4MOD.

Research & Innovation Roadmap

Dec. 2024

OUTLINE

1. *Introducing 4MOD*
2. *Introducing Speakers*
3. *4MOD's Environmental management system*
4. *4MOD's Research projects*
5. *Conclusion*

1- INTRODUCING 4MOD

GNKGO Group

1- INTRODUCING 4MOD

4MOD's Locations

Nantes, France
Headquarter, design & administration

Bordeaux, France
Engineering & suppy chain

Shenzhen, China
Quality & Sourcing

Tunis, Tunisia
IoT dedicated factory

Spain, Netherlands, USA, Indonesia, Thailand & Argentina
Sales

Portugal & China
Industrial partners

1- INTRODUCING 4MOD

4MOD's Activities

Remote control

Our historical core business.
Spin off of Thomson's Remote Control Business Unit.
Developing advanced user interface solutions.

Internet of Things

4MOD connected studio dedicated to designing complete solutions for IoT in **Industry, SmartHome, Smart Metering and Agriculture**.

EMS dedicated to IoT business with our best-in class factory.

4MOD.

In 2017, **4MOD.** launched its own initiative to reduce its global environmental footprint.

1- INTRODUCING 4MOD

4MOD's References

1- INTRODUCING 4MOD

Organization Chart

2- INTRODUCING SPEAKERS

Research program coordination : CV

EDUCATION

Université de Bretagne Occidentale (UBO), Brest, France
Ph.D. in Electronics, November 2019

Université de Montpellier, Montpellier, France
Master in Devices and Systems for telecommunications (EEA), September 2016

Lebanese American University, Beirut, Lebanon
Master of Business Administration, July 2014

PROFESSIONAL EXPERIENCE

4MOD Technology, Nantes, France
Research program coordinator, October 2020 – Present

Université de Bretagne Occidentale (UBO), Brest, France
Post-doc. Researcher, October 2019- October 2020

MADA Communications, Khartoum, Soudan / Beirut, Lebanon
Telecommunications Engineer, July 2008 – August 2014

2- INTRODUCING SPEAKERS

Research program coordination: Main Missions

Mission 1 – Coordination of research programs at the French and European level (+Research and Innovation Funding officer, French competitiveness clusters , European (HORIZON, CHIPS JU, etc.) or French (ADEME, BPI, ANR, Regions, etc.))

Mission 2 – Collaboration with laboratories/companies on applied research projects

Mission 3 – Applied research activities

Mission 4 – Writing activities (state of the art, scientific reports , articles and patents , CIR (Research Tax relief) files)

Mission 5 – Internal/external communication

2- INTRODUCING SPEAKERS

Sustainability manager CV

EDUCATION

Cranfield University, Cranfield, UK
MSc in Environmental Engineering , Sept 2018 – Sept 2019

University of the West of England, Bristol **,** UK
BSC (HONS) Environmental Science, Sept 2013 – May 2017

PROFESSIONAL EXPERIENCE

4MOD Technology, Nantes, France
Sustainability manager, March 2022 – Present

Puma Energy UK
Lead Environmental Engineer, September 2019 – January 2022

GE Aviation, Wales, UK
Full Time Environmental Health and Safety Intern, July 2015 - August 2016

2- INTRODUCING SPEAKERS

Sustainability manager Main Missions

Missions – Responsible for undertaking life cycle assessments of 4MOD products and managing the EMS:

- Conduct **Life cycle analyses (LCA)** for the new and existing products, quantifying their environmental impact. The LCA process identifies the areas/materials of a product that are most damaging, helping identify and directing development of new materials to replace them.
- Implement **ISO 14001 Environmental Management System.**
- Produce the **Annual Sustainability report** for the Group of companies integrating the UN SDG into all aspect of the business.
- Working within **4MODs research's projects** to develop and implement a methodology for the **Eco-Design for electronics products.**

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

GNKGO Sustainability journey

March 2017
commitment to reduce our environmental footprint

June 2019
We joined United Nations Global Compact, to include our approach in a worldwide effort

September 2019
Greenmode Bluetooth energy saving technology developed

May 2020
Development of our environmental impact tool to assess 4MOD's product

March 2022
Hiring of an environmental engineer to undertake Life Cycle Assessments on 4MOD's products

June 2022
Project Perfecto developing Sustainable PCB supported by ADEME

January 2023
Joined EECONE, an EU funded research program, Its goal is to move toward a zero-waste electronic industry

May 2023
Awarded Ecovadis Bronze medal

July 2023
First ISO 14040/44 certified LCA for a remote control

January 2024
ISO 14001 certification of GNKGO Environmental Management System

January 2024
First certification of an IOT product LCA to the ISO14040/44 standard

June 2024
Achieved a 3-month turnaround time for the certification of an IOT product LCA to the ISO standard

June 2024
Publication of GNKGOs first Annual sustainability report

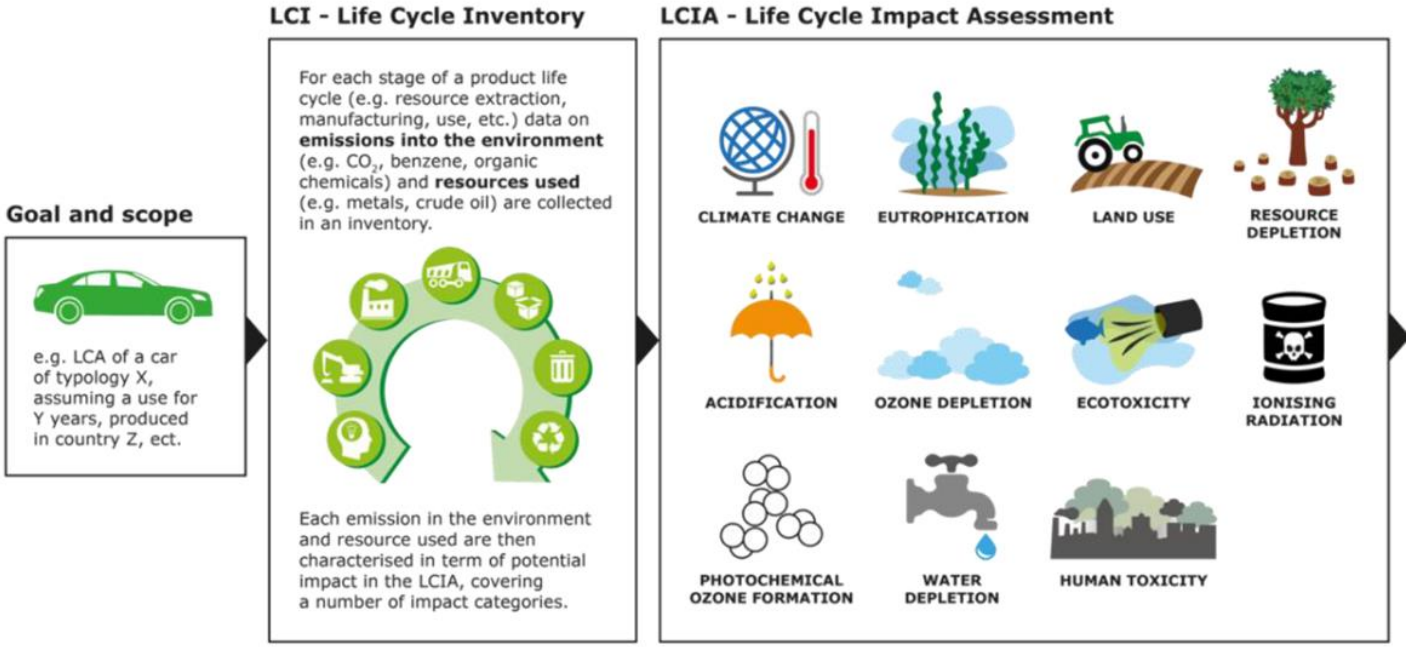
July 2024
Improved our Ecovadis rating from Bronze to Silver

