GRAPHERGIA

SUSTAINABILITY ASSESSMENT AND ECO-DESIGN FOR GRAPHENE-BASED PRODUCTS

GRAPHERGIA Hub Webinar | March 28th, 2025

Online (12:00 CET)

GRAPHENE FLAGSHIP

Funded by the European Union

GRAPHERGIA is supported by the European Union, under Horizon Europe Programme (Grant Agreement n.101120832).

FRAMEWORK OF THIS WEBINAR

1. What GRAPHERGIA is about?
2. Proposed by the GRAPHERGIA Hub
3. Today's agenda
4. Part 1 - The eco-design principles applied in graphene-enabled innovations
5. Part 2 - Sustainability assessment methodologies for products eco-design
6. Part 3 - Collection of participants insights with Social Life Cycle Assessment online survey

WHAT'S GRAPHERGIA ABOUT?

INNOVATIVE PILOT LINES FOR SUSTAINABLE GRAPHENE-BASED ENERGY HARVESTING AND STORAGE DEVICES

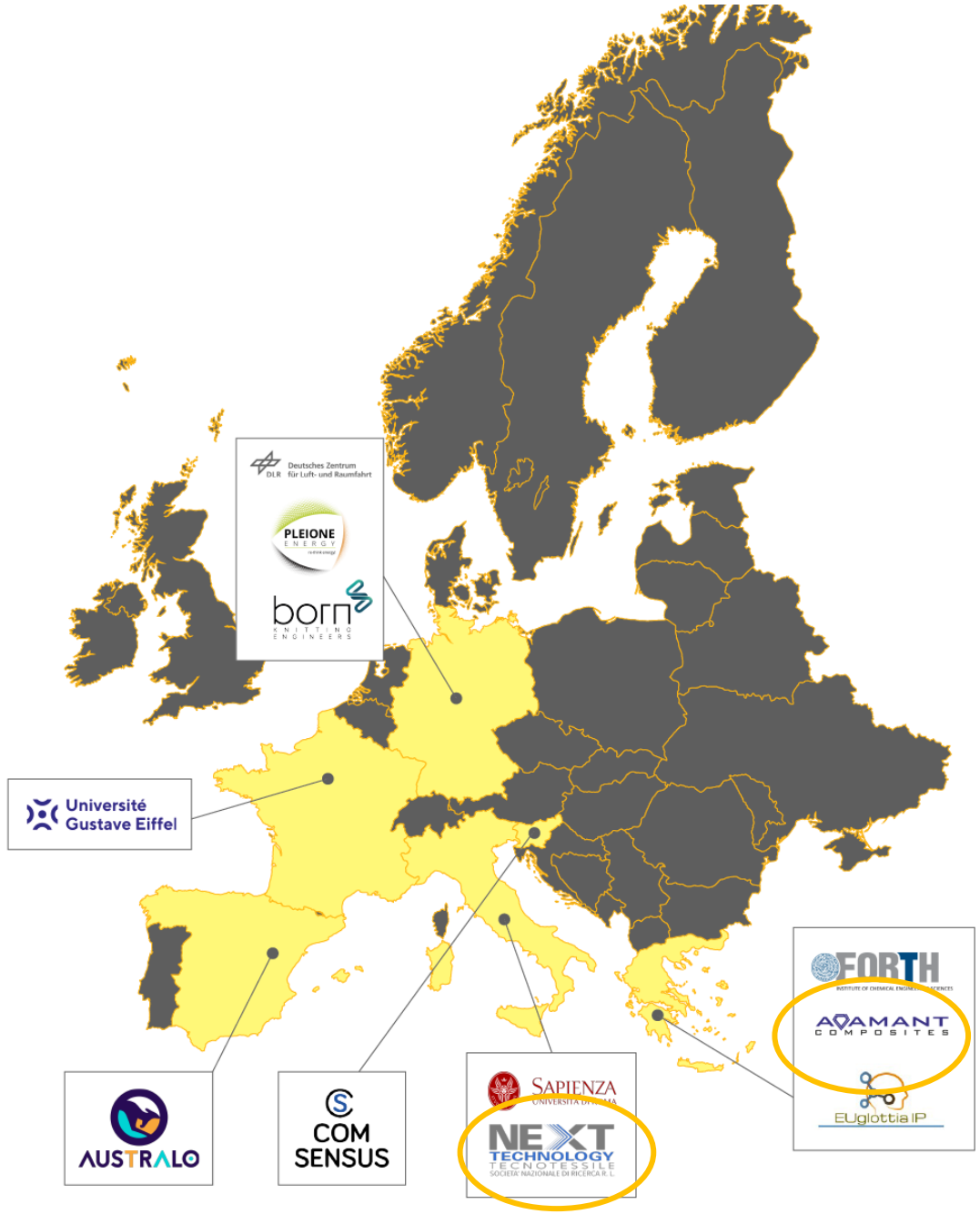
PROJECT DURATION: 3.5 years Oct. 2023 – March 2027

