provider) and reinforced with those obtained in CIRC4Life project. Working together with KOS to further develop a sustainable production approach based on the cycLED and Ecolights results, this was demonstrated via the manufacture of KOS industrial lights and ONA domestic lights on this project.

This section of the Deliverable, 6.1a, will focus on the industrial lighting demonstration of Kosnic specifically, with this section detailing exactly how CEBM1, co-creation of lighting products, has been implemented throughout the project. For details on how this CEBM has been implemented within the domestic lighting demonstration by Ona, please see Deliverable section 6.1b, later in this document.

2.2 DEMO 1A Kosnic Lighting Ltd.

2.2.1 Activities

Development of the PDS with reduction of product impact on the environment

Design is the most important phase for reducing the product's impact on the environment, because over 80% of all product-related environmental impacts can be influenced during the design phase [1 - EU Science Hub. 'Sustainable Product Policy']. Product design specification (PDS) is a fundamental control mechanism that allows the success of the product development. Therefore, it is important to address the product's impact on the environment in the PDS. However, although the PDS method has been applied in product design for many years, the incorporation of reducing product impact on the environment in the PDS has not been given enough attention. To address this issue, the CIRC4Life project developed an approach to utilise the PDS with reduction of product impact on the environment throughout the product development process, which can be seen in a later section.

The PDS documents for both domestic and industrial lighting products, which are manufactured by Ona and Kosnic respectively, were initially developed based on eco-constraints, sustainability related regulations/directives/standards, and product technical requirements. The initial versions of PDS documents were developed at the early stage of the CIRC4Life project, in Month 4, and are detailed in Deliverable 1.1.

Further development of the PDS for the industrial luminaire demonstrator through LL activities

End-users of the Kosnic demonstration are usually industrial users (e.g. warehouse owners), who are not as widely available as the users of domestic lamps. Therefore, the Living Lab approach developed in WP7 was applied to address the end-users' requirements, such as end-user workshops, to refine the initial PDS developed in Deliverable 1.1.

Figure 1 Co-Creation Workshop at the LIA in May 2019

As part of the LL framework, a one-day Co-Creation workshop was facilitated by Laurea at the Lighting Industry Association (LIA), Telford, UK on 28 May 2019 using various service design canvases, brainstorming techniques and mock-ups. The workshop was targeted at: facility management companies, wholesalers, Lighting Industry Association (LIA) experts, contractors, Carbon Trust etc. All the initial PDS items were reviewed in the workshop, but two PDS groups (i.e. operation environment; functional and performance requirement) were deeply discussed, and corresponding suggestions were also provided by the invited stakeholders, which were referred by the Kosnic technical team to re-define these PDS items. For example, the optics choice was suggested by the participants from the view of luminance performance maximum, then

Kosnic technicians converted it into a more detailed specification (i.e. include 90-degree beam angle and polarised 40 degree) based on the products overall characteristics and applied into the final product manufacturing. Those revised PDS items are described as following and the final PDS is shown in Appendix 1.

1) Operation Environment

The LED light product developed by Kosnic in the CIRC4Life project is designed to be used in a commercial or public environment, with higher ceiling, such as warehouse, exhibition hall, sport hall and barn etc.

- Impact protections need to be higher than IK8[1].
- Optics choice to include 90-degree beam angle and polarised 40-degree beam angle.

Originally, the product was focused on warehouse/industrial applications only. Following the co-creation workshop at the LIA, and after discussions with specialists in the lighting industry, it was recommended to expand the application into other areas, such as exhibition and sports halls. A higher impact protection rating, and a 90-degree optic option was recommended for such applications and thus added to the PDS. As the focused application for the product was based on indoor areas, the requirement for IP65[2] ingress protection was removed, as it was unnecessary and complicated the design and manufacturing process.

2) Functional and performance requirement

This section details the technical specifications required. It provides sufficient information that allows the design engineers to complete the product development without ambiguities.

- **Luminaire Body**

  This luminaire comprises 3 parts, base unit, gear tray and lighting unit.
  - Base unit: This is the mounting plate, including fixing openings and wiring entry. It can be used for surface-mount and suspended mount. The wiring terminals are also prefixed to this base unit. After wiring, the gear tray and lighting unit are mounted to this base unit.
  - Gear tray: This metal tray holds the LED drivers and control modules.
  - Lighting unit: This front metal panel holds the LED board and optic lens.
  - Protection: Class I, >IK8
  - Material: folded sheet metal (steel with powder coating)
  - Fixing: suspended and surface mounting.

The new specification outlined above was significantly simplified in order to minimise material use. Following discussions with lighting specialists at the LIA workshop event, it was also suggested that emphasis in design should be made to include easier installation steps.

- **Driver Module**

  Control Gear: This unit compromises multiple LED driver modules interlinked with power bus and control bus.
  - Housing: Polycarbonate Housing
  - Dimming: PWM dimmable
  - Type: isolated

[1] IK ratings are defined as IK and a number from 00 to 10. This indicates the degree of protection provided by the electrical enclosures against external mechanical impacts. IK08 is protected against 5 joules impact. Equivalent to impact of 1.7kg mass dropped from 300mm above impacted surface.

[2] IP (or "Ingress Protection") ratings are defined in international standard EN 60529 (British BS EN 60529:1992, European IEC 60509:1989). They are used to define levels of sealing effectiveness of electrical enclosures against intrusion from foreign bodies (tools, dirt etc) and moisture. The first digit is intrusion protection. “6” means total dust tight. The second digit is moisture protection. “5” is rated as protected against low-pressure jets of directed water from any angle.

- Flicker: Non-flicker
- Wattage: 75W/100W driver module

Instead of having one driver per LED engine, which was the design included under the initial PDS, the updated PDS includes a modular driver system that allows the output current to be combined over the power bus. The combined current drives all LED engines. This development was introduced following discussions at the co-creation event at the LIA workshop. Discussions at the event highlighted that under the old initial spec, if a driver fails, the corresponding LED module would also be off. This would reduce user experience.

- **LED Engine**

  This is a LED lighting unit that includes LED PCB board, heat sink and optic lens.
  - LED Chips: High efficient LED chip. (Possibly 3030 1W)
  - PCB board: Aluminium 1.5mm (the LED PCBs is replaceable)
  - CCT: 6500K (Optional LED board of other CCT)
  - Optic Lens: Replaceable, 90 degree and Polarised 40 degree
  - CRI: >80
  - Watt: 40W / LED module
  - Lumen: >6000lm /Module
  - Heat Sink: folder sheet steel
  - Aluminium (from bauxite): 227-342MJ (63,000 to 95,000 watt-hours)
  - Iron (from iron ore): 20-25MJ (5,550 to 6,950 watt-hours)
  - Steel (from iron): 20-50MJ (5,550 to 13,900 watt-hours

Per discussions with customers and specialists at the LIA workshop, it was strongly recommended to allow the LED boards and LED lens/optics to be replaceable.

- **Emergency Module**

  Lithium battery emergency module could be plugged in the modular driver system. Output Wattage: 4W
  - Output Lumen: >600lm
  - Time: >3hrs (initial emergency time should >hrs)
  - Function: Selftest as standard
  - Indicator: Red/Green. The light should be strong enough, so it is visible from distance of 9m.

- **Sustainability considerations**

As mentioned above (under LED Engine), it was strongly recommended that all functional modules such as LED boards, drivers, lens/optics should be made replaceable where possible for sustainability reasons.

Life Cycle Assessment

In order to ascertain current impacts on the environment and society, LCA studies were conducted on an existing industrial LED luminaire from the Kosnic range. The object of analysis was one unit of a KMSD100LLBE (Arcus Compact), a lighting product for general industrial use seen in Figure 2 below. The inventory data is listed as follows:

Assembly Component	Material	Amount	Unit
Housing	Plastic	0.29	kg
	Steel	2.199	kg
	Aluminium	1.1	kg
LED driver	Plastic	0.172	kg
	printed circuit board	0.688	kg
LED lighting board	LED	0.32	kg
	Aluminium	0.012	m2
Junction Box	Plastic	0.02	kg
Press button	Plastic	0.007	kg
Fasten members	Steel	0.07838	kg
	Plastic	0.0016	kg
Packaging	printed board box	1.17	kg
	plastic film	0.0003	kg
	paper	0.0004	kg
	plastic form	0.066	kg
Electricity		4000	kWh
Shipping		56451.96	kg*km
waste aluminium		1.1	kg
waste steel		1.854	kg
Solid waste		1.7667	kg
Electronic waste		0.86	kg
Waste paperboard		1.8537	kg

Figure 2 100W LED Low Bay Luminaire (KMSD100LLBE) Under Assessment

Figure 3 shows the main contributors of the overall environmental impact. The results of the environmental study showed that impacts were dominated by the production phase, as the manufacture stage is an input-output intensive stage where the majority consumption of materials and energy have taken place. as seen in Figure 3 below. Use of the product in the base scenario also plays a notable role in the environmental burden. It is noticed that different energy sources of producing electricity significantly affect the environmental impact of the product, this study assumes that the energy source in the use phase is from the UK according to the target market. In the meantime, Transportation and EoL phase contribute very limited (EoL shows a small number of positive effects) impacts to the total environmental profile, thus has been removed from Figure 3.

Impacts of Use stage mainly come from the consumption of electricity, since production of electricity requires a large number of material and transportation inputs even though photovoltaic power is applied in the analysis, the emissions generated from the whole production process also lead to several environmental issues, consequently, contributing more impacts compares to other life cycle stages. It is assumed that the functional unit after service time is processed in compliance with the WEEE directive, in which, electrical devices in the LED lighting product are disassembled from the product and placed in a recycling waste bin, then sent for material recovery. Other parts of the lighting product are disposed of as general solid waste.

Packaging waste is separated from the general waste bin, then is incinerated. A full detailing of the study can be found in Deliverable 1.2.

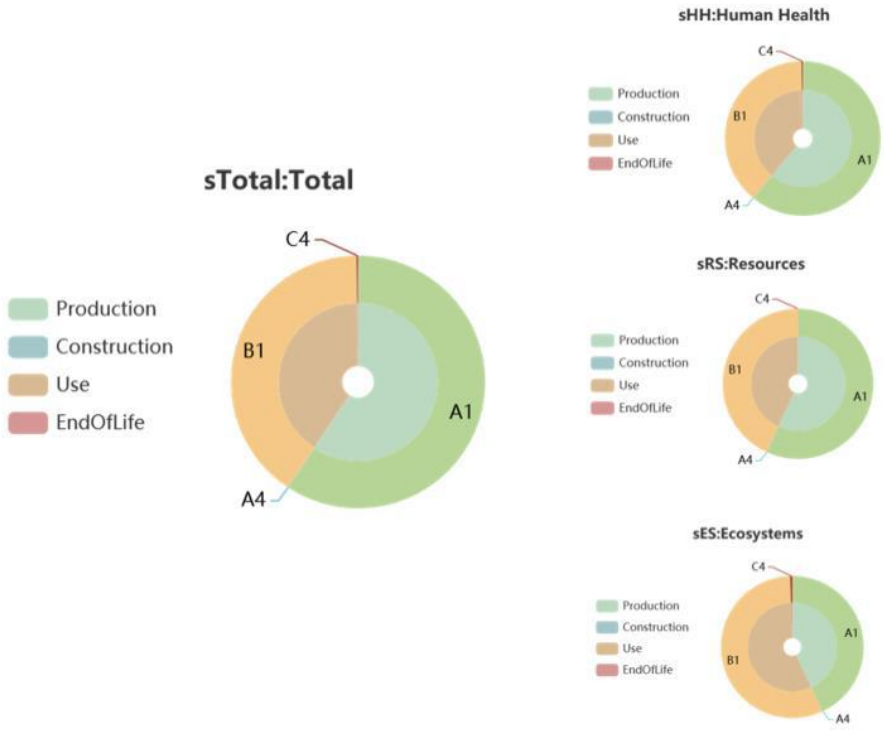


Figure 3 Life Cycle Stage Contribution Results in Endpoint Impact Categories

After analysing the results, several recommendations were made in order to improve environmental impact by making necessary changes/developments to the proposed PDS. Specifically, the recommendations made regarding eco-design, or opportunities towards environmental sustainability on a company and product level, were as follows:

- Redesign of the LED driver. For short-term: redesign the circuit board; eliminate or reduce the precious metal input within components in electric devices, substitute the material with other materials. In a long-term, with the take back scheme, remanufacture of the LED driver by replacing or repairing the dis-function components instead of manufacturing the driver with brand new components.
- Improve the energy efficiency by replacing the light emitting diode with higher luminous efficiency product.
- Reduce housing material, refine the product's dimension.
- Reduce housing material, refine the product's dimension.
- Use recycled aluminium instead of aluminium alloy.
- Use recycled plastic material, make sure chlorine content in the plastic parts are not greater than 50%.
- If there are hazard substances which present in mixtures, make sure the concentration of the hazard substance is lower than 0.1%.
- Implement modular design for easily assemble and disassemble.
- Improve power control system for energy efficiency.
- Use recycled packaging material (at least 80% post-consumer cardboards and 50% recycled plastic materials).

- Provide a user guide that contains information on mode settings, end-of-life options for self-operating of the LED product (other option is provided by the company, such as whole life cycle service).

As with the feedback received from LL activities (explained in the previous section), the recommendations from the LCA study were taken on board and used to inform PDS development. Specifically, the following improvements were made to the PDS:

- According to the LCA study, electricity consumption contributes heavily to environmental impact. Enhancing the efficiency can significantly reduce the electricity required. This means that for a given site application, less luminaires will also be required. Longer rated life is also key in making sure that the products life cycle is extended, and overall waste produced is minimised.
- As shown in the previous segment, the luminaire body was also changed and significantly simplified to minimise material use at the production phase.
- The LED engine design was also changed as shown in the previous segment. As previously explained, the LCA study showed that energy use in the manufacture/production stage was one of the main contributions to environmental impact. The energy needed to produce aluminium is 5 times higher than steel, therefore the need of an aluminium heat sink was removed from the PDS. Sheet steel was specified as a replacement. The difference in energy use to work with these materials can be seen below as stated in the product design specification for industrial lighting (see Appendix 1):
    - Aluminium (from bauxite): 227-342MJ (63,000 to 95,000 watt-hours)
    - Iron (from iron ore): 20-25MJ (5,550 to 6,950 watt-hours)
    - Steel (from iron): 20-50MJ (5,550 to 13,900 watt-hours)
- The power of the emergency module was reduced to 4w, so that only half of the initial batteries were required. The batteries are not reusable and need to be replaced roughly every 4 years, so reducing the battery requirement reduces the overall battery waste and impact on the environment.

The CIRC4Life Approach for Sustainable Lighting Product Development

The approach

The NTU and Ona teams were the members of the EU CIP Ecolights project [2, Ecolights project: 'Market Deployment of Eco-Innovative Lighting Products'] and the FP7 cycLED project [3, Cycled project: 'Cycling resources embedded in systems containing Light Emitting Diodes']. An integrated framework was applied in both the Ecolights and cycLED projects to develop sustainable lighting products [4, Jose L. Casamayor and Daizhong Su, 2020, 'Integrated Approach for Eco-Lighting Product Development', and 5, FP7 cycLED project Deliverable 3.1 'Proposal for increasing resource efficiency and reducing environmental impact from the production of lighting products', submission date: 31 March 2015. Nottingham Trent University.]. The framework integrates various tools and methods into the product development process including product design specification, conceptual design, prototyping and test, and manufacture. With the experience gained by NTU and Ona in the previous two projects, the integrated framework is applied in this project as shown in Figure 4 below. In comparison with the Ecolights and cycLED project, several methods/tools including co-creation, living labs, online data mining and social LCA are used in this project.

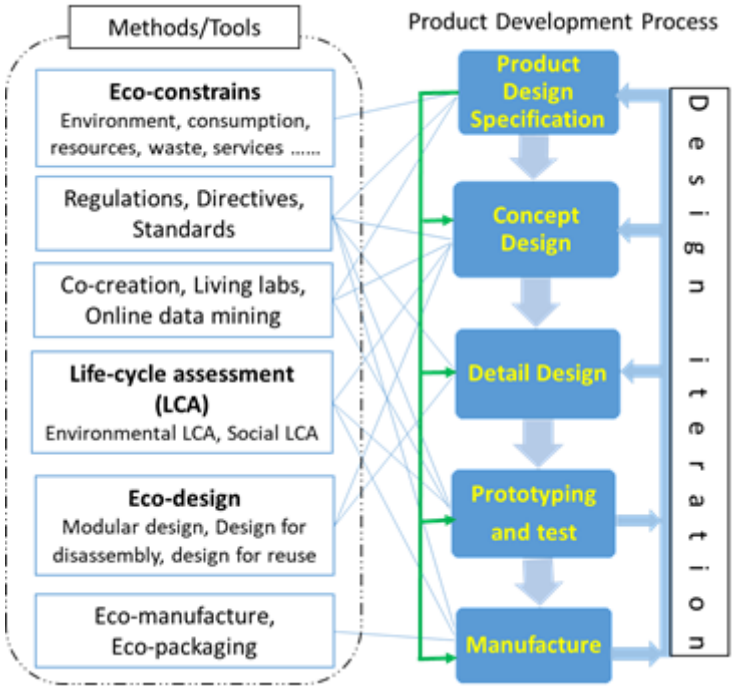


Figure 4 The CIRC4Life approach for Sustainable Product Development

Within the CIRC4Life approach, various sustainability methods and tools are integrated in the product development process. For example, the development of PDS involves relevant regulations, directives, standards, eco-constrains, online data mining to gain consumer preferences, LL (workshops) methods applied to reflect the various end-users' comments on the products, as presented in section 1 above. The LCA methods, including the environmental LCA and social LCA, are applied to assess the product's impact on the environment, and the company's social behaviour in relation to the product to be developed, as shown in the previous section. The eco-design methods, such as modular design, design for disassembly in order to facilitate the recycling and reuse when the product reaches its end-of-life stage, and design for energy efficiency are utilised in the conceptual and detail design. Relevant methods for reducing the impact on the environment are also applied in the manufacture stage.

It is significant to point out that the PDS plays an important role in the product development. The PDS has to be met at each stage of the product development process, as shown in Figure 4 The CIRC4Life approach for Sustainable Product DevelopmentFigure 44.

Development of the industrial luminaire demonstrator

The CIRC4Life sustainable product development approach is applied in the development of an industrial lighting product manufactured by Kosnic Ltd.

In the **conceptual design phase**, the most important benefits related to innovation strategy are identified for sustainable lighting product design and manufacture. The method developed in Task 1.1 is applied to derive the PDS with eco-constrain. In the development of the PDS, the key design requirements are confirmed and relevant directives and standards for sustainable lighting product design are applied.

The **modular design** method is applied in the design, which makes the product easy for assembly and disassembly, and easy for recycling, repair, and reuse. Each LED engine has its own dedicated driver. This means that each luminaire can contain up to 6 independent LED lighting units. Any component failure will only affect the corresponding lighting unit and not result in complete product failure. Only the faulty module (light engine or driver) is replaced, minimising unnecessary waste, and strongly encouraging reuse.

The luminaire can adopt from 1-6 lighting modules depending on the customer lighting needs. It also can adopt new modules with new colours/finishes, as well as new components (i.e., LEDs) which might be developed in the future that may allow new functions. In addition, the LEDs, drivers, and heat sinks can be accessed and repaired or upgraded easily. The modular design of the product can be seen in Figures 5 and 6.

Product design specification

More technical details are defined and revised by using the outcomes of LL oriented workshops, which can be seen in more detail in the LL section on page 8-10. Some broad conclusions from the workshop are presented as follows:

- Easy to assemble/installation
- The new luminaire would be adjustable or upgradeable but the introduction of new modules.
- Easy maintenance can be done by "competent enough (needs to be defined)" but no specialist knowledge in needed.
- Modules: LED Engines & Heat Dissipation, LED Optics, Colour Tuning, Light Output, Dimming, up scalability for future components.
- Long life does not always equal environmentally friendly, Use Recyclable/recycled Materials
- Standardized the interface and compatibility of the products:
- Monitoring emergency consumptions

These broad conclusions are then applied into the development of the PDS revision work. Different from the domestic luminaires, industrial luminaires have high standard for the technical performance, some technical characteristics are defined and adjusted in the PDS revision work. For example, the wattage of driver module is defined as 75W/100W from the original 40W, which is adjusted based on the lighting performance improvement of the product.

Design and prototyping

When revising initial PDS items, modular design approach was implemented as the industrial luminaries have more technical requirements compared to domestic lighting luminaries, e.g. industrial luminaire usually extensively operates hence certain components may broke when they reach the lifespan, easy replacing the failure components are not only cost effective but also are more sustainable. Additionally, some industrial luminaires require customisation modules to meet the requirements of the operation environment, e.g. emergency module, sensor module.

The environmental and social LCA for Kosnic luminaires are also implemented, and the key issues and opportunities from these assessments are identified, analysed, and subsequently applied to the PDS revision work and applied in the concept improvement. The assessment details are reported in CIRC4Life Deliverable 1.2, "Report on sustainable (environmental, social and economic) impact analysis" [6, CIRC4Life Deliverable 1.2 "Report on sustainable (environmental, social and economic) impact analysis], and can be seen in more detail in the previous section titled "Life Cycle Assessment".

Manufacture, packaging, and the final product

Manufacturing of Main Structure

- Cutting: Use laser cutting machine to cut metal sheets into the designed shape, and holes are also drilled in this process. Approx. 15 minutes are required per luminaire in this process.
- Bending: Use bending machine to bend these manufactured shapes into base, fasten panel, top cover.
- Painting: Use electrostatic powder coating machine paint the base and top cover.
- Process and outcome can be seen in Figures 7 and 8.

Driver installation:

- Push wire connector installation: install earthing plate into the luminaire push wire connector, then fasten the connector into the fasten panel with the tapping screw (a serrated Lock are placed underneath of the plate to ensure the maximum fasten). Install the drivers into the fasten panel with blind rivets.
- Wiring: connect the input wire into the push wire connector and fasten the cable with a clip; connect the input wire of the drivers with the push wire connector; connect output wire and motion out cable of the drivers through the switch board, as seen in Figure 9.

Emergency module assembly

- Fasten the emergency driver and a battery into the fasten panel and wire the battery with the emergency driver; connect the emergency driver with the push wire connector, then connect the output wire of the driver with the switchboard, as seen in Figure 10.

Assemble the base and top cover

- Install fasten panel into base: fasten the panel into the base with machine screw.
- Panel installation: use screen printing machine to print Silicone Thermal Grease on the surface of the base, which is for heat dissipation. Then, fasten the panel into the base with blind rivets, and wire the cable through the holes in the base, as seen in Figure 11.
- Assemble the top cover as seen in Figure 12.
    - Connect the 4pin cable in base with the 4pin cable in the fasten panel.
    - Hook the top cover with the base.
    - Fasten the top cover with the base by installing screws into both sides.
    - Front and back appearance of the luminaire.

The final prototype fully follows the revised PDS that are presented in Appendix 1. Each component can be replaced, minimising unnecessary waste, and strongly encouraging reuse. The luminaire can also adopt new modules which might be developed in the future to allow new functions, so that consumer requirements can be met on a project-by-project basis. An example of these options can be seen below. In addition, the LEDs, drivers etc. can be accessed and upgraded easily.

- Driver: Standard, Dimmable, Bluetooth etc.
- Sensor: On/off, Dimming, Daylight Harvesting
- Emergency: Standard, Self-test, DALI

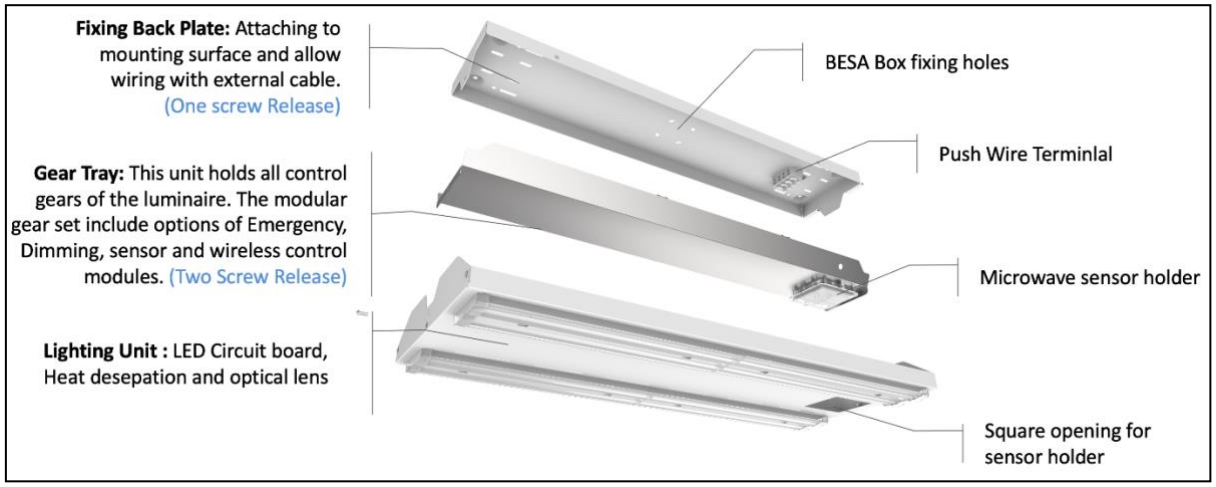


Figure 5 Main structure of product

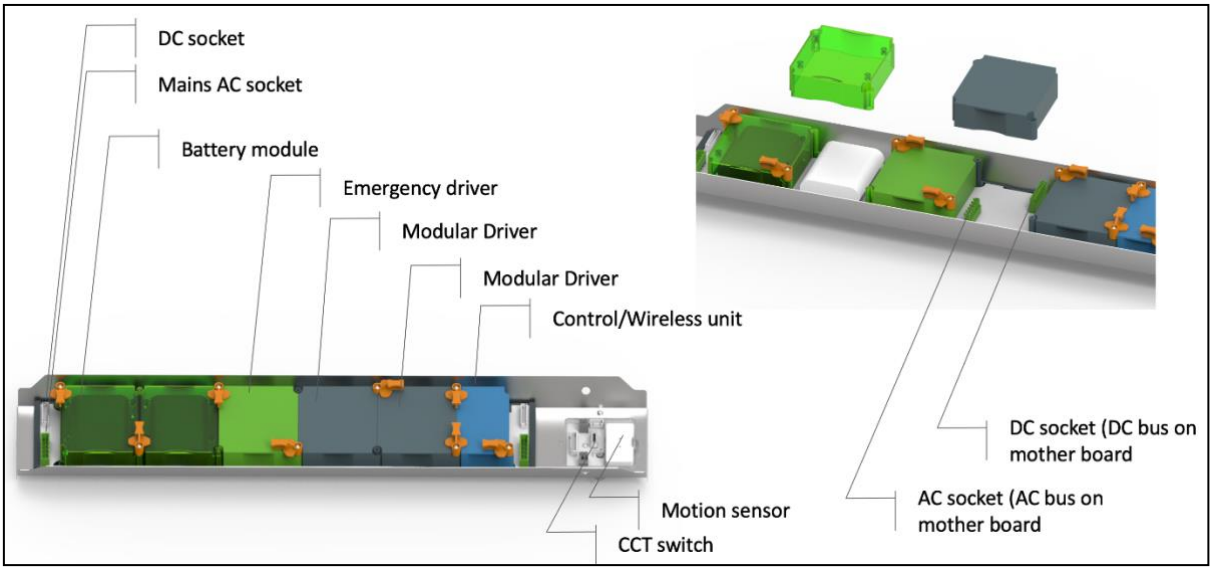


Figure 6 Control gear structure based on the revised PDS

2.2.2 Stakeholders involved

Stakeholder	External / Internal	Type of Stakeholder	Involvement
John Wilson	External	Wholesaler (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Dave Frank	External	Independent Lighting Consultant (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Stan Dunderdale	External	Wholesaler (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development. Attended one-to-one business meetings to discuss product and leasing service in Jan 2020. Attended validation interviews in Feb/Mar 2021.
Rich Green	External	Sales Manager at the LIA (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Paul Stearman	External	Independent Lighting Consultant & LIA Course Leader (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Gareth John	External	Lighting Photometry Expert & LIA Course Leader (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Brian Healy	External	Independent Lighting Consultant (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Kristin Shortt	External	Staff Member at the LIA (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.

Peter Hunt	External	Chief Policy Officer at the LIA & President at LightingEurope (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and PDS development.
Christine Whitrick	External	Managing Director of RMW Electrical (Contractor)	Attended one-to-one business meetings to discuss product and leasing service in Jan 2020. Attended validation interviews in Feb/Mar 2021.
Aramis Tonks	External	Lighting Project Consultant (The Lighting People)	Attended validation interviews in Feb/Mar 2021.
Ben Innes	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Hannah Driscoll	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Ross Smart	External	Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.
James	External	Apprentice Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.

2.2.3 Results, lessons learnt and further recommendations

Throughout the CIRC4Life Project, Kosnic have embraced and implemented the CEBM of co-creation. It has been extremely important and beneficial in encouraging PDS development, and really helped to put key stakeholder's requirements and desires at the forefront of new product development. By implementing the CEBM developed by the Project, Kosnic have successfully developed a product and a service that has truly been co-created.

The product developed has also been produced in a much more sustainable way. The E-LCA and S-LCA studies conducted on the existing Kosnic product (KMSD100LLBE) and the new Kosnic product (developed for the Project) show that the new product is up to 46% more sustainable over the lifetime of the product. The initial E-LCA and S-LCA study helped to achieve this result as it showed exactly where the hotspots for impact on the environment came from, and thus helped to inform product development and necessary changes to make to the PDS.

Unfortunately, the Covid-19 pandemic and resulting restrictions made it impossible to hold any kind of physical event to receive high amounts of participation for validation purposes. Due to this, virtual activities had to be planned instead, such as online presentations/interviews and an online virtual showcase.

The online presentations/interviews were conducted with a sample of key stakeholders, such as wholesalers, lighting project consultants, contractors, and electricians in early 2021. The responses to the questions asked showed a clear level of satisfaction with the product that was co-created. A selection from some of these questions and responses can be seen below. Full transcripts can be found in Appendix 2.

Interview question: What do you like about the product shown?