October 2024
Kick-off of the ENLIGHTENED research project to integrate the Bio based solar cells into a remote-control unit.

2017 2019 2020 2022 2023 2024 2025

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

4MOD's bespoke LCA System



ecoinvent

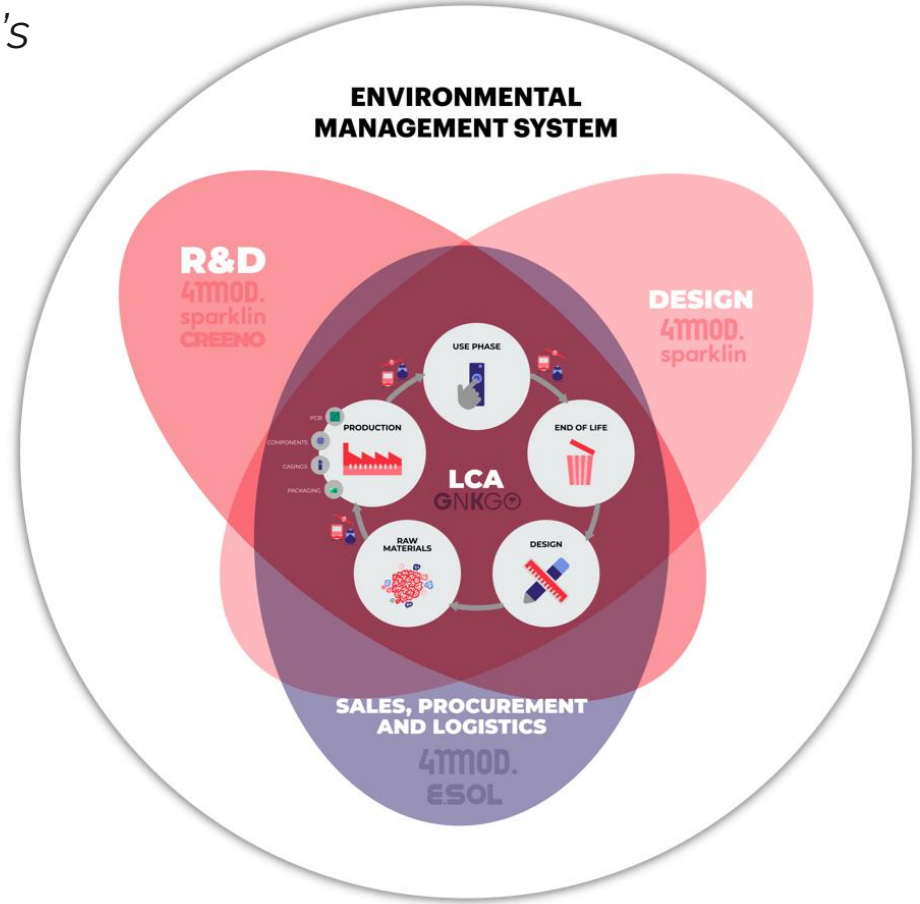
SimaPro

ISO

14040/44

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

GNKGO's



Certified under ISO 14001

International Organization for Standardization
ISO
14001

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

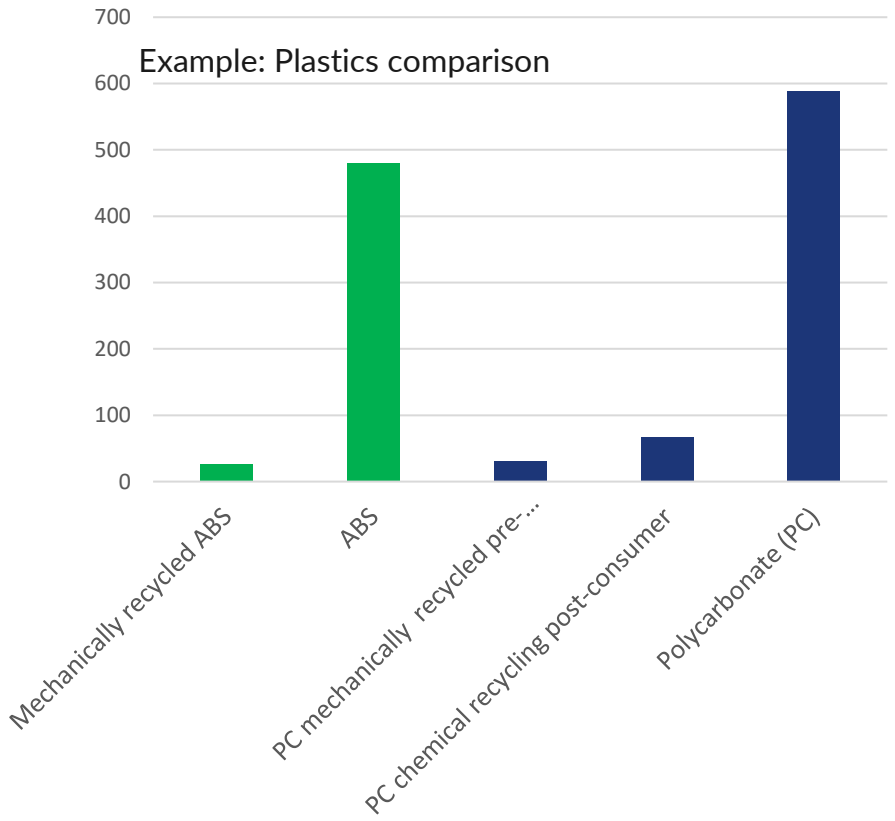
LCA in design

For RCUs an LCA is completed for every remote control we offer, based on a ISO14040/44 certified LCA.

LCAs for IOT products are produced as requested by the customer or sales team. A dynamic LCA is made from scratch when the complete BOM is received.