PARTNERS: 11 from 6 countries

TOTAL BUDGET: 4,5M€

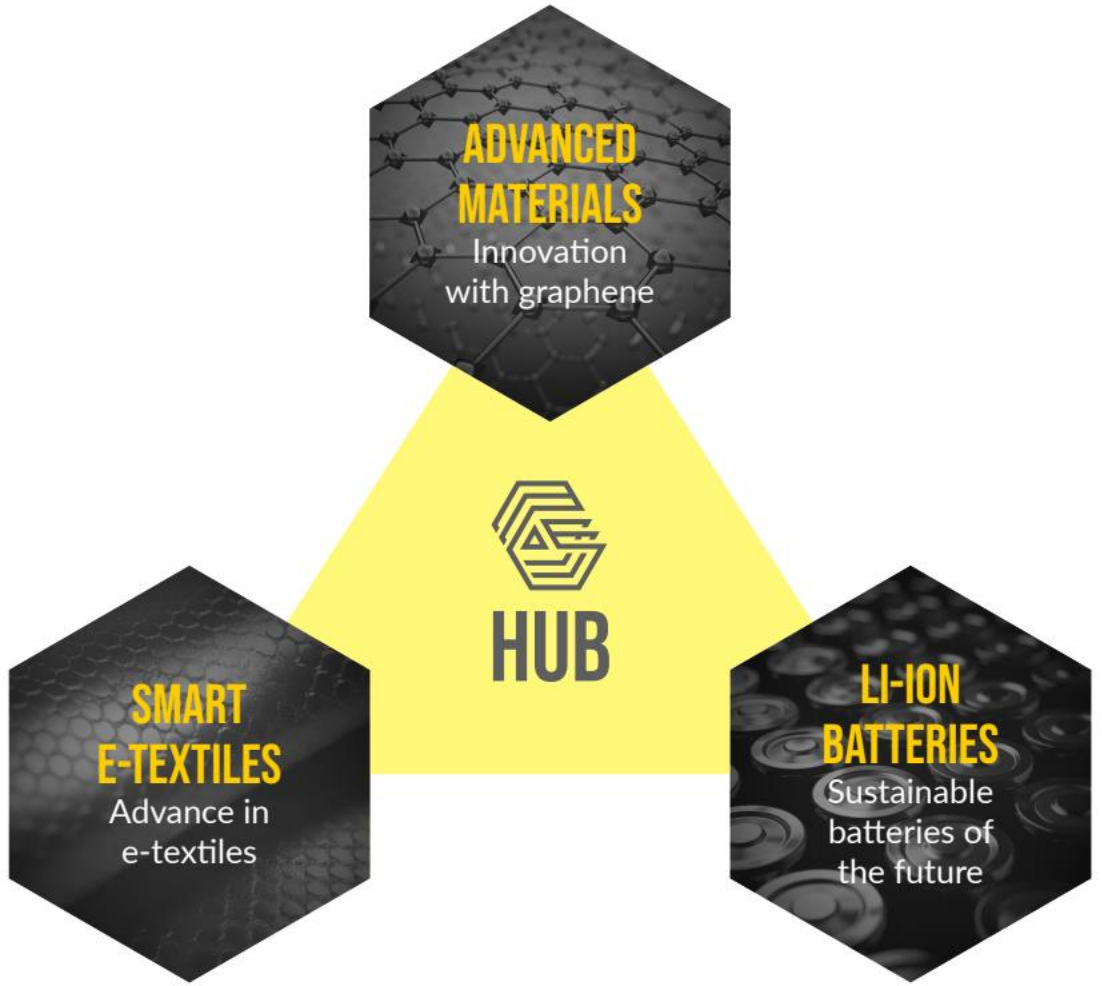
Funded by the European Union

We develop and integrate graphene-based materials into energy devices for scalable, eco-friendly production of e-textiles and next-gen Li-ion battery electrodes.