- *"The thing I particularly like about it is the modularization of it, I think it's really clever, it's going in the right direction, if not following the market it's forcing the market down a route that I think is really important. The circular economy, the reusing modules, refurnishing modules, I think that's really important for our economy, but it has other benefits, the ability to upsell to our client and the ability to install an emergency module that makes life easier for us means we carry less components on site and being able to introduce a CCT, wireless controls, self-test, all these different things being introduced*

during the lifecycle of the product. At the moment, we do find it difficult to sell the benefits of a product, they want what they know and unfortunately that's twenty-year-old technology. But once they've had that new product, it's much more within their reach and understanding, that ability to have a product that is very recyclable or even better, reusable, being able to upgrade and change the features of that fitting are attractive." Aramis Tonks, The Lighting People.

- *"The main thing that stood out for me was the way the control gear was so modular and so easy to move them in and out or to replace them. The most important thing is the remote emergency testing."* Hannah Driscoll, Smith Bros.
- *"I like that it builds up in a modular way, I presume from a spare parts point of view its easier for you guys, if you keep a few of those modules in stock, if you decide you want it brighter then you'll be able to add another driver module in. I've used fittings that use those two linear strip styles before and I do find that they are easy to use, depending on what type of optics that they've got but they do a good job of lighting up industrial spaces."* Ben Innes, Smith Bros.

Validation of Kosnic's implementation of the co-creation CEBM was also considered at the 2nd Open Innovation Camp (OIC) event hosted and facilitated by Laurea in May 2021. The OIC was an online virtual event conducted over Zoom, with HowSpace also utilised to gather validation and feedback for what the project has achieved. Further details on the OIC validation framework developed by Laurea can be found as part of WP7 and D7.2. Participants for the DEMO validation sessions included the internal consortium members of the CIRC4Life Project. The initial vote conducted on whether Kosnic "successfully applied CEBM (a) Co-creation of products and services" received 43 votes from participants. The result of the vote was extremely positive with 14 participants strongly agreeing, 22 agreeing, 6 neither agreeing or disagreeing, and only 1 participant disagreeing, as seen in Figure 7.

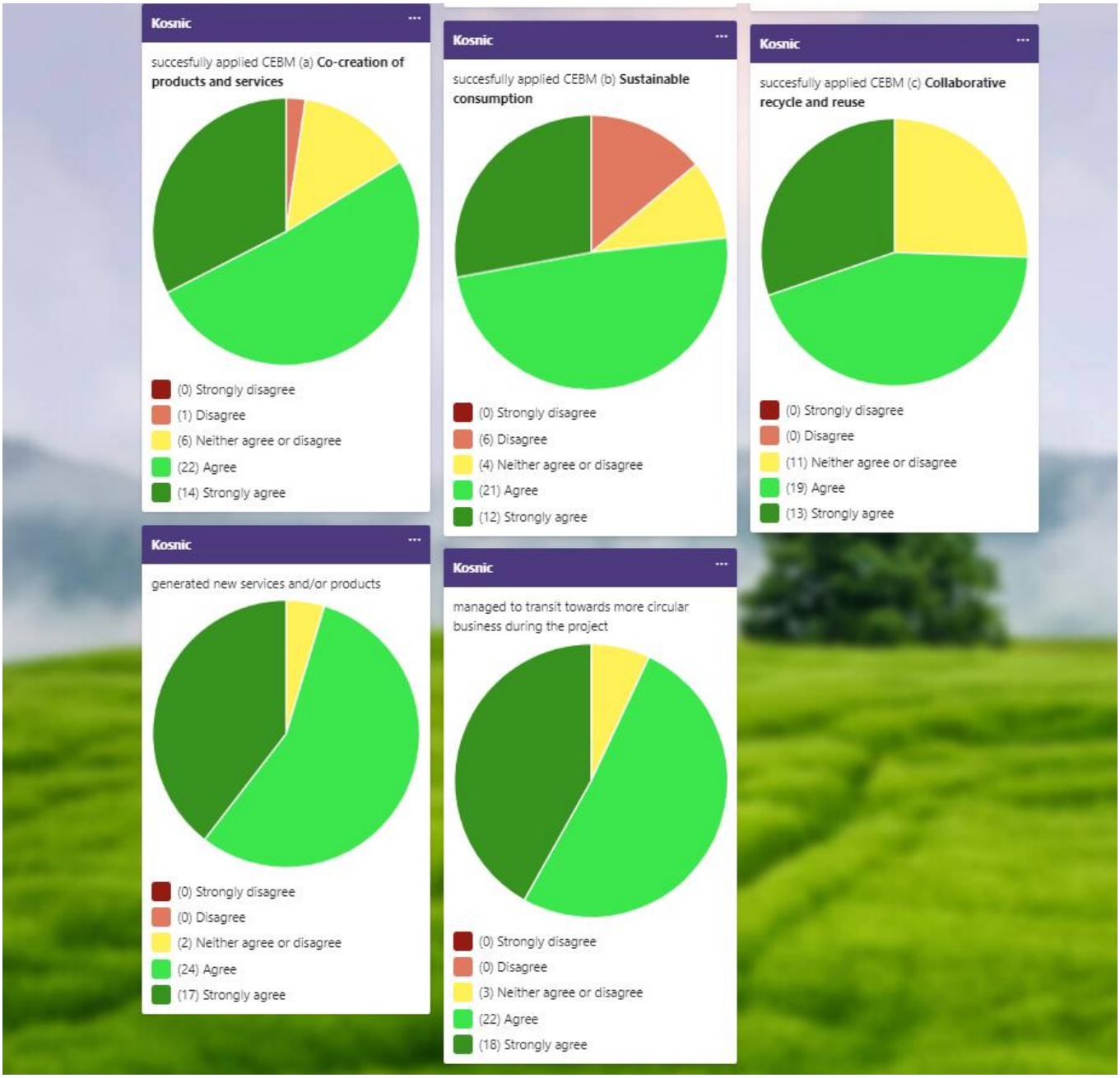


Figure 7 Initial voting results for successful implementation of CEBMs in Kosnic DEMO

After this initial vote, work groups were established to discuss the implementation of CEBM1 within the Kosnic DEMO further. This included open discussions and Q&A sessions. After this was completed, a new vote was conducted within these smaller work groups and the final results were just as positive as before with 7 participants strongly agreeing, 7 participants agreeing, and only 2 participants deciding to neither agree nor disagree.

The process of implementing this CEBM and conducting the various activities to achieve this successful implementation, have led to several lessons being learnt and further recommendations being discovered. These include:

- Co-Creation, and the LL methodology in particular, are very useful tools in making sure that customer and key stakeholder requirements are identified from the start of product development.

- These methods also help to build more rewarding relationships with supply chains and key stakeholders which can result in developing key relationships and discovering further opportunities for collaboration.
- LCA studies, both environmental and societal, can provide key technical insights into how to improve not only a products environmental impact and sustainability, but also the impacts and sustainability of a company as a whole.
- Specifically, these studies can highlight hotspots of environmental and societal impacts which allow a company to explore alternative methods to improve upon.
- The caveat for this is that you need to have a certain degree of technical knowledge in order to understand and implement these changes effectively.

In conclusion, by implementing the CEBM for co-creation, Kosnic have learnt many valuable lessons for the future. Before our involvement with the CIRC4Life Project, we were already very much developing products along the modular route as we understood its importance in not only reducing required stock lines, but also, its much-improved access and usability for relevant stakeholders and consumers. This could be seen with our pre-existing Bulkhead and LED DD ranges. The CIRC4Life Project has taught us that this is definitely the correct route to continue pursuing with product development, as it also strongly relates to improved sustainability and the incentivisation of reuse. This is also the way that the lighting industry seems to be moving, with new regulations being brought in to further encourage modularisation and accessibility for light sources and control gear within lighting products.

3 Demonstration of sustainable consumption

3.1 Objectives

The second CEBM aimed to demonstrate product sustainability and sustainable consumption of the lighting products. The main objective for this was to effectively communicate this to key stakeholders and end users. Some of the key aspects implemented to achieve this are as follows:

- The eco-points method developed in WP1 was applied to both lighting products. The eco-information of the products, including the eco-points, will be informed to customers when the product is on sale. To do this, the traceability and interoperability methods developed in Task 5.2 will be applied into the EPCIS-based electronic label/chips, which will be embedded in the light products to monitor the eco-information of products. The different models of light products with EPCIS-based labels will be displayed on the product shelves of stores. When choosing the products, customers can access the eco information via the eco-shopping app (Task 3.1) with their smart phones, to help consumers to select more environmental products.
- The eco-information will be included in the product manual and provided for consumers together with product's manufacture information.
- ONA will demonstrate the eco-shopping in their online store using the approach developed in T3.1. The customer can view the product's eco-information, the customers receipt shows the information of both the cash payment and ecopoint related to each item purchased, and the eco-points can be recorded into the consumer's eco-account.

This section of the Deliverable, 6.1a, will focus on the industrial lighting demonstration of Kosnic specifically, with this section detailing exactly how CEBM2, sustainable consumption, has been implemented throughout the project. For details on how this CEBM has been implemented within the domestic lighting demonstration by Ona, please see Deliverable section 6.1b, later in this document.

3.2 DEMO 1A Kosnic Lighting Ltd.

3.2.1 Activities

Due to Kosnic having a very different supply chain and route to market to the rest of the demonstrators within the CIRC4Life project, a different method for effectively communicating sustainability to key stakeholders and end users was required. The eco-points method developed in WP1 was designed to be implemented within store fronts, or on product packaging for products that were directly accessible to a customer, so that they can access the eco-information of a product to help them make more sustainable buying choices. This was not an option in Kosnic's demonstration, as the route to market for specialist industrial lighting is through electrical wholesalers. These operate more as a trade counter, rather than your traditional store front, so stock of specialist industrial lighting products is not simply on the shelf, or accessible to the general public or potential customers. Due to this, it was important to come up with an alternative way to promote sustainable consumption to end users, or specifically in the case of industrial lighting, building owners/managers.

To achieve this, an LCA comparison descriptor was developed which is included in Kosnic project proposals. This effectively communicates sustainable consumption and product sustainability to the key stakeholders and end users involved within the specialist sector of industrial lighting.

Life Cycle Assessment (LCA) and Product Sustainability Evaluation

LCA studies are important as they allow us to understand exactly how our product has an impact on a wide range of environmental and societal issues, such as climate change or human health, which can occur at different product life cycle stages, from materials used, production processes, packaging, transportation, product reuse, recycling, and disposal.

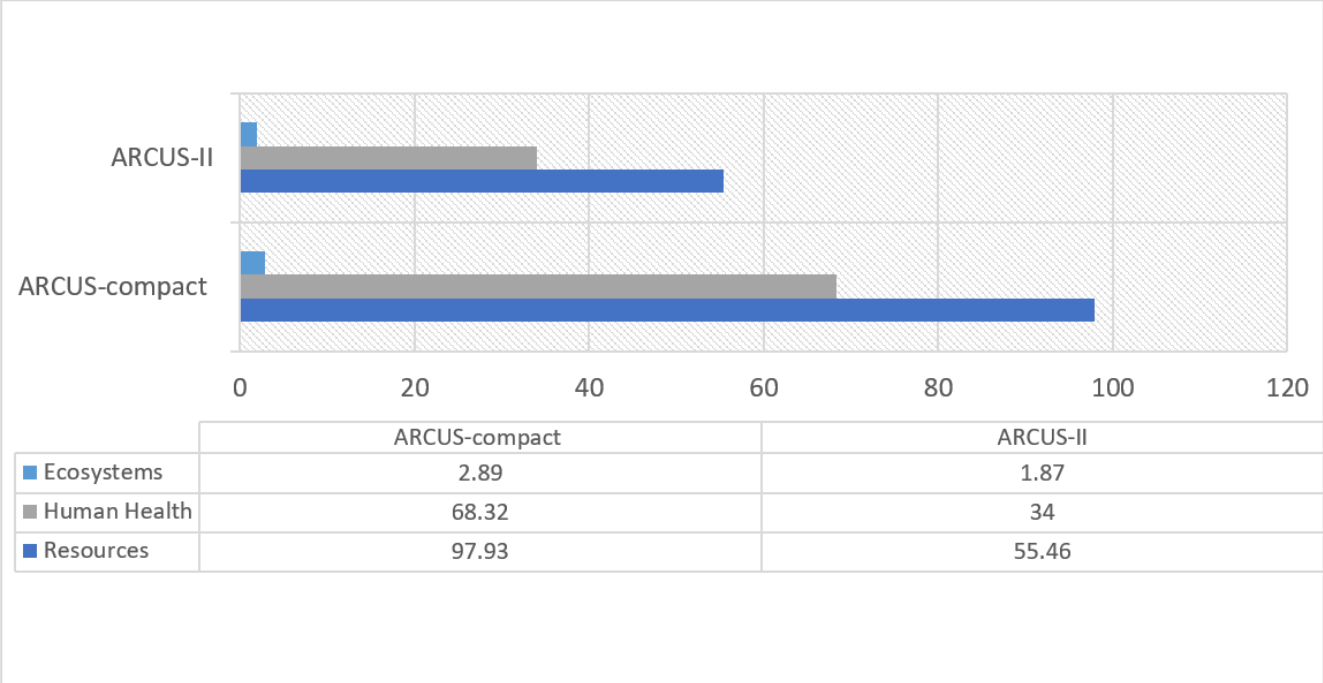
As previously explained in the section on co-creation, performing studies such as these helps identify and analyse any potential issues, and apply them to concept improvement and PDS revision, resulting in a product that is more sustainable and better for the environment. To make sure that the proposed modular industrial LED luminaire developed by Kosnic met sustainable production goals, an LCA study was carried out by Nottingham Trent University (NTU). This study was initially performed on an existing industrial LED luminaire from the Kosnic product range, the Arcus-Compact. The results from this study helped to highlight exactly where improvements could be made, and helped to shape the updated Product Design Specification, or PDS, for the new modular industrial luminaire proposed for the CIRC4Life Project. For example, the initial LCA study highlighted various opportunities to lessen environmental impact throughout development, such as: changing the design of the LED driver, to eliminate or reduce the use of precious metal components. Improving energy efficiency to lower consumption, and using recycled plastic material, making sure chlorine content in plastic parts is no greater than 50%.

Following the initial LCA study, and coupled with feedback received from LL activities, the updated PDS was completed, and a new LCA was conducted by NTU to understand the environmental and societal impact of the new product. The results showed that the new modular industrial luminaire made substantial improvements, registering at a 46% reduction of impact to the environment when compared with the previous version, from 169pt to 91pt (by aggregating the endpoint single scores, e.g. 55.46+34+1.87=91.33). The environmental impact on the three categories of the new model is 55.46, 34 and 1.87 for Resources, Human Health and Ecosystems impact categories respectively, which improved 43%, 50%, and 35% on the impact categories accordingly in comparison to those of the Arcus-Compact.

Figure 14 presents the single score results of the three impact categories of the two variant products. The impact category resource is dominated by the production/assembly stage and the use stage in the case of both the products as these stages require high energy and material. For the Arcus-Compact, the contribution

of the production/assembly stage (approximately 58%) to the total impact is higher than that of the use stage (42%), which can be primarily attributed to the production of electronic devices. By contrast, the primary contributor (75%) in the Arcus-II is the electricity production during usage, whereas the production/assembly stage contributes approximately 25% to the total impact. It assumes that the LED lighting product manufacturer and distribution company, i.e., Kosnic, operate a take-back scheme, in which the EoL lighting products will be collected by the company for further processing: the product will be disassembled and checked for reusability, and the selected electrical devices (assumed 60% reuse efficiency by the manufacturer) will be repaired and refurbished for producing new LED lighting products. Similarly, the qualified materials in housing, such as aluminium and steel, will be repainted (assumed with 70% reuse efficiency) for new products. A similar pattern was observed in other endpoint impact categories. The usage and production method of electricity is identical in both products. However, the Arcus-Compact and Arcus-II accounted for 42% and 75% of the total impact, respectively. This implies that the impact of Arcus-II reduces significantly from the production stage (58% to 25%), thereby demonstrating that the LED lighting product developed exhibits an outstanding overall environmental improvement owing to the impact reduction during the production stage.

Further info can be seen in the Journal Entry titled “A Sustainable Product Development and Service Approach with its Application in Industrial LED Lighting Products” produced by Shuyi Wang, Diazhong Su, Ming Ma, and WenTao Kuang, respectively. [7, Wang, S., Su, D., Ma, M. and Kuang, W., 2021. Sustainable product development and service approach for application in industrial lighting products. *Sustainable Production and Consumption*, *27*, pp.1808-1821.”]



	ARCUS-compact	ARCUS-II
Ecosystems	2.89	1.87
Human Health	68.32	34
Resources	97.93	55.46

Figure 8 Endpoint Single Score Results

A Social LCA of Kosnic as a company was also conducted, in order to measure the impact of their products on the health, safety and well-being of their workers, and the wider impact on the community in which they operate. The results of this showed that Kosnic’s social performance, compared with other lighting manufacturers, also contribute to a healthier society. Some of the key results for the study showed that…

- Environmental impact on the local community was 28.88% better
- Contribution to local economic development was 22.24% better

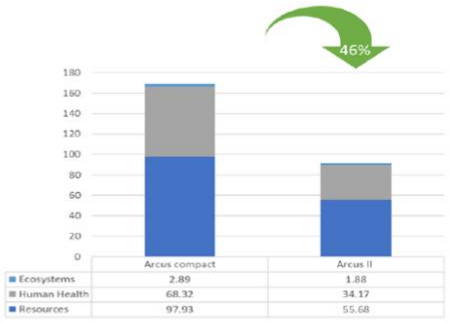
- Health expenditure was 10.93% better
- Fatal accidents at the workplace were 25.26% lower
- Weekly hours of work per employee were 27.14% better

The LCA framework is also used to calculate Eco-costs. Eco-costs are a scheme developed within the CIRC4Life Project. They are demonstrated as a single score via weighting, which allows the consumer to easily compare the environmental impact of different products. This approach facilitates decision making, since it is clear whether a product's environmental impact is higher, lower, or similar to alternative products. This aims to support users to become active caretakers of the resources included in the product and take full responsibility for their consumption patterns, impacts, and use of resources.

Communication of sustainability to the consumer (LCA Comparison Descriptor)

As shown by the eco-cost scheme explained above, communication of the environmental impacts that a product has is important in order to create a business model that encourages sustainable consumption. As previously explained, in the case of Kosnic's demonstration, sustainability had to be communicated to our key stakeholders and consumers in a different way though, as it is not possible to guarantee direct exposure to end users or consumers through store front exposure or QR codes on packaging (due to our route to market). To achieve this, an LCA Comparison Descriptor was created. Using the data available from the LCA studies, and the eco-cost scores that are created from this, an LCA comparison table was developed to highlight the improvements that the new Kosnic product had made in terms of sustainability and impact on the environment. This is included within our project proposals and has been designed using our pre-existing cost of ownership/payback calculators as the base, so that the format is the same as other aspects of a Kosnic project proposal. It compares the improvements that have been made on the product when compared to previous iterations, and provides the data in a clear, concise, and easy to understand manner.

Existing Eco-Cost per Lamp	Area	Quantity	Existing Lamp Type	Existing Lamp Wattage	Existing Lamp Rated Life	Eco-Cost on Resources	Eco-Cost on Eco-System	Eco-Cost on Human Health	Total Eco-Cost of Existing Fitting	Total Eco-Cost on Resources	Total Eco-Cost on Eco-System	Total Eco-Cost on Human Health
169	Warehouse	100	Arcus-Compact	100	40,000	97.93	2.89	68.32	16900	9793	289	6,832
Replacement Eco-Cost per Lamp	**Area**	**Quantity**	**Replacement LED Fitting Type**	**Replacement LED Fitting Wattage**	**Replacement LED uselife**	**Eco-Cost on Resources**	**Eco-Cost on Eco-System**	**Eco-Cost on Human Health**	**Total Eco-Cost of Replacement Fitting**	**Total Eco-Cost on Resources**	**Total Eco-Cost on Eco-System**	**Total Eco-Cost on Human Health**
92	Warehouse	100	Arcus II	100	40,000	55.68	1.88	34.17	9200	5568	188	3,417
Eco-Cost Savings									**7700**	**4225**	**101**	**3,415**



Risk on depletion of oil, fossil fuel saved over life of LED
43.14%

Damage to species saved over life of LED
34.95%

Chance of getting human disease reduced over life of LED
49.99%

Environmental improvement over life of LED
46%

Overall, the Eco-cost of the replacement lamp (Arcus-II) has improved by 46 % in comparison with that of the existing product (Arcus-Compact) over the life of the LED. The Eco-cost of the three categories in the case of Arcus-II are 55.68, 34, and 1.88 for resources, human health, and ecosystems categories, which are improved by approximately 43, 50, and 35 %, respectively in comparison with those of Arcus-Compact.

- 'Resources' refers to potential risk on resource extraction, including oil, gas and coal related energy cost increasing.
- 'Human health' refers to potential harm to human body, potential risk on increasing diseases, such as respiratory diseases, cancer and malnutrition.
- 'Ecosystem' refers to potential damage to living species in freshwater, marine and terrestrial.

The eco-costs were calculated according to ISO14040 standard, using world recognised software and databases, as well as the most recent life cycle impact assessment approach (for more information about the assessment, please see CIRC4Life website).

Figure 9 LCA Comparison Descriptor

As a company, our Project Team provide project consultancy and proposals to various stakeholders throughout our supply chain, including wholesalers, contractors, architects, Facility Management (FM) companies, local authorities, end-users, and more. By including our LCA comparison descriptor within our proposals, we can highlight these improvements, and showcase just how sustainable the product we are proposing is compared to previous iterations, or alternatives on the market.

3.2.2 Stakeholders involved

Stakeholder	External / Internal	Type of Stakeholder	Involvement
Shuyi Wang	Internal	NTU	Conducted and reported on LCA studies for Kosnic DEMO.
You Wu	Internal	NTU	Support for LCA study for Kosnic DEMO.
Diazhong Su	Internal	NTU	Support for LCA study for Kosnic DEMO.

Stan Dunderdale	External	Wholesaler (Links Electrical)	Attended validation interviews in Feb/Mar 2021.
Christine Whitrick	External	Managing Director of RMW Electrical (Contractor)	Attended validation interviews in Feb/Mar 2021.
Aramis Tonks	External	Lighting Project Consultant (The Lighting People)	Attended validation interviews in Feb/Mar 2021.
Ben Innes	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Hannah Driscoll	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Ross Smart	External	Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.
James	External	Apprentice Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.

3.2.3 Results, lessons learnt and further recommendations

Kosnic's implementation of the Sustainable Consumption CEBM has been challenging because the route to market for an industrial lighting product is not as simple as business to consumer supply chains that are evident in other demonstrations in the CIRC4Life Project. Due to this, a different method for communicating sustainable consumption, and the sustainable improvement of the product developed, needed to be created and implemented.

This was achieved with the LCA Comparison Descriptor. The LCA Comparison Descriptor followed the same methodology as other demonstrations, such as conducting LCA studies and following the eco-points method developed in WP1, to create an eco-cost for the product developed which could be used to easily demonstrate its improved sustainability. This LCA Comparison Descriptor was created to be used within Kosnic project proposals. This allowed Kosnic to directly communicate sustainable consumption, and product sustainability, to all parties involved within specific lighting projects that required industrial LED lighting. This includes key stakeholders throughout the supply chain such as wholesalers, contractors, and most importantly, end users/building owners, who are the real end users of the industrial lighting product. This meant that sustainable consumption could be effectively communicated to the relevant key stakeholders.

To validate the CEBM, and what Kosnic had implemented to demonstrate it, online presentations/interviews were conducted with a sample of key stakeholders, such as wholesalers, lighting project consultants, contractors, and electricians in early 2021. The responses to the questions asked showed a clear level of satisfaction with the methods of communication when it came to product sustainability and sustainable production. They also showed that there is an appetite for information like this, but there would be a lot of development required to make something like this an industry standard. A selection from some of these questions and responses can be seen below:

Interview question: Does the environmental impact of a product influence your buying decisions?

- *"Time will tell, I think at the moment, it is very difficult if not impossible to present a product selection to a client and say this product is much more sustainable, it ranks 90 on your sustainability index but is 10% higher (cost) vs this product which is cheaper but unrecyclable. We don't have a means to present that to our client, in a competitive market we almost have to ignore that in favor in of the other value-*

based observations like its ethics and efficiently and lifespan. However, I would like to be in a position where we can offer clients not only your sustainability index that we talked about, that would be fantastic, but your energy efficiency ratings but also the ability to full offset using carbon credits." Aramis Tonks, The Lighting People.

- *"I think at the moment there is an appetite for it, which is only going to increase, at the moment I think people may pay 10% more for a product that has got a full lifecycle and be recycled. This year people are interested, and I think by next year people will be even more interested."* Hannah Driscoll, Smith Bros.
- *"From my point of view, it would depend on if I were talking to the end user or the contractor. Because the contractor doesn't care, he just wants it to be as cheap as possible. But if you can get in front of an end user and explain the benefits to them, I think that they would be happier knowing that the fittings were more eco-friendly. I think they would stomach 15-20% more, it depends on who the end user is. If you had something that just had a big shed to light up, he may not be too bothered but I've done a job recently for Doncaster council and they were a little bit more conscious of their carbon footprint. It's all well and good where we do a job and reduce their energy bill and carbon footprint and they say how good it is but then if you were to tell them that it would sit in landfill for a long time after it's been used then it's not a good example of a carbon reducing fitting."* Ben Innes, Smith Bros.
- *"I think that if there was something visual on the product rather than from a salesman point of view if they had something that advertised the face that it's more environmentally friendly, I think it would have more of an impact than just me saying its environmentally friendly."* Ben Innes, Smith Bros.
- *"I do like to purchase products with high sustainability levels, things with a high carbon footprint might be unavoidable but if there are product on the market that are more sustainable that would be of interest to me and my clients, a selling point. And I'm sure a lot of people would be interest to know that the lighting fittings that they are having installed are a lot more sustainable. Certain industries may be willing to spend around 10-15% more, depending on the company to promote their green credentials."* Ross Smart, Smart Electrical.

As a part of D7.2, Validation of Kosnic's implementation of the sustainable consumption CEBM was also considered at the 2nd OIC (Open Innovation Camp) event hosted and facilitated by Laurea in May 2021. The initial vote conducted on whether Kosnic "successfully applied CEBM (b) Sustainable consumption" received 43 votes from participants. The result of the vote was extremely positive with 12 participants strongly agreeing, 21 agreeing, 4 neither agreeing or disagreeing, and 6 participants disagreeing as shown in Figure 13 in the previous section on Co-Creation.

After this initial vote, work groups were established to discuss the implementation of CEBM2 within the Kosnic DEMO further. This included open discussions and Q&A sessions. After this was completed, a new vote was conducted within these smaller work groups and the final results were just as positive as before with 4 participants strongly agreeing, 11 participants agreeing, and only 1 participant deciding to disagree.

The process of implementing this CEBM and conducting the various activities to achieve this successful implementation, have led to several lessons being learnt and further recommendations being discovered. These include:

- As explained in the CEBM for co-creation, LCA studies, both environmental and societal, can provide key technical insights into how to improve not only a products environmental impact and sustainability, but also the impacts and sustainability of a company as a whole.
- Unfortunately, the caveat to this is that they need to be made accessible for everyone to understand. The LCA Comparison Descriptor is a step in the right direction to achieve this.
- One thing that became apparent throughout our validation interviews was that there is a real, growing appetite for this sort of information to be readily available for consumers so that it can help

them to make sustainable buying choices. This is great, as it shows that the need for a CEBM, such as the one developed in the CIRC4Life Project, is desired and this desire will only continue to grow.

- The issue will be that for something like this to really take off and be successful, it will have to become an industry standard. There is little use for information like this if only a handful of manufacturers implement it. In order for consumers to make truly informed buying decisions when it comes to sustainability, a scheme like this needs to be adopted by all so that products can be truly compared.

4 Demonstration of collaboratively recycling/reuse

4.1 Objectives

Collaborative recycle/reuse, or CEBM 3, has been demonstrated by Ona and Kosnic in two different ways, due to the fact that one product is targeted towards domestic users, and the other to more specialist industrial users. For the domestic lighting products:

- Customers will recycle their EoL lighting products on demand via the logistic or the Internet-based recycling manners.
    - For the logistic recycling, customers can recycle their products by sending them back to collection points or contacting the company for collection if the delivery service scheduled is applicable. The intelligent bin approach developed in WP2 will be used here for the consumers to dispose the EoL lights into the intelligent bins, the features of which can then be demonstrated using the EoL lights.
    - For the Internet based recycling, consumers can utilise a self-service recycling/collection system developed in WP2, which could be placed at collection points like shops or car parks, to conduct recycling activities. The intelligent bins, which are further developed in Task 2.3, will be used for online recycling the EoL lights. With integrating with multiple ICT technologies (e.g. RFID, NFC, and Internet), the intelligent bins will allow for remote tracking of information data of different light products and quick disposal of multiple lights.
- After the completion of recycling, the customer will be awarded eco-credits, to encourage them to keep participating. The eco-credits will be used to record and track the environmental impacts that consumers recycle and reuse their products every day, according to the incentive scheme developed in Task 2.5.
- Re-manufacture/reuse: the EoL product will be sorted at the recycling centre (IND for this project), then the components in working condition will be returned to the manufacturer, ONA, for making the new lights. In order to make it easy to recycle, design for disassemble and modular design will be applied.

For Kosnic and the industrial lighting products:

- KOS will provide a service to lease the product to the end-users, which will enable KOS to look after the lights throughout the service life of the product and provide necessary services, such as repair, to enable the product's performance, and take-back the products when it reaches the end of life, then the recycling, reuse and remanufacture will be implemented with those EoL products.

This section of the Deliverable, 6.1a, will focus on the industrial lighting demonstration of Kosnic specifically, with this section detailing exactly how CEBM3, collaborative recycle and reuse, has been implemented throughout the project. For details on how this CEBM has been implemented within the domestic lighting demonstration by Ona, please see Deliverable section 6.1b, later in this document.

4.2 DEMO 1A Kosnic Lighting Ltd.

4.2.1 Activities

Leasing Service Development

As already shown, the modular industrial LED luminaire has been developed with collaborative reuse and recyclability in mind. By adopting a modular approach, not only is the product very flexible, with various options to suit specific needs, but it also allows for the product to be repaired with minimum effort in the event of faults.

The main modules of the product make up the luminaire's construction. These include the fixing back plate, gear tray, and the lighting unit. The sub modules within the gear tray allow for complete flexibility, with a plug and play system which makes reuse and recyclability easily achievable. Traditionally, if an industrial luminaire were to fail, it would be common for the whole unit to be replaced which would lead to unnecessary waste. However, with the flexibility of a modular plug and play system, if an LED driver were to go faulty, it is as simple as replacing the affected module. The faulty module can then be returned, repaired, and reused. If repair is not possible, then the module will be recycled in a responsible manner.

