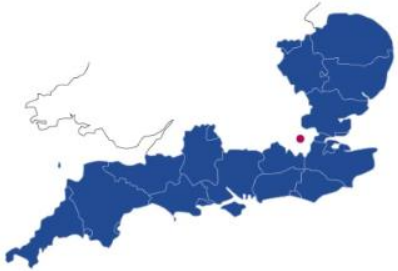

Interreg France (Channel Manche) England

EUROPEAN UNION

Fonds européen de développement régional

Sustainable Bio&Waste Resources for Construction (SB&WRC)

Methodology note: environmental and economic assessment

By :

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SB&WRC Sustainable Bio & Waste Resources for Construction

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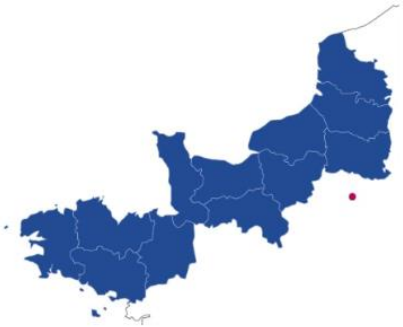

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Reminder of the objectives

- The SB&WRC project aims at designing and producing 3 prototypes of thermal insulant for buildings, made from biobased and waste-based raw materials.prototypes for the building sector. Their carbon footprint will be at least 25% lower than that of standard insulants (neither biobased nor waste-based) on the market (such as glass wool and rock wool).
- The facilitators asked the partners to define the **methodology to demonstrate** the economic impact and environmental benefits of the prototypes and the **function of each partner**.

The partners should be able to provide a **rationale demonstrating** of:

→ The **environmental benefits** of the project (reduction of the carbon footprint of the new products);

→ The **value for money** of the project, for the producers as well as for the consumers (production cost, selling price, insulation performances) compared to standard insulation materials.

In this context, it will be necessary to give additional information about:

→ **Detailed calculations** about the environmental and economic impacts of the project;

→ **Baselines** of the carbon footprint, production costs and insulation performances of existing insulation materials.

Chosen approach to identify the evaluation method

This report tends to:

- Detail the **environmental and economic assessment methods** which will be used within the project and the role played by each partner;
- Identify **baselines** which will be used to objectify the added-value of the prototypes (production costs, insulation performances and carbon footprint).

The assessment methodology has been defined thanks to:

- A **benchmark** of existing environmental and economic assessment methods;
- A synthesis of the **knowledge and skills of each partner** regarding the environmental and economic assessment.

Global approach

Objective: identifying the main methods of environmental assessment that can be applied to a **product** and that includes an analysis of the **carbon impact**.

8 different methods have been preselected to identify the most relevant method for the SB&WR project:

- Carbon footprint
- Energy content / grey energy
- Ecological Index Matrix
- *Ad hoc* matrix approach
- Materials, Energy and Toxicity Matric (MET)
- Environmentally Responsible Product Assessment Matrix (ERPA)
- Simplified and qualitative LCA
- LCA (Life Cycle Analysis)

N.B. : This benchmark is not exhaustive but presents a selection of differentiated methods. Many other tools have been developed, some of them specialized in different industrial sectors such as packaging, textiles (Instant LCA Textile / Spin'it), construction (Eco-Bat), etc.

Descriptive criteria:

- **Global principle of the method**
- **Main stakeholders / creators of the method**
- **Type of method**
- **Detailed description**
- **Strengths and weaknesses**

Energy content / grey energy

Global principle of the method

The **energy content**, also called **grey energy**, assesses the quantity of energy needed during the life cycle of a product (production, use, end of life).

Main stakeholders / creators of the method

Type of method

Quali tative	Semi-quanti tative	Quanti tative ✓

Monocriterion ✓	Multicriteria

Detailed description

The energy content corresponds to the energy which is necessary to extract, transform and deliver a product. It also includes the energy used for recycling and managing the end of life.

The energy content is calculated thanks to the sum of all the **energy consumptions** of each step of the life cycle, substracting the **recovered energy** (for example thermal energy produced during incineration).

To use this method, it is necessary to have a precise knowledge of all the means of production as well as of all the materials used during the production.

The very notion of energy content is often used in the building sector to highlight the important part of energy due to the materials.

Strengths and weaknesses

Strengths	Weaknesses
• This method is frequently use to communicate about insulation materials.	• It is a monocriterion method, that does not directly indicate the impact of the product on the climate (especially on GHG).

Carbon footprint

Global principle of the method

Different methods allow to evaluate the **carbon footprint of a product** (its greenhouse gas emissions) and to identify the main carbon emission spots within the life cycle of this product.