GRAPHEGIA HUB

- Platform for collaboration and exchange of knowledge.
- Dedicated to stakeholders working with GRAPHERGIA's innovation related domains of future energy solutions.
- Opportunities for joint workshops, webinars, and publications.
- **If you are interested in setting up a joint activity**, contact us at contact@graphergia.eu



TODAY'S AGENDA

- The session is recorded.
- Q&A on the chat and at the end of the session.

- **Matteo Maccanti –** Next Technology Tecnotessile

- **Despoina Batsouli –** Adamant Composites Ltd.

Timing	Topic	Speaker
12:00 – 12:05	Welcome by GRAPHERGIA's Moderator	Mona Marill, AUSTRALO Markeing Lab
12:05 - 12:20	**The eco-design principles applied in graphene-enabled innovations**	Matteo Maccanti, Next Technology Tecnotessile Despoina Batsouli, ADAMANT COMPOSITES Ltd.
12:20 - 12:40	**Sustainability assessment methodologies for products eco-design**	Matteo Maccanti, Next Technology Tecnotessile
12:40-13:00	**Collection of participants insights with Social Life Cycle Assessment online survey**	Matteo Maccanti, Next Technology Tecnotessile

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#2 - SCIENTIFIC SESSION:

The eco-design principles applied in graphene-enabled innovations

Part 1

Matteo Maccanti & Despoina Batsouli

NEXT TECHNOLOGY TECNOTESSILE SOCIETA' NAZIONALE DI RICERCA R. L.

ADAMANT COMPOSITES

- **Next Technology Tecnotessile** Società Nazionale di Ricerca r.l. is an Italian research center established in **1972 in Prato** (Tuscany);
- Stakeholders: 40% Ministry of University and Research (MUR), 60% textile and machinery-textile industries;
- 28 employees;

Consultancy services on textile technologies from raw materials to final products.

Modification of materials, surface functionalization, development of novel chemical processes.

Composites (packaging, automotive, furniture and building sectors).

R&D on process automation and control systems.

Circular economy and sustainable textile practices.

R&D on treatment and reuse of industrial wastewaters.

Design of mechanical devices and machinery development.

Environmental monitoring of textile value chain by Life Cycle Thinking methodologies (LCA, LCC, S-LCA, etc.)

ADAMANT COMPOSITES

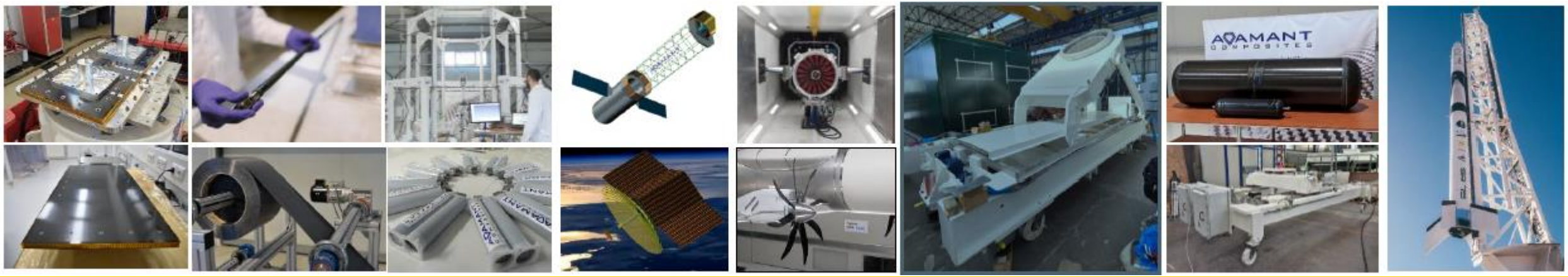
ADAMANT is a developer of bespoke complex structures, equipment and materials for the European Aerospace, Defense and Energy markets, headquartered in Greece.

Research

- Composites research
- Nano-enabling technologies
- Advanced Concepts
- Qualification Programs
- Technology piloting
- Prototyping
- IPR creation

Products

- Satellite & Launcher structures
- Deployables & Complex Shapes
- Panels and Solar Arrays
- CFRP Tanks
- CFRP Struts
- MGSE
- Engineering & Design Services
- Engineering Support



ECODESIGN: WHY IT IS SO IMPORTANT?

Ecodesign is defined as “a systematic approach, which considers environmental aspects in design and development with the aim to reduce adverse environmental impacts throughout the life cycle of a product ” (ISO, 14006: 2020).