Producing a sustainable product that encourages reuse and recyclability, and the reduction of waste, is a core fundamental of the CEBMs that the CIRC4Life project has developed. Delivering a product with this potential can only go so far though. To truly achieve a collaborative reuse/recycle business model, the consumer needs to be incentivised to make the most of the product's potential for reuse. Therefore, Kosnic have also developed a leasing service model.

Initial Proposal of Leasing Service Model

As stated in the CIRC4Life proposal, Kosnic will provide a service to lease the product to the end-users, which will enable Kosnic to look after the lights throughout the service life of the product and provide necessary services, such as repair, to enable the product's performance, and take-back the products when it reaches the end of life, then the recycling, reuse and remanufacture will be implemented with those EoL products.
To fully demonstrate just how the Circular Economy Business Models, or CEBMs, created within the CIRC4Life Project can be implemented in a real-world situation, it was important not just to create a product that encourages these goals, but also, a service to deliver them via the traditional supply chain and stakeholders. A leasing model achieves this as it brings traditional stakeholders together to work alongside one another within a supply chain and business model that encourages and implements all the key goals of the CIRC4Life Project.

As with the industrial LED luminaire, Kosnic developed an initial outline for this leasing service model at the start of the CIRC4Life Project in May 2018. As shown below in Figure 16, the leasing service started as an idea that was very centralised to Kosnic and really failed to involve traditional stakeholders and actors from our supply chain and current business model.

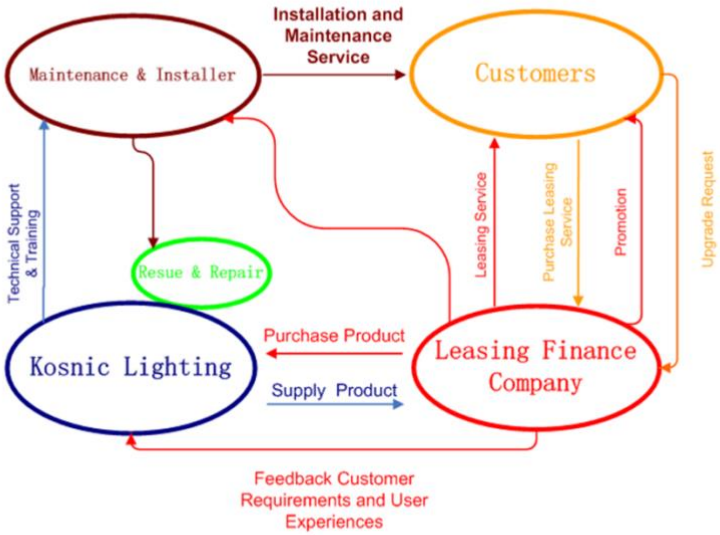


Figure 10 Initial Centralised Proposal for Kosnic Leasing Service Eco-System

Since that time though, co-creation of the service has been evident throughout the CIRC4Life Project by polling stakeholder opinion through the same methods used for the product itself. By going through these co-creation activities, it has become evident what is important or required, which has helped to develop a service that meets the needs of both the CIRC4Life Project and the stakeholders/consumers

Kosnic proposed the initial industrial lighting leasing service with the following features:

- Leasing servicing with monthly payment instead of purchasing.
- Leasing contract can be customised, taking into account the following considerations:
  - Customer's budget, type of payment plan
  - Type of service/maintenance, and possible product upgrade (during or when renewing the contract)
  - Daily usage, and operation environment

Two type of payment plans were proposed to provide flexible payment options and suit different financial situations for different customers: 1) stepped payment plan where installation fees are paid in full at the start, and the product cost is paid over the first 5 years with only a small maintenance fee paid over the next 5 years or, 2) flat payment plan over a 10-year contract period with intertest taken into consideration.

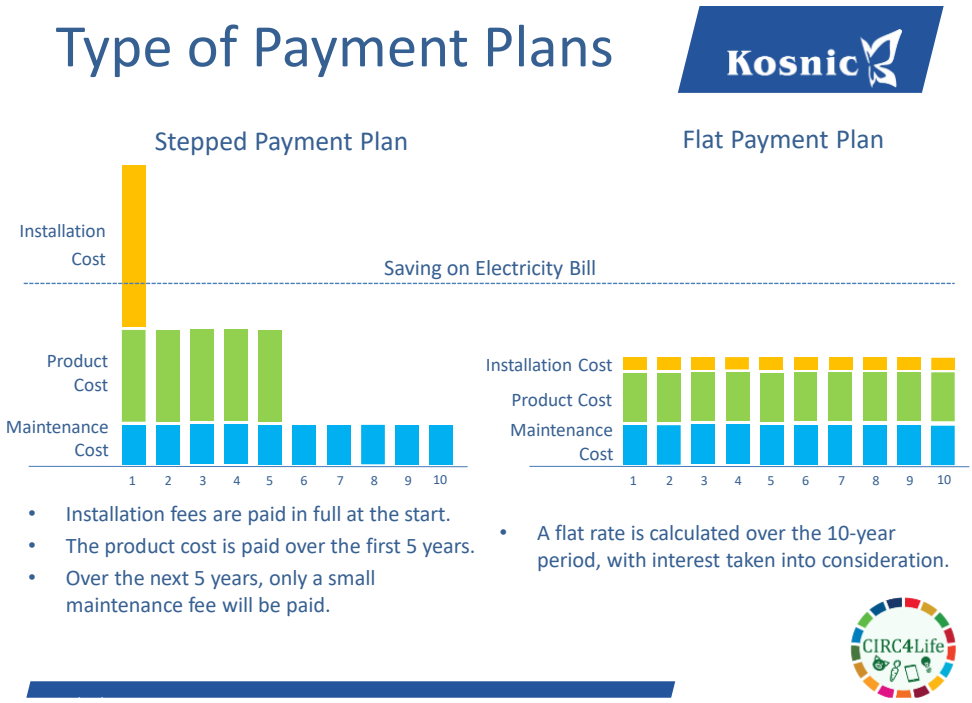


Figure 11 Initial Payment Plan Options for Proposed Leasing Service

Regarding CIRC4Life CEBM3, collaborative recycling and reuse, Kosnic's focus has been centred on reuse, and minimising waste, by using a modular product design to allow the product to be repaired with minimum effort, and usually on site. The fixing of the product will be included in the maintenance service as part of the leasing contract. In such way, the product's life is expected to be significantly extended with minimum waste.

1st Open Innovation Camp

Date: November 2018
Location: Krakow, Poland

As a part of WP7, the Open Innovation Camp 2019 is the very first innovation stage process called "concept create/testing" of LL testing framework in CIRC4Life. There was a brainstorming session, in which external experts and participants from the project partners joined to try and find as many solutions as possible to each task. Each session had a dedicated facilitator from LAUREA to look after and help session participants to follow the proper living lab process.

For Kosnic's leasing service solution for CEBM 3 Collaboratively Recycling and Reuse, this innovation camp helped to identify the following:

- **Who:** stakeholders such as user, wholesaler, maintenance, financial service and refurbish company, and potential targeted customers.
- **Value:** high quality light systems, maintenance included, stable long term financial planning and low environmental impact.
- **Impact:** environmental, business, and social impact.

Survey of Leasing Service

Date: January – March 2019
Location: Online

Following the first concept LL test during the Innovation Camp at Krakow, Kosnic developed 30 questions on Kosnic Industrial Lighting modular design and leasing service with support of the LAUREA team during January 2019 to March 2019. The questionnaire was circulated to Kosnic's existing customer database, plus selected Lighting Industry Association (LIA) members by email with the following key themes/questions:

1) Perceived importance of the environmental sustainability and strategic readiness.

2) Current status of lighting systems.

3) Perceived importance of the different lighting leasing services and options.

4) Willingness to become a leasing service business partner for Kosnic.

Based on the responses from the online survey on the proposed leasing service, the following results are abstracted:

- More than **57%** responses think this service is important and align with company's business goals, mission, and values, willing to build, maintain or improve brand reputation.
- **90%** responses show that their own company is doing the replacement work when the lighting product goes faulty.
- More likely interested services: A) Intelligent usage and energy analytics via IoT solutions'; B) Transition of equipment at end of term; C) One service provider provides holistic solution together with its partners.
- A flat rate payment plan is preferred (**71.43%**).

Co-Creation Workshop for Developing Leasing Service

Date: May 2019
Location: LIA, Telford, UK

As a part of WP7, a further one day Co-Creation Living Lab workshop for developing the leasing service model was facilitated by Laurea at the LIA, Telford, UK on 28 May 2019, using various service design canvases, brainstorming techniques, and mock-ups. The workshop was targeted at: facility management (FM) companies, wholesale companies, LIA experts, contractors, Carbon Trust members etc.

The key themes of this workshop were: testing and gathering new ideas, various thoughts, and feedback on the Kosnic's leasing service business model; identifying: 1) key functionalities and sales arguments for leasing service; 2) roles for each business partners; 3) revenue sharing model and 4) identification of the potential end-customer types.

Figure 12 Discussion on proposed leasing service at LIA Workshop, May 2018

Figure 13 An example of a service design canvas at LIA Workshop using Laurea's Coco-toolkit, May 2018

Some thoughts on how to implement a leasing service model were presented as shown in figure 20 with following points:

- The creation of a Circular Economy Leasing Company (CEL) that would ideally involve all key stakeholders such as manufacturer, wholesaler, contractor, installer, facility management company, finance institute, share profit, a win-win model for all.
- The CEL would have a group central office that would comprise a set of directors or managers who are responsible for delivering manufacture, project, finance, maintenance & upgrade.
- The CEL would involve multiple franchises; each local franchisee will look after the regional Maintenance, Warranty, Returns, Exchange, and Performance Insurance.

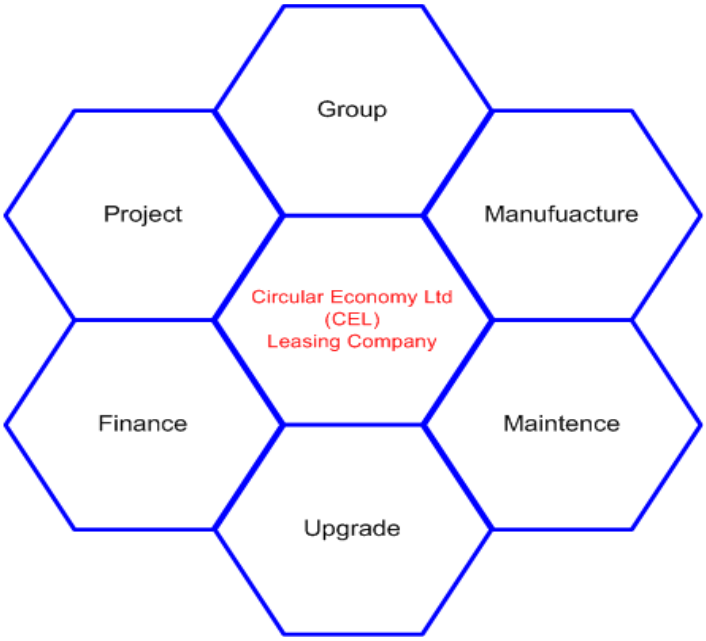


Figure 14 The proposed idea on how to implement leasing service

In the proposed solution for leasing service model, the following key partners are identified:

- Manufacturer (Supply of quality, affordable product)
- Contractors (Installation, initiate project leads)
- Wholesalers (Initiate project leads, customer relations, local knowledge)
- Bank (Due diligence, finance)
- Insurance Company (Due diligence, affordability of scheme)
- End-User (Initiation recommendation)

The benefits are considered:

- Partners benefit due to regular financial income.
- Benefit via cost saving over existing models.
- Social conscience
- The advantage to the customer is local contact but receives support from all stakeholders. One point of contact. Local connection – global outreach

With lots of challenges ahead as follows:

- Integrated Building Management System. How would this integrate?
- Building owned by third party (landlord different to end user).
- How to split payment?
- How do you split the franchises up?
- What happens at the end of the leasing term?
- Cost and/or due diligence of the insurance.
- How to monitor energy performance?
- How to manage upgradeability. Perhaps modular design could limit the impact of this?
- How to provide client with the confidence?
- How to provide potential members of the business plan to buy in to the idea and get involved?
- How to make the client aware of how the business model is set up?

Face to Face Meeting with Business Partners

Date: January 2020
Location: Kosnic HO, Newbury, UK

On 22 January 2020, Kosnic's business partners Mr Stan Dunderdale (wholesaler) from Link Projects and Christine Whitrick (contractor) from RMW Electrical ware invited to Kosnic HO at Newbury, Berkshire, UK to seek the future potential industrial lighting leasing project. The feedback from this face-to-face meeting regarding leasing service is as follows:

- Leasing Model is very promising from the financial point of view.
- More business opportunities due to ease financial planning provided by flat payment scheme, especially for projects from local councils (such as school, leisure facility, etc.).
- All key stakeholders of industrial lighting eco-system should be included and bind together (wholesaler, Manufacturer, End User, Contract and Maintenance).
- 3-to-5-year leasing term is preferred instead of longer 10-year term.
- A shorter term is better for the contractor as lots of them are self-employed.

Leasing Contract and flowchart

Date: January to October 2020
Location: Newbury, UK

Based on all input from the above activities regarding industrial lighting leasing service and studying on general leasing contracts, a draft multi parties leasing contract with all stakeholders from industrial lighting business model involved was prepared, in which all essential contents from the co-creation process of the leasing service ware included. This can be seen in Appendix 3. A flowchart for the leasing contract was also developed and can be seen in Figure 21 and 22. The five-year payment plan for the leasing service was chosen, in which installation fees are paid fully during the first two-and-a-half-year period to reflect the fact that majority of the contractor are self-employed who require a shorter time of payment. This can be seen in Figure 23.

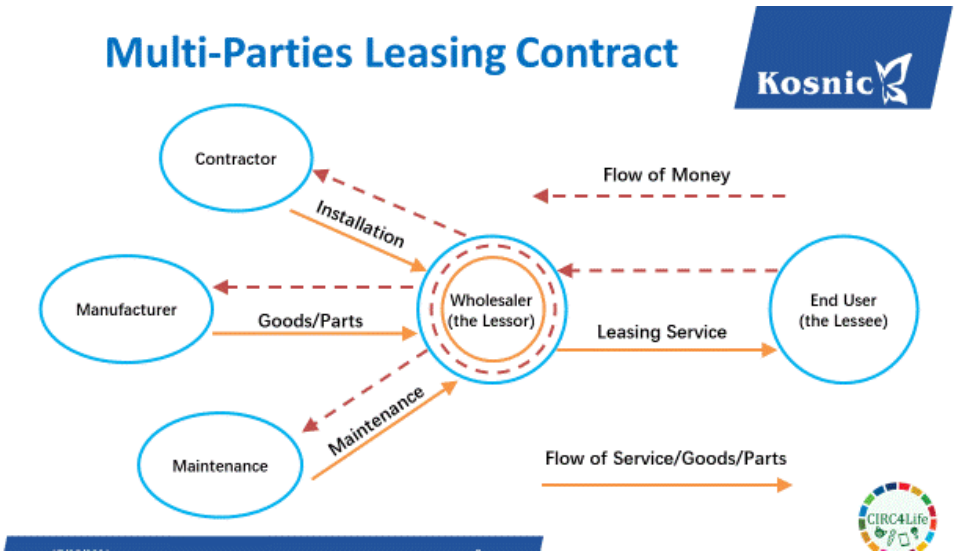


Figure 15 Multi-parties leasing contract model

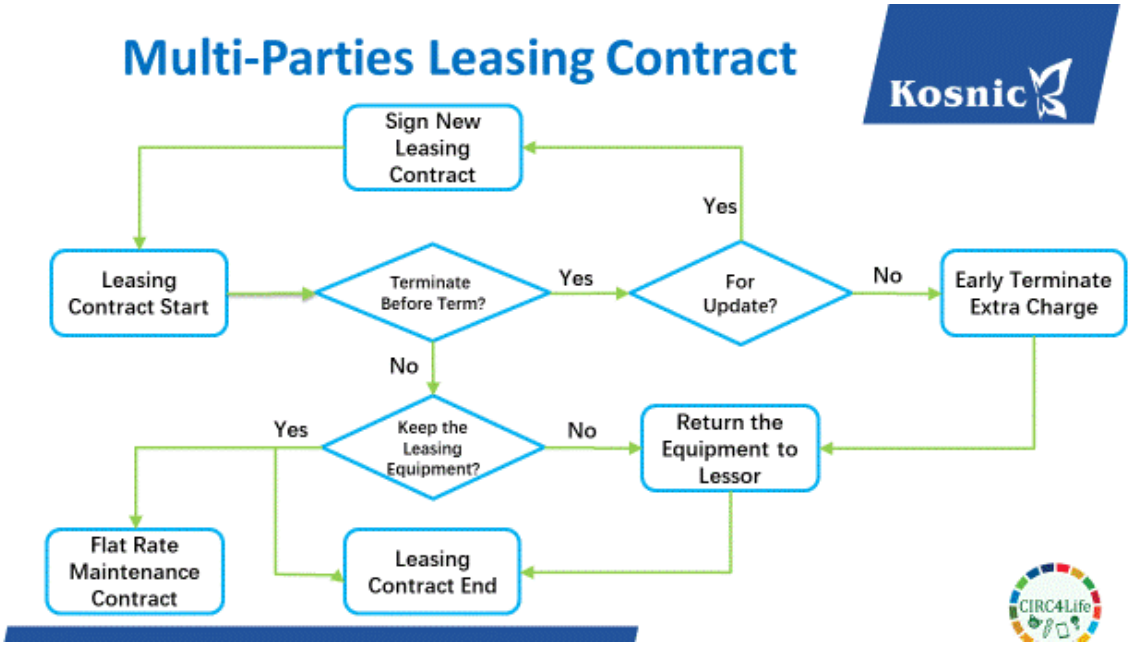


Figure 16 Multi-parties leasing contract flowchart

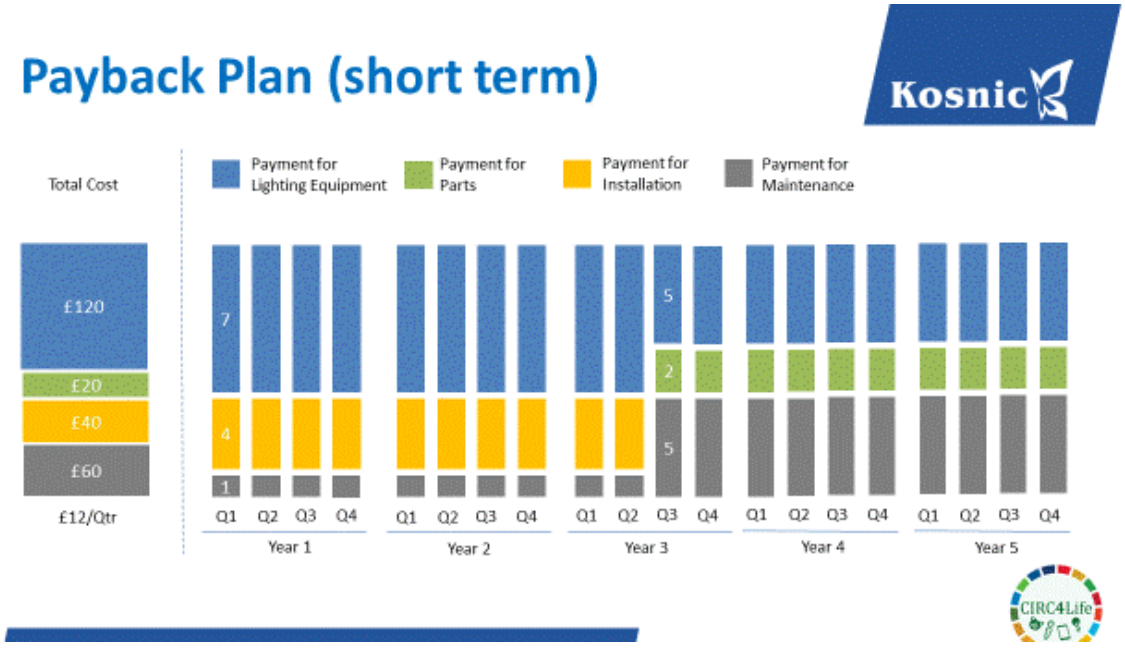


Figure 17 Final payment plan of leasing service

By operating under the leasing service model developed by Kosnic, every party is incentivized to follow a collaborative recycling and reuse approach to the products life cycle. Under traditional supply, where product ownership passes solely on to the consumer, if a fault were to occur, it would be left up to the consumer to decide how best to replace the affected unit. However, with a maintenance service built into the leasing service model, every party remains involved. This means that a fault can be reported, a replacement module can be supplied, and the faulty unit can be replaced at site and returned to Kosnic for repair or recycle.

The leasing service also allows for upgradability. Lighting is an industry that is constantly evolving with new technology and increased efficiency taking place at an ever-increasing rate. In much the same way that both the modular design of the product and the leasing service make it possible for product life to be extended, they both also make it possible for the product to be upgraded. As is common with leasing services in other industries, upgradability is an option at the end of the leasing contract. Rather than ending the contract and taking ownership of the existing products, it would be possible to consider upgrade to the lighting, by adding new modular components such as more efficient drivers, improved LED boards, or even new controls with more expansive options (such as remote control or remote reporting).

The leasing service, working hand in hand with Kosnic's modular products, will be able to deliver effective collaborative recycle and reuse, as set out by the aims of CEBM3 of the CIRC4Life project. Product life can be significantly increased through both flexibility to repair and upgrade, which works towards reducing waste and making the most out of the installed products.

4.2.2 Stakeholders involved

Stakeholder	External / Internal	Type of Stakeholder	Involvement
John Wilson	External	Wholesaler (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Dave Frank	External	Independent Lighting Consultant (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Stan Dunderdale	External	Wholesaler (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development. Attended one-to-one business meetings to discuss product and leasing service in Jan 2020. Attended validation interviews in Feb/Mar 2021.
Rich Green	External	Sales Manager at the LIA (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Paul Stearman	External	Independent Lighting Consultant & LIA Course Leader (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Gareth John	External	Lighting Photometry Expert & LIA Course Leader (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Brian Healy	External	Independent Lighting Consultant (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Kristin Shortt	External	Staff Member at the LIA (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.
Peter Hunt	External	Chief Policy Officer at the LIA & President at LightingEurope (Co-Creation)	Attended LIA Workshop Co-Creation event in May 2018 and offered a range of feedback that led to co-creation and leasing service development.

Christine Whitrick	External	Managing Director of RMW Electrical (Contractor)	Attended one-to-one business meetings to discuss product and leasing service in Jan 2020. Attended validation interviews in Feb/Mar 2021.
Aramis Tonks	External	Lighting Project Consultant (The Lighting People)	Attended validation interviews in Feb/Mar 2021.
Ben Innes	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Hannah Driscoll	External	Wholesaler (Smith Bros)	Attended validation interviews in Feb/Mar 2021.
Ross Smart	External	Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.
James	External	Apprentice Electrician (Smart Electrical)	Attended validation interviews in Feb/Mar 2021.

4.2.3 Results, lessons learnt and further recommendations

After face-to-face meetings with our business partners regarding the proposed leasing service, there seems to be a great deal of optimism that a leasing service project could be identified and developed together. Unfortunately, due to COVID-19 lockdown from March 2020 in UK, the business partners shift their priorities on other projects instead of the leasing contract trial one and things have not managed to improve so far. However, Kosnic would like to continue seeking any leasing opportunities that may arise. A risk management for the pandemic event may be needed to be included in any future project, although this kind of natural disaster is very difficult to predict.

Having said this, it is very clear that all of the groundwork for a successful service has been developed in accordance with the collaborative recycle and reuse CEBM developed by the CIRC4Life Project. Collaborative recycle and reuse is intrinsically linked to the solutions created by Kosnic. The modular product strongly encourages reuse and improved recyclability through its very purpose, as modules are easily removed and replaced if a fault occurs, which makes reuse of fittings easily achievable. The leasing service furthers this, by creating an eco-system that incentivises all parties to take advantage of the modular nature of the product and prioritise reuse and recycling through the built-in maintenance aspect of the service.

To validate the CEBM, and what Kosnic had implemented to demonstrate it, online presentations/interviews were conducted with a sample of key stakeholders, such as wholesalers, lighting project consultants, contractors, and electricians in early 2021. The responses to the questions asked showed a clear level of satisfaction with the idea of lighting as a service in general, and the leasing service eco-system that Kosnic have developed. They also showed that there is a growing desire for a service like this in the future. A selection from some of these questions and responses can be seen below:

Interview question: Do you consider lighting as a service (leasing) a good idea?

- *"Yes, lighting as a service Is a brilliant idea, as you know we have a funding facility in house, there so much more value that you can add. Customers want to get a good service of design, specification, a survey that gives them a full asset list for their building."* Hannah Driscoll, Smith Bros.
- *"It's something that a lot of people are talking about at the moment, we've got parts of our business that are looking at it, if we're doing a placement project, we would make sure that the customer is cashflow positive by taking their energy saving and using that to fund the finance proposition. It would then be the customer who owns the product after."* Ben Innes, Smith Bros.

What do you like our proposed leasing service eco-system?

- *"I like that every party is be involved. I think we're going in a direction where having a partnership with a manufacturer, wholesaler, installer and end client, it just works better as everyone knows everyone's responsibility and role."* Hannah Driscoll, Smith Bros.
- *"Everyone has got a stake in it, so you wouldn't get it where the contractor installs it and then doesn't care about it anymore, especially if they're getting paid along the way."* Ben Innes, Smith Bros.
- "*It created close links between installers, manufacturers, and suppliers. As an installer I could liaise with the manufacturer if there are any product issues and help the manufacturer out if something isn't performing as it should do."* Ross Smart, Smart Electrical.

What might put someone off the idea of lighting as a service (leasing)?

- *"I think a lot of the time customers want to see the benefit, say if it's an upgrade project, they like to see the benefit of the reduced energy bill straight away. So, if it gets to the point that they don't own the fittings and they're still paying the same sort of money because they're paying the leasing agreement. I would expect that their monthly payment would have to be less than the amount of energy that they're saving otherwise they won't see the benefit."* Ben Innes, Smith Bros.
- "*The only thing that would put someone off is ridiculous interest rates, so something where the interest rated are through the roof and not comparable. You've got to be able to demonstrate what you're saving off your energy bill will fund the project."* Hannah Driscoll, Smith Bros.

Would you consider a leasing model for your next installation / project?

- *"I would absolutely consider it, it's a no brainer, I think the likelihood to succeed depending on the appetite of the client, as long as all factors fit for them, there's no reason why they wouldn't do it. There's no risk, you get new lighting, you're going to save money, you're going to be cashflow positive at the end of it, why wouldn't you do it."* Hannah Driscoll, Smith Bros.
- *"I would say we would, at this stage as it's still relatively new and unfamiliar to people and theirs lots of hurdles to overcome we would probably offer it as an option to our clients."* Aramis Tonks, The Lighting People.
- "*If you've got the right customer, it could be the thing to win a project, if you come in slightly over budget on a project and they say they don't have enough money to do it you could say about leasing options instead. Then you could win projects that you would have lost before because it was too expensive."* Ben Innes, Smith Bros.

Validation of Kosnic's implementation of the collaborative recycle and reuse CEBM was also considered at the 2nd OIC event hosted and facilitated by Laurea in May 2021. The initial vote conducted on whether Kosnic "successfully applied CEBM (c) Collaborative recycle and reuse" received 43 votes from participants. The result of the vote was extremely positive with 13 participants strongly agreeing, 19 agreeing, 11 neither agreeing or disagreeing, and no participants disagreeing. This can be seen in Figure 13, in the previous section.

After this initial vote, work groups were established to discuss the implementation of CEBM3 within the Kosnic DEMO further. This included open discussions and Q&A sessions. After this was completed, a new vote was conducted within these smaller work groups and the final results were just as positive as before with 5 participants strongly agreeing, 6 participants agreeing, 3 neither agreeing or disagreeing, and only 2 participants deciding to disagree.

The process of implementing this CEBM and conducting the various activities to achieve this successful implementation, have led to several lessons being learnt and further recommendations being discovered.

Specifically, the CIRC4Life Project has truly taught us to look at how we could implement the Circular Economy approach within our route to market. Over the last few years, whilst taking a very initial idea for "lighting as a service" and developing it throughout the co-creation CEBM, we have discovered that a leasing service, if done correctly, could be a very popular idea within the lighting industry. There are already a handful of

examples of leasing within the lighting industry in operation, but these tend to centre around a financier, or loan company, meaning that the client is effectively just loaning the money and then making repayments. This keeps the supply chain very linear. The CIRC4Life Project, and the emphasis of Circular Economy, forced us to look at things differently whilst developing our service eco-system. By keeping all relevant parties involved (manufacturer, wholesaler, contractor/maintenance), we could provide a holistic approach that encourages and incentivises all parties to work towards achieving a circular business model that emphasises sustainability and reuse/recyclability, in a way that the traditional leasing models seen today cannot.

5 Showcases

5.1 Demo 1A Kosnic Lighting Ltd

Kosnic's demonstration activities started in February 2021. It is important to note that this aspect of the project, and Kosnic's efforts to showcase our role as a demonstrator for the CIRC4Life Project, were heavily impacted by the Covid-19 pandemic, and the resulting restrictions made initial plans unachievable. This meant that the option for physical events was no longer feasible and alternative plans had to be made.

Specifically, it was no longer possible to attend Frankfurt Light + Build, the biggest lighting trade show in Europe. This would have been a great platform to showcase exactly what Kosnic had worked on throughout the CIRC4Life Project.

It was also no longer possible to target a trial project with potential business partners. The initial plan was to achieve an installation on a real-world trial project, using the Arcus II product developed and the leasing service eco-system created. This would have perfectly showcased exactly how successful the Kosnic demo could be. Unfortunately, this was not possible to achieve because restrictions throughout the UK had severely impacted the chance to get in front of prospective clients and lowered prospective clients' inhibitions to commit to something as long term, and financially impactful, as replacing industrial lighting within their property. Due to this, an alternative showcase had to be developed, which would showcase the products operation with installation within Kosnic's own warehouse.

By the time of May 2021, it was also not possible to hold a physical showcase event at Kosnic's Head Office. This meant that the final showcase event had to be converted to a virtual online event.

Kosnic Trial Install

As explained above, Covid-19 restrictions meant that alternative showcase plans had to be developed and implemented. Under the conditions, it was decided that the new modular industrial LED luminaire developed would be installed within the warehouse at Kosnic's Head Office in Newbury, UK. The aim was for the install to simulate the typical environments that the new product had been designed/developed for. Industrial areas that require a high output fitting as install heights are anywhere between 6 to 12 metres. To showcase the results in a manner that replicates a real-world scenario, a full project proposal was completed, from initial survey to completion.