At the request of a client or on our recommendations, several scenarios can be explored. For example, what is the environmental impact of:

- A "Classic" ABS vs bio-based plastic?
- From a manufacture in China, Tunisia or Europe?
- Delivery by truck, train or plane?
- Batteries, a solar panel or a power supply?
- The efficiency of the electronic chip on the impact of the product use phase



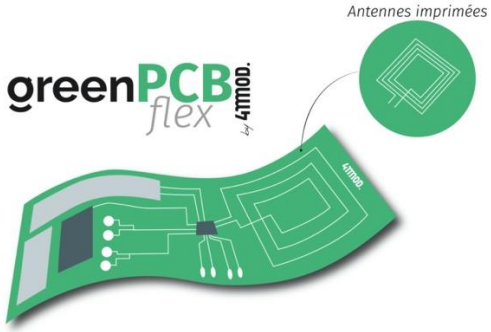
3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

LCA in R&D

The results of from our products are used to prioritize research and development projects The LCA process directs research and development by:

- Identifying which areas of a product are most damaging to the environment and therefore should be prioritised for R&D.
- Assessing and screening new developments.
- Provides justification and quantification of improvements.

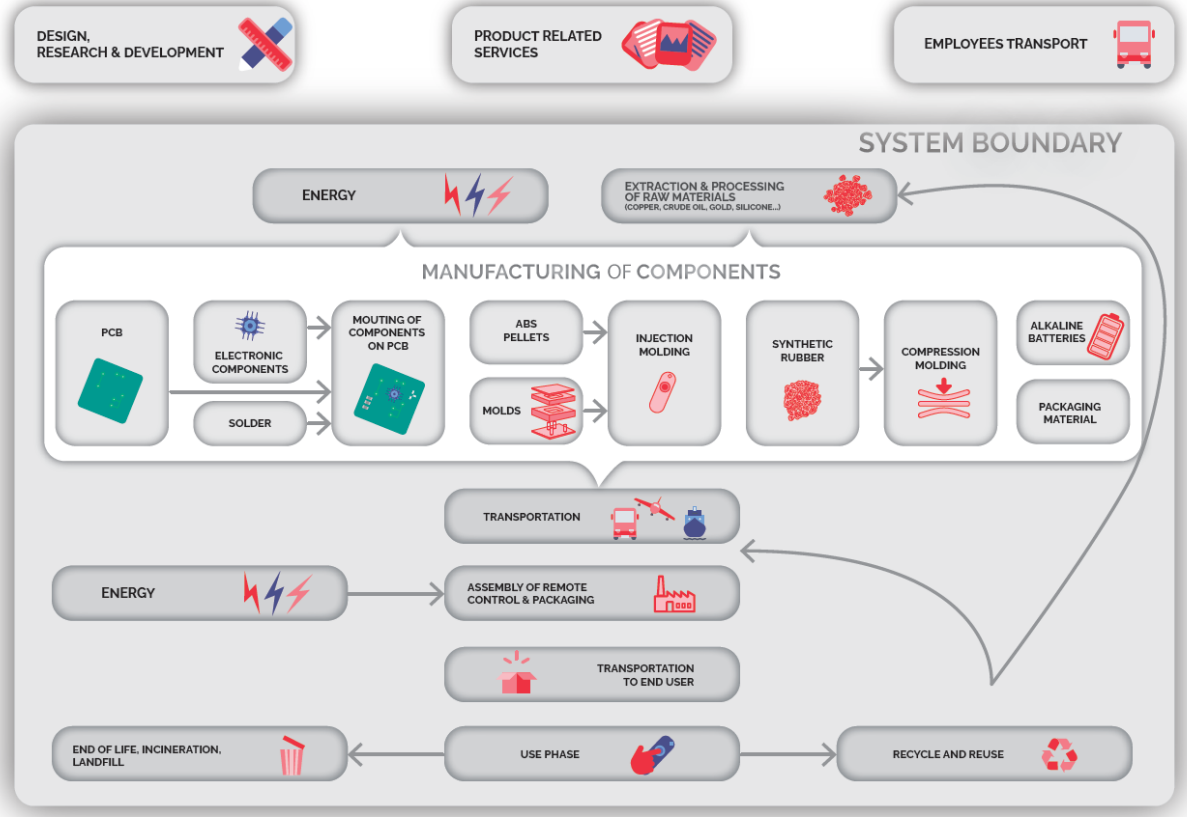
We are currently taking part in 2 EU and 1 ADAME funded research projects totalling over 1.2 million Euros of funding. Developing flexiblee low impact PCB and integrating Biobased Photovoltaic cells into Electronic devises replacing the need for batteries.



ENLIGHTENED

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

System boundary: Cradle to Grave: Remote control

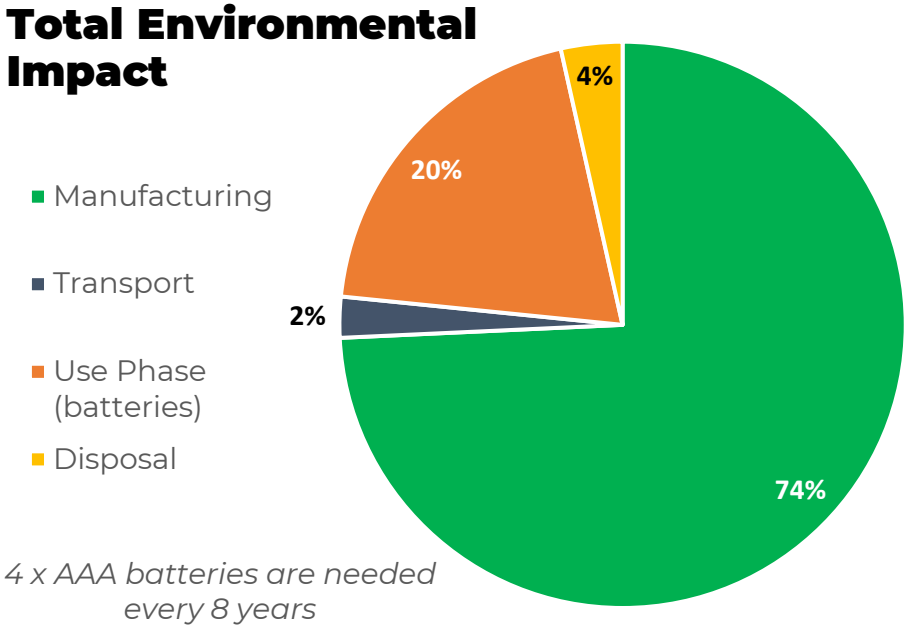


The Function unit for this study is the use of 1 Remote control used for 8 years.