- As product design can dictates **up to 80% of its life-cycle environmental impact**;
- Globally, **half of all greenhouse gas emissions** and **90% of biodiversity loss** are caused by extracting and processing primary raw materials;
- **Only 11.5% of the materials consumed in the EU came from recycling**, meaning the majority of materials were derived from extraction and harvesting;
- The cumulative effect of current EU rules on eco-design and energy labelling means a **10% lower annual energy consumption** by the products in scope, comparable to the energy consumption of Poland;
- In 2021 alone, existing eco-design requirements for energy-related products saved consumers EUR 120 billion, even if counting in the acquisition costs.

ECODESIGN: A TOOL FOR THE EU 2050

In April 2024 European Parliament approved the deal reached with the Council on a new ecodesign regulation that will significantly broaden the scope of products it applies to.

COM(2022) 140 final

The proposed Ecodesign for Sustainable Products Regulation – ESPR (Regulation 2024/1781) is the cornerstone of the Commission's approach to more environmentally sustainable and circular products.

The ecodesign requirements cover:

- Product **durability**, **reliability**, **reusability**, **upgradability**, **reparability**, ease of maintenance and refurbishment;
- Restrictions on the **presence of substances** that inhibit the circularity of products and materials;
- **Energy use** or energy **efficiency** of products;
- **Resource use** or resource efficiency of products;
- **Recycled content** in products (essential minimum values will be defined);
- Ease of **disassembly**, **remanufacturing** and **recycling** of products and materials;
- Life-cycle **environmental impact** of products, including their carbon and environmental footprints;
- Preventing and reducing **waste**, including **packaging** waste.

FEATURES OF ECODESIGN

The eco-design approach has an impact on many product characteristics, which include:

- Fewer materials
- Easy to recycle
- Use of bio-materials
- Long-lasting
- Multipurpose, reusable and recyclable
- Lowering emissions
- Innovative
- Green message

Sustainable design spreads the idea of sustainability with messages intrinsic to the product itself

CHARACTERISTICS AND EXAMPLES OF ECODESIGN

ADAMANT COMPOSITES

Ecodesign is a practice that seeks to **reduce the environmental** impact of products throughout their life cycle, from their design to their removal. In today's society, more and more people are adopting this practice in their daily lives and in industry. Below are some characteristics and examples of ecodesign:

1. Design for disassembly and recyclability

An example is the cellphone Fairphone, whose parts can be interchanged and replaced to extend its service life.

2. Reduced use of materials

CHARACTERISTICS AND EXAMPLES OF ECODESIGN

3. Use of sustainable materials

An example is the clothes brand Patagonia, which uses sustainable materials in its products and encourages repair and recycling.

4. Energy consumption reduction

An example is the electric car Tesla, which uses high-efficiency batteries and technology to reduce energy consumption.

CHARACTERISTICS AND EXAMPLES OF ECODESIGN

5. Design for durability

An example is the luggage company Samsonite, which offers a lifetime guarantee in its products and uses resistant materials to prolong their useful life.

6. Design for reuse

Ecodesign is a practice that aims to **reduce the environmental impact of products** and encourage sustainability.

The ecodesign within the GRAPHERGIA project

Eco-design analysis and optimization of the critical parameters of the technology demonstrators

Leader: NTT

Democase #1. All-in-one self-charging textile capable of energy harvesting and storage

Leader: BORN

Democase #2. Self-powered structurally integrated sensor for aerospace structures

Leader: ADAMANT

Democase #3. Advanced graphene-based LIB module prototype for space applications

Leader: PLEIONE

THE ECODESIGN WITHIN THE GRAPHERGIA PROJECT

AVAMANT COMPOSITES

DEMO CASE #1

ALL-IN-ONE SELF-CHARGING TEXTILE CAPABLE OF ENERGY HARVESTING AND STORAGE

Single electrode TENGs on the surface of a T-shirt for energy harvesting/storage

DEMO CASE #2

SELF-POWERED STRUCTURALLY INTEGRATED SENSOR FOR AEROSPACE STRUCTURES

Miniaturized TENG-based self-powered wireless sensor in a scaled aerospace composite structure

DEMO CASE #3

ADVANCED GRAPHENE-BASED LIB MODULE PROTOTYPE FOR SPACE APPLICATIONS

Module prototype based on the optimal laser-scribed graphene-based electrodes and LIB cells

THE ECODESIGN WITHIN THE GRAPHERGIA PROJECT

Based on the Commission's definition of eco-design, in particular for the textile sector, the project partners will follow a strategy to address this fundamental aspect in product design.