The first step in surveying a potential project is to understand what the goals or aims of the consumer are. In this case, the goal was to improve the quality of light from the existing installation and see a reduction in energy expenditure. A survey was conducted to determine what was currently installed, and how Kosnic's new modular industrial LED luminaire could be used to achieve the goals that had been set out.

Figure 18 Site Survey of Kosnic Warehouse

Upon completion of the survey, a lighting scheme was produced using specialist lighting software. This software is used to simulate the area and the lighting levels that could be achieved if the proposed products were to be installed and can be seen in Figure 26. A cost of ownership/payback calculation was also carried out. This shows exactly how much energy expenditure can be saved per annum by making the change to the proposed product and can be seen in Figure 25. Once these aspects are completed, the proposal is presented to the client.

The proposal shows the client all the necessary estimations of what could be achieved if they decide to make the change. This includes the lighting scheme calculation and cost of ownership/payback calculation, as previously explained. In this specific trial case, the lighting scheme shows that the light levels achieved would meet guideline levels for a warehouse area such as this.

The cost of ownership/payback calculation shows a multitude of information, including the savings on both energy expenditure and CO2. It also takes the energy expenditure per annum, converts this into monthly savings, and informs the client exactly how many months of savings it would take to "payback" the initial investment to install the new lighting. This would be adapted under a leasing service proposal to show exactly how much the savings on energy expenditure could contribute to scheduled repayments.

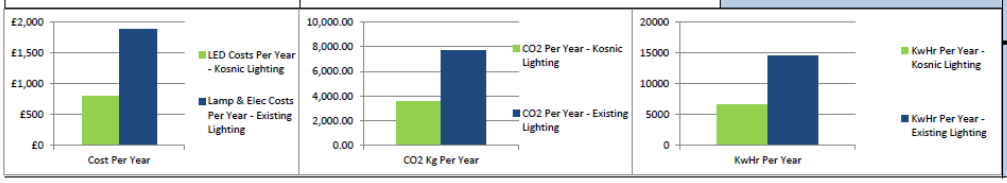
Cost of Ownership Calculator — Project Name; Kosnic Warehouse — Kosnic

Cost of Electricity Per KwHr	Hours Per Year	Area	Quantity	Existing Lamp Type	Existing Lamp Wattage	Existing Lamp Cost Per Fitting	Labour Cost to Replace Fitting	Lamp Life Hours	Lamps per Year	Existing Electricity Per Year £	Existing Lamp Costs Per Year	Lamp + Electricity Costs Per Year	Existing Kilowatts Per Year	Existing CO2
£0.12	2,470	Warehouse	15	250w MH Lowbays	326	£25.00	£5.00	10,000	0.25	£1,449.40	£111.15	£1,560.55	12,078	6,426
£0.12	2,470	Warehouse	3	250w MH Circular Highbays	326	£25.00	£5.00	10,000	0.25	£289.88	£22.23	£312.11	2,416	1,285
Cost of Electricity Per KwHr	**Hours Per Year**	**Area**	**Quantity**	**Replacement LED Fitting Type**	**Replacement LED Fitting Wattage**	**Replacement LED Cost Per Fitting**	**Labour Cost to Replace Fitting**	**LED Fitting Life Hours**	**Fittings per Year**	**LED Electricity Per Year £**	**LED Fitting Costs Per Year**	**LED Fitting + Electricity Costs Per Year**	**LED Kilowatts Per Year**	**LED CO2**
£0.12	2,470	Warehouse	18	Arcus II - 150w	150	£75.00	£5.00	40,000	0.06	£800.28	£88.92	£889.20	6,669	3,548
Savings Per Year					3168					£939.00		£983.46	7,825	4,163

	Year 1	Year 2	Year 3	Total	£ Savings Per Year
Existing Costs (Lamps & Electricity)	£1,872.66	£1,872.66	£1,872.66	£5,617.97	
LED Costs (Purchase in Year 1 + Elec Costs)	£2,150.28	£800.28	£800.28	£3,750.84	**£1,072.38**
Payback Period Months	15				

Payback Period Months: **15**

£ Savings over life of LED: **£17,366.40**



*All figures for illustration purposes only and do not form any guarantee from Kosnic Lighting Ltd

Figure 19 Cost of Ownership Calculation for Kosnic Warehouse Install

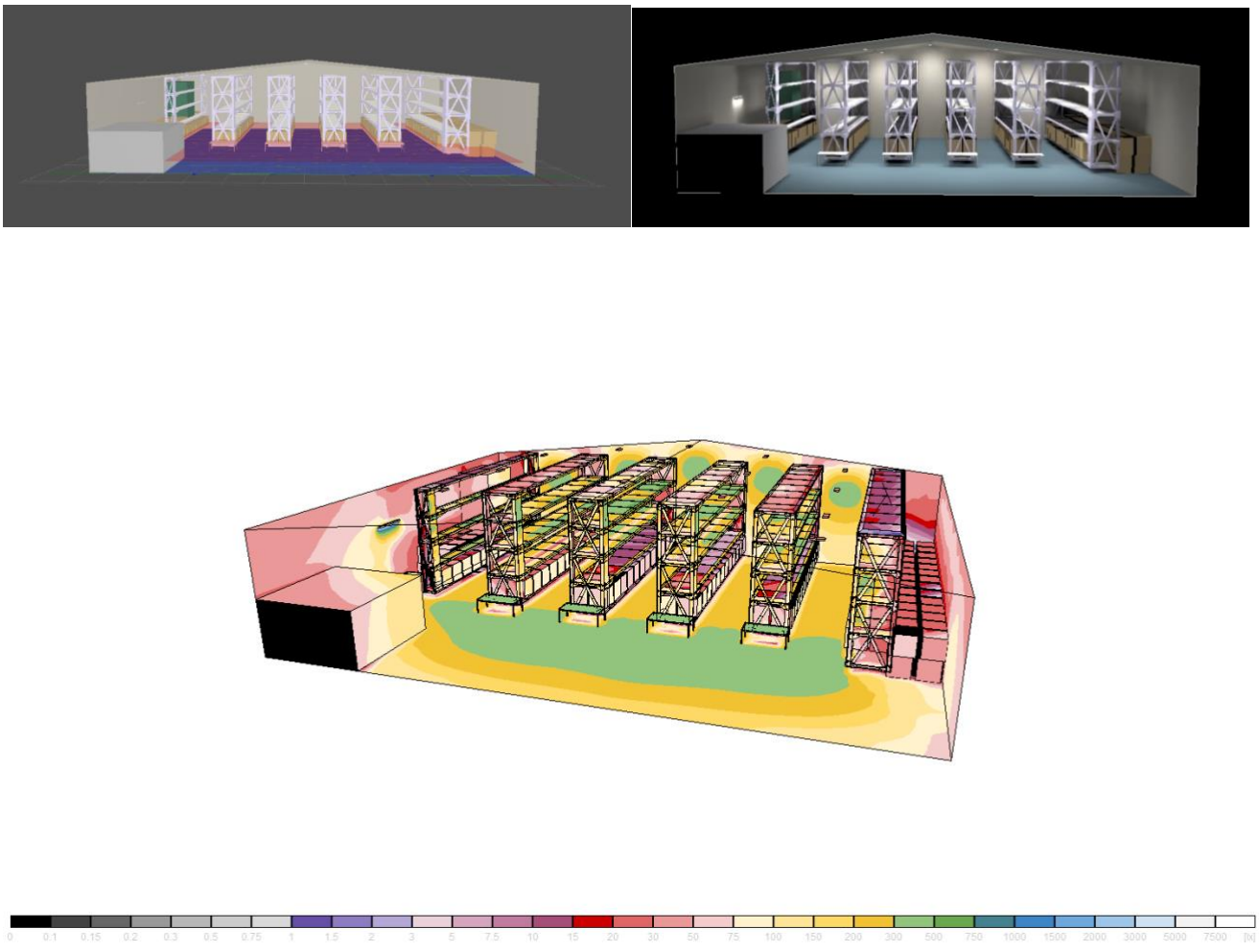


Figure 20 Lighting Scheme Calculations for Kosnic Warehouse

As previously explored, an LCA label, or comparison sheet with descriptor, is also included within the proposal to show the client that the product proposed is sustainable and has a much lower impact on the environment than potential alternatives.

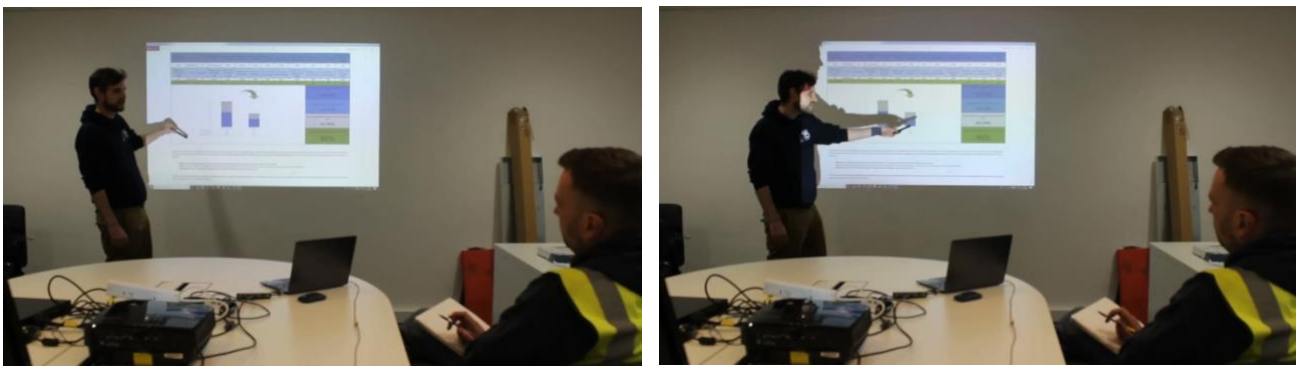


Figure 21 Presenting LCA Comparison Descriptor

Online Validation Interviews

In late February and early March 2021, several online validation interviews were conducted with key stakeholders. These interviews were held via Microsoft Teams and the stakeholders included wholesalers, contractors, lighting project consultants, and electricians. A full list can be seen in the stakeholders included sections for CEBM1 and CEBM3 earlier in this deliverable.

Kosnic's work as a demonstrator in the CIRC4Life Project was presented to the participants, showcasing the modular industrial LED luminaire and the leasing service eco-system. A series of questions and open discussions followed. Selected responses to these can be seen in the previous sections on the respective CEBMs, within the results and lessons learnt sections. Full transcripts are also available under Appendix 2.

Virtual Showcase Event

In May 2021, a virtual online showcase was also conducted. The event was hosted via Microsoft Teams, with a workspace also being created and hosted on HowSpace. The event included 7 external participants from various stakeholder groups including wholesalers, academia, LIA staff, and lighting project consultants, and 5 participants from other CIRC4Life consortium members. Unfortunately, this was not as many participants as desired, but guaranteeing participation for an online event such as this is extremely challenging without the option of offering any form of compensation. The industry we work in means that taking time away from a job means a loss of money, and this is not something that many wholesalers or contractors can accept. Especially at a time where restrictions from Covid-19 were beginning to be eased, and they could begin to visit more sites for potential projects again.

For the event, a series of videos were created in order to showcase how Kosnic had implemented the three CEBMs. Links for these videos can be seen under Appendix 4. The structure for the event was dictated by the HowSpace workspace, with participants all receiving an invitation to the workspace prior to the event. During the event, the relevant videos for each section were shown to the participants, who were then asked to answer the validation questions on the HowSpace and ask any open questions they had to the Kosnic team members.

Some key insights towards Kosnic's demo KPIs can be seen below:

- On a scale of 1-5, participants voted an average of **4.6** when asked "**if they were satisfied with the final modular design shown and its possibilities"**, with one comment stating, **"From a sustainability angle this product is fantastic in demonstrating and leading the way in which products can be made in the future".**
- When asked "**Do you believe that the co-creation processes outlined in the above video, such as Living Lab workshops, can help to provide extra value within new product development?",** all participants responded **Yes,** with participants placing an average figure of **4.3** out of 5 to its value.
- When asked "**Do you believe that the new modular product shown is a more sustainable product based on the described development processes (such as stakeholder co-creation and LCA studies)?",** all participants responded **Yes,** with participants placing an average figure of **4.2** out of 5 to its value.
- On a scale of 1-5, participants voted an average of **3.8** when asked "**if they were satisfied with the final leasing service shown and its possibilities**."
- When asked "**Do you believe that co-creation processes, such as Living Lab workshops outlined in the video, can help to provide extra value when trying to develop a new business model, such as the leasing service model shown?",** 9 participants responded **Yes,** and 2 responded **Not Sure**.
- When asked "**Do you think the option of a leasing service, and it's potential to eliminate big upfront fees to update lighting, would appeal to building owners?",** 9 participants responded **Yes,** and 1 responded Maybe.

- On a scale of 1-5, participants voted an average of **3.5** when asked "**hypothetically, if they were looking to update their buildings lighting, how strongly would they consider the leasing service that has been shown?"**
- On a scale of 1-5, participants voted an average of **3.6** when asked "**how satisfied they were with the proposed contract structure shown and its options for flexibility?"**

- On a scale of 1-5, participants voted an average of **4.6** when asked "**how important is the idea of sustainability to you?"**
- When asked "**Does environmental impact of a product influence your buying decisions?",** all participants responded **Yes**.
- On a scale of 1-5, participants voted an average of **4** when asked "**how likely would you be to purchase more sustainable products, even though they might be more expensive?",** with some participants commenting that they would be willing to pay up to 20% more.
- When asked "**Do you believe that the eco-information, or sustainability of a product, could be decisive at the point of purchase if it was made available to the consumer as shown in the video?",** all participants responded **Yes**.

- When asked "**Given the option, would you rather have the option to repair a light fitting instead of having to replace it?",** 10 participants responded **Yes,** and 1 responded **Not Sure.**
- On a scale of 1-5, participants voted an average of **4.7** when asked "h**ow important is ease of reuse/recyclability to you?"**
- When asked "**Do you think that the measures that have been implemented within the modular product shown to encourage reuse and recyclability could be successful?",** all participants responded **Yes,** with participants placing an average figure of **4.1** out of 5 on how successful they feel it could be.
- When asked "**Do you think that the leasing service eco-system proposed will help to incentivise effective reuse and recyclability of lighting products?",** 9 participants responded **Yes,** and 1 responded **Not Sure,** with participants placing an average figure of **4** out of 5 on how successful they feel it could be.
- When asked "**Would you be willing to accept a refurbished lighting product?",** 10 participants responded **Yes,** and 1 responded **Maybe. Under the right circumstances.**

Overall, even though the sample size for the event and the validation is smaller than would have been desired, the event and the responses received were largely positive, as seen above. This was further cemented with a larger sample size at the 2nd OIC event that took place online in late May 2021. The results for this have been discussed throughout this deliverable, in the relevant CEBM sections, but the overall results for how Kosnic have been seen to have implemented the three CEBMs developed within the CIRC4Life Project have been very successful.

On top of successful validation for the three CEBMs, the participants at the 2nd OIC (developed as a part of WP7 & D7.1) also voted overwhelmingly in favour of Kosnic's success in generating new products and/or services and managing a transit towards more circular business during the project. The results for this can be seen in the following image and in more depth in Deliverable 6.5. When it came to generating new products and/or services, 17 participants strongly agreed, 24 agreed, and only 2 decided to neither agree nor disagree. For managing to transit towards more circular business during the project 18 participants strongly agreed, 22 agreed, and only 3 decided to neither agree nor disagree.

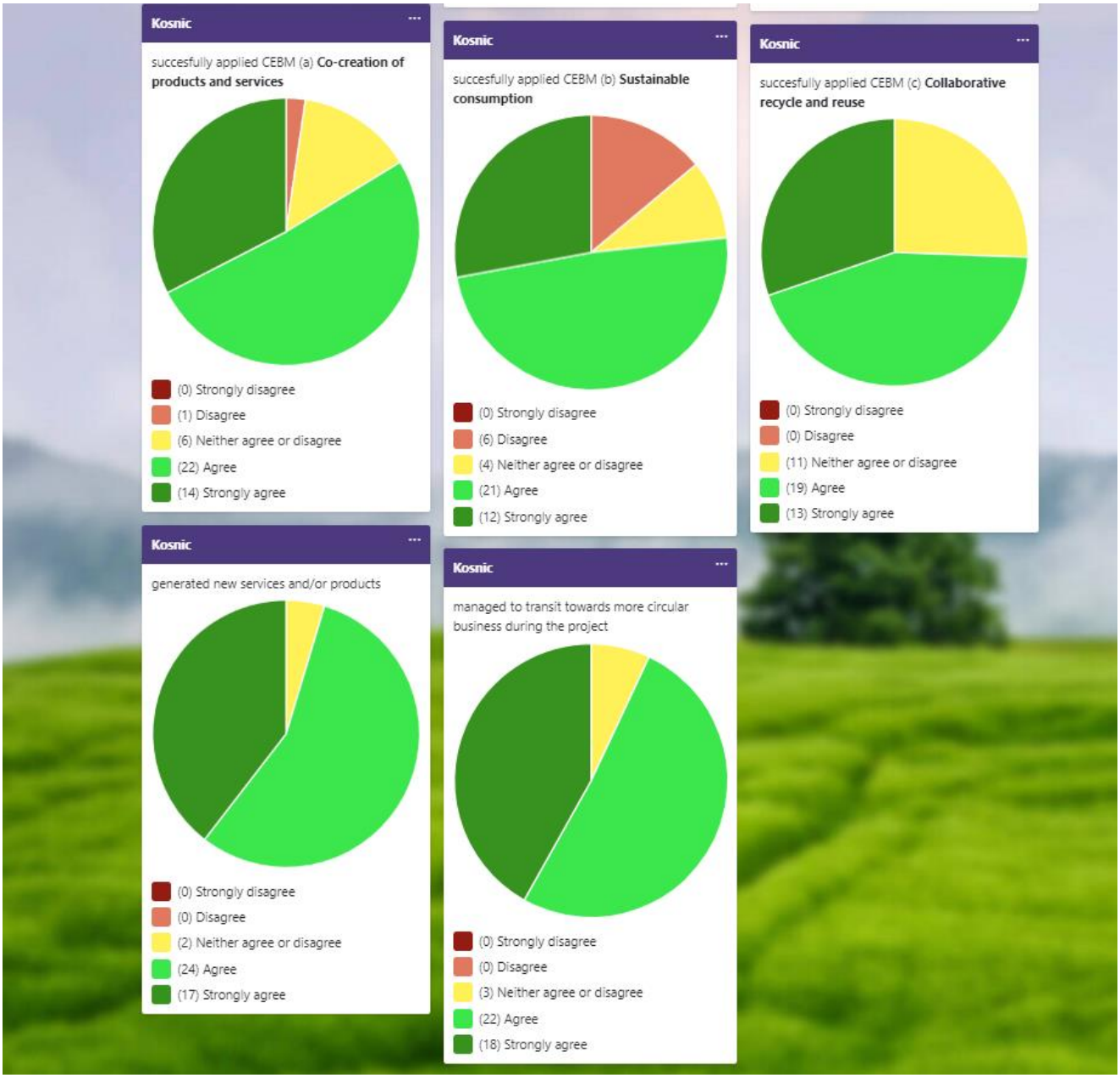


Figure 22 Initial voting results for successful implementation of CEBMs in Kosnic DEMO

This was followed by interactive workshops, where the results were discussed in more depth and the solutions were evaluated further. A final evaluation was then conducted with a more focused level of 15 participants. The implementation of all three business models was voted on positively by most participants as shown in Figure 29 below. Additionally, 14 out of 15 participants considered that Kosnic had developed new services and/or products during their demonstration and 13 out of 15 **agreed** or **strongly agreed** that Kosnic had managed to transit towards more circular business during the project.

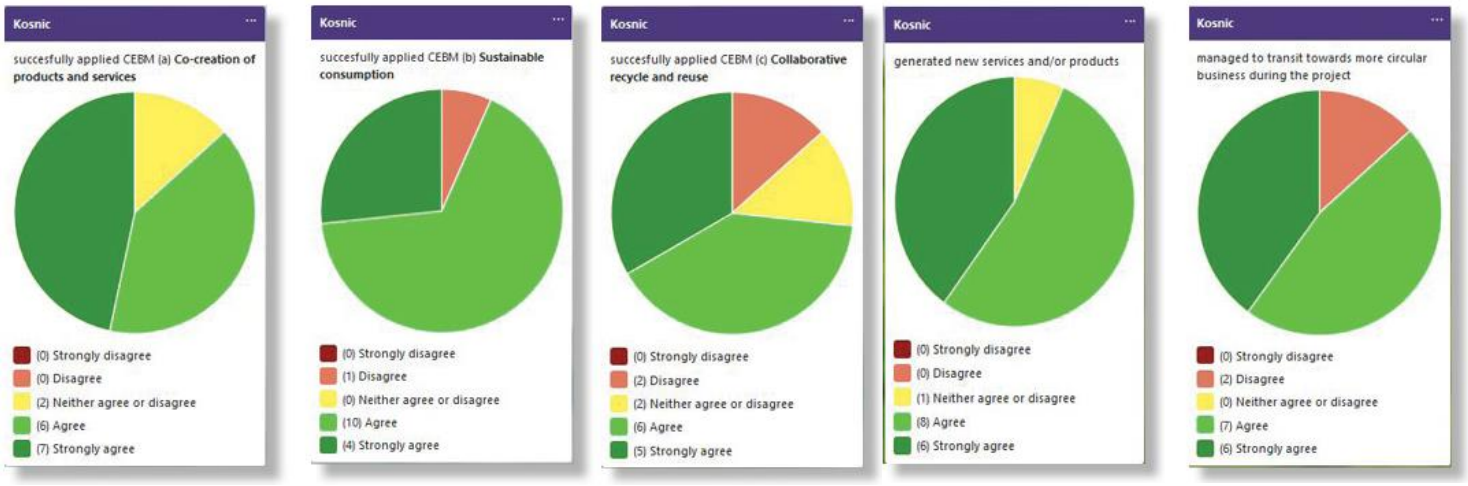


Figure 23 Results for Kosnic DEMO from the validation activity at the second OIC as a part of D7.2

Specifically, Kosnic received positive feedback on how the LCA data was implemented into PDS development, and the holistic approach developed for the leasing service eco-system. Co-creation activities, such as workshops and surveys, were also considered to be a success within the Kosnic demonstration as they truly helped to shape PDS evaluation and development throughout the project. There was some uncertainty towards the evaluation of how well the solutions would be accepted in practice, as the lack of potential customers and real-life implementation opportunities were not demonstrated, or possible, because of the impact of the Covid-19 pandemic and subsequent lockdowns.

6 Conclusions

The CIRC4Life Project has offered Kosnic the chance to gain a much deeper understanding for the idea of Circular Economy, and a solid foundation to continue implementing the ideas developed within the project, and the three CEBMs, in the future.

Co-creation and the LL methodology have allowed us to make sure we address key stakeholder needs from the start, and even helped us develop relationships with key stakeholders to collaborate with in the future. LCA studies have not only given us a much deeper understanding for the sustainability of both our products and our company, but they have also helped us to specifically highlight hotspots of environmental and societal impacts throughout a products lifecycle and remedy them from the start. Our involvement has also taught us that modular product design is the future for luminaire development within the lighting industry. This is shown by new regulations being brought in to further encourage modularisation and accessibility for light sources and control gear within lighting products.

Our involvement within the sustainable consumption CEBM has also shown us that there is a growing appetite for more sustainable options, and the introduction of an indicator to show a products sustainability, and impact on the environment, could be a key selling point when it comes to specifying industrial lighting projects as more and more companies begin to become more conscience of how “green” they are perceived to be. For this to be truly successful though, it would have to be regulated and become an industry standard. Without this, it would never truly be possible to compare one product to the next.

When it comes to collaborative recycle and reuse, our involvement in the project has not only made us consider product design and modularisation, but it has also made us think about our route to market too. Lighting as a service, or leasing, could be a very popular idea within the lighting industry. It is already a service that is extremely popular in other industries that traditionally require a large amount of upfront capital, so the potential is certainly there. Rather than centring around a financier, or loan company, which keeps the supply chain very linear, the CIRC4Life Project taught us to look at things differently whilst developing our service eco-system. By keeping all relevant parties involved (manufacturer, wholesaler, contractor/maintenance), we could offer a truly holistic approach which emphasises circularity, sustainability, and reuse/recyclability in a way that the traditional leasing models seen today cannot.

Although we were not afforded the chance to truly showcase the product and service developed in a real-world trial project, due to Covid-19 restrictions, the validation that has been received for what was developed as shown a great deal of success and acceptance. As a company, we would strongly recommend that other companies explore the power and potential of circular economy business models and what they can offer, not only for them as a company, but also in terms of sustainability for the future of us all.

7 References

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2) Ecolights project: 'Market Deployment of Eco-Innovative Lighting Products' https://cordis.europa.eu/project/id/304409
3) Cycled project: 'Cycling resources embedded in systems containing Light Emitting Diodes' https://cordis.europa.eu/project/id/282793
4) Jose L. Casamayor and Daizhong Su, 2020, 'Integrated Approach for Eco-Lighting Product Development', in in Daizhong Su (ed.) 'Sustainable Product Development: Tools, Methods and Examples', Springer, https://doi.org/10.1007/978-3-030-39149-2_15
5) FP7 cycLED project Deliverable 3.1 'Proposal for increasing resource efficiency and reducing environmental impact from the production of lighting products', submission date: 31 March 2015. Nottingham Trent University.
6) CIRC4Life Deliverable 1.2 "Report on sustainable (environmental, social and economic) impact analysis https://25cd04c9-5fc8-4b44-8c3c-9ad39fc8bbac.usrfiles.com/ugd/25cd04_12398d4cc36e4b41934e10d807ad00a5.pdf
7) Wang, S., Su, D., Ma, M. and Kuang, W., 2021. Sustainable product development and service approach for application in industrial lighting products. *Sustainable Production and Consumption*, *27*, pp.1808-1821. https://www.sciencedirect.com/science/article/pii/S2352550921001159

8 Appendices

Appendix 1 - Product Design Specifications for the Industrial luminaire

The product to be developed is an Industrial high-power LED luminaire, known as the LED High Bay. This particular luminaire is installed in an industrial environment with a height between 5 to 13 meters. Comparing with the traditional industrial luminaire that uses HID lamps, the LED high bay uses 1/3 or less of energy with average life 8-10 times longer.

1) Operation Environment
This product is designed to be used in a commercial or public environment, with higher ceiling, such as warehouse, exhibition hall, sport hall and barn etc.

- Impact protections need to be higher than IK8
- Optics choice to include 90-degree beam angle and polarised 40 degree.

2) Cost
In the current market situation, the retail price (price to be paid by end user) should be:

- Standard Model: £300 - £500 based on the power and lumen output.
- Additional emergency module: around £150
- Additional motion sensor: around £80

3) Lifespan
The average life of this product as a complete unit that includes LED engine and driver is 50,000 hours, where the LED module's average life is expected to be 100,000 hours, and the average life of the LED driver is 50,000 hours.

4) Maintenance
For an installation site, annual check should be carried out. The failed parts/luminaire should be replaced. The expected failure rate is as below

- LED driver: <1% year1; <5% within year 3; <10% within year 5; <30% within Year 10
- LED Engine: <0.5% year1; <2% within year 3; <5% within year 5; <15% within Year 10

5) Packaging & Shipping
Carton Boxes should be used for the complete luminaire and replacement parts. Protection insert will be used where necessary, however the materials used must be recyclable.
Weight of a single package should not exceed 25Kg for manual handling. The
packaging should pass the following drop test:

- A sample packaged product is dropped (must be free fall) from a height of 70cm to a hard floor on three different sides. After the test the product should be in a sellable condition.
- The packaging should be suitable for shipping using standard courier services (such as UPS, DHL & TNT etc.).

6) Safety
The product must meet the EU safety regulations outlined in the section below, "regulations and standards".

7) Functional and performance requirement

This section details the technical specifications required. It provides sufficient information that allows the design engineers to complete the product development without ambiguities.

- **Luminaire Body**

  This luminaire comprises 3 parts, base unit, gear tray and lighting unit.
  - Base unit: This is the mounting plate, including fixing openings and wiring entry. It can be used for surface-mount and suspended mount. The wiring terminals are also prefixed to this base unit. After wiring, the gear tray and lighting unit are mounted to this base unit.
  - Gear tray: This metal tray holds the LED drivers and control modules.
  - Lighting unit: This front metal panel holds the LED board and optic lens.
  - Protection: Class I, >IK8
  - Material: folded sheet metal (steel with powder coating)
  - Fixing: suspended and surface mounting.

- **Driver Module**

  Control Gear: This unit compromises multiple LED driver modules interlinked with power bus and control bus.
  - Housing: Polycarbonate Housing
  - Dimming: PWM dimmable
  - Type: isolated
  - Flicker: Non-flicker
  - Wattage: 75W/100W driver module

- **LED Engine**

  This is a LED lighting unit that includes LED PCB board, heat sink and optic lens.
  - LED Chips: High efficient LED chip. (Possibly 3030 1W)
  - PCB board: Aluminium 1.5mm (the LED PCBs is replaceable)
  - CCT: 6500K (Optional LED board of other CCT)
  - Optic Lens: Replaceable, 90 degree and Polarised 40 degree
  - CRI: >80
  - Watt: 40W / LED module
  - Lumen: >6000lm /Module
  - Heat Sink: folder sheet steel
  - Aluminium (from bauxite): 227-342MJ (63,000 to 95,000 watt-hours)
  - Iron (from iron ore): 20-25MJ (5,550 to 6,950 watt-hours)
  - Steel (from iron): 20-50MJ (5,550 to 13,900 watt-hours

- **Emergency Module**

  Lithium battery emergency module could be plugged in the modular driver system. Output Wattage: 4W
  - Output Lumen: >600lm
  - Time: >3hrs (initial emergency time should >hrs)
  - Function: Selftest as standard
  - Indicator: Red/Green. The light should be strong enough, so it is visible from distance of 9m.

- **Sensor Module**

  Microwave sensor with integrated light sensor that can detect movement 16m Away. The sensor module can be easily installed and connected with minimum effort. Allow remote control and setting.

Ideally it should also contain mater/slave operation mode and daylight harvesting function. This module will be purchased externally.