250 key presses lasting 500 ms each , 120 seconds of voice, 8 hours connected to the STB a day

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

Total Environmental Impact: Remote control

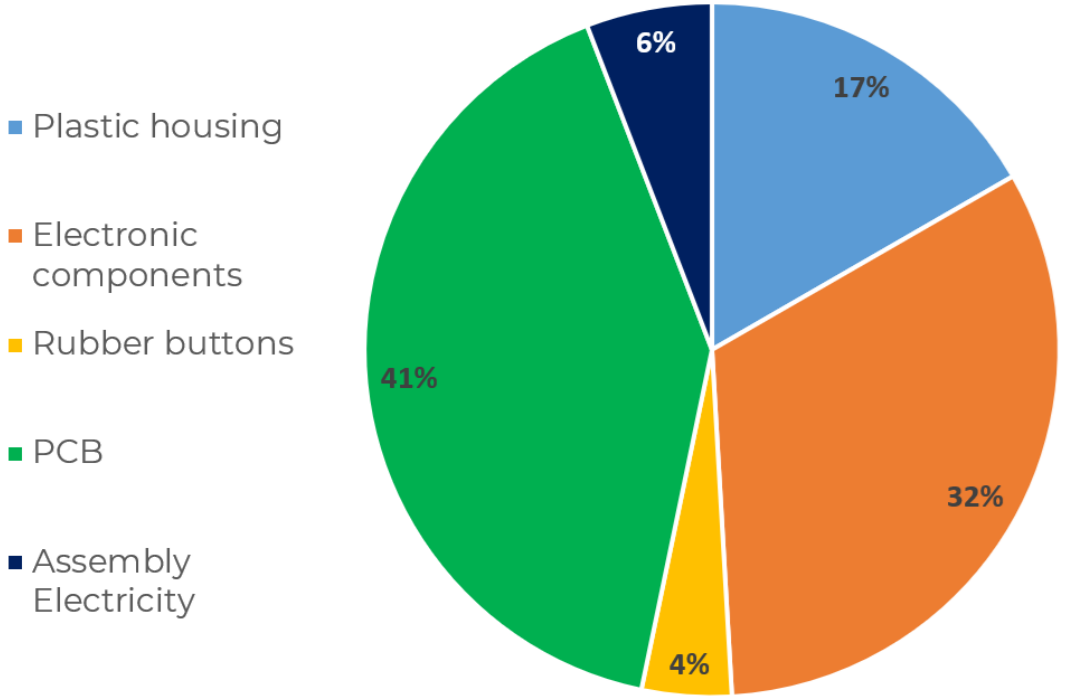


4 x AAA batteries are needed every 8 years

The majority (74 %) of the environmental impact is from the manufacturing phase. For the weighted impact categories, the impact category Climate Change (37 %, 1.5 kg of CO_2) contributes the largest proportion to the weighted score.

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

Total Manufacturing Impact: RCU

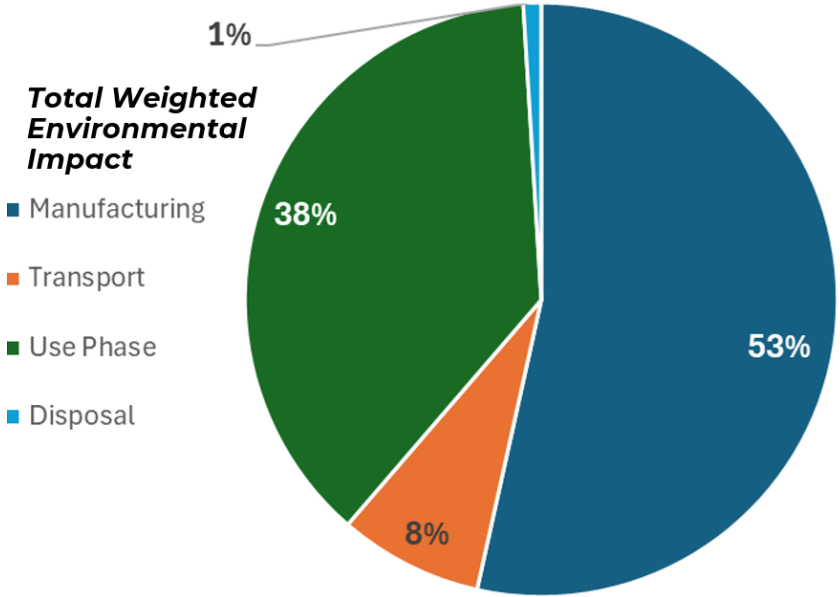


The weighted results indicate that the **PCB is responsible for 41 % of the impact** from the manufacturing phase **and the electronic components, 32 %.** The weighted impact categories with the most significant contribution to the single score are Climate Change (35 %) and Acidification (18 %).

3- 4MOD'S ENVIRONMENTAL MANAGEMENT SYSTEM

Total Environmental Impact: CO2 Sensor

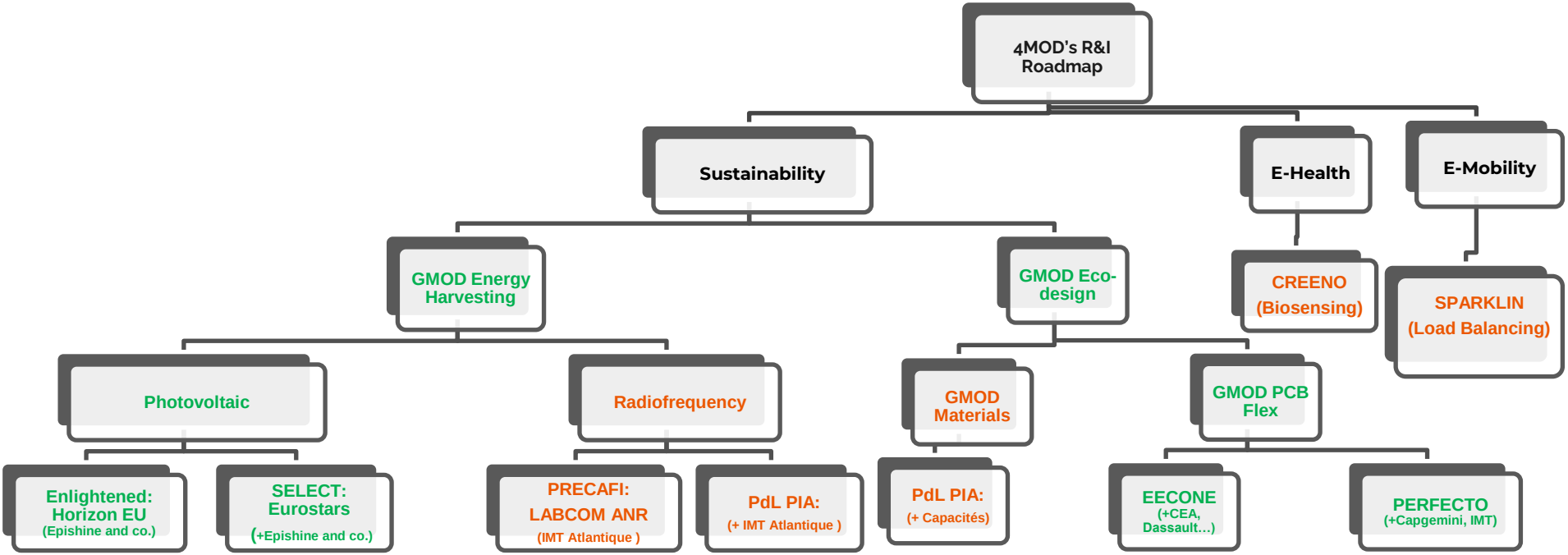
The weighted impact indicates that the major environmental impact is from the manufacturing phase (53 %) and Use Phase (38 %). The total Climate change impact of the Wave Enhance is 5.24 kg CO2 eq. with the Manufacturing contributing 2.86 kg CO2 eq.