1. Analyze all components of a product/material, aimed at assessing the recyclability/reusability of the components comparing the product;
2. Identify the chemical composition of the non-replaceable key components and verify if they are recyclable or reusable;
3. Analyze secondary components (if key components are recyclable) and understand if they can be replaced to be made of the same (or compatible) materials, as those of the key components;
4. Investigate how many secondary components can be made with recyclable materials, without compromising the product performance according to KPIs;
5. Assess the technologies available for the recycling or end-of-life treatment of the key components;
6. Based on previous steps, design the simplest possible disassembly process.

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#2 - SCIENTIFIC SESSION:

Sustainability assessment methodologies for products eco-design

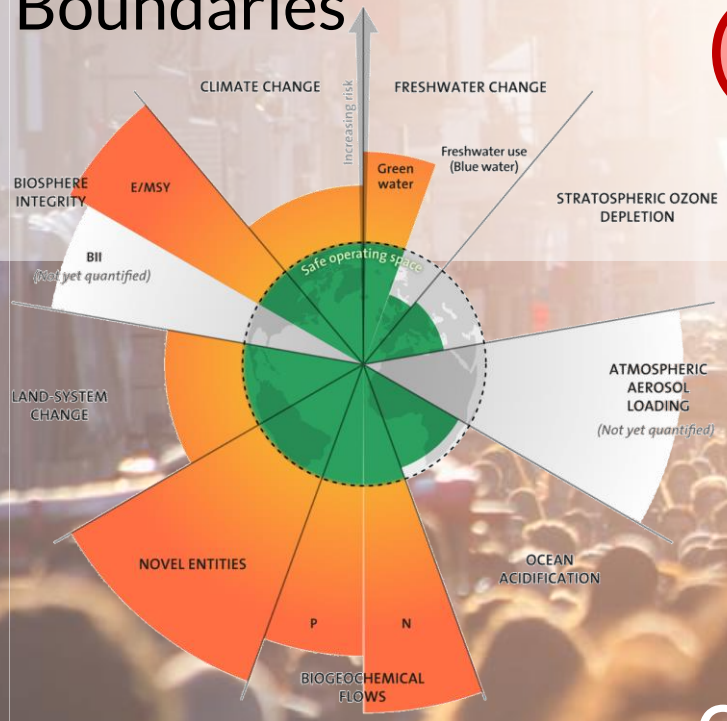
Part 2

Matteo Maccanti

NEXT TECHNOLOGY TECNOTESSILE
SOCIETA' NAZIONALE DI RICERCA R. L.