- **Sustainability considerations**

  Minimise the waste, this means when components fail, only the necessary parts are replaced this mean structural part, cables and even heat sink that have no limit on lifetime should remain as much as possible.
  - Avoid high power consumption manufacturing processes, which means injection mounding, die casting etc.
  - Minimise non-recyclable material (plastic).
  - Minimise packing materials and use recyclable materials where possible. Minimise Packing size, allowing more product being shipped in a container.
  - The product should not use any SVHC materials per REACH regulation.
  - All functional modules such as LED board, drivers, lens should be made replaceable where possible.

8) Standards and regulations

The applied standards and regulations for developing the Kosnic industrial lighting product include:

LOW Voltage Directive 2014/35/EU

Referenced standards:

EN 60598-1:2015(Luminaires. General requirements and tests)

EN 60598-2-5:2012(Luminaires. Particular requirements. Floodlights)

EN 62493:2015(Assessment of lighting equipment related to human exposure to electromagnetic fields) EN 62031:2008+A1:2013+A2:2015(LED modules for general lighting. Safety specifications)

EN 62471:2008(Photobiological safety of lamps and lamp systems)

Electro Magnetic Compatibility Directive 2014/30/EU Referenced standards:

EN 55015:2013+A1:2015(Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment)

EN 61547:2009(Equipment for general lighting purposes. EMC immunity requirements)

EN 61000-3-2:2014(Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment input current = 16 A per phase))

EN 61000-3-3:2013(Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current = 16 A per phase and not subject to conditional connection)

Restriction of Hazardous Substances Directive 2011/65/EU

Energy-related Products Directive 2009/125/EC

REACH--Registration, Evaluation, Authorization, and Restriction of Chemicals) restriction of SVHC (Substances of Very High Concern) in (EC) 1907/2006

Appendix 2 – Transcripts from validation interviews

Interview with Aramis (The Lighting People)

00:40	**Q1. What 3 key features do you look for in an industrial luminaire?** Unfortunately, we can't get away from price, but we don't look for the best price we look for the best value, is the price point relevant to its efficiency, capitol cost, the lifespan. Ease of installation is important but because most fittings are quite comparable now, I don't think there's enough differentiation between one manufacturers ease of fitting to another manufacturers ease of fitting. If one fitting was particular difficult to install we would only choose that if the value was particularly good, but they are all pretty easy to install now. One of the things that is particularly useful to us is having products that can be modular fittings, play & play sensor, or emergency. Lifespan is something we have to be careful on. The support is another important part, that Kosnic is UK based, we can solve problems very quickly.
03:50	**Q2. What are the key problems you have faced in the past with industrial lighting?** The failure rate, I would be uncomfortable if the failure rate meant that after a few weeks the client called me and said the product has failed because it costs me, even with a free replacement it still costs me in time, inconvenience, and lost reputation to keep going back to that client to replacement.
05:17	**Q3. What do you like about the product we described, is there anything in particular you'd like to talk about it?** The thing I particularly like about it is the modularization of it, I think it's really cleaver, it's going in the right direction, if not following the market it's forcing the market down a route that I think is really important. The circular economy, the reusing modules, reburnishing modules, I think that's really important for our economy, but it has other benefits, the ability to upsell to our client and the ability to install an emergency module that makes life easier for us means we carry less components on site and being able to introduce a CCT, wireless controls, self-test, all these different things being introduced during the lifecycle of the product. At the moment, we do find it difficult to sell the benefits of a product, they want what they know and unfortunately that's twenty-year-old technology. But once they've had that new product, it's much more within their reach and understanding, that ability to have a product that is very recyclable or even better, reusable, being able to upgrade and change the features of that fitting are attractive.
07:25	**Q4. Is there anything you don't like about the product, anything that you think could be improved?** I would be interested in, how wide of a range you can make, for example we use your Mauna downlights, can those (modular) fittings transfer to your other fittings?
09:00	**Q5. Does the environmental impact of a product influence your buying decisions?** Time will tell, I think at the moment, it is very difficult if not impossible to present a product selection to a client and say this product is much more sustainable, it ranks 90 on your sustainability index but is 10% higher (cost) vs this product which is cheaper but unrecyclable. We don't have a means to present that to our client, in a competitive market we almost have to ignore that in favor in of the other value-based observations like its ethics and efficiently and lifespan. However, I would like to be in a position where we can offer clients not only your sustainability index that we talked about, that would be

	fantastic, but your energy efficiency ratings but also the ability to full offset using carbon credits.
11:16	**Q6. How often do controls get specified?** We are seeing more and more appetite for it; however, I think where it becomes difficult is where you have an expensive control module that has to go into every fitting, but we are definitely seeing more and more interest in it. When we present the technology to a client, and they see the benefits then they get onboard. But if they aren't guided, they are less likely to specify controls.
12:45	**Q7. Do you consider lighting as a service (leasing) a good idea? Is it something that you would be interested in?** Yes it is, because we already offer it, we offer asset finance to our clients, where someone else funds the project over a four-year project. We get lots of clients that are interested in this, they're interested in the asset finances.
16:12	**Q8. How would you usually dispose of a faulty light?** I think it just goes in a skip to be honest, I don't think we take a responsible route. I think it happens so infrequently. We may take it back to the wholesaler for them to dispose of it.
17:07	**Q9. Have you experienced a customer that has asked you to take back older fittings before installing new ones?** I don't know because we always offer to takeaway waste as part of our project. What we would typically do is the lamps themselves go back to the wholesaler and the plastic/metal/glass is taken by skip to a licensed waste recycler.
18:00	**Q10. Given the option, would you rather repair a fitting instead of having to replace it?** I think using your modular system, yes, I think without that we are already replacing LED fittings with new LED fittings. The reason that's happening is because sometimes the LED fittings we are replacing are already 10 years old, and the technology has moved on so much in that time that the fitting can't be upgraded. I do wonder what it'll look like in another 10 years. At the moment no (to repair) unless the technology plateaus, maybe in that case but I think there will always be a risk in that way (as technology progresses).
20:00	**Q11. How important is the idea of sustainability and the ease of reuse/recyclability to you? On a scale of 1-5** It's very important, it's a 5, the problem is you can only push the market so quickly. It is very important to us, and we like to present to our clients that they are saving as much energy which is this much carbon.
22:05	**Q12. Would you be willing to sell a refurbished product?** Yes absolutely, because you as a manufacturer tell me that it's a refurbished product but it still comes with a 7-year warranty then I see absolutely no problem with that.
22:40	**Q13. Would the offer of a leasing service model with no big upfront fee make it easier for you to win bigger potential projects?** Yes, for example we are talking to a car assembler, they just don't want the asset cost on their balance sheet, they want an off-balance sheet solution, we've been chasing them for about 4 years, and it would have paid for itself 2 or 3 times over by now.

23:40	**Q14. If so, could you describe the kind of customer that is more likely to go with a leasing model?** Clients that have good long revenue streams but not necessarily a lot of cash are perfect for this. One client group that we've been targeting are schools because they aren't usually a business that would disappear overnight. The ones that are a bit tricker are the manufacturing industries that are in danger of disruptive technology within a 5-year window, we wouldn't necessarily taking a 10 year lease deal because it might be that in 5 years' time that their business model is so disruptive by battery technology or community transport systems that make their business no longer viable, they're the tricky ones. Hospitals and schools are brilliant.
25:32	**Q15. Would you consider a leasing model for your next installation / project? If so, how confident do you think you are that it would succeed?** I would say we would, at this stage as it's still relatively new and unfamiliar to people and theirs lots of hurdles to overcome we would probably offer it as an option to our clients.

Interview with Ben – Smith Bros

00:37	**Q1. What 3 key features do you look for in an industrial luminaire?** I things I need the most from that sort of high bay would be - Different outputs, because you mount them at different heights, different lens optics, because it depends if they're going down a rack or in an open area. - Sensors, that gets asked for a lot, that would be a good option on the sensor where you could incorporate movement and daylight sensor to be able to dim the fitting up and down.
02:30	**Q2. What are the key problems you have faced in the past with industrial lighting?** Mounting heights, I've had a job recently where the fittings wanted mounting at 20 meters, but they also wanted sensors on everything, and the sensors only went up to 15 meters. I've also had a linear fitting where there's been racks in a warehouse, but the trunking has run the opposite way, we didn't have a bracket to make the fitting mount at 90 degrees so it wasn't in line with the racks. So, having that for the contractors to install them the right orientation would be ideal. The 20 meter high one I had problems with different outputs, so I could have done with another 8 or 9 thousand lumens out of the fitting so means that I needed less overall, that was also a problem on the emergency side, the output and emergency wasn't enough that I could get away with having one emergency fitting and two standard so I had to have every other one as an emergency fitting which always racks up (cost).
06:00	**Q3. How would you describe the installation process? Was the product easy to work with?** Yes, it didn't look like it would be tremendously tricky to install, I assume you would put the back section up first? (Tao: Yes, the back section goes up first then everything else slots in) I think from a contractor's point of view once they're got the power into the fitting then it all just slots in nice and easy.
06:30	**Q4. What do you like about the product we described, is there anything in particular you'd like to talk about it?** I like that it builds up in a modular way, I presume from a spare parts point of view its easier for you guys, if you keep a few of those modules in stock, if you decide you want it brighter then you'll be able to add another driver module in. I've used fittings that use those two linear strip styles before and I do find that they are easy to use, depending on what type of optics that they've got but they do a good job of lighting up industrial spaces.
08:00	**Q5. Is there anything you don't like about the product, anything that you think could be improved?** The only thing I've found with microwave sensors in warehouse settings before is they tend to be quite sensitive so especially if you've got racks where there's any sort of movement at all they tend to go off. I've had problems commissioning jobs before with microwave sensors so if there was the option for PIR sensors at the higher levels rather

	than microwave that would be useful. Is there an option for daylight sensing? Yes. I think in general it would be absolutely fine.
11:22	**Q6. Does the environmental impact of a product influence your buying decisions? If so would, what would your limit on price increase be? 10%? 20%?** From my point of view, it would depend on if I were talking to the end user or the contractor. Because the contractor doesn't care, he just wants it to be as cheap as possible. But if you can get in front of an end user and explain the benefits to them, I think that they would be happier knowing that the fittings were more eco-friendly. I think they would stomach 15-20% more, it depends on who the end user is. If you had something that just had a big shed to light up, he may not be too bothered but I've done a job recently for Doncaster council and they were a little bit more conscious of their carbon footprint. It's all well and good where we do a job and reduce their energy bill and carbon footprint and they say how good it is but then if you were to tell them that it would sit in landfill for a long time after it's been used then it's not a good example of a carbon reducing fitting.
13:50	**Q7. Does the environmental impact of a product influence your buying decisions?** I think that if there was something visual on the product rather than from a salesman point of view if they had something that advertised the face that it's more environmentally friendly, I think it would have more of an impact than just me saying its environmentally friendly.
15:32	**Q8. How often do controls get specified?** In warehouse projects it's around 50 50, I would say it's more edging towards so than not. People will want sensors on the fittings especially from a contractor if they know they don't have to install other controls, if they can just put fittings up that will do it themselves. It does seem to be happening a lot more. When I'm selling them to people I'll suggest, where they can save a lot more money. We did a big install at the end of 2019 for an old site, they were swapping 250 metal lightings out for 135W fittings, but the lights were on 16-17 hours a day, but they were on all the time because they didn't have any controls, the people would only spend about an hour a day down each of the racks so when we put these new fittings in with sensors that switch the fittings off after a few minutes. I think we reduced their lighting bill by about 80%. So, there is a massive impact with the right install.
18:20	**Q9. Do you consider lighting as a service (leasing) a good idea? Is it something that you would be interested in?** It's something that a lot of people are talking about at the moment, we've got parts of our business that are looking at it, if we're doing a placement project, we would make sure that the customer is cashflow positive by taking their energy saving and using that to fund the finance proposition. It would then be the customer who owns the product after.
21:10	**Q10. What do you like about the idea of lighting as a service?**

	It takes some of the problems away from the end user, in that they don't have service it and maintain it. It's similar to the benefits of doing a car lease agreement, you're never left with old technology you've always got the newest most efficient technology.
21:58	**Q11. What might put you off the idea of lighting as a service?** I think a lot of the time customers want to see the benefit, say if it's an upgrade project, they like to see the benefit of the reduced energy bill straight away. So, if it gets to the point that they don't own the fittings and they're still paying the same sort of money because they're paying the leasing agreement. I would expect that their monthly payment would have to be less than the amount of energy that they're saving otherwise they won't see the benefit.
24:40	**Q12. What is the problem that you can see with this multi-party model?** Everyone has got a stake in it, so you wouldn't get it where the contractor installs it and then doesn't care about it anymore, especially if they're getting paid along the way.
26:22	**Q13. How would you usually dispose of a faulty light?** If it's a faulty we would usually return it to the manufacturer, I don't know what then happens to it, I would hope they then dispose of it responsibly. They would normally have a recycling company take it away.
28:40	**Q14. Given the option, would you rather repair a fitting instead of having to replace it?** I would, I've had a project recently with some spotlights where we returned them to the manufacturer, the manufacturer fixed them then sent the same ones back out. Which I think makes more sense than using new materials and throwing the old ones away. But from the contractor's point of view they would rather have a replacement one sent to them that's working so they can install it and send the other one back. From a manufactures point of view I think when they get faulty fitting back, they should repair or reuse where they can as long as they aren't damaged.
34:55	**Q15. How important is the idea of sustainability and the ease of reuse/recyclability to you? On a scale of 1-5** From my point of view it would be around 4 or 5. It's a fine line between that and price. Smith brothers and our sister companies are trying to be as environmentally friendly as possible.
35:52	**Q16. Would you be willing to install a refurbished product?** We've done projects before existing products have been refurbished. We've done projects with floodlights before where we've put new gear trays in them, instead of completely new fittings. I don't see why it would be a problem, as long as they carry the same warranty from the manufacturers.

	So long as there's more benefits to the customer for being offered the refurbished product, for example you could be offered the new one that costs £100 or you could have this refurbished one that carries the same amount of warranty but is costs £60, I think people would be interest in it. I don't see the problem in it as long as you get the same backing from the manufacturer.
38:30	**Q17. Would the offer of a leasing service model with no big upfront fee make it easier for you to win bigger potential projects?** I think it depends on who the customer is and what their situation it. A lot of the time I think it's an interesting proposition, I've had it before where customers have a pot of money allocated or some capital allocated for a project, if you were to tell them that you can pay for this over the next five years and use that money towards a different project, it'll make them think about it. They might be umm-ing and ah-ing between doing all the lighting or doing the roof, they might now think we can do both at the same time because we can spread the cost of one of the projects out over the next five years.
40:25	**Q18. Would you consider a leasing model for your next installation / project? If so, how confident do you think you are that it would succeed?** If you've got the right customer, it could be the thing to win a project, if you come in slightly over budget on a project and they say they don't have enough money to do it you could say about leasing options instead. Then you could win projects that you would have lost before because it was too expensive.

Hannah – Smith Bros

Part 1	**Q1. What 3 key features do you look for in an industrial luminaire?** Efficiency Good quality of light Control
Part 1	**Q2. What are the key problems you have faced in the past with industrial lighting?** Key issues – Flexibility if we had more flexibility and control would have solved the problem.
Part 1	**Q3. What do you like about the product we described, is there anything in particular you'd like to talk about it?** The main thing that stood out for me was the way the control gear was so modular and so easy to move them in and out or to replace them. The most important thing is the remote emergency testing.
Part 2	**Q4. Is there anything you don't like about the product, anything that you think could be improved?** Understanding ow quickly the product can be installed and what parts can be recycled. I may need more information on the product before knowing that.
Part 2	**Q5. Does the environmental impact of a product influence your buying decisions?** I think at the moment there is an appetite for it, which is only going to increase, at the moment I think people may pay 10% more for a product that has got a full lifecycle and be recycled. This year people are interested, and I think by next year people will be even more interested.
Part 2	**Q6. How often do controls get specified?** Full control – varies. We are always thinking of extra controls. Important for an energy saving point of view.
Part 2	**Q7. Do you consider lighting as a service (leasing) a good idea? Is it something that you would be interested in?** Yes, lighting as a service Is a brilliant idea, as you know we have a funding facility in house, there so much more value that you can add. Customers want to get a good service of design, specification, a survey that gives them a full asset list for their building.
Part 2	**Q8. What might put you off the idea of lighting as a service?** The only thing that would put someone off is ridiculous interest rates, so something where the interest rated are through the roof and not comparable. You've got to be able to demonstrate what you're saving off your energy bill will fund the project.
Part 2	**Q9. What do you like about our proposed business model for lighting as a service, should a third party be involved?** I think every party should be involved, I think we're going in a direction where having a partnership with a manufacturer, wholesaler & installer and end client it just works better as everyone knows everyone's responsibility and role.

Part 2	**Q10. What would be the downside of such a partnership having everyone involved in the partnership?** Probably the time frame, if you've got lots of parties invoked and you're always waiting for someone to make a decision. The way around that would be to always have a KPI, and time scale, clear project management and communication.
Part 2	**Q11. How would you usually dispose of a faulty light?** We would usually use a contactor to come and collect it.
Part 2	**Q12. Given the option, would you rather repair a fitting instead of having to replace it?** I think some customers would prefer to have it repaired, I think if you're left without a light fitting while the light is being repaired, there may be health and safety implications, people wouldn't want to be without the fitting. From an ecological point of view you'd prefer to repair it because it's better for the environment.
Part 2	**Q13. How important is the idea of sustainability and the ease of reuse/recyclability to you? On a scale of 1-5** I think it's a solid 4. It should be a 5 but it's a 4. I think sustainability is incredibly important and we've had a couple of customers ask what we do with the fitting at the end of a job. Can they be recycled or donated; people are beginning to ask that question.
Part 2	**Q14. Would you be willing to install a refurbished product?** As long as there's a full warranty against it, people would be wary if the product didn't have a warranty. That would be the important thing from a customer point of view.
Part 2	**Q15. Would the offer of a leasing service model with no big upfront fee make it easier for you to win bigger potential projects?** Yes! Yes, it would.
Part 2	**Q16. If so, could you describe the kind of customer that is more likely to accept this offer?** A don't think there's a type of customer, varies too much.
Part 2	**Q17. Would you consider a leasing model for your next installation / project? If so, how confident do you think you are that it would succeed?** I would absolutely consider it, it's a no brainer, I think the likelihood to succeed depending on the appetite of the client, as long as all factors fit for them, there's no reason why they wouldn't do it. There's no risk, you get new lighting, you're going to save money, you're going to be cashflow positive at the end of it, why wouldn't you do it.

Interview – Ross Smart, Smart Electrical.

MVI_6357 00:09	**Q1. What are the 3 key features you look for in an industrial fitting?** **Examples: Installation (easy to install), high efficiency, price, long life, option of controls** 1. Consider what the client what's – pricing point. 2. As an installer – quality. 3. Efficiency – saving money int the long run.
MVI_6357 01:34	**Q2. What is the key problem that you have faced before on this kind of product?** Product failures, the problem has been identifying where the product was originally purchased from.
MVI_6357 03:06	**Q3. How would you describe the installation process? Was the product easy to work with?** The product was very simple, the instructions are clear, the termination are plug & plug, which is very easy to do, base bracket was easy to fit, and the modules are easy to change if needed.
MVI_6357 03:54	**Q4. Would you recommend this product to other people?** Yes, I would recommend this to other electricians, I would also recommend it to my clients.
MVI_6357 04:22	**Q5. What do you like about the product, anything in particular?** High lumen output, daylight 6500K, does the job and looks great too! It's a good-looking product.
MVI_6357 05:02	**Q6. Is there anything that you don't like about this product, is there anything that could be improved?** (No answer given)
MVI_6357 06:37	**Q7. Does the environmental impact of a product influence your buying decisions? If so, how much more as a limit you would pay for it, 10%, 20% or 30%.** I do like to purchase products with high sustainability levels, things with a high carbon footprint might be unavoidable but if there are product on the market that are more sustainable that would be of interest to me and my clients, a selling point. And I'm sure a lot of people would be interest to know that the lighting fittings that they are having installed are a lot more sustainable. Certain industries may be willing to spend around 10-15% more, depending on the company to promote their green credentials.

MVI_6358 00:02	**Q8. If a product carries an environmental label would that influence your buying habit?** I think an environmental impact labeling would be a good thing, you could compare it to an energy performance certificate, an EPC, I think that would influence their decision.
MVI_6358 01:24	**Q9. How often are controls specified in your installations?** Controls are specified quite a lot with daylight dimming and occupation sensors. On some projects I work on the consultants will specify that if they know that's going to increase efficiency for the end user, also nice to go into commercial environments to offer that.
MVI_6360 00:00	**Q10. Do you consider lighting as a service (leasing) a good idea? Is it something that you would be interested in?** Lighting as a service is a very good idea, mainly for the end user, if they have any issue a simple phone call to the service provider would get the issue resolved.
MVI_6360 00:30	**Q11. What might put you off the idea of lighting as a service?** The thing that would put me off offering a lighting service would be the quality of the product, - locked into a contract with a poorly constructed product.
MVI_6360 01:15	**Q.12 What do you like about our proposed business model for lighting as a service?** It created close links between installers, manufacturers, and suppliers. As an installer I could liaise with the manufacturer if there are any product issues and help the manufacturer out if something isn't performing as it should do.
MVI_6360 03:55	**Q.13 How would you usually dispose of a faulty light?** If it's still in warranty it goes back to the manufacturer or return to the supplier to return to the manufacturer for a credit note. Other times they go back to the wholesaler to dispose of correctly.
MVI_6360 04:50	**Q.14 Given the option; would you rather repair a fitting instead of having to replace it?** Yes, definitely if it can be returned simply and efficiently then that is the way to go so it matches with all the other products installed.
MVI_6361 00:00	**Q.15 How important is the idea of sustainability and the ease of reuse/recyclability to you?** **1 – 5 with 5 being the most important.** I would say a 4.
MVI_6361 00:22	**Q.16 Would you be willing to install a refurbished product?** I would if it came with the same warranty and back up as a brand-new product.

MVI_6361 00:40	**Q17. Does the idea of having no big upfront fee to update the lighting in your building make you more likely to do so?** Yes, I would be interested in that and I would offer that to my clients.

Interview – James, Apprentice Electrician, Smart Electrical

MVI_6362 00:00	**Q1. What 3 key features do you look for in an industrial luminaire?** Efficiency, lifecycle of the product & price.
MVI_6362 00:20	**Q2. What is the key problem that you have faced before on this kind of product?** Quality of product, if it is not a quality product it is a mess, you have to go back and fix it.
MVI_6362 00:40	**Q3. How would you describe the installation process? Was the product easy to work with?** Very easy, easy instructions, not too many screws, nice and simple.
MVI_6362 00:58	**Q4. What do you like about the product, anything in particular?** I like how bright it is and that it uses LED's, its efficiency, I like the environmental impact.
MVI_6362 01:20	**Q5. What do you dislike about the product, is there anything specifically that you would like to change?** No
MVI_6362 00:00	**Q6. Does the environmental impact of a product influence your buying decisions? If so, how much more as a limit you would pay for it, 10%, 20% or 30%.** I would pay 10%, it is subjective, it depends on your financial situation, but I believe it should be important to everyone.
MVI_6362 02:05	**Q7. If a product carries an environmental label would that influence your buying habit?** Yes
MVI_6362 02:14	**Q8. How often are controls specified in your installations?** No answer
MVI_6362 02:38	**Q9. Do you consider lighting as a service (leasing) a good idea? Is it something that you would be interested in?** I think it's a good idea, it gives more range to the customer so if they don't have much money, it makes it more accessible.
MVI_6362 03:06	**Q10. What might put you off the idea of lighting as a service?** It depends on the warranty and quality of the product, if it's got a good warranty and a high quality, if they have a good reputation then I don't see why not.
MVI_6362 03:40	**Q11. What do you like about our proposed business model for lighting as a service?**

	It brings a lot of people together, so you can make a lot of contacts, and everyone gets a share, everyone's winning!
MVI_6362 04:17	**Q12. How would you usually dispose of a faulty light?** I don't dispose of lights – so I don't know about that one. (Not within his role)
MVI_6362 04:32	**Q13. Given the option, would you rather repair a fitting instead of having to replace it?** Repair, its less waste, and it better for the environment in general.
MVI_6362 04:50	**Q14. How important is the idea of sustainability and the ease of reuse/recyclability to you?** **1 – 5 with 5 being the most important.** I would be a 5, because I'm part of the younger generation we need to be very careful of the planet and so any benefit to sustainability I would be vouching for.
MVI_6362 05:35	**Q15. Would you be willing to install a refurbished product?** I don't see why not, as long as its quality and got a warranty like anything else.
MVI_6362 05:46	**Q16. Does the idea of having no big upfront fee to update the lighting in your building make you more likely to do so?** Yes, if it's a big company with a large amount of lights I feel it would be easier for everyone, no sudden costs.
MVI_6362 06:08	**Q17. If so, could you describe the type of customer that is more likely to take that offer?** A large contractor with a large-scale building hat need needs a vast amount of lights.
MVI_6362 06:27	**Q18. Would you consider a leasing model for your next installation?** There's a lot of partners involved so it could be hard if company has a good reputation and the wholesalers have a good reputation.

Appendix 3 – Proposed Leasing Contract

The LED equipment lease agreement (this "Agreement")

BETWEEN

_____

(the "Lessor")

OF THE FIRST PART

AND

_____

(the "Lessee")

OF THE SECOND PART

_____

(the "Manufacturer")

OF THE THIRD PART

_____

(the "Contractor")

OF THE FOURTH PART

_____

(the "Maintenance")

OF THE FIFTH PART

(the Lessor, the Lessee, the Manufacturer, the contractor and the maintenance are collectively the "Parties" of the lease agreement)

In consideration of the mutual covenants and promises in this Agreement, and the receipt and sufficiency of which consideration is hereby acknowledged, the Lessor leases the LED equipment to the Lessee, the Manufacturer supplies the LED equipment and parts to the Lessor, the contractor installs the equipment and the maintenance provides maintenance service for the equipment on the following terms:

1 Definitions:

1.1 The following definitions are used but not otherwise defined in this agreement:

a) The LED lighting equipment (the "Equipment") leasing eco-system mainly consists of the Equipment manufacturer (the "Manufacturer"), the Equipment wholesaler (the "Wholesaler") as the lessor , the Equipment end user (the "End User") as the lessee, the Equipment installation contractor (the "Contractor"), the Equipment maintenance company (the "Maintenance") and the Equipment recycle and disposal company following WEEE directive and regulations (the "WEEE").
b) The Wholesaler acts as the Lessor, and provides the leasing service to the End User.
c) The End User who acts as the Lessee buys the leasing service from the Wholesaler.
d) The Manufacturer manufactures and supplies the Equipment to the Wholesaler, supplies repair parts to the Maintenance.
e) The Contractor provides the Equipment installation service to the Wholesaler.
f) The Maintenance provides the Equipment maintenance service for the Wholesaler.
g) The leasing service life (the "Life") is the service life period at the end of which the full amount of the leasing value of the Equipment is paid.
h) The leasing value (the "Value") is the full value of the Equipment which includes manufacturing, installation, maintenance, recycle and disposal costs.

2 The Wholesaler

2.1 The Wholesaler leases the Equipment from the Manufacturer to the End User.
2.2 The Wholesaler subcontracts the Equipment installation and maintenance to the Contractor and the Maintenance respectively.
2.3 The Wholesaler makes the regular payments to the Manufacturer, the Contractor and the Maintenance from the End User's leasing payments.

3 The End User

3.1 The End User buys the Equipment lease service from the Wholesaler and makes the regular leasing payments to the Wholesaler.
3.2 The End User will use the Equipment in a good and careful manner and will comply with all of the manufacturer's requirements and recommendations and with any applicable law respecting of the Equipment.
3.3 The End User will not alter, modify the Equipment unless the End User obtains the prior written consent of the Manufacturer.
3.4 The End User will provide all possible conveniences necessary to the Contractor and the Maintenance for the installation and maintenance of the Equipment.

4 The Manufacturer

4.1 The Manufacturer manufactures and supplies the Equipment to the Wholesaler.
4.2 The Manufacturer supplies the parts to the Maintenance.
4.3 The Manufacturer provides the service of collecting the Equipment for either a) reuse, or b) WEEE recycle and disposal service for the Equipment.
4.4 The Manufacturer provides installation and maintenance materials or necessary training to the Contractor and the Maintenance.

5 The Contractor

5.1 The Contractor supplies the Equipment installation service to the Wholesaler.
5.2 The Contractor carries out the installation according to the instruction from the Manufacturer.
5.3 The Contractor provides the uninstall service to the Manufacturer when the Equipment needs to be uninstalled when a) the leasing term is ended and the Equipment needs to be returned to

Manufacturer, or b) the faulty Equipment needs to be returned to the Manufacturer for reuse or recycle.

6 The Maintenance

6.1 The Maintenance supplies the Equipment maintenance service such as repair and replacement to the Wholesaler according to the maintenance instruction provided by the Manufacturer.
6.2 The Maintenance will inspect the Equipment at the Lessee every _____Months to ensure the Equipment in good condition and repair the Equipment as needed.
6.3 The Maintenance will give minimum five working days' notice, unless agreed otherwise for the inspection and repair work to the End User.
6.4 The repair and maintenance are at the Maintenance's expenses.

7 The Equipment details

7.1 The Wholesaler leases the Equipment as a new (the itemized details are provided as an appendix to the Agreement) to the End User, and the End User leases the Equipment from the Wholesaler.
7.2 The ownership of the Equipment that is the subject of this leasing Agreement always belongs to the Manufacturer..

8 The Lease Cost and Payment

8.1 The Value of the Equipment as of this date is _____GBP including VAT.
8.2 The lease interest rate is ____% per annum.
8.3 The lease term (the "Term") is ____ years (____months).
8.4 The flat monthly payment (the "Monthly Payment") under the Term is _____GBP including VAT spread over the Term. The first Monthly Payment will be due upon signing and the following Monthly Payments will continue each month on the same day of the month as the Agreement is signed. The Wholesaler reserves the right to change the Monthly Payment to adjust for increases or decreases in taxes.
8.5 The Wholesaler will make a monthly payment of _____GBP excluding VAT over the Term to the Contractor for the Equipment installation.
8.6 The Wholesaler will make a monthly payment of _____GBP including VAT over the Term to the Maintenance for the Equipment maintenance.