4- 4MOD'S RESEARCH PROJECTS

Research & Innovation Roadmap

Based on the EMS feedback, our Research and Innovation roadmap is mainly focused **on sustainability** with several **ongoing (in Green) and potential (in Orange)** projects, with 2 aside projects on E-health and E-mobility.



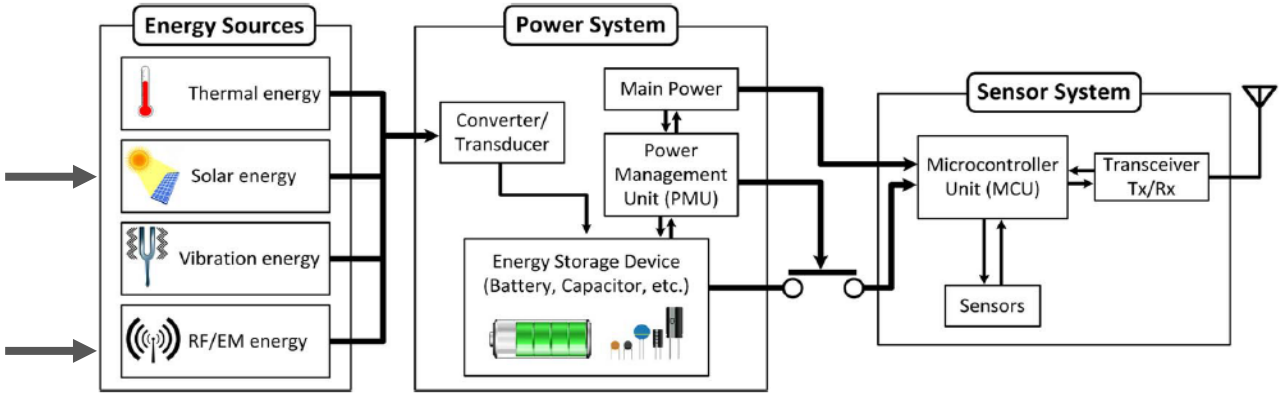
4- 4MOD'S RESEARCH PROJECTS

GMOD EH principle

4MOD chose to focus our work on two ambient energy sources:

1. Solar / Photovoltaic energy (PVEH): given its high-power density.

2. Radiofrequency wave energy (RFEH): given its omnipresence and simplicity of implementation.



4- 4MOD'S RESEARCH PROJECTS

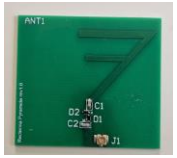
GMOD EH achievements

EH-PV: First RCU prototypes developed in collaboration with EPISHINE (Sweden)

Battery for Life remote

Battery-less remote

EH-RF: First Rectenna demos developed in collaboration with IMT Atlantique



Ambient RF Power source: 2G/3G/4G Orange Station @IMT Atlantique

RÉPUBLIQUE FRANÇAISE

inpi

BREVET D'INVENTION

Code de la propriété intellectuelle - Livre VI

REQUETE EN DELIVRANCE

Numéro d'enregistrement : FR2312023
Lieu de dépôt : 92 INPI - Dépôt électronique
Date de la demande : 06/11/2023
Référence client : 4MO B002 FR1
Type de brevet : Brevet français

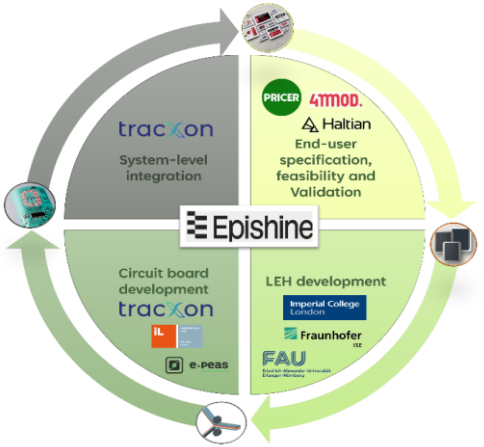
Patent filed in France and Europe

4- 4MOD'S RESEARCH PROJECTS

GMOD EH new projects

HORIZON EUROPE program: Enlightened

(D**E**monstratio**N** of integrated roll-to-roll assembly of **LIGHT EN**ergy harvester and flexible hybrid **E**lectronics to produce IoT **D**evices)



Euro-stars program: SELECT

(**S**ustainable **Elect**ronics for Energy Harvesting Applications)