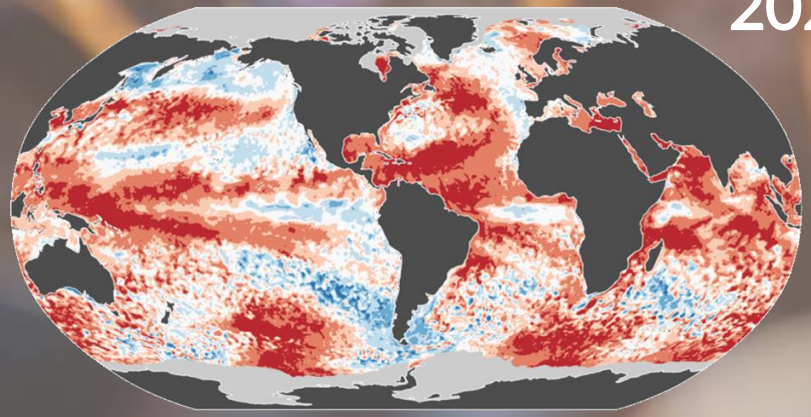
8 Billion

Planetary Boundaries



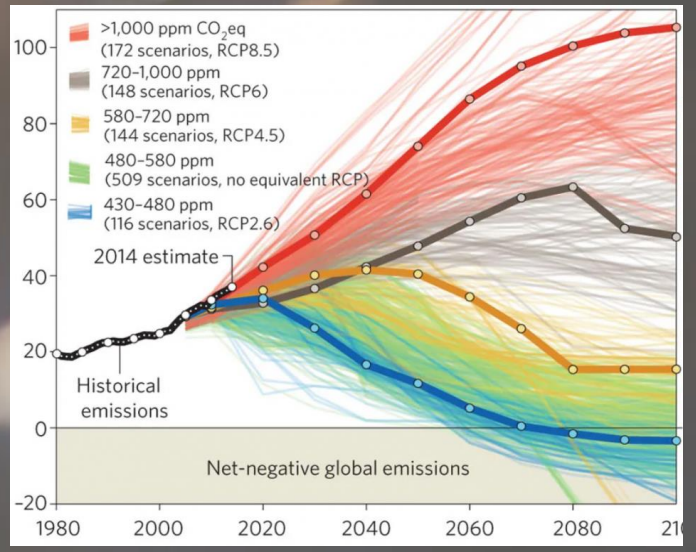
Warming Stripes

Ocean Temperature 2024



OverShootDay

Representative Concentration Pathways (RCP)



We cannot solve our problems with the same thinking we used when we created them.
Albert Einstein

SUSTAINABILITY: A BEACON FOR THE DESIGN OF OUR PRESENT

The epistemological basis, the “philosophy” on which the work is based, is **Sustainable Development.**

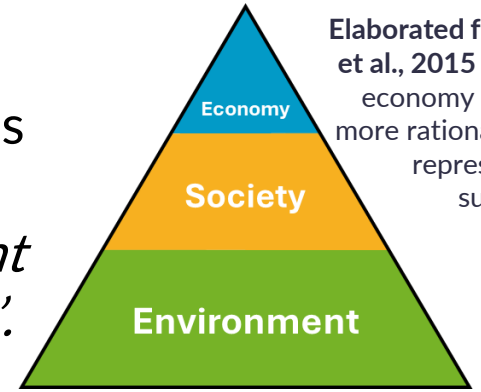
‘sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’.

Our Common Future, the ”**Brundtland Report**”, 1987

Hence the theoretical approach used, called **Life Cycle Thinking**, that emphasizes the assessment and minimization of environmental impacts at all stages of a product's life.

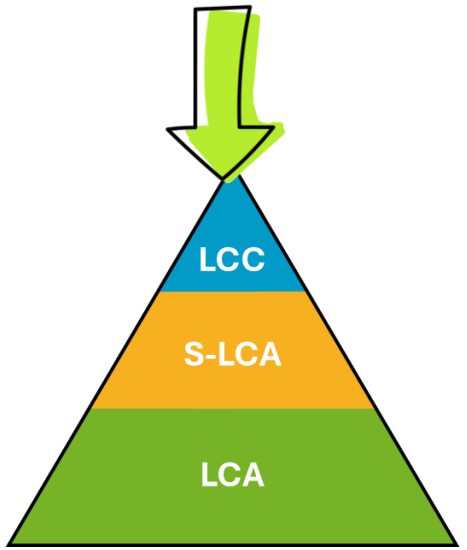
‘It is a way of thinking that considers the economic, environmental and social consequences of a product or process throughout its life cycle’.

UNEP Life Cycle Initiative



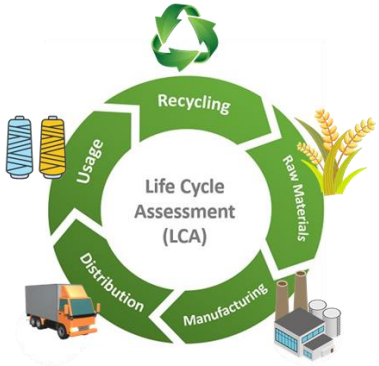
Elaborated from Pulselli et al., 2015 - The world economy in a cube: A more rational structural representation of sustainability.

The Pillars



The Methodologies

SUSTAINABILITY: THE METHODOLOGIES

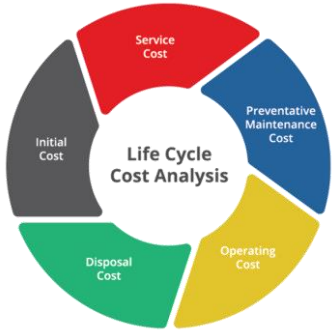


Life Cycle Assessment (LCA):

It is a **standardized methodology** (ISO 14040 and 14044) that evaluates the environmental impact of products or processes throughout their life cycle.
The study is based on a **comprehensive assessment** of the materials, energy consumption, and emissions to the environment (water, air, soil, waste) generated by the processes involved in the "life" of the product or service being assessed, from the extraction of the natural resources needed to produce it to the treatment of waste end-of-life.