9 Lost, Damage and Insurance

9.1 The Equipment shall be at the sole risk of the End User during the Life of this Agreement and any further term during which the Equipment is in the possession, custody or control of the Equipment.
9.2 The End User shall, at its own expense, obtain and maintain the following insurance:
a) Insurance of the Equipment to a value not less than its full replacement value.
b) Insurance of such amounts to cover any third party or public liability risks of whatever nature and however arising in connection with the Equipment.
c) Insurance against such other or further risk relating to the Equipment as may be required by law. against loss, damage or destruction to the Equipment for the full replacement value of the Equipment。
9.3 In the event of loss, damage or destruction to the Equipment, the End User shall notice the Manufacturer promptly,
9.4 The Manufacturer will replace or repair the Equipment _____ weeks after receiving insurance compensation from the End User.

10 Default

10.1 The End User will be in the default if:
- a) The End User fails to make a regular monthly payment on the due date;
- b) A bankruptcy, receivership, or insolvent proceeding is initiated by the End User or again the End User;
- c) The Equipment is not returned at the end of the Term unless a new maintenance agreement is signed regarding the Equipment.

10.2 The End User breaches any other term of the Agreement.

10.3 In the event of default under the Agreement, the End User will be required to pay the amount applicable to the Equipment during the reminder of the Term.

10.4 In the event of default under the Agreement, the Wholesaler will pursue the remedies outline in this Lease, in addition to any other remedies allowed by law.

10.5 In the event of default under the Agreement, the Wholesaler may terminate the Agreement and recover the Equipment and sue the End User for damages.

11 Force Majeure

11.1 Any failure or delay by the Wholesaler in performing its obligations under this Agreement which results from a failure or delay by its associated party shall be regarded as due to a Force Majeure Event only if the associated party are impeded by a Force Majeure Event from complying with an obligation to the Wholesaler.

11.2 Where the performance by the Wholesaler of their obligations under this Agreement is delayed, hindered or prevented by a Force Majeure Event, the Wholesaler shall promptly notify the End User in writing, specifying the nature of the Force Majeure Event and stating the anticipated delay in the performance of this Agreement.

11.3 From the date of receipt of notice given, the End User may, at its sole discretion, either suspend this Agreement for up to a period of _____ months or terminate this Agreement.

11.4 In the event that the End User does not terminate the Agreement, the all parties shall consult in good faith and agree any steps to be taken to enable continued provision of the service affected by the Force Majeure Event.

11.5 The affected party shall notify the other party as soon as practicable after the Force Majeure ceases or no longer causes the affected party to be unable to comply with its obligations under this Agreement.

11.6 If by the end of the suspension period, the parties have not agreed a further period of suspension or reinstatement of the Agreement, this agreement shall be terminated automatically.

12 Remedies

12.1 In the event of default, the Wholesaler will be entitled to pursue any one or more of the following remedies (the "Remedies"):
- a) Declare the entire amount of the lease payment for the Term immediately due.
- b) Purse the legal proceeding to recover the leasing payment.
- c) Take possession of the Equipment without demand or notice.
- d) Terminate the Agreement immediately upon written notice to the End User.
- e) Pursue any other remedy available in law.

13 Update

13.1 The End User has right to terminate the Agreement after _____ months before the end of the Term if

a) new and more energy efficient LED lighting equipment (the "New Equipment") is available from the Wholesaler and the End User decides to lease the New Equipment.

13.2 The End User will be entitled to ____% discount for the New Equipment.

14 Termination

14.1 The Agreement will be terminated automatically after the Term.

14.2 The End User is entitled to sign a new maintenance agreement with the Wholesaler in order to continue using the Equipment with the flat monthly payment ____GBP.

14.3 If the Agreement is terminated by the End User before the Term except in the event of the Update, the End User will pay a certain percentage of the Value of the Equipment to the Wholesaler for the early termination based on the termination time covering the full installation and uninstall fees, logistic expenses for delivery and take back, and any other costs as shown in the following table:

Termination time from start	Extra Charge (%)
3 Months	
6 Months	
1 Year	
2 Years	
3 Years	
4 Years	

15 Dispute Resolution

15.1 The Parties will attempt in good faith to negotiate a settlement to any claim or dispute between them arising out of or in connection with this Agreement. If the matter is not resolved by negotiation within 45 days of when either Party first made contact in respect of the same, the parties will refer the dispute to mediation in accordance with CEDR (Centre for Effective Dispute Resolution in London, UK) procedures. If the parties fail to agree terms of settlement within 90 days of the initiation of the procedure the dispute may be referred to an arbitrator as agreed between the parties or failing such agreement as may be nominated by the President of the Law Society of England and Wales upon application of any Party. The initiation of the procedure is defined as the written request to CEDR by any Party for mediation provided that such request is copied to the other Party. his Agreement shall be governed and interpreted in accordance with English Law and shall be subject to the exclusive jurisdiction of the Courts of England Wales.

15.2 The decision of the arbitrator shall be final and binding on both parties.

15.3 The seat and place of arbitration shall be London.

16 Law and Jurisdiction

16.1 This Agreement shall be governed and interpreted in accordance with English Law and shall be subject to the exclusive jurisdiction of the Courts of England Wales.

Appendix 4 – YouTube links to Kosnic Showcase videos

Circular Economy into Practice: Industrial Lighting -
https://www.youtube.com/watch?v=XiC_kGn7Ecs&ab_channel=CIRC4LifeEUProject

CEBM1 Co-Creation of Products and Services Business Model: Industrial Lighting -
https://www.youtube.com/watch?v=FL4CAhJ60rc&ab_channel=CIRC4LifeEUProject

CEBM2 Sustainable Consumption Business Model: Industrial Lighting -
https://www.youtube.com/watch?v=40_EI3OXQ8w&ab_channel=CIRC4LifeEUProject

CEBM3 Collaborative Recycling and Reuse Business Model: Industrial Lighting -
https://www.youtube.com/watch?v=uaQjHl4LzZ0&ab_channel=CIRC4LifeEUProject

Showcase Event: Installation of New Modular Industrial LED Luminaire at Kosnic Warehouse -
https://www.youtube.com/watch?v=31Vi-35_U5M&ab_channel=CIRC4LifeEUProject

A circular economy approach for lifecycles of products and services

D6.1b On site Demonstration for industrial and domestic lights, ONA

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Summary

The three Circular Economy Business Models (CEBMs) developed by the CIRC4Life CEBMs are demonstrated viatwo types of LED lighting products: the industrial lights manufactured by Kosnic and the domestic lights manufactured by ONA.

Due to the differences of their end-users, two approaches have been utilized: an industrial-user focused approach has been demonstrated using the Kosnic products, and a domestic-consumer focused approach to bedemonstrated using the ONA products. The major differences of the two approaches are their end-users' involvement and end-of-life product treatment.

The demonstration of CEBM for industrial and domestic lights will involve the following work:
1. Demonstration of co-creation of lighting products

- Development of a modular lamp (Medusa) with industrial scrap material, based input from consumer feedback (via reviews, workshops, surveys)
- Use of big data technique to address end-user's requirements in the product development. This provided input for the Product Design Specification (PDS) which was used throughout the developmentprocess
- Life Cycle Assessment (LCA) was conducted by NTU and the results were used to understand the environmental impact of the new product and used in the design of the new luminaire Medusa.
- Social-LCA (S-LCA) conducted as a way of measuring the impact of ONAs products on the health, safety and well-being of their workers and the wider impact on the community in which ONA operates. The S-LCA results and further information displayed at the ONA website

2. Demonstration of sustainable consumption

- Information about the environmental impact of each lamp available in the online shop, in the form of eco-costs and eco-credits, as a way of informing customers at point of purchase. This way, customer can view the product's eco-information, where 1) eco-costs shows consumers the direct impact on the environment of their purchases, and 2) eco-credits is designed to encourage end-users to recycle lighting products[3]

3. Demonstration of collaboratively recycling/reuse

- Development of a take-back scheme, which includes both 1) a system for remanufacturing of returnedlamps, and 2) a discount system where customers receive a discount on a new purchase based on eco-credits for the lamp
- The new take back system provides ONA to reuse components or the whole lamp for remanufacturing,whilst faulty parts are sent to correct recycling activities

The aim of Task 6.1 is to demonstrate the CEBMs listed above, within the industrial and domestic lights sector. This task has shown how the CEBMs developed in WPs 1-3 can be implemented in real world scenarios and howthe methods developed, and the structure for the CEBMs, is also transferable to various industries and sectors.

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Acronyms and abbreviations

Abbreviation	Description
CEBM	Circular Economy Business Models
DEMO	Demonstrator
DoA	Description of Action
EoL	End of Life
IND	Indumetal (CIRC4life partner)
KOS	Kosnic ((CIRC4life partner)
LCA	Life Cycle Assessment
LL	Living Lab
NTU	Nottingham Trent University (Circ4life partner)
PDS	Product Design Specification
S- LCA	Social Life Cycle Assessment
WP	Work Package

1 Introduction

ONA has demonstrated the three Circular Economy Business Models (CEBMs) in the luminaire sector by producing domestic lighting product named MEDUSA. The pilot action has taken place in Valencia (Spain).

Using the big data mining and Living Lab (LL) tools, ONA have applied the big data technique developed in WP3 to mine consumer preferences via large volumes of light products' reviews and comments through social mediawebsites and onaemotion.com.

Sustainable consumption has been encouraged by showing the eco-costs information of the new domestic lighting in ONA´s online store, providing valuable information to help consumers on their sustainable purchasedecisions. As part of the **CIRC4Life** research project, **ONA** is demonstrating a new circular economy approach, which includes a model rewarding consumer's eco-friendly behaviors.

The model is based on using an *eco-cost* and *eco-credit* system which helps consumers evaluate the environmental impact of **ONA**'s lamps; and to compensate them for the good behavior by recycling the lamps at the end of their life cycle.

Collaborative recycling has been demonstrated by extending the lighting recycling practices to the end-user, ONA offers the costumer the possibility to engage in a good environmental action: the costumer can recycle their ONA products by contacting and sending back the ONA lamps they no longer use, are broken or do no longer work. This sustainable action will provide the consumer with eco costs that will be reflected in their customer eco-account that afterwards will be transformed as a discount that the client will receive as a part oftheir recycling action.

The components in working condition will be kept by the manufacturer (ONA) for making new lights while the rest of the product will be sent to the apparel facilities for recycling.

2 Demonstration activities

Demonstrator 1 have applied the CEBMs into the sustainable development of domestic LED lighting products manufactured by ONA and industrial LED lights manufactured by Kosnic, through the product value chain, including product specification, design, manufacture, retail, use, recycle and reuse. Table 1 provides an overview of planned activities from the Description of Action (DoA).

Table 1: Demo activities per CEBM for demo 1

CEBM 1	• End-user's requirements are addressed at the beginning of the product development, via two methods: (1) applying the big data technique to mine consumer preferences via large volumes of light products' reviews through social media websites; (2) the user-group approach developed will be applied to address the end-users' requirements. • To include user's requirements and eco-constrains into the product design specification (PDS), which will be further evaluated using the LL approach, involving various stakeholders in the value chain of the lighting products. • LCA will be conducted to evaluate the environmental impacts through the product life cycle, and to implement sustainable manufacturing approaches in the production process. • Eco-point method will be used to measure and record the eco-impacts throughout the product development process.
CEBM 2	The eco-information of the lighting products, including eco-points, will be informed to customers via the following means to help consumers select more environmental products: • Customers can access the eco-information with their smart phones by scanning the barcode attached to the product or with computers to get the information online. • The eco-information will be provided in the product brochures for consumers to make decision for purchase. • In ONA's online store, customers can view the product's eco-information, the customers receipt can show the eco-point related to each item purchased, and the eco-points can be recorded into the consumer's eco-account.
CEBM 3	• Customers can recycle their EoL lighting products through intelligent bins, which can read the barcode/RFID attached to the product to get the product's eco-points, then record it to the consumer's eco-cost account. • Re-manufacture/reuse: the EoL product will be sorted at the recycling center (Indumenta for this project), then the components in working condition will be returned to the manufacturer for making the new lights. • For the industrial lighting product, Kosnic will provide a service to lease the product to the end-users.

2.1 Demonstration of co-creation of lighting products

2.1.1 Addressing User Requirements for Product Development

In order to address end-user's requirements at the beginning of the product development, for the domestic lighting products, ONA applied the big data technique developed in WP3 to mine consumer preferences via large volumes of light products' reviews and comments through ONA Website.

In the first place, it was planned to use the comments of the Amazon and eBay portals as part of this activity, but due to the copyright and privacy policy, this attempt was failed, and ONA Website of ONA online shop is used.

The purpose of this is that through the information collected, the end-users'/customer's needs are analyzed, particularly, their considerations for the environmental impact of domestic lights. This analysis would

lead to the production of a luminaire that would meet the demands or tastes of the consumer since its preparation would be focused on the information obtained in the study.

The big data technique was applied to mine consumer views on ONA online shop[4], in order to gain consumer preferences. This activity was developed with the collaboration of the NTU team. Below are the recommendations given based on the data mining results (Appendix 1):
To design the product with 'easy to assemble' and 'easy to use' features.

- The appearance of the lighting products needs to be modern and stylish
- The lamp material and packaging material must be recyclable/easy to recycle.
- The information provided on the Website/manual must be clear and sufficient.
- The stand of new product needs to be stable enough, suggest using tripod structure.
- The new product needs to be easy to repair and the parts need to be easy to obtain.
- The product needs to have more delivery options such as: a) pre-assembled; b) flat pack (self-assemble) in order to reduce the environmental impact.
- The product must be easy for disassemble in order to easily recycle the components and/or material ofthe product after the product reaches its end of life.
- More choices in colour, size and materials, for example weight reduction or usage of a smaller numberof materials, easy to manufacture.

In addition, several workshops with the end-users and potential end-users took place regarding the development of the demonstrator of ONA domestic luminaire. For example, three workshops were conductedto comment on ONA lamps, with the participants aged from 20 to 46 years, having various backgrounds of students, managers, high-end luxury hair stylists, accommodation maintenance workers and receptionists. From the participants' responses, it was found that [2]:

- All participants like having sustainable features but are not always actively thinking about all various types of features that could be present when purchasing. The majority are focused towards the sustainability of the lamp when in use, the energy efficiency and bulb type. When other sustainability features were mentioned, participants liked the ideas. It would be important to make the users awareof all the various ways the product is sustainable in its packaging and branding when in market.
- All participants liked the idea of a cheaper price in exchange for assembly at home. The majority preferred no use of glue in assembly. It will be important to thereby create a design that doesn't requireany use of adhesive, and easy assembly without special tools.
- It will be very important to redesign the feet to provide additional support, it is currently too easy to knock over due to the rounded feet.
- Keep the prototype within 50 mm of its current dimensions as all participants thought the size and weight are currently perfect.
- Suggestions for improving the Luminaire design were provided:
- Magnets for joining the pickets to the inner ring
- Adding a shade to the inside to prevent direct light hitting your eyes between the gaps
- A chain link design where you wrap one end around to the other, like a chain-link watch
- Make the feet flatter so it isn't as easy to knock over / add an extra leg for support
- Most users don't care too much about having a dimmer switch, it's a feature that can be added on if costing allows for.

In another of the workshops carried out, with participants between 20 and 50 years old with different educational levels and careers, the aim was to check if the product developed by ONA met the tastes or preferences that the consumer is looking for. From the participants' responses, it was notice that:

[4] https://onaemotion.com/

- They considered important to know the degree of recycling and sustainability but only if this information is provided.
- When choosing between a product with a not recyclable version but more economical and a recyclableand sustainable one with a higher price, the consumer is clear that it will depend on the kind of product it is.
- Related to the materials, many affirm as a good idea the option of being able to choose between different materials for the purchase of the product considering this as a way where the preferences ofeach type of consumer are fulfilled.
- Despite being a domestic lamp all of the participants agreed that the lamps could work in other places such as: restaurants, offices, etc. Even adapt it for outdoor use,
- The possibility of using other types of materials to develop the demo was also raised. Among this answers materials such as: textile, glass, ceramics or paper where consider as possible materials to usein this prototype.
- The lamp design was considered simple original and discreet with a modern and innovative philosophythat could attract a lot of attention.
- Among the answers a common result was related to the shape, considering the option that all of the top pieces were the same size so that it had a more rational form.
- When presenting the two sizes of the lamp (S and L) some doubts were raised among the attendees. When responding, everyone proposed the small lamp as the best option to be a domestic lamp but thelarge size was also considered an option depending on the place where the lamp was to be located. Few suggestions were made to develop an intermediate size between these two sizes.
- For greater safety, it was reconsidered among the attendees to place a cover to cover the bulb, in this way it would be safer and the light would be diffused
- Warm lighting and adjustable light kit were the preferred options for the attendees while the option to regulate color was not everyone's taste.

Based on the online data mining and the workshop review results, the initial PADS was further refined and thefinal PDS was obtained as shown in Appendix 2. Selected items of the final PDS are listed below (the PDS item number is shown inside the bracketsat the end of each PDS item):

- Prevent direct light hitting the user's eyes, and, hence, to add a cover on the top of the lamp and a shade to the inside of the side cover (PDS item 1.5).
- The lamp should be easy for repair, change of components, and upgrade (PDS item 4.2)
- The lamp should be easy for disassembly in order to facilitate to recycle the material and to reuse thecomponents when the lamp reaches at its end-of-life stage (PDS item 4.3).
- No special connectors to be used. The lamp must be easily installed with simple and common tools. (PDS item 5.2)
- Use low environmental impact manufacturing processes (PDS item 9.1).
- The lamp should use as few components as possible, whilst maintaining the required quality (PDS item9.2).
- The materials used should be recyclable and have low environmental impact (PDS item14.1).
- Use the minimum type of materials, which facilities the sorting of components for reuse and recyclingwhen the product reaches its end of service life (PDS item 14.2).
- In order for the consumer to recycle the lamp when it reaches at its end-of-life, the instruction how torecycle has to be given (PDS item 19.1).
- The eco-cost and eco-credit information of the lamp should be available for the customer (PDS item19.2).

2.1.2 Development of the product design specification (PDS)

A Product Design Specification (PDS) includes the characteristics or main objectives of the product to be developed. In the CIRC4Life project, the PDS is based on a method established in WP1, which govern the

development process of the product, and in this case, is based on the information collected through the study of Big Data developed by the NTU team, in order to include insights and input from end-users. This document was initially developed based on eco-constrains, sustainability related regulations/directives/standards, and product technical requirements.

With these preferences it is intended to fulfill the wishes of the consumer when buying a domestic luminaire. The development of the PDS will also include the eco-restrictions for the product development process. Information with which it is intended will add value to the product since it will make the consumer know exactly the information of its production and how it affects the environment or not.

The information contained in this document has been modified throughout the progress of the project. In the first place, a first version of the document was created and then later be evaluated in the development of the Living Lab methodology developed in WP7 (and described in 7.1) which involved various stakeholders in the value chain of the lighting products. Once the LLs had been carried out and the results obtained by the participants, the PDS document was reviewed and the necessary information was introduced, based on the results of these activitiesto check if the product guidelines were consistent with the LL results or if some consumer preferences were not reflected and had to be added.

The product life cycle stages considered in the production of the product includes the following stages:

- **Product:** extraction and production of materials. The suppliers that ONA use for the manufacturing of the lamp is about 25 / 30 km away from where the luminaires are mounted, the type of transport is by vans that are responsible for collecting the materials and taking them to the warehouse where the assembly and packaging, of the pieces.
- **Manufacture:** Manufacturing activities including packaging. ONA has indicated that the product is in a cardboard box and packed with paper.
- **Packing and Transportation:** Main destination country: Spain. The Packing and Transportation stage are divided into materials stage which calculated in production and manufacture stages and product to consumer which calculated in use as well as end of life stage.
- **Use:** The expected useful life of the product considered is 40,000h. This useful life is considered as a long by the study of (Casamayor et al., 2017). Maintenance activities are out of the scope of the analysis.
- **End of life:** end of life scenario considered for the product and packaging. When the Lamp at its end of life, the consumer could send the lamp back to ONA by post or courier when he wants to recycle. The calculation of the end-of-life transportation has been assumed same with the product to consumer.

2.1.3 Design and Prototyping of the domestic luminaire demonstrator

The CIRC4Life sustainable product development approach is applied in the development of table lamp manufactured by ONA. The development process includes conceptual design, detail design, prototype, manufacture and market deployment. Its sustainable design and manufacturing features are briefly presented below.

The initial concept is to develop a simple structure without requiring many different types of parts but also ensure that it is visually appealing to consumers. Following the initial concept, the prototypes of the luminairewere developed, as shown in Figure 1.

Figure 1 Prototype of the domestic luminaire

The pieces of the casing are design with a similar shape but in different sizes. A simple LED bulb is used in the product, which does not require complex disassembly, so the lighting part is easily dismantled for recycling.

The prototype is built with three different materials: wood, metal and plastic for three types of casing. Being completely manufactured in these materials without other parts (joints) it can be recycled with the whole part directly without having to disassemble them. It is only necessary to remove the electrical system, which can also be easily recycled without the need of additional disassembly with a tool.

The main pieces of the casing are made from the waste materials provided by ONA suppliers. The pieces are supported by the structure so that the use of adhesive is not necessary which is able to control overall costs ofthe product and shorten the recycling time of the product.

The source of light is LEDs feed with energy efficient electronic drivers. The casing dimensions are designed to contain a wide range of drivers and LEDs types in order to allow customization and upgrading of components over time. The driver used is RoHS compliant.

The product casing is formed by pieces of the same shape and size to form the outside of the lamp. They are joined together by two inner ring-shaped pieces which keep the together in a circular shape. The outer pieces are rounded at the ends to avoid edges and aesthetic. The product can be dismantled easily and fast for easy repair and maintenance. All the components have easy access for repair and/or upgrade.
Both the environmental LCA and social LCA of the luminaire have been conducted. The environmental LCA results are reported in the CIRC4Life Deliverable 1.2 “Report on sustainable (environmental, social and economic) impact analysis” and the social LCA results are shown in ONA online shop Website.

Based on the results obtained from the online data mining consumer preferences from ONA online shop and consumer/stakeholder workshops, the domestic luminaire is further improved as shown in Figure 2.

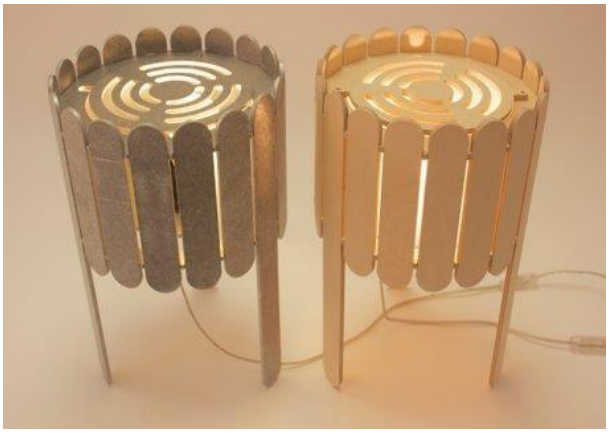

Figure 2 The improved version of the domestic luminaire

Due to the problem of material supply, the plastic material has not been used to make the final product, and, hence, only the casings with metal and wood materials are currently made. The detailed technical data, including engineering drawings, of the luminaires can be found in for the one with metal casing and for the onewith wood casing.

For the packaging of the product, the lamp will be wrapped with plastic and papers, and then put inside a cardboard box. There will be a clear and easy to understand description to help the consumer recycle the different parts of the lamp, and the packaging material used for filler and boxes will be able to be reused or recycled.

The final PDS (see Appendix 2) is followed in the final version of the domestic luminaire, for example,

- To comply with PDS item 1.5 'Prevent direct light hitting the user's eyes, and hence to add a cover on the top of the lamp and a shade to the inside of the side cover', the top cover and side shade are added as shown in Figure 2.
- To comply with PDS item 4.2 'The lamp should be easy for repair, change of components,' all the elements of the outside cover have the same dimension (Figure), instead of the previous multiple dimensions (Figure 1).
- To comply with PDS item 19.2 'The eco-cost and eco-credit information of the lamp should be available for the customers', the luminaire's eco-cost and eco-credit information can be found now in the product's online shop page.
- To comply with PDS item 19.1 'In order for the consumer to recycle the lamp when it reaches at its end-of-life, the instruction how to recycle has to be given', the instruction is now available in the ONAonline shop.

2.1.4 Environmental Life Cycle Assessment (E-LCA) and Social Life Cycle Assessment (S-LCA)

The E-LCA were conducted for all Ona existing domestic lighting products (the details of existing products E-LCA analysis results can be found in a journal paper "Application of life-cycle assessment to the eco-design of LED lighting products" [1], Euro-Mediterranean Journal for Environmental Integration (2020) 5:41). Below is an illustration how the E-LCA is conducted using the demonstration LED luminaire "Medusa", a lighting product from ONA shown in Figure 3 and 4 below.

The E-LCA was carried out by NTU in collaboration with Ona to evaluate the environmental impacts through the product life cycle. The ReciPe method was used to conduct the analysis to understand the environmental impact of the product, which is applied in the design of the new luminaire Medusa (Figures 3 and 4).

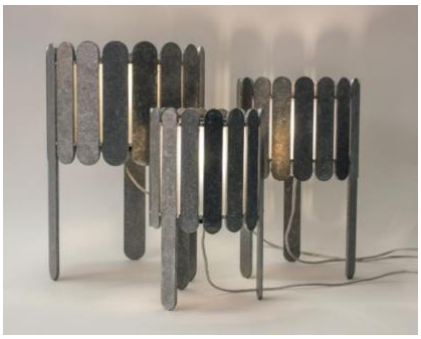

Figure 3 Medusa luminaire (aluminium) with three different sizes (small, medium and large)

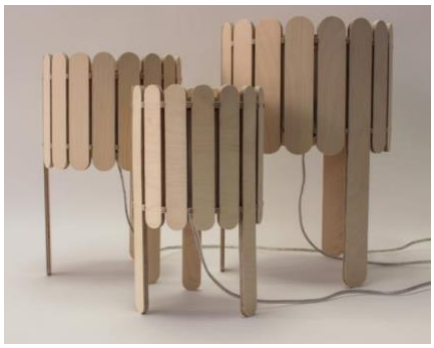

Figure 4 Medusa luminaire (wood) and three different sizes (small, medium and large)

The LCA study is carried out according to ISO 14040 [2], which comprises the following four phases:

- **Goal and scope definition:** this research aims to evaluate the life cycle environmental performance of luminaire Medusa featured with sustainable concepts, to achieve optimum design solutions, with particular attention in the materials selection. The results obtained will also be used to develop the production and consumption strategy towards more sustainable domestic luminaires.
- **Inventory analysis:** compiling a complete record of the important materials and energy flows throughout the lifecycle, in additional to releases of pollutants and other environmental aspects being studied. The inventory data are listed in Table 1.
- **Impact assessment:** Online LCA Platform http://h2020.circ4life.net/ [4] is used for the LCA modelling. It links the reference flows with the life cycle inventory (LCI) database, and then utilises the LCI flows with relevant characterization factors. The ReCiPe single score method [3] is applied in this study, and the total environmental impact is expressed as a single score.
- **Interpretation:** identifying the meaning of the results of the inventory and impact assessment relative to the goal of the study.

Table 1. Inventory data of Medusa lamp lighting product

Medusa (wood)		Medusa (aluminium)	
Wood	0.81 kg	Aluminium	1.944 kg
Lamp holder	0.0182 kg	Lamp holder	0.0182 kg
Cable Dam	0.0026 kg	Cable Dam	0.0026 kg
Electrical connection	0.0614 kg	Electrical connection	0.0614 kg
Washer	0.0049 kg	Washer	0.0049 kg
Electricity, low voltage	400 KWh	Electricity, low voltage	400 KWh
Road transportation	314.4 kgkm	Road transportation	707.6 kgkm
End of life (multiple waste treatment)	0.9067 kg	End of life (multiple waste treatment)	2.0407 kg

With the results from LA Online Platform, the ReCiPe Midpoint results are shown in Table 2 and the ReCiPe end Point results are shown in Table 3.

Table 2-1. ReCiPe Midpoint results of Medusa Wood

Characterization	Explanation	Unit	Value
mCCHH	Climate change Human Health	kg CO2 eq	1.64E2
mOD	Ozone depletion	kg CFC-11 eq	1.41E2
mHT	Human toxicity	kg SO2 eq	8.6E0
mPOF	Photochemical oxidant formation	kg P eq	9.21E-2
mPMF	Particulate matter formation	kg N eq	9.45E1
mIR	Ionizing radiation	kg 1,4-DB eel	1.11E2
mCCE	Climate change Ecosystems	kg NMVOC	1.29E5
mTAF	Terrestrial acidification	kg PM10 eq	6.61E-1
mFEP	Freshwater eutrophication	kg 1,4-DB eq	2.02E-2
mTET	Terrestrial ecotoxicity	kg 1,4-DB eq	5.33E0
mFET	Freshwater ecotoxicity	kg 1,4-DB eq	4.64E0
mMET	Marine ecotoxicity	kBq U235 eq	3.38E1
mALO	Agricultural land occupation	m2a	7.46E0
mULO	Urban land occupation	m2a	1.24E0
mNLT	Natural land transformation	m2	7.07E-2
mWD	Water depletion	m3	1.22E0

mMD	Metal depletion	kg Fe eq	1.22E2
mFD	Fossil depletion	kg oil eq	4.05E1

Table 2-2. ReCiPe Midpoint results of Medusa Metal

Characterization	Explanation	Unit	Value
mCCHH	Climate change Human Health	kg CO2 eq	1.64E2
mOD	Ozone depletion	kg CFC-11 eq	1.41E2
mHT	Human toxicity	kg SO2 eq	8.6E0
mPOF	Photochemical oxidant formation	kg P eq	9.21E-2
mPMF	Particulate matter formation	kg N eq	9.45E1
mIR	Ionising radiation	kg 1,4-DB eq	1.11E2
mCCE	Climate change Ecosystems	kg NMVOC	1.29E5
mTAF	Terrestrial acidification	kg PM10 eq	6.61E-1
mFEP	Freshwater eutrophication	kg 1,4-DB eq	2.02E-2
mTET	Terrestrial ecotoxicity	kg 1,4-DB eq	5.33E0
mFET	Freshwater ecotoxicity	kg 1,4-DB eq	4.64E0
mMET	Marine ecotoxicity	kBq U235 eq	3.38E1
mALO	Agricultural land occupation	m2a	7.46E0
mULO	Urban land occupation	m2a	1.24E0
mNLT	Natural land transformation	m2	7.07E-2
mWD	Water depletion	m3	1.22E0
mMD	Metal depletion	kg Fe eq	1.22E2
mFD	Fossil depletion	kg oil eq	4.05E1

Table 3-1 The endpoint (eco-point) results of Medusa wood

Characterization	Explanation	Unit	Value
sTotal	Total	Pt	1.91E1
sHH	Human Health	Pt	1.26E1
sES	Ecosystems	Pt	5.47E-1
sRS	Resources	Pt	5.96E0

Table 3-2 The endpoint (eco-point) results of Medusa Metal

Characterization	Explanation	Unit	Value

sTotal	Total	Pt	2.11E1
sHH	Human Health	Pt	1.33E1
sES	Ecosystems	Pt	5.45E-1
sRS	Resources	Pt	7.2E0

As shown in Tables 3-1 and 3-2, the total value is 19.1 Pt for wood version and 21.1 Pt for metal version. The total value is used as the eco-cost value of the product, indicating the product's impact on the environment. The eco-cost value for every Ona lighting product is shown in Ona online shop (https://onaemotion.com). Figure 5 and 6 shows the life cycle stage contribution analysis results. As shown, the use stage is the key contribution to the total environmental impact, followed by production stage. The use stage is the majority consumption of energy have taken place. It is noticed that different energy sources of producing electricity significantly affect the environmental impact of the product, this study assumes that the energy source in the use phase is according to the total primary energy supply worldwide in 2019, by source [11]. In the meantime, packaging and distribution phase contribute very limited (EoL shows a small number of positive effects) impacts to the total environmental profile and they have been calculated in production and use phase respectively already, thus it not shown in Figure 5 and 6.