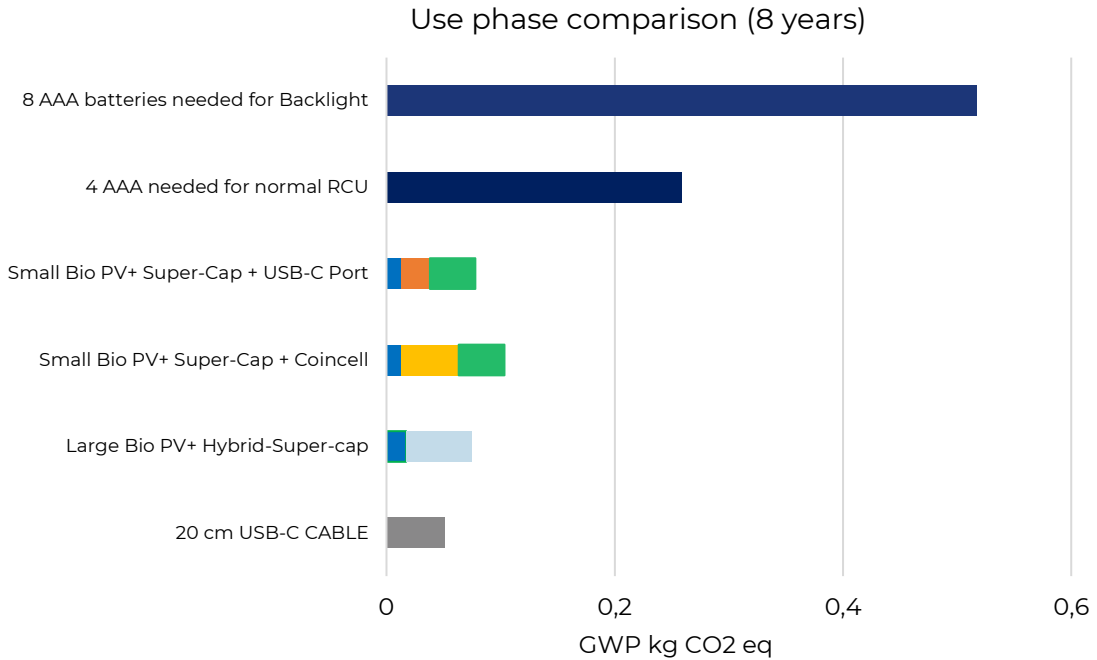
French ANR LABCOM program: PRECAFI

(**P**lateforme de **R**écupération d'**E**nergie pour **C**apteurs **A**utonomes à **F**aible **I**mpact Environnemental)

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

4- 4MOD'S RESEARCH PROJECTS

GMOD EH Environmental impact for a Remote-control use phase

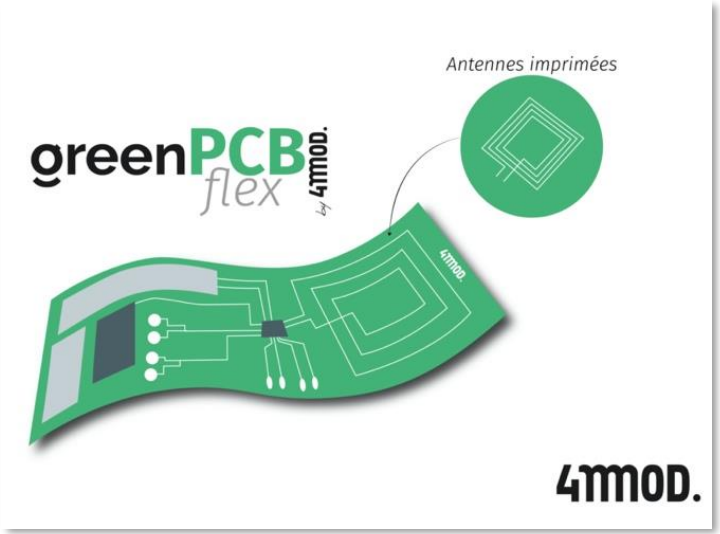


REF	Components	Kg of CO2
	14 cm2 Biobased PV	0.017
	10 cm2 Biobased PV	0.013
	Hybrid supercap	0.057
	Super capacitor	0.04
	USB-C Port	0.025
	USB-C cable	0.05
	4 AAA battery	0.26
	CR2032 coincell battery	0.05

4- 4MOD'S RESEARCH PROJECTS

PERFECTO

4MOD's GREEN PCB FLEX *funded by ADEME (The French Agency for Ecological Transition) – End early 2025*



LCA Evaluation & Critical review

Capgemini engineering

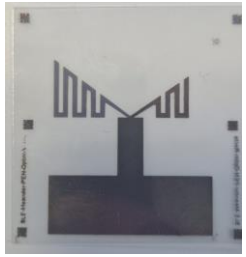
1 LCA of an RCU externally certified to the **ISO 14040/44 standard**

Conferences > 2024 18th European Conference...

A Compact Flexible BLE Antenna for a Remote-Control Application

Publisher: IEEE | Cite This | PDF

Ihsan El Masri ; Jean-Philippe Coupez All Authors



Eco-designed electronic boards and based on **low environmental impact substrates**

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

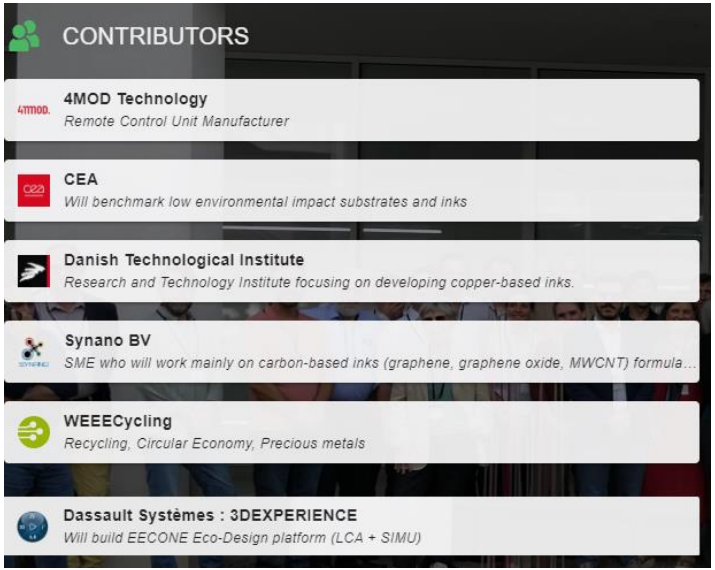
4- 4MOD'S RESEARCH PROJECTS

EECONE

EECONE (European ECOsystem for greeN Electronics)

Focus topic on Eco designed smart electronic systems supporting the Green Deal objectives

"**6R concept**" (Reduce, Reliability, Repair, Reuse, Refurbish, Recycle).



4- 4MOD'S RESEARCH PROJECTS

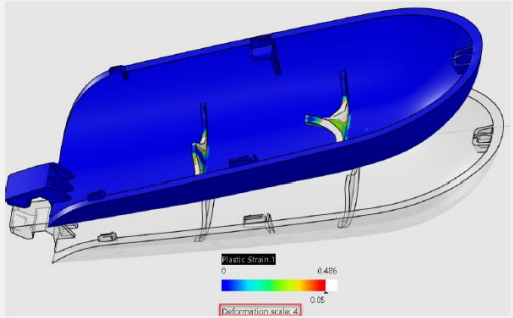
EECONE

EECONE (European ECOsystem for greeN Electronics)

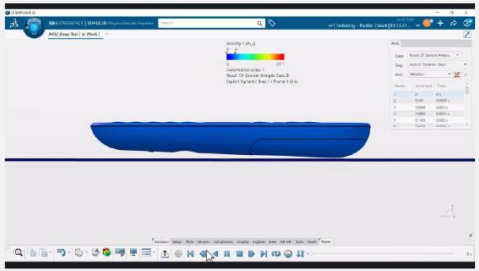
Focus topic on Eco designed smart electronic systems supporting the Green Deal objectives