Life Cycle Costing (LCC):

It takes into account the **life cycle costs of a product** incurred by the actors involved, including externalities. This analysis complements the LCA, considering the costs of product development, materials, energy, labour, waste management, emission control, transport, maintenance, etc.

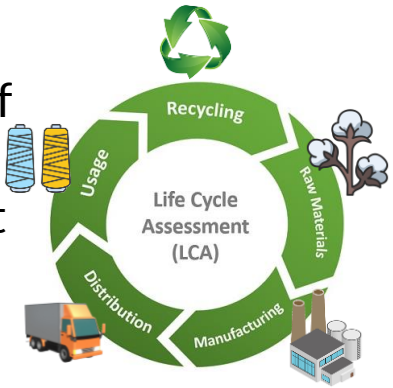


Social Life Cycle Assessment (S-LCA):

It is a **technique for assessing social impacts (and potential impacts)** by evaluating the social and socio-economic aspects of products and their positive and negative impacts throughout their entire life cycle, including raw material extraction and processing, production, use, reuse, maintenance, recycling and waste disposal.

LCA – A TOOL FOR THE STUDY OF PROCESSES

The life cycle approach, of which the LCA is the most representative, involves the evaluation of a production process, assessing all relevant energy and material inputs and outputs.
The assessment begins with the extraction of raw materials, taking into account their transport and use, the disposal of production waste, the sale of the product (the distribution), its use, its end of life, the management of the product as waste and the reintroduction of the waste into the production cycle as a second raw material.



Upstream

- Raw material extraction, production and finishing
- Production of semi-finished products (auxiliary materials, chemicals and packaging)
- Transport of raw and semi-finished materials

Core

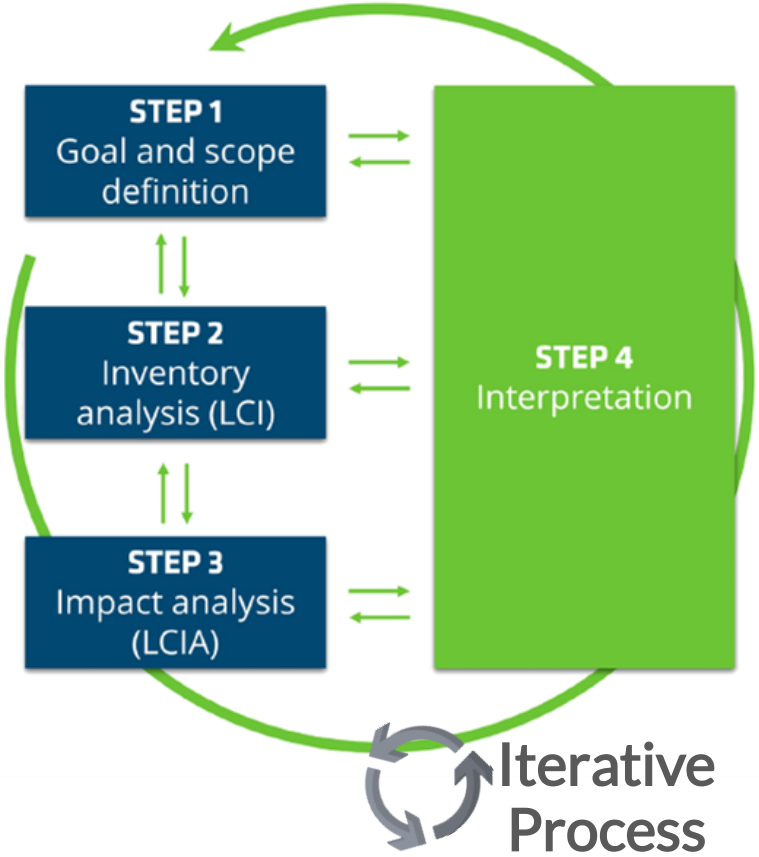
- Product processing and assembly
- Finished product storage and packaging
- Transport of components and product to the manufacturer
- Treatment of waste generated in the Core module

Downstream

- Distribution of the product to the customer
- Product use
- Disposal of product and packaging

LCA – A TOOL FOR THE STUDY OF PROCESSES

The LCA involves a well-defined and internationally standardised process



1. **Goal and Scope Definition** – This step defines the purpose, boundaries, and functional unit of the LCA. It determines what will be analyzed, the level of detail, and how the results will be used.
2. **Life Cycle Inventory (LCI)** – This phase involves data collection on all inputs (e.g., raw materials, energy) and outputs (e.g., emissions, waste) associated with each stage of the product's life cycle.
3. **Life Cycle Impact Assessment (LCIA)** – The collected data is translated into environmental impacts (e.g., global warming potential, water use). This step helps in understanding the significance of different emissions and resource consumption.
4. **Interpretation** – The results are analyzed to draw conclusions, identify improvement opportunities, and provide recommendations, ensuring consistency with the study's goals.