Figure 5 Life cycle stage contribution analysis results (Medusa Wood)

Figure 6 Life cycle stage contribution analysis results (Medusa Metal)

Taking the assessment results and reflections into account, the key characteristics defined in the product design specifications (PDS) for the new LED lighting product (Medusa) were devised as:

- Low energy consumption during the manufacturing stage (easy to manufacture)
- Prolong the lifespan by enabling repairability—the product is expected to have a 10-year lifespan.
- Modular design.
- Easy to assemble/disassemble (the consumer can assemble the product by themselves).
- Made from low-impact materials; postconsumer/recycled materials are preferred.
- Refine the dimensions of the product to reduce weight.
- Fully recyclable at end of life.

The sustainability of the Medusa lamp is addressed through the following characteristics:

- High-availability material. There were two types of material used in the design to meet wider customer needs: wood and metal. The chosen materials are all standard materials that are readily available and easy to recycle.
- Modular structure. The goal of eco-design is to achieve a simple structure that uses relatively few materials but is still visually appealing to consumers. The external structure of the lamp is constructed from multiple pieces of the same shape and size. These pieces are joined to two internal rings. The outer pieces are curved at the ends for safety and aesthetic reasons. The modular structure of the lamp also makes it easy to assemble/disassemble the lamp (the consumer can assemble the lamp by themselves) and to access the inner parts of the lamp when repairs are needed or for maintenance purposes.
- Easy to manufacture. The main pieces used in the lamp are all made from postconsumer recycled materials that are processed using extrusion. No joint members are required, reducing the complexity of the lamp as well as the energy consumption during manufacture. A special adhesive is used to join the pieces together. One novel aspect of the design is that chemicals can be used to dissolve the adhesive, thus circumventing a potential hindrance to disassembly and recycling.
- High recyclability/reusability. The whole lamp is made from just one material without no additional joint members (although there are three material options). Therefore, the lamp can be recycled as a whole—it does not need to be disassembled before passing through the WEEE procedure during its End of Life stage.

The S-LCA was conducted, the results of which are available in the Ona Website https://onaemotion.com/lamparas-reciclables/. In the assessment, the material resources (local community) and Health and Safety (consumers) were identified with high significance for ONA and with a high influence on the

perception of user groups as a results of the materiality analysis. Thus, the certification in environmental management systems (eg ISO14001) and the proposal of an alternative (in terms of materials and costs) for the metal parts (mainly virgin stainless steel and Iron) and the lampshade table could improve the S-LCA results and have a positive impact on the prioritized categories mentioned above. Finally, because the use phase also has a representative impact on the results, the options with lower lamp power could improve the final scores.

A S-LCA was also conducted as a way of measuring the impact of ONA's products on the health, safety and wellbeing of their workers and the wider impact on the community in which ONA operates. With regards to the gender pay gap, ONA has a 35% better performance compared to other Spanish companiesin the manufacture of domestic appliances sector. In addition, ONA's staff has flexible working conditions including telework, which has an impact in supporting the advancement of the career of the female's workforce.In relation to the use of industrial water, it is very low and has a 50% better result compared to other companiesin that sector. Innovations carried out by ONA do not entail the use of industrial water.

When producing new lamps, material resources used by ONA do not have a negative impact on mineral consumption or fossil fuel depletion. Finally, concerning the worker's health and safety, ONA has a very low risk for accidents as they have a policy to maintain this level low.

2.1.5 Development of a sustainable production approach

The development of a sustainable production approach was based on the results of FP7 cycLED Project, where NTU was the leader of the Sustainable Production WP and ONA produced a domestic LED light as a demonstrator of the Project, and the EU CIP Ecolights project, where ONA was the project coordinator and NTU was the key technology provider and reinforced with those obtained in CIRC4Life project.

Through the CIRC4Life Project we have worked with NTU and KOS to develop a sustainable production approach based on the cycLED and Ecolights results, as shown in Figure 7 below. The approach has been applied in the demonstrated in the ONA domestic light DEMO.

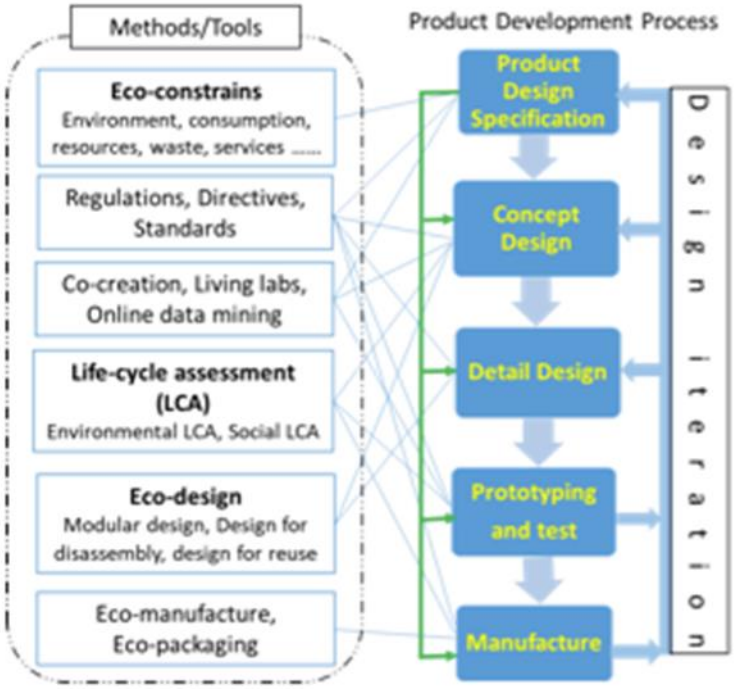

Figure 7 The Circ4life approach for Sustainable product development

Based on the experience acquired in the cycLED and Ecolights projects in which tools and methods were used in the product development processes, including product design specifications, conceptual design, prototyping, testing and manufacturing, we have addressed the development of the product of our demonstrator taking into account some of the conclusions of the same:

- The choice of material: In the aforementioned projects we saw that it is not only important that the material can be recycled or recycled, but that our suppliers know it and know how to work and what machinery they should use. This is very important for the development of a sustainable product, we can use a very sustainable material that is not yet widely introduced in the industry and this generates problems when manufacturing the product (demonstrator) causing, for example, the need to create tools or machinery that does not yet exist on the market to be able to correctly manipulate the said material, causing an increase in resources to be able to carry out said demonstrator.

- The processes: It is very important that the product is made with the minimum possible processes, it does not make any sense to make a product with a recycled or sustainable material while, for its handling, to use more processes than for a normal material, because the fewer steps are taken in the manufacturing process will enable to obtain a more sustainable product.

- Recycling: It is essential that the products when they arrive at the recycling plants are made with a usual material for said plants, that its different elements can be easily separated to carry out a correct recycling of the product, that the material is the least contaminated so that the material can be reused / recycled again with the necessary quality for its sale and extend its life. For example, in one of the aforementioned projects, PET was used as a material and we realized that in the recycling plant, they selected the bottles with labels difficult to separate, and, hence, such bottles were not introduced into the recycling chain, since the label contaminated the PET flake, so a good material was not obtained to sell, and the cost of separating the label was high, according to what they explained to us, so they preferred to sell the bottles as they came from the containers of the streets to another country and have it crushed to produce the PET flake.

- Value: the material must have an economic value for the recycler, that is, if we use a material that is not in demand in the market, the recycler will not be interested, since the recycler will not benefit from it and therefore we must use materials that not only they can be reused once the consumer throws them away or recycled them, but they are also consumed in abundance in a way that is interesting for recyclers.

The two materials, wood or aluminum, that make up our demonstrator are scraps that we obtain from our suppliers so they are prepared to work with them, they are not unknown materials for them. In recycling plants they are the most common, so they do not generate problems for recyclers when they arrive at the

plants and are in demand in the market (value). They are made up of two elements that are separated quickly and easily, the body of the product that is made of wood or aluminum and the electrical component (cable), so the material is not contaminated when it is recycled. The process is a single process only, once the parts that make up the demonstrator are obtained, whether they are metal or wood, there is no other process than that of assembling the luminaire, which makes the product very sustainable, and it is not necessary, for example, to make a new mechanization to place the electrical system, it is not painted, etc. In this way we avoid more consumption of energy, water, transport, etc.

As we have mentioned previously, the above are contributions that we have obtained from the aforementioned projects and which we have taken into account in the approach to the development of the demonstrator, which well fits the scheme illustrated in Figure 7 of the CIRC4Life project.

Within the project and as can be seen in Figure 7, we have used sustainable product development methods, but we must highlight that the development of the PDS that plays a very important role in product

development in which we have been able to carry out workshops (living labs) which have served to improve aspects of the product according to the interests of the end user - potential consumer.

The LCAs have served to give that information that the user concerned about the environment was demanding, not only the LCA for the evaluation of the product's life, but also the Environmental and Social, these last two we have realized that they worry more than the of the product itself. We must say that in the previous EU projects in which we have participated, the LCA of the product had been carried out, but they were not shown to the consumer, they were rather information for internal use. Due to the PDS method used in this approach to sustainable product development used in CIR4Life and especially in living labs, it is where we have realized that the consumer is interested in this information, not in a technical way in many cases but if informative, they do not want to know the process but if data such as resources, ecosystem, health, etc.
The sustainable production approach that we have developed in CIRC4Life in comparison with the other projects in which we have participated, has helped us to see that the information obtained in the development of a sustainable product must be explained in a simple way so that the Potential consumers value these results and be part of them. As we have mentioned previously, some of these processes were carried out, but the consumer was not involved in them.

2.1.6 Stakeholders involved

Stakeholder	External / Internal	Involvement	Involvement
Anabel Cano	Internal	Actively participate	Intervenes in all phases of communication, website, development of the demonstrator and all other activities of the CIRC4life project/demonstrator.
Juan Manuel	Internal	Actively participate	Intervenes in the process of design, production and audiovisual media of the demonstrator.
Belen Buira	Internal	Actively participate	Intervenes in the website development and management.
Juan Costa	Internal	Participate in all the project activities	Intervenes in all the project activities.
Elvira Costa	Internal	Participate at the beginning of the project	Intervenes in the first tasks of the project with Juanma and Joanna.
NTU Team	External	Actively participate	Intervenes in the Big Data and LCA activities as part of the demonstrator.
MYPAGRIL	External	Actively participate	Intervenes in the process of co-creation with the use of scrap materials from their waste for the plastic version and in production of the demonstrator.
LIDEMA	External	Actively participate	Intervenes in the process of co-creation with the use of scrap materials from their waste for the metal version and in production of the demonstrator.
TORNERIA ALCASSER	External	Actively participate	Intervenes in the process of co-creation with the use of scrap materials from their waste for the wood version and in production of the demonstrator.

2.1.7 Results, lessons learnt and further recommendations

From a business point of view, the results obtained when implementing a methodology such as big-data, LCA, Living labs, etc. in the development of a product are very satisfying. Using multiple methodologies give a more enriching work approach when projecting a product.

Big-data and living labs have helped us to get through the comments of users and analyzed the type of product they want in a more direct way. The difficult thing is to know if all this information is correct and how to nourish the company with this information. The use of this information is the most complicated part, since if the information is not chosen well we can obtain a bad result.

The PDS allows us to define aspects before developing a final design, thus allowing us to determine concepts throughout the entire process. In this case, the lesson that companies should learn is not to start designing until they have contrasted the big-data data and the information contained in the PDS.

Using the LCA methodology involves knowing all of the data regards the product development process. It has been essential for ONA to know the suppliers that work with our company since in many occasions suppliers had to change their processes to obtain a different and more positive data for the LCA results. ONA as a company has learned that with certain suppliers, such as ceramics companies, their working processes are very handcrafted meaning that this methodology is difficult to apply with them since it involves an additional effortthat on many occasions the suppliers do not want to carry out.

On the contrary with the metal material there have been no obstacles. The data obtained through the social LCA, for example, has been very useful for the suppliers and ONA since it makes us see factors that we had nottaken into account before.

2.2 Demonstration of the sustainable consumption

Based on the DoA this sub-task aims to demonstrate the product sustainability tracking and monitoring during the sale and use stage. The eco-points method developed in WP1 have been applied into all ONA lighting products in the online shop. The product eco-information is provided for consumers, together with product's manufacture information. The outcome is demonstrated on the ONA website, in the online store using the approach developed in Task 3.1. Customers are given the chance to view the product's eco-information where eco-costs show consumers direct impact on the environment of their purchases and eco-credits is designed to encourage end-users to recycle lighting products.

In this demonstrator, the customer can view product's eco-information during shopping, the information is also shown in the customers receipt where both the cash payment and eco-cost related to each item purchased can be seen. The eco-costs of the purchased products and eco-credits awarded due to recycling of end-of-life products are recorded into the consumer's eco-account.

2.2.1 Stakeholders involved

Stakeholder	External / Internal	Involvement	Involvement
Anabel Cano	Internal	Actively participate	Intervenes in all phases of communication, website, development of the demonstrator and all other activities of the CIRC4life project/demonstrator.
Juan Manuel	Internal	Actively participate	Intervenes in the process of design, production and audio-visual media of the demonstrator.

Belen Buira	Internal	Actively participate	Intervenes in the website development and management.
Juan Costa	Internal	Participate in all the project activities	Intervenes in all the project activities.
Elvira Costa	Internal	Participate at the beginning of the project	Intervenes in the first tasks of the project with Juanma and Joanna.
LIDEMA	External	Demonstrator	Manufactures the metal demonstrator
TORNERIA ALCASSER	External	Demonstrator	Developed the first wood prototypes of the project
BAOBAD	External	Demonstrator	Manufactures the wood demonstrator
MYPAGRIL	External	Demonstrator	Developed the first methacrylate prototypes of the project
PIX cook	External	Website	Web implementation
MATRIC SALAD	External	Website	Web implementation
PIX cook	External	Website	Web implementation

2.2.2 Results, lessons learnt and further recommendations

Taking into account that the eco-cost method is something that was explicitly created by the CIRC4Life project and something totally unheard of by customers it already posed quite a few risks in terms of understanding the method. Applying something unknown or that has never been incorporated into a company to a web page implied a prior study of how the consumer had to view the information and how it should be expressed to be understood.

The web pages created through online platforms have certain limits regarding the creation of content and the application of the information. ONA demonstrates on its website the predetermined eco-costs (Figure 8 shows an example) for each of the lamps, so that the customer, once clicking one of the products, can visualize the eco-costs that this lamp has. The eco-cost is a single value combined from three end-points of the LCA, including human health, ecosystems and resources. The LCA (Figure 9) results of the product are also available; so that the consumer is enable to know all information in relation to resources, ecosystems and human health. Through this information the client would know exactly the positive or negative of that product in relation to those fields.

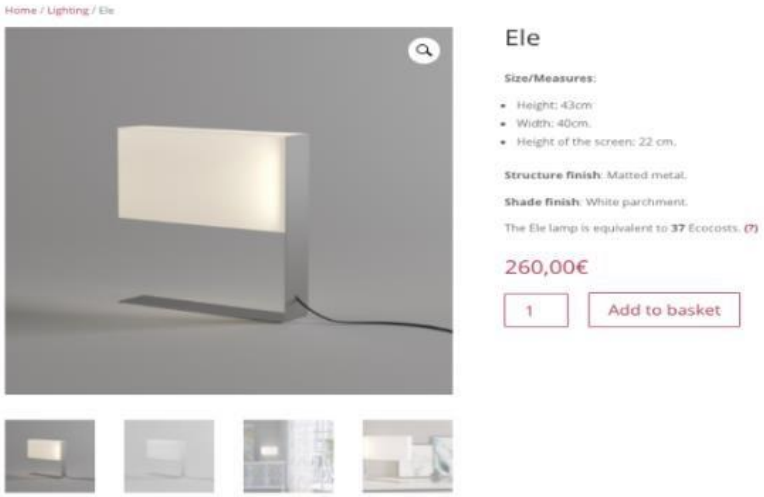

Figure 8: Eco costs are represented in all of the ONA products in the online store

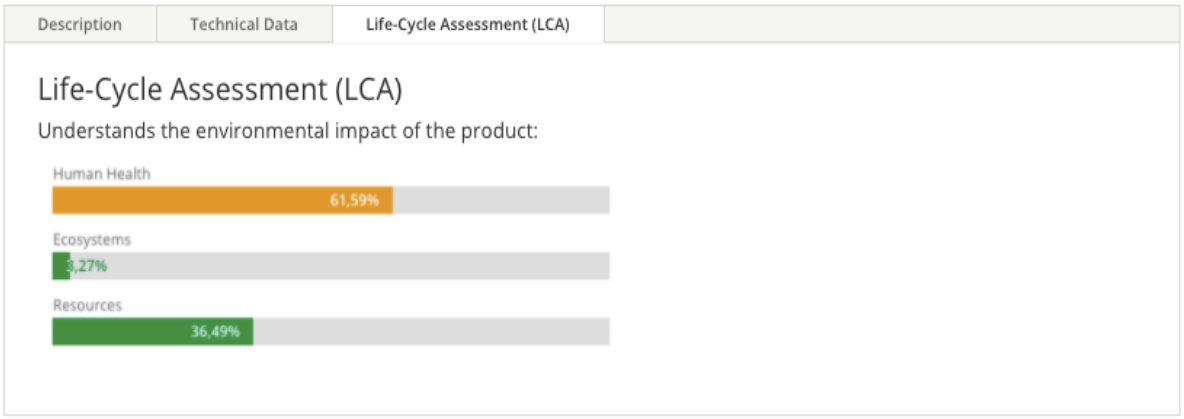

Figure 9: LCA information is shown in each of the lamps

The introduction of these fields (LCA and Eco costs) was incorporated without any problem. New editing fields were incorporated into the template in order to capture these two elements and were placed at points where the client could see them instantly. In this way, the costumers could view the product's eco-information.

The biggest challenges in terms of the establishment of this method on the ONA website were those related to putting the eco-cost information on the invoice. The invoice had to represent both, the cash payment information and the eco-cost related to each item purchased. Meanwhile, information on eco-costs throughout the purchase process and that eco costs would also be recorded into the costumer's eco-account.

The invoice was predetermined by the website itself once one of the products was purchased, so work had done to link the added information field of each lamp (field where the number of eco costs is reflected) to the invoice. It was conducted in the way that when the consumer chooses one of the products, all the information about the product, including the related eco-costs, will be linked with the payment, reflected throughout the purchase process and displayed at the end on the invoice.

For this, a program was developed to create new fields that the page did not have predetermined in order to capture all this and meet the expectations and demands of the CIRC4life project. The fields were set automatically so that everything was captured directly during all stages.

The clients have a client account in which the information and possibilities of the demonstrator would be reflected, and the client can quickly and easily access this information. The client account was also something predetermined by the website, it has the neutral fields that all the pages have in this type of sections (returns, address, personal data, etc.).

Taking into account our DEMO and the possibilities that ONA wanted to offer the client, not only in terms of eco-costs but also the possibility of recycling (take back system), we reconfigured the client account so that it had all the fields and information necessary for the client. New fields were created (Figure 7) to enter inthe customer account related to the possibilities of the demo (eco system, lamp break and recycling).

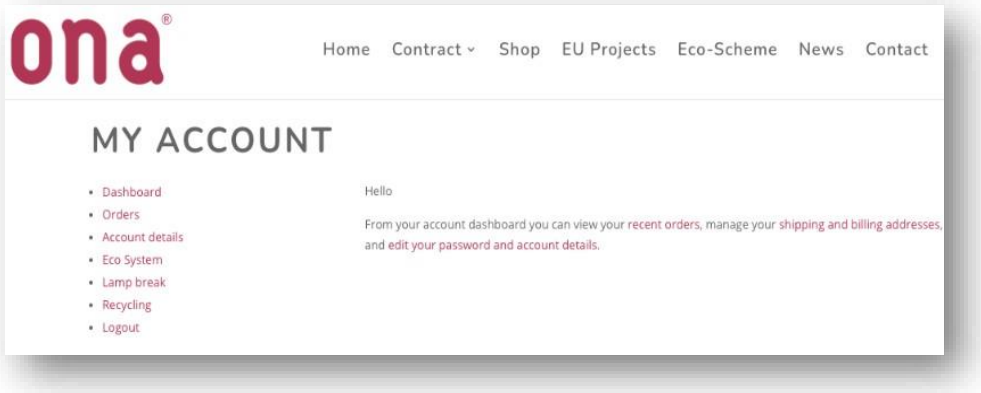

Figure 10: Fields created for the user account in the ONA website

Through these new fields the client could contemplate the different possibilities or consult the eco information regarding their purchases, eco costs and eco credits received for carrying out a sustainable action (Figure 8).

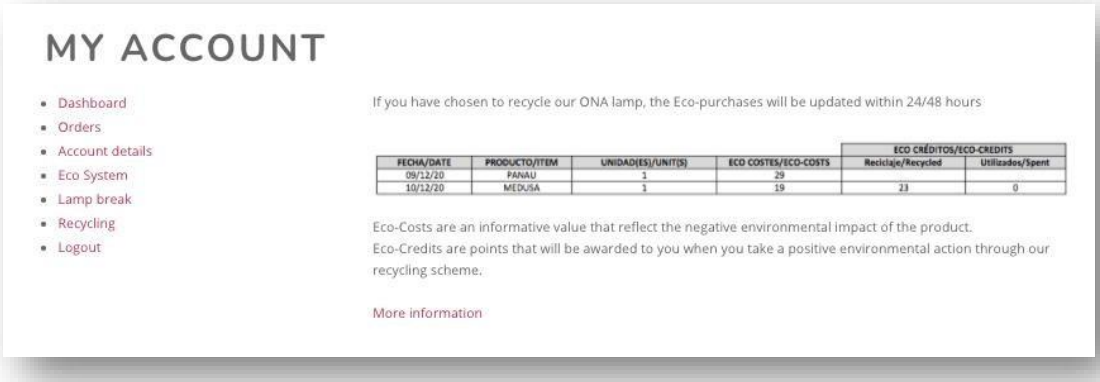

Figure 11: Eco information of the client reflected in his/hers user account

2.3 Demonstration of collaboratively recycling/reuse

When the products reach its end-of-life (EoL) stage, ONA offers a newly developed take back system. Customers can recycle their EoL lighting products via the Internet-based recycling manners applied on the website.

Customer can recycle their products by sending them back to ONA once the delivery service scheduled is applicable. The customer can contact ONA directly (e-mail) to process the collection of the product or by accessing their user profile and accessing the recycling section (Figure 9). In it the customer can fill out a form with the product data (very important when calculating eco-credits) and the process for recycling the product will begin.

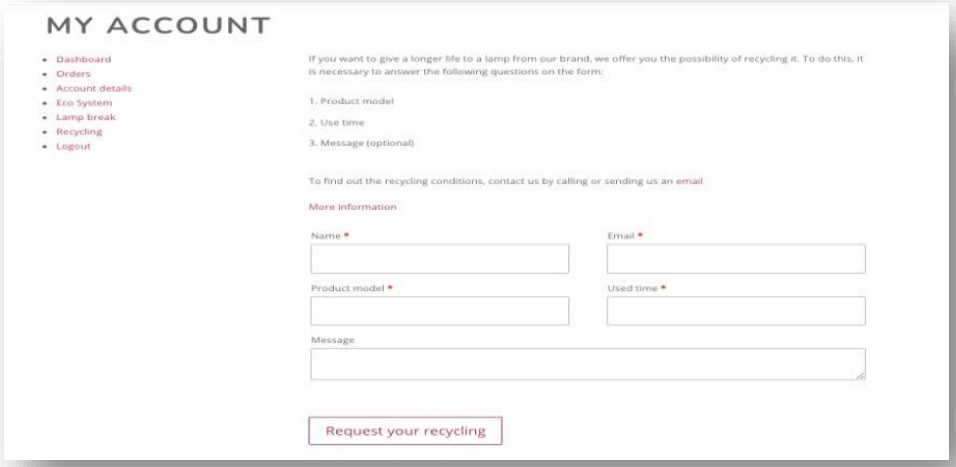

Figure 12. Recycling section in the user account

The intelligent bin approach developed in WP2 with the integrating multiple ICT technologies was established following the DoA that it should be part of the Domestic Lighting Demonstrator. Due to the fact that ONA has its own database through its website where it internally controls all the details regarding orders, users, etc. Incorporating the intelligent bin in our DEMO meant that all the information in relation to the client would be "merged" with the mobile application developed for the CIRC4life project. In this way, the customer information would not appear in the ONA database.

In addition, the application of a barcode was also complicated since in the ONA demo it is a non-face-to-face online sale, so the client could not scan these barcodes at any point. The intelligent bin option was therefore discarded and the take back system was proposed. ONA offers its customers the possibility of recycling those ONA lamps that they no longer use, are broken or want to get rid of them. The state of the lamps would be analysed, once received, and from this analysis a number of eco-credits would be provided to the user.

After the completion of recycling, the customer will be awarded eco-credits, to encourage them to keep on the participation. These Eco-Credits are points that will be awarded to the costumer when they take a positive environmental action through our recycling scheme. With these points obtained, they are provided with a discount that they can use in their next purchase. The eco-credits are used to record and track the environmental impacts that consumers recycle and reuse their everyday products according to the incentive scheme developed in Task 2.5.
When consumer decides to carry out the action of recycling and sends the lamp to ONA, ONA gives him some Eco-Credits and these are given depending on how the product arrives and this implies the reuse of parts and their recycling, for example if ONA can reuse electrical parts, ONA will give the consumer more Eco-Credits.

The lamps received by ONA are previously examined. The electronic components that may have a second life remain in the ONA facilities to be reused for remanufacturing. The rest of the material is sent to the IND facilities for recycling. For an easy recycling process the lamp has been designed for disassembly and with a modular design.

2.3.1 Stakeholders involved

Stakeholder	External / Internal	Involvement	Involvement
LIDEMA	External	Participate in the manufacture of the demonstrator	Selection of scrap from metal material
TORNERIA ALCASSER	External	Participate in the manufacture of the demonstrator	Selection of scrap from wood material

BAOBAD	External	Participate in the manufacture of the demonstrator	Selection of scrap from wood material
MYPACRIL	External	Participate in the manufacture of the demonstrator	Selection of scrap from plastic material
Juan Manuel Pascual	Internal	Participates in the design of the demonstrator	Intervienes in the design and production process
Juan Costa	Internal	Participates in all the project processes.	Intervenes in all the Project activities
DOMOBIT	External	Dissassembly	Dissassembly and selection of material for reuse
Indumetal Recycling	External	Dissassembly	Recycling

2.3.2 Results, lessons learnt and further recommendations

In this aspect, it was necessary to take into account how to take advantage of the materials that our usual suppliers did not use 100% and see which ones generated waste in order to extend their useful life. That is whythe product have to be modular and made with small parts, for example, in the case of our Medusa luminaire, we observed that our potential suppliers used many plates of wood, metal, plastic.

We realized that in the production process once the works were finished, pieces/remnants were always left over, most of the time small pieces. With this we learned that a modular object with repetitive pieces and limited size should be thought of. Without losing sight of the fact that the materials have to be recycled even being able to spend already recycled material, as is the case with aluminum in which there are already recycled aluminum sheets.

In relation to the reuse, the conclusion was to use the waste that our suppliers generated as part of a new product and offer the consumer the possibility of recycling, sending us our products, to be able to reuse parts or recycle the material to correctly extend its life cycle, in exchange for eco-credits.

Through this idea we have learned that we must pay more attention to what will happen to the materials that we use once the consumer does not want them and how to face solutions when it comes to improving the lifecycle of products. This has meant a new way of business within the company itself, thus taking charge of reusing certain materials, to sell it again later if it is suitable for reuse, and if not, send it to the corresponding plant for recycling and obtain a profit from it.

In order to obtain a profit, a very large product return is needed (in the case of sending products to recycling plants), which in our case when marketing with a product that is not mass-sold and has a very long useful life it ismore complicated. We are not talking, for example, about clothing that although it can last a long time, is a product with a very large turnover and people usually stop using it in a short time.

Including concepts such as recycling and reuse have allowed us as a company to get closer to the target customer weare looking for and limits us in terms of forms and processes when developing new products. In addition to promoting among our consumers, an alternative that represents a profit for the most important thing, our planet.

3 Showcase Event

Due to the current situation regarding COVID-19, the RISE team suggested two ways to develop the event, online or physical. In the first place, the option that was going to be carried out was the online option since in Valencia the restrictions regarding COVID-19 did not allow us to carry out this type of activity in person. As the months went by, the situation in Valencia was improving, in terms of infections, and the restrictions were modified allowing us to contemplate the possibility of developing the face-to-face event.

Due to the restrictions we could not be a group greater than 6 people, so we decided to carry out the event 3 different times during the same day with 6 participants in each of the 3 groups (4 external people and two members of the ONA team) with a total of 12 external participants. The event in which different stakeholders participated took place in May 2021 (Figures 11-13). The types of stakeholders attended the event include architects, hotel management, interior designer, etc.