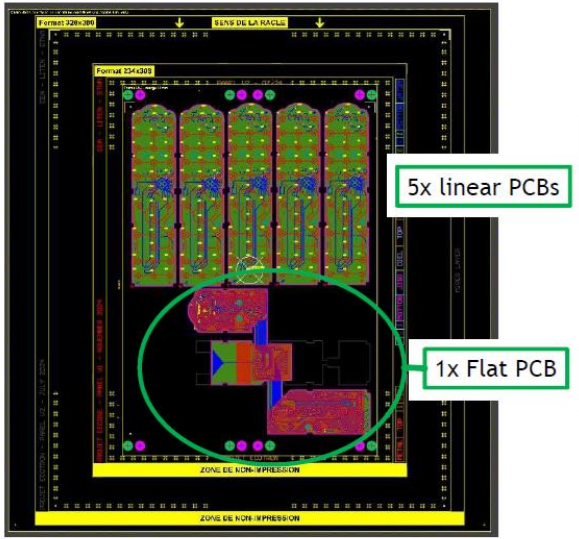
Several simulations SW are being used through the 3DS platform

Plastic Strain above 5 % is more represented !!



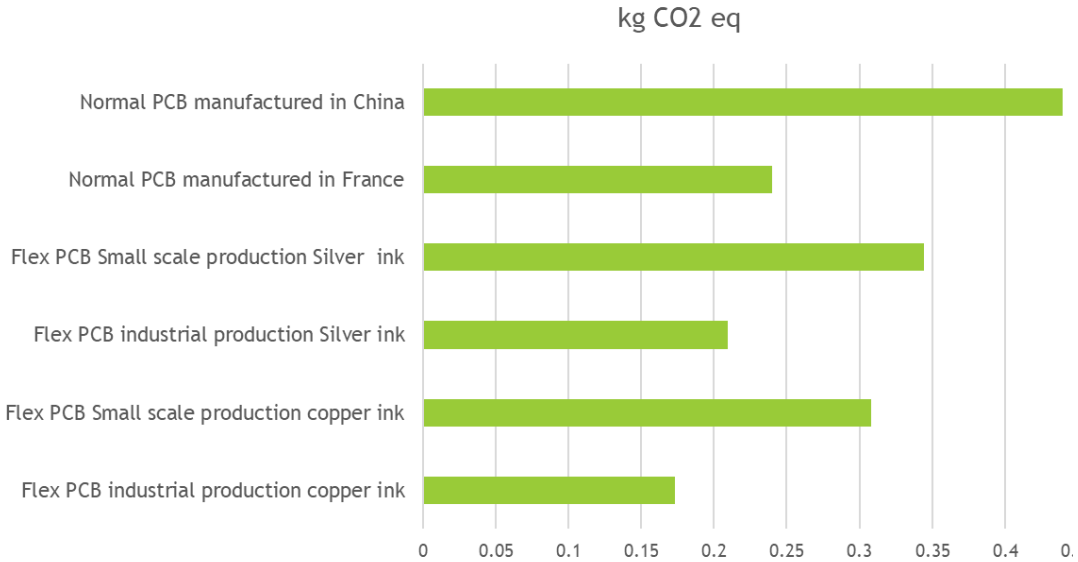
Impact animation (Velocity)





4- 4MOD'S RESEARCH PROJECTS

EECONE: Flex PCB Environmental impact Inks and scale of production comparison



EECONE

Compared to a normal PCB manufactured in China, Flex PCB produced at a small-scale with copper ink reduces CO2 emissions by 30 %, while being produced at an industrial furthers the reduction to 61 % . While flex PCB produced at a small-scale with Silver ink reduces emissions by 22 % or 52% at scale.

The Environmental Impact for Flex PCB is primarily driven by the Electricity need for the manufacturing. For the industrialised version, the Screen-printing process is responsible for 55% of energy demand and the Laser ablation 40 %.

Comparing Normal PCB manufactured in France to the best Flex result indicates a 28 % reduction in Carbon footprint.

4- 4MOD'S RESEARCH PROJECTS

GMOD Materials

Potential collaboration

1. *Study and analysis of alternative materials of Plastic and Rubber.*
2. *Eco-design / Recycling / Refurbishment.*

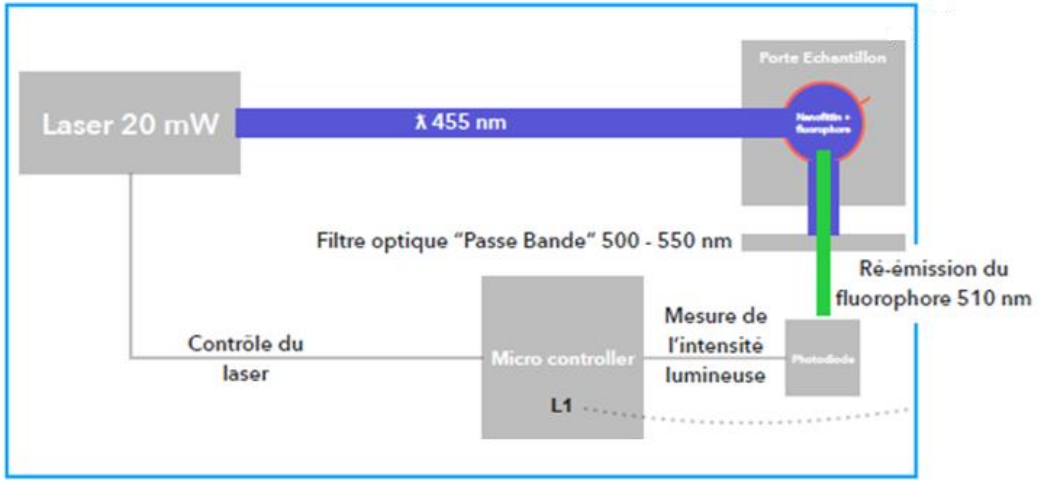
	Solution 1 ABS recyclé		Solution 2 Alternatives ABS	
	Matière	Process	Matière	Process
ABS coque	Grades disponibles sur le marché	ISO process	Benchmark bio polymères ou bio composites	ISO process mais modification probable du moule (maîtrise du retrait)

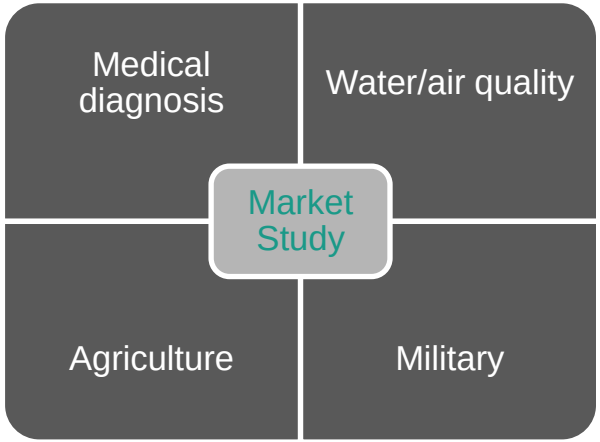
	Solution 1 Caoutchouc « vert »		Solution 2 Elastomères thermoplastiques	
	Matière	Process	Matière	Process
Caoutchouc Boutons	Peu d'alternative	ISO process	Benchmark bio polymères	Passage moulage compression à injection