Main stakeholders / creators of the method

World Resources Institute (WRI), World Business Council for Sustainable Development (WBCSD)

French Agency of Standardization (AFNOR)

British Standards Institute (BSI)

Type of method

Quali tative	Semi-quanti tative	Quanti tative ✓

Monocriterion ✓	Multicriteria

Detailed description

Several toolkits are used to frame the realization of a carbon footprint analysis, applied to a product:

- **ISO 14 067 standard** : carbon footprint of products and services;
- **PAS 2050 standard** assessment of the life cycle greenhouse gas emissions of goods and services;
- **GHG Protocol Product Standard**: standard that includes requirements regarding the emissions calculation but also the reporting;
- **Bilan Carbone®**: carbon footprint calculation method which is mainly used in France. This method is based on 5 steps: launch of the carbon balance, data collection, data treatment and reporting of the GHG emissions, identification of solutions to reduce GHG emissions, conclusion of the project.

Strengths and weaknesses

Strengths	Weaknesses
• Several standards / toolkits are available; • Coverage of the whole life cycle.	• Monocriterion analysis, based only on the GHG emissions.

Environmentally Responsible Product Assessment Matrix (ERPA)

Global principle of the method

The ERPA Matrix is a simplified life cycle assessment (LCA). It can be used to evaluate the impact of the life cycle of products, services, processes, infrastructures, etc. This method is based on a 5x5 matrix completed by a checklist.

Main stakeholders / creators of the method

Graedel et Allenby (AT&T, American telecommunications company)

Type of method

Quali tative	Semi-quanti tative ✓	Quanti tative

Monocriterion	Multicriteria ✓

Detailed description

This method is based on a matrix with an axis evaluating the 5 phases of a life cycle (pre-manufacturing, manufacturing, product delivery, product use, refurbishment / recycling / disposal) and a second axis evaluating five impact criteria: material choice, energy use, solid residues, liquid residues, gaseous residues.

Each cell of the matrix is completed by an expert with a **mark from 0 to 4** thanks to pre-established questions. More precise protocols can help to establish more reliable marks thanks to extra questions and conditions.

A global score is obtained thanks to the addition of all the marks. If experts consider that one the 5 environmental dimensions has a much stronger weight than the rest for the product which is evaluated, a different weighting of each impact criterion can be considered.

Strengths and weaknesses

Strengths	Weaknesses
• Quick and easy to implement; • Qualitative data only, which are simpler to collect.	• Mainly qualitative method; • Experience needed in environmental impacts analysis; • Subjectivity in the attribution of the marks; • Each impact and each step of the life cycle have the same weight in the global score.

Materials, Energy and Toxicity Matrix (MET)

Global principle of the method

The Materials, Energy and Toxicity Matrix method is based on a list of inputs and outputs for each step of the life cycle. Three criteria are being considered: material consumption, energy consumption and toxicity (of the emissions and of the waste). A fourth dimension can be added: "others".

Main stakeholders / creators of the method

Danish Institute for Product Development (IPU), dk-TEKNIK

Type of method

Quali tative	Semi-quanti tative ✓	Quanti tative

Monocriterion	Multicriteria ✓

Detailed description

This method uses a matrix which identifies all the impacts of the product during each step of its life cycle (supply, manufacture, delivery, use, end of life). These impacts are divided into three or four categories:

- **Material consumption** (in milli pro capita reserve, i.e. considering the pro capita reserve of each resource);
- **Primary energy consumption** during the extraction of materials, the production, the shipping, the utilization and the maintenance, and finally the end of life (in MJ);
- **Toxicity** of the products used during the production (according to the official statements of hazardous substances by the EU and the Danish government);
- **Other impacts** relating for example to the working environment (noise, dust, land use, physical impacts on the people and on the environment, etc.).

Strengths and weaknesses

Strengths	Weaknesses
• Relatively easy and quick to implement; • Identification of the key steps to reduce the environmental impact; • Based on quantitative and qualitative data (complementary to the LCA).	• No result aggregation: it is hard to compare the different steps of production and the interpretation is mainly qualitative; • Almost as much data necessary than to perform an LCA; • Difficulty to compare different products / scenarios.

Simplified and qualitative LCA

Global principle of the method

The simplified and qualitative evaluation of the life cycle is a diagnosis method which uses some notions that can be found in a LCA but in a quicker, more selective and simpler way. This method allows to evaluate the impacts of a product during different steps of its life cycle.

Main stakeholders / creators of the method

AFNOR (in the FD X30-310 leaflet considering the inclusion of the environment in the conception and development of the products).

Type of method

Quali tative	Semi-quanti tative ✓	Quanti tative

Monocriterion	Multicriteria ✓

Detailed description

Simplified and qualitative LCA is a selective method that focuses on the search of quantitative data on some environmental impacts and / or on some steps of the life cycle.

This method is based on the following steps:

- **Qualitative