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#2 - SCIENTIFIC SESSION:

Collection of participants insights with Social Life Cycle Assessment online survey

Part 3

Matteo Maccanti

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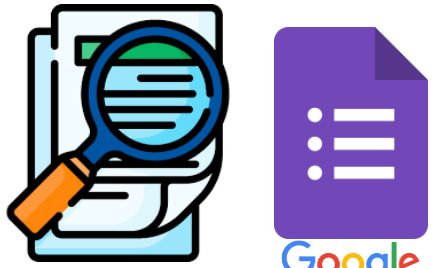
SOCIAL LCA: VOICE TO STAKEHOLDERS

Two complementary routes will be followed for the evaluation of the Social LCA of products:

On the one hand, a supply chain assessment of the production lines will be carried out, trying to study the products as far as possible using the system boundaries used for the LCA, **using the SHDB** database integrated in the SimaPro software.



On the other hand, an assessment of the social aspects will be carried out by **collecting information directly from stakeholders** involved in the sectors studied in the project.
This will be carried out through the administration of a dedicated questionnaire, which investigates social aspects of three stakeholder categories

THE SURVEY STRUCTURE

Social LCA (S-LCA) will be employed to address social and socio-economic benefits of GRAPHERGIA processes and products.

Companies:

The questionnaire counts with 4 main sections. The first one addresses general data about the product. The second one addresses the working conditions within the company. The third one refers to the relationship the company has towards the local community. The fourth section addresses the relationship the company has with suppliers and other main actors along the supply chain.

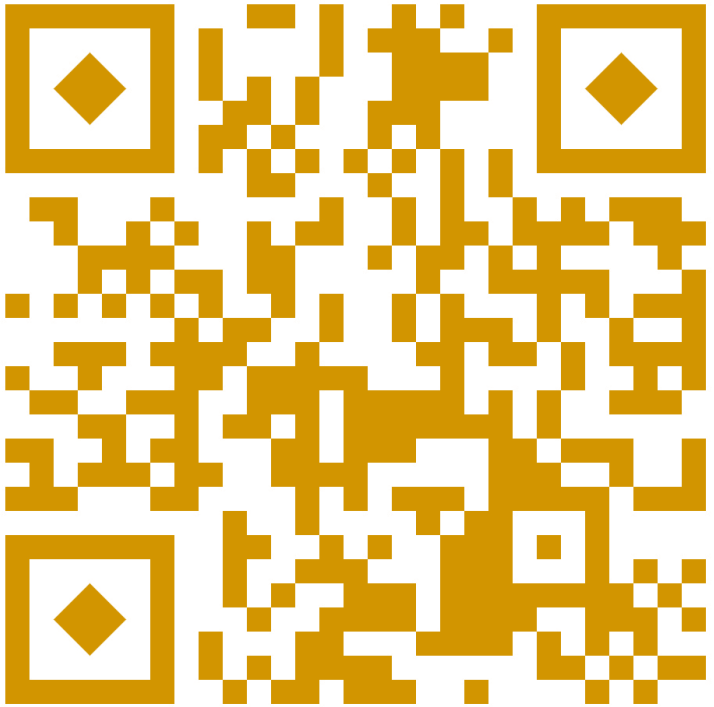
Workers:

The questionnaire comprises multiple inquiries that delve into social aspects such as wages, working conditions, health, and safety in the workplace, among others. The honest answers of the respondent are crucial for obtaining valuable and accurate insights.

University/Research institute:

The questionnaire comprises multiple inquiries that delve into social aspects related to applicability and Social Impact of project demonstrators, design, future challenges and research topics for products improvements.

SCAN ME



Thank you for taking part in our research on social sustainability. Your response will be part of the **GRAPHERGIA project.**

https://docs.google.com/forms/d/e/1FAIpQLSfbra6n-Fh_bNqfzNSxMP-e9n5myqHQRYj3Of5AU3YK48Oqmw/viewform?usp=sf_link

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THANK YOU!

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