4- 4MOD'S RESEARCH PROJECTS

CREENO

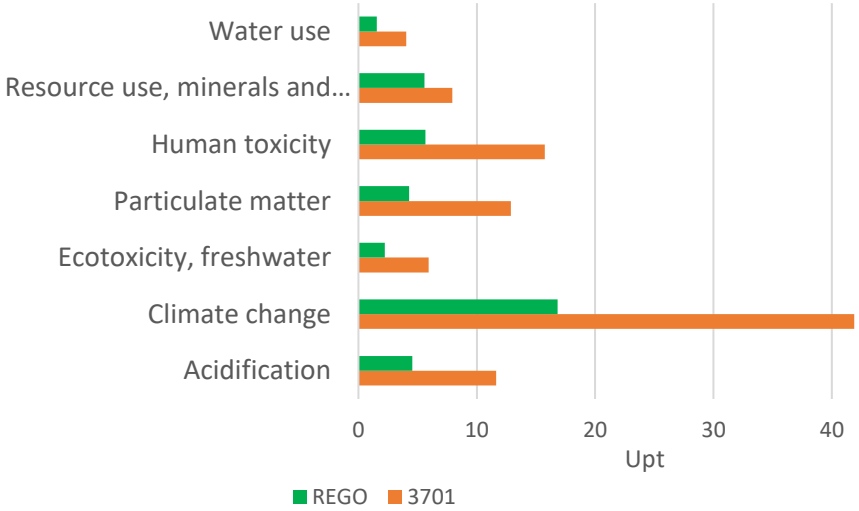
Real-time Alert Platform for Infectious Disease (RAPID) aims at a secure digital platform of connected in vitro testing devices allowing the detection and instant information of the presence of pathogens in humans and more particularly SARS-COV2.





5- CONCLUSION

Bring it all together: LCA Results for Rego vs 3701



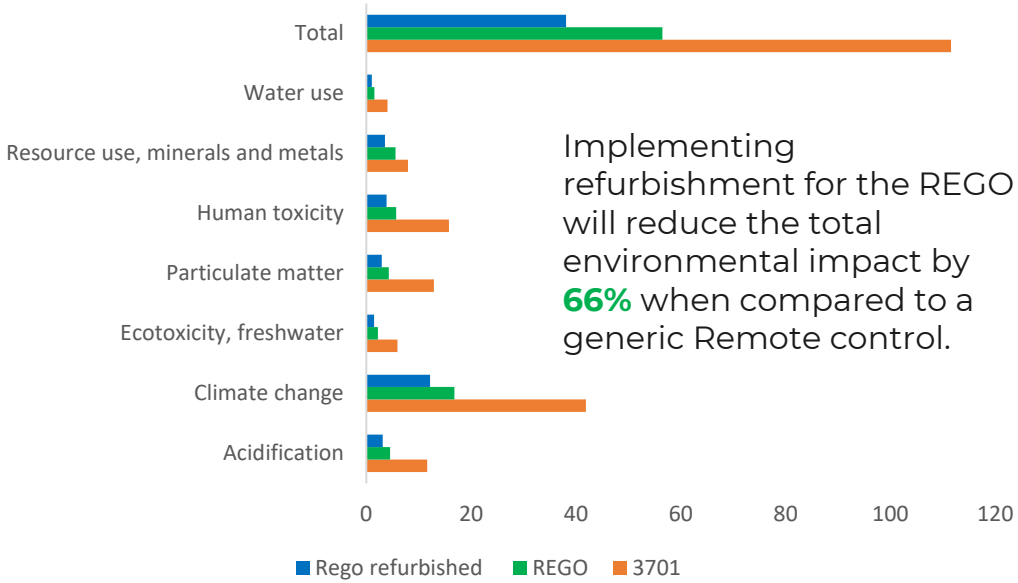
A Biobased Solar panel on the top of the remote control removes the need for batteries, Housing is made from 70% mechanically recycled plastic, and Flexible printed PCB replaces 80 % of the traditional PCB.

Implementing changes suggested has the potential reduce the total environmental impact by **50%.**

In terms of CO2 we reduce from 1.5 kg to 0.6 Kg (60% reduction)of CO2 Eq per RCU. Given 4MOD Manufactures around 5 million RCU a year a potential reduction 4,500 tonnes of CO2 could be achieved.

5- CONCLUSION

Results for refurbishment



Implementing refurbishment for the REGO will reduce the total environmental impact by **66%** when compared to a generic Remote control.

"One clip" concept

The disassembly and reuse scenario assumes the following:

- 25% of remotes are disposed of without reuse or disassembly.
- 75% are disassembled and refurbished 4MOD's factory in Tunisa where 80% of the PCB and 20% of the plastic is reused

5- CONCLUSION

EMS Outcomes

Commercial benefits / ROI

1. 11 LCAs created for our Remote-control unit (RCU) business, we now have a LCA for each RCU in our line-up.
2. 6 additional Benchmark RCU LCAs generated for our customers.
3. 1 LCA of an RCU externally certified to the 14040/44.
4. 7 LCAs created for our IOT business 2 of certified to the 14040/44 standard.
5. Generation of additional revenue through the sale of LCA services and green marketplaces.
6. ECOVADIS Silver rating achieved.
7. Short listed for the Environmental and Sustainability award at IBC 2023.

5- CONCLUSION

Research Outcomes

Commercial benefits / ROI

1. **EH RF Patent filed -> Study of a Patent Portfolio undergoing.**
2. **Circular economy branding (LCA).**
3. **Visibility** to French & European SMEs / Large groups / Academic & research entities.
4. Installation in France of a **production unit** for the Green PCB FLEX solution by **2025/2026.**
5. 1.2 million euros of funding received for the 4MODs green research projects.
6. **10% additional annual growth** in turnover due to the attractiveness of the low environmental impact solution, in addition to the structural growth of the activity

6- CONCLUSION

Further Steps

Techno

1. **Hybrid Energy harvesting** (photovoltaic + radiofrequency).
2. Bio-based substrates and low impact cards.
3. **Ultra Green remote** (combination of every element contributing to low footprint).
4. Autonomous connected objects / RCUs.

Further steps

Funding

5. GMOD: New/Additional Funding programs to come for MAT & EH.
6. SPARKLIN: R&D Funding plan to be set up over H1 ’25.
7. CREENO: Business development actions to be triggered over Q2 ’25.

Merci !

For further information, don't hesitate to get back to us :

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