Regarding the structure of the event, we followed exactly the idea that RISE proposed to us at first:

- Presenting a Power Point presentation and a video[5] about our demonstrator
- Present the new modular lamp that has been developed and that has been made using industrial scrap materials
- Provided a guided presentation of the webpage including the new eco-cost and eco-credit system
- Presented the take back system
- Conducted a survey with the participants, based on the validation framework (Appendix 3)

Figure 13 Ona showcase: Group 1

[5] https://www.youtube.com/watch?v=HKNgvwa__jc&ab_channel=CIRC4LifeEUProject

Figure 14 Ona showcase: Group 2

Figure 15 Ona show case: Group 3

3.1.1 Results, lessons learnt and further recommendations

Regarding the feedback obtained in the event, the sensations regarding the system developed by the CIRC4life project were satisfactory.

Participants consider the method of eco-costs and eco-credits something innovative that could work and could promote an improvement in society. Although the system seemed innovative to them, the points system may be confusing considering that they do not know the maximum and minimum eco-cost scores are not defined. It is also unclear to the users how these have been calculated. To address this, related information about the eco-cost and eco-credit has been presented on the Web pages of Ona online shop.

As for ONA, the attendees contemplate the possibility of improving the information and capturing it in a more interactive and visual way, since they consider that many consumers do not stop to read the information carefully when they visit web pages. Many mentioned the idea of using some kind of label, like the one used by household appliances, so that in a quick and visual way it could be sensed whether the product was more or less eco-friendly.

Regarding the possibility of recycling, there were different opinions, some of the attendees would take their time to request recycling with us and participate in the take back system, while others considered throwing the product directly into the trash for which we should consider how to avoid for them to do so. The purchase process was not a problem for anyone and everyone found it agile and efficient.

4 Successes and barriers

At the time that ONA was presented with the possibility of entering the CIRC4Life project, we saw the opportunityto change the concept of our online store. At first our lighting company was specialized in the contract sector with a very cheap product sold in our online store, but this did not reflect what we were capable of creating.

Participating in a project like this provided the opportunity to change the existing concept of the online web. The sale of a product with greater added value and with little circulation was reflected in order to direct the store to a different profile of consumers. The purpose of this was to position the ONA brand as a trend company within the domestic lamps sector.

This has caused during these years a change of the web that has affected not only the product, but also its positioning, distribution channels, etc. For this, some products that had already been manufactured for contract projects were put on in the online store to start with this new concept, also concepts, systems and work methodologies raised in the CIRC4Life project have been implemented.

Regarding the LCA information required for the MEDUSA demonstrator, we have had to make a great effort so that our suppliers provide us with all the data that was necessary when performing the LCA, such as time, energy expenditure, transportation, etc. We work with suppliers with very different structures and working methods, so the information was multiple and varied. This has been a barrier that we have been able to overcome by going to these providers ourselves and gathering the required information for the study of the LCA data.

The LCA information has not only been implemented in the demonstrator's product, but in all the products onthe ONA website. We wanted this method to be displayed on all products so that the customer would becomefamiliar with this concept and interpret it as an extra help in making decisions regarding the purchase of their product.

Regarding the materials used for the demonstrator, three types of materials were proposed (aluminum, wood and plastic) and a fourth (glass) that was valued later but did not convince and finally not used. The proposal for Medusa was to develop a project through material waste from our own suppliers. For these, theproviders, the fact of proposing to take advantage of the waste material (scraps), which they throw into the recycling containers, and to be able to produce pieces from which they benefit they have seen it as a great business opportunity.

With the wood and metal materials we had no problem. The one that was an obstacle was the plastic version. Despite being a product that I liked in the development of the LL, we had to decide not to produce it since we could not provide an optimal quality of the product in terms of resistance and development of the pieces. Developing this product would have caused several breakage problems.

Another obstacle in terms of the manufacturing part, and the most complicated, has been in addition to makingthe supplier aware of providing us with the parameters that we indicate, as we have previously explained, is that said information (LCA calculation) would allow him to better control the factory processes and costs, evenif this means additional work.

In relation to the implementation of what we have called the "Eco Scheme", as explained before, we had to reprogramming within it to capture the information that was required in the project since they do not exist in said platform some plugins needed for the development of our demonstrator.

This has led us to have to make many programming changes that in turn affected the operation of

The Word Press template itself due to incompatibility issues.

After holding the Show Case in May 2021, we have been able to collect consumer opinions about the MEDUSA product, the CIRC4life eco-cost method, our take back system, etc. Once the concept is explained to the consumer, it seems very interesting and daring. A lamp can last 25 years or more and continue to function as the first day, so recycling it is long-term and we have to wait a long time for the consumer of our products to decide to contact us to carry out the recycling action. The most important barrier is that the consumer has to send the lamp to ONA, this step is the most complicated, since it costs them money and another of the things that has also caught our attention is that they would like to know what the maximum value of Eco-Credits thatthey would receive from the product before making the purchase, that is, how many Eco-Credits the part theywould like to buy would have if they decided to recycle it. For ONA, this last point is very complicated since it will depend on the state of the product and this cannot be known until we receive the lamp.

It was planned to attend a fair in the sector to promote the website and the demonstrator, but due to the pandemic such action was not viable. This had to allow us to improve the positioning of our website since we are changing the segment/target audience and promote the product MEDUSA in an event such as a fair in which a very high number of potential clients attend. That is why we have decided to advertise in industry magazines (Figures 14[6] and 15[7]) and thus start promoting the website and the demonstrator.

Figure 16: Diario Design Magazine

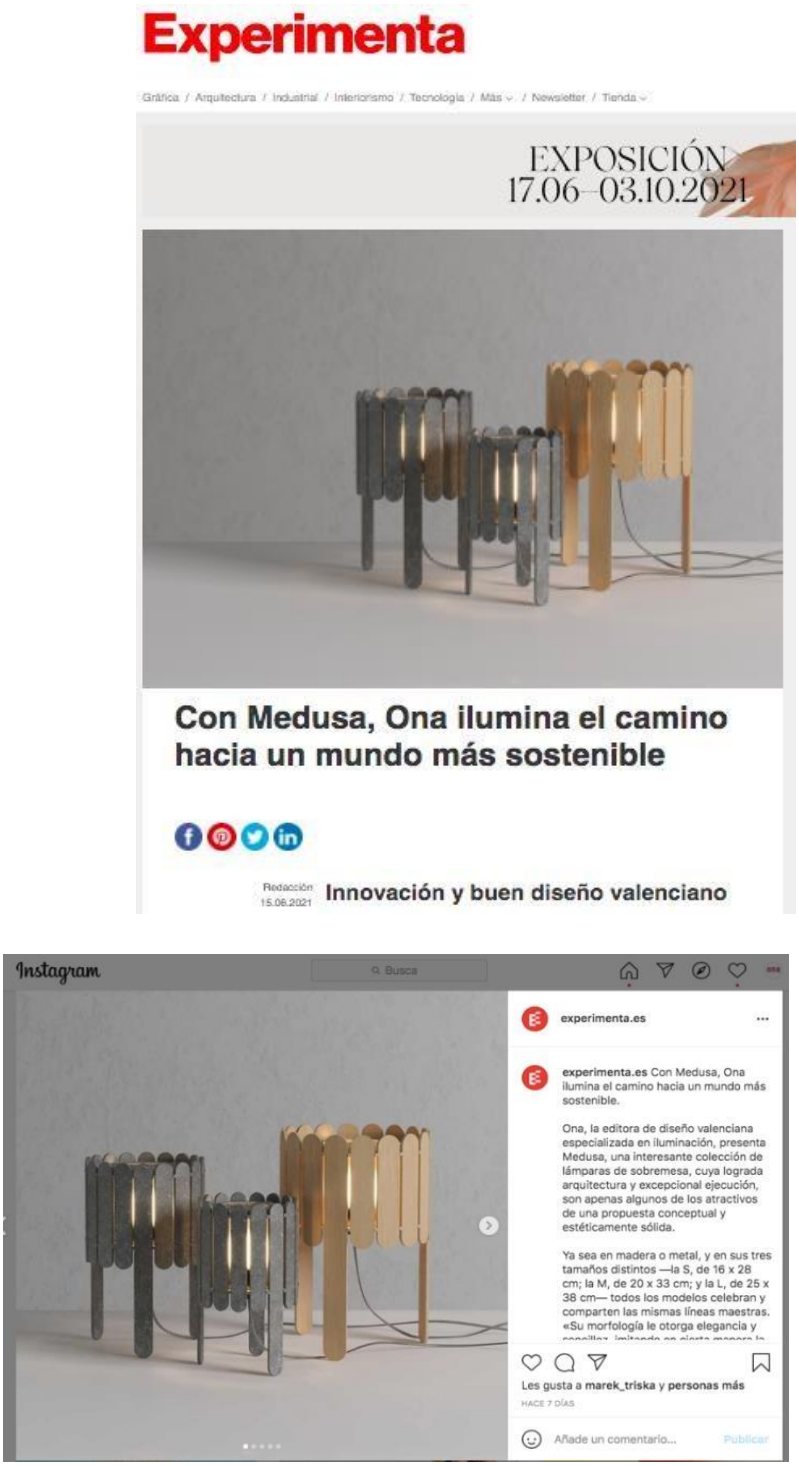

Figure 17: Experimenta Magazine

[6] https://diariodesign.com/2021/06/iluminacion-de-bajo-impacto-medioambiental-con-ona/
[7] https://www.experimenta.es/noticias/industrial/con-medusa-ona-ilumina-el-camino-hacia-un-mundo-mas-sostenible/

These actions began to be carried out in June 2021. These actions allowed us to show the new online store concept that ONA had developed thanks to the CIRC4Life project and introduce ourselves into a new market niche in which the online store was not yet positioned, allowing ONA to enter another segment where the customer bases his choice on values such as design, sustainability, circular economy and not based only on theprice when buying.

The fact that information on MEDUSA lamps sold is not available is due to the fact that we have started promoting it in June 2021 in the media as indicated above. In our sector, the product needs time to see if it is accepted, we are not talking about a mass-selling product, we have proposed a medium/high-end product that needs a considerable time to see if it is accepted by its future target audience, we are not talking of a product of necessity, although we have received good comments, it is not enough, you have to see how it is positioned within its segment.

For a few months, we added our MEDUSA product on an online sales portal (Figure 16) during the developmentof the demonstrator, but we did not obtain any sales. We decided to put the product back on the online platform for a longer time, to give it more visibility.

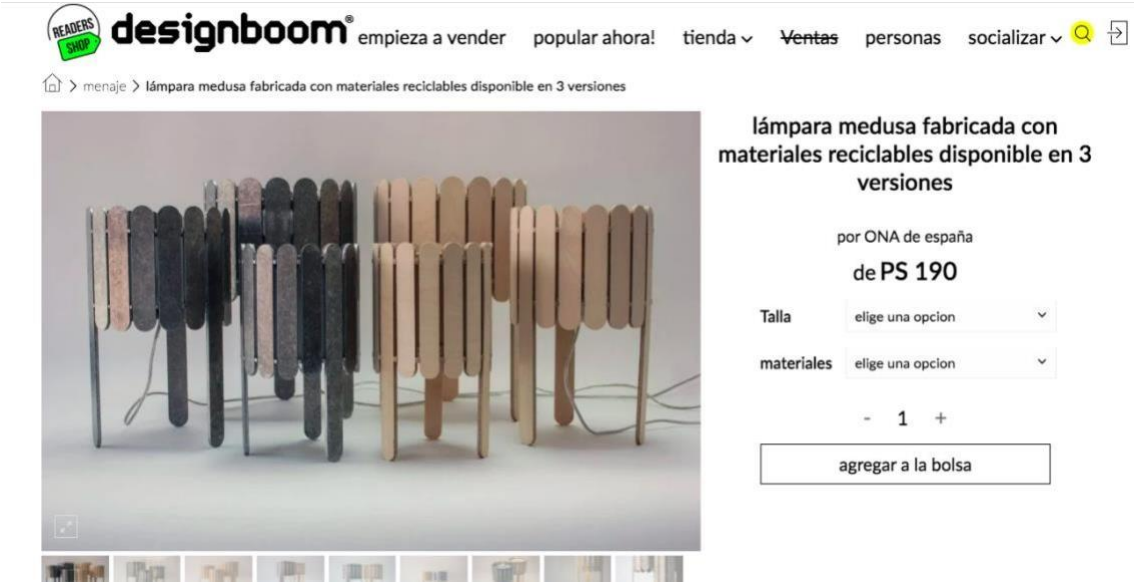

Figure 18: Designboom, an online sales portal

Currently and as a consequence of the pandemic in which we are still, the medium / high range lighting sector,which is where the “MEDUSA” product is found, is suffering a considerable decrease in sales. In the contract sector, since COVID-19 entered the scene, more than a year ago, our potential clients, hotels and restaurants are closed or with limited capacity, which has caused investments to stop and consequently sales, so we have not been able to offer the product through this channel.

5 Conclusions

The CIRC4Life Project has offered ONA the opportunity to develop a new online store concept based on the Circular Economy strategy, allowing to define better objectives necessary for its implementation and to searchfor a new market niche.

Through the co-creation practices and Living Lab methodology that we have developed during the demonstration, ONA has understood better the needs; problems and concerns of our potential customers andin this way try to solve these problems when generating new products.

Before entering this project, ONA listened to the commercials, lighting store sales people, etc. and it was they who conveyed the market needs to us, but we have understood that we have to go one step further if we want to sell products in our online store. To aimed at a customer interested in design and aware of environmental impact we must place more emphasis on listening to potential customers with this profile and leaving traditional channels aside.

The LCA not only provides very interesting information for the customers aware of sustainability, but also allows the company to connect with customers by providing the data in each product. Another very important aspect when implementing this concept in our products has been to establish with our suppliers a new way of understanding the manufacturing processes to improve their impact and to be able to manufacture products demanded by the sector to which we are directed.

After the different actions that ONA have carried out during the project, we have appreciated that there is a considerable number of potential clients who are very concerned about the final destination of the products once they decide to dispose of them, either because they have been broken or because they no longer have them want. What their demand is that companies not only make products with sustainable materials, but that they become more involved in recycling, that they are part of it.

The fact that in our demonstrator the customer is given the possibility to return a product of ours and that the company takes responsibility for its recycling, is the way to solve that problem that the consumer detects and to see that the brand also has the same concern them and try to give a solution. This action is an effort for the brand, in some cases not being profitable, but this effort is offset by the loyalty that is created between the customer and the company.

Although we have not been able to attend a fair, due to the COVID-19 restrictions, to present our demonstrator at a massive event, we have been able to develop a new concept of an online store, which has shown good acceptance to the people. We have explained our new methodology based on circular economy concepts, which will allow us to enter a new market niche that is growing. So we consider that we should try to enter it, so that our brand can grow and try to be a trend brand within a few years in this segment.

As a company, ONA believes that companies should implement Circular Economy Business models so that they themselves are parties involved in the objective of reducing both the entry of virgin materials and the production of waste and can solve the problems that society faces. It is faced in relation to the sustainability ofthe planet.

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7 Appendices

Appendix 1 - Recommendations for ONA lighting product design based on the results of mining consumers review inOna online shop https://onaemotion.com/en/

(Note: this is Section 4 of the internal technical report 'Data analysis of ONA online reviews'[10])

The aim of the online data mining is to help the manufacturer to gain valuable information from online reviews and make this information to be utilized in product design. With the application of the approach for ONA website online reviews, the results obtained can contribute for ONA to improve current product design or new product design. However, the online reviews can only show that the customer preference part of the PDS, the technical PDS part still needs to be constructed by the designer and manufacture. Based on the analysis result, there are some recommendations for ONA todesign/improve their lighting products as listed as follows:

- To design the product with 'easy to assemble' and 'easy to use' features.
  Easy to use is one of the most concerns of the consumers. The keywords such as easy to assemble, east to use, simple, and some of relevant keywords such as put together, ready to use, etc. appear in same review or the review contain such keywords as assembly, thus this review has been considered useful regarding to the structure design about the table lamp. Related customer reviews shown as below:
  - I like it very much, it is easy to assemble,
  - Very easy and fast to set up, even for people with 2 left hands like me :-) floor lamp looksvery good and would be bought again.
  - This lamp looks beautiful and practical and easy to set
  - up.Simple and easy. They look lovely on our bedside
  - tables Easy to fit and absolutely for kids.
  - Easy to put up but I was expecting them to actually send an extra piece as they only sendthe actual shade.
  - The assembly was pretty simple though.
  - My 6 years old son put them together all by himself.
  - As regular user, it's extremely simple to fit, and the function setup is really simple.
  - Easy to install, nice light shade, great colour!
  - There is barely instruction on how to install this lamp. The parts are all separate and I don't know how to install them at all.
  - Although the description said some self-assembly, it all actually needs technical skills to assemble it which I do not have, and, hence, I asked someone helped me to do the assembly job.
  - Very good design, very easy to put them together, came with parts, but nice and tidy.
  - I'm very impressed, really easy to install
  - Easy to install, nice light shade, great colour! A bit difficult to install just because of thelack of instructions but it took me no more than 3 minutes
  - Nice lamp, easy to assemble, modern
  - design.Love this. Easy to assemble
- The appearance of the lighting products need to be modern and stylish
  According to table 3.3, such keywords as "design" and "good looking" are regarding to the appearance of the table lamp, it is another key element of concern of consumers. The reviews

contains the keywords of “design”, “looking” or relevant keywords as “nice”, “elegant”, “stylish”,“modern”, “attractive” etc. are as following:

- I like the lamps in their house; most of them are in an industrial
- style.Floor lamp looks very good and would be bought again.
- His is such a lovely lamp. The shade is beautiful and the base is so easy to keep clean and looks much more expensive than it was.
- They look much more expensive than they are and finish my room of perfectly.
- Excellent design and quality purchased this lamp for our bedroom. Extremely pleased with both the design and quality.
- This lamp looks beautiful and practical and easy to set
- up.They are fabulous and look good placed on side
- tables.
- I love the lamp shade, it looks so fresh and modern
- Very pleased with everything about this shade - good quality, stylish and easy to
- clean.The combination of ceramic and wood design is really ingenious
  Wood and ceramics, the whole gives me a very natural feeling. I love this design; it's justthe right light for the tea room.
- I like this design very much. If ONA can design a few more lamps in this way, it will be more perfect, I will definitely buy it.
- Brilliant decoration lamp, it could create a special
- atmosphere.It's very nice decor/lamp
- This product is modern in shape and practical in function.

- The lamp material and packaging material must be recyclable/easy to recycle

According to table 3.3, consumers concern about the sustainable design, when they buying a product, they more likely to choose the ones easy to recycle in order to reduce the impact to ourenvironment. The reviews contain keywords such as “material”, “delivery”, “package” show that consumers prefer sustainable products. Such reviews include:

- The packaging is a bit complicated, it feels a bit wasteful.
- The plastic bottom may take away from the luxury feel of the product, I think it would be nice to make it wooden, which would be more environmental friendly.
- The use of wood materials, reduce the generation of environmental pollution, good design.
- All the materials seem to be recyclable asides from the fact the base is stuck to the woodenpart with glue.
- I bought a lamp and put it in my newly decorated house, the whole effect is good, and the material looks very green
- This kind of packaging is just too much. Such a waste.
- I wonder if the lamp can be recycled when it’s broken or I don’t need it. If I can trade this lamp for a discount when buying a new lamp, it’ll be great.
- The packaging is too complicated. I unpacked it for a long time. It may be to prevent the glass cover from breaking. Personally, I feel a bit unfriendly to the environment.

- the product is alright but the package could be more environment friendly, like using some recyclable materials;
- the delivery package is over packed, which is a kind of waste
- the package used lots of plastic bubbles in the package

- It is very special in shape, outstanding in design, giving people a strong visual
- impact.What attracted me at first was its unique style
  The material is energy-saving and environmental-friendly, the shape is simple.
- My only problem is the package material is hard to be recycled.
- It's a nice lamp, but they use too much stuffing on the packaging to make sure the lampshades don't crush. I don't think it's environmentally friendly.
- Very special pendant light, using a natural rattan as material, I think it is in line with the current environmental protection concept. I am very satisfied.

There is still much more valuable consumer requirements contain in the reviews; these reviews could help the designer/manufacture to further understanding the customer needs. Below are the relevant critical reviews.

- The information provided in the Website/manual must be clear and enough. Examples of the online reviews related to this issue as:
  - There is barely instruction on how to install this lamp. The parts are all separate and I don't know how to install them at all.
  - Are there any pictures of use scenes? I did not find them from the website, so I can't tell what it really looks like when it works. This lamp is expensive, so I have to make clear everydetail before I buy it.
  - I suggest providing more product information, such as specification, on the product website.
  - I don't quite understand the instructions; I hope you can improve it a little bit.
  - the assemble instruction is not clear and hard to understand
  - Easy to install, nice light shade, great colour! A bit difficult to install just because of thelack of instructions but it took me no more than 3 minutes
  - My only problem with this package was some of the very hard to read instruction
  - bookLack of information to show which type of blub I can use for this lamp
  - Can't find the structure drawing on the instruction
  - can you please provide a video to show how it works
  - Need a clear information to show what to do if the shade dirty or broken
  - Can't find anything about where to get a new shade
- The stand of new product need to be stable enough, suggest using tripod structure. Below are examples of the online reviews related to this issue:
  - bottom of the support could be improved to increase the stability when the lamp is placedon the table
  - suggest changing to three-bulge points
  - contactThis lamp is stable enough on my
  - desktop.
  - It's a bit bulky and not very stable. It's different from what I expected.
  - The base is a bit small, it's very easy to fell
  - downThis lamp is not very stable, it always
    fell off
    I like the L shape design, but the base need more wider
- The new product needs to be easy to repair and the parts need to be easy to obtain. Below are examples of online reviews related to this issue:
  - no idea where to get spare parts
  - my shade is broken, but cannot contact the seller

- need a repair centre in town; the unique cover is not
- changeableThe marble base is too heavy and non-replaceable
- once broke. Shade not replaceable
- The shade is broken. However, the rest of components are still working. I don't intend tobuy a new lamp but can't find a suitable shade.
- The online shop does not sell spare parts
- Want a different colour shade
- It takes a long time to get the broken lamp
- fixedCan you provide UK type plug
- The cable is not long enough and need UK type plug

- The product needs to have more delivery options such as: a) pre-assembled; b) flat pack (self-assemble) in order to reduce the environmental impact. Below are examples of the online reviewsrelated to this issue
  - Because they are unique, they even used a big box to ship the 'ball' intact, which was too wasteful.
  - A huge box for a small light
  - I can put them together myself; each part has their individual package which is not necessary
  - Need some help to assemble them
  - togetherTake ages to put them together
  - Used lots of plastic bubbles in the package, can u provide flat pack package that I want assemble myself
  - Asked my friend help me to put them
  - together Put them together with my son, he
  - very enjoy it
  - It's impressed that the lamp is assembled already
  - One suggestion is if you do not preassemble the lamp, it will save 50% package
    The package is very compact, and it's super easy to assemble them together
- The product must be easy for disassemble in order to easily recycle the components and/or material of the product after the product reaches its end of life. Below are examples of the online reviews related to this issue
  - No idea what to do when it
  - broken Hard to split the different
  - materials The recycle centre not
  - accept marbleNot easy to take the
  - shade off
  - Need to send the whole lamp back, it's very hard to take the broken piece off
  - Need cut the wire to replace the switch
  - Very hard to open the cover to change the
  - bulbTotally have no idea how to change the
  - bulb
  - I like this lamp, just simply change a bigger bulb then it's perfect
  - Simple design, simple structure, very easy to recycle the materials
  - The metal structure is very easy to recycle, but need take the wire out from the tube.They glued them together, not easy to take them apart
    The lamp shade was broken by an accident, but after I replaced a similar size shade, it works again, happy.

- More choices in colour, size and materials, for example weight reduction or usage of less number of materials, easy to manufacture…… Below are examples of the online reviews related to this issue
  - I want an unbreakable and Eco-friendly lamp for my new dining room. Plastic and glass shades were not suitable
  - Lack of colour choice, want different colour
  - If could change the shade colour would be better.
  - The plastic bottom may take away from the luxury feel of the product, I think it would benice to make it wooden, which would be more environmental friendly.
  - I would expect it to be fully constructed from premium materials; I don't expect to see plastic.
  - It just provides one colour even if it seems very easy to set up.
  - I suggest that you provide more colour modes for this lamp so that we can change the atmosphere once in a while
  - We went for the larger size, but it's not big enough which is good as a table lamp. I want to use it as a floor lamp so I think it'll be perfect if you provide more size offers form floorlamp to bedside lamp.
  - Actually the lamp is bigger than i thought

Appendix 2 - Product Design Specifications for the table lamp (Medusa)

1) Performance

1.1. The lamp must be able to light a small room (4 by 5 meters) perfectly if necessarily. Theilluminance should be no less than 300 lumens.

1.2. The lamp has an option to be dimmed, as some people want a less bright light than others.1.3.The light must be soft and evenly speared.

1.4. The lamp must be able to provide enough luminance for reading.

1.5. Prevent direct light hitting the user's eyes, and hence to add a cover on the top of thelamp and a shade to the inside of the side cover.

1.6. Bulb type: E27

1.7. The product must have a stable support.

1.8. LED should be used as the lighting source for energy saving.

2) Environment

2.1.The lamp should be used in any household temperatures without losing the ability to perform properly.

2.2. The lamp will not make any noise while in use.

3) Life in Service

3.1. The target service life is 15,000 hours

3.2. The lamp should be stable and doesn't flick while in use.

4) Maintenance

4.1. The lamp should be designed for easy to change the bulb and to clean the dust.

4.2. The lamp should be easy for repair, change of components, and upgrade

4.3.The lamp should be easy for disassembly in order to facilitate to recycle the materialand to reuse the components when the lamp reaches at its end-of-life stage.

5) Installation

5.1. There will be detailed guidance (paper or video) for the assembly.

5.2. There will be no special connector used. The lamp must be easily installed with simple andcommon tools.

5.3. Minimise the adhesive using for assembly.

6) Target Product Cost

6.1 The price is to be in the range between 180€ and 300 € per lamp

7) Shipping

7.1 The lamp will be able to be shipped in normal types of transportation means (pallet, truck, bus).

7.2 Delivery time within 14 days.

8) Packing

8.1 The lamp will be wrapped with plastic and papers, and then put inside a cardboard box.

8.2 There will be a clear and easy to understand description to help the consumer recycle thedifferent parts of the lamp.

8.3 The packaging material used for filler and boxes must be able to be reused or recycled.

9) Processes

9.1 Use low environmental impact manufacturing processes.

9.2 The lamp should use as few components as possible, whilst maintaining the required quality.

10) Manufacturing Facility

10.1 The company has been making domestic lamps, and the existing machinery tools are suitableto make the lamp.

11) Size

11.1 Round shape with three size options:

- Small: diameter = 16 cm, height = 28 cm
- Medium: diameter = 20 cm, height = 33 cm
- Large: diameter = 25 cm, height = 38 cm

12) Weight

12.1 Maximum weight per lamp is 3.5 kg (metal), 1.5 kg (wood) and 2 kg (plastic), without bulb.

13) Aesthetics, Appearance and Finish

13.1. Design and implement systems (related with the product) that facilitate components and luminaries' recovery for re-use, re-manufacture and recycle.
13.2. The lamp will be modern-styled.
13.3. The edge and finish must be clean and well-manufactured.
13.4. The lamp will use red or white or any dark colours or use any combination of these colours.

14) Materials

14.1. The materials used should be recyclable and have low environmental impact.
14.2. Use the minimum type of materials, which facilities the sorting of components for reuse andrecycling when the product reaches its end of service life.
14.3. There should be at least two kinds of casing materials for customer to choose.

15) Customer

15.1. The target consumers of this product are domestic users and hotels.
15.2. Recovery for re-use, re-manufacture and recycle.
15.3. Avoid: The use of special tools for disassembly, non-detachable joints (welded or glued joints),labels attached the product, finishes in materials, and toxic materials.

16) Timescales

16.1. The prototype for evaluation must be available in May 2020 and the final product will beavailable in the market by July 2021.
16.2. The LCA and the Living Labs (carried on to know the opinions of the end consumers) will bedone by May 2021.
16.3. To avoid using toxic materials.

17) Testing

17.1. The design of the lamp is tested to ensure the type of certification and safety. This will alignwith relevant standards for electronic products.
17.2. The Environmental life cycle assessment (LCA) is conducted at the design phase with the LCAprogram.

18) Safety

18.1. Keep away from children since there is use of electronics.
18.2. The lamp has the indication which type of protection against electric shocks it has. This isaligning with relevant standards for electronic products.

19) Documentation

19.1. In order for the consumer to recycle the lamp when it reaches at its end-of-life, the instructionhow to recycle has to be given.
19.2. The eco-cost and eco-credit information of the lamp is available for the customer.
19.3. The product technical information is available in the manufacturer's Website for consumer to

Appendix 3– Showcase Event Survey for Attendees

1) Name _____

2) Age

Under 18 years old

Between 18 to 24 years

Between 25 to 34 years
Between 35 to 44 years
Between 45 to 54 years
More than 54

3) Where are you from

_____

4) Studies

Compulsory Secondary

EducationHigh School

Vocational

trainingCareer

Master's Degree
PhD

5) Actual job Situation

Part time

jobFull

time job

Unemploy

ed

Freelance

Student

Retired

6) Job

_____

7) Do you find our website attractive?

Yes/No

8) Do you find it intuitive and easy to navigate?

Yes/No

9) Do you like the product design of our online store?

Yes/No

10) Would you buy a product of exclusive design for a high price?

Yes/No

11) What product from the online store do you like the most?

_____

12) What Medusa lamp would you buy?

Aluminium/ Wood

13) Which MEDUSA size would you choose if you had to choose just one?

Small/ Medium/Large

14) Does it seem safe when making a purchase in our online store?

Yes/No

15) Would you buy a product with 15 or 30 days of shipping from the date of purchase?

Yes/No

16) Do you think Eco costs are misleading?

Yes/No

17) Do you take into account if a product is sustainable when making the purchase?

Yes/No

18) If you had a lamp that you do not use, you will request recycling or you would throw it directly into thetrash before processing anything?

Recycling/Bin

19) You find the recycling request process easy with ONA?

Yes/No

20) How satisfied are you with the MEDUSA product? (Rate 1 to 5, where 1 is not satisfied and 5 is verysatisfied)

21) Do you believe that this co-created product gives you additional value compared to a traditional product (PDS)?

Yes/No

22) Do you believe that this product is a more sustainable product?

Yes/No

23) Was the eco-information/eco-points useable/easy to understand during the shopping process?

Yes/ No

24) Was the eco-information/eco-points decisive at point of purchase?

Yes/No

25) Was the eco-shopping process efficient and well-functioning?

Yes/No

26) How satisfied are you with the take back service? (Rate 1 to 5, where 1 is not satisfied and 5 is verysatisfied)

27) Suggestions and ratings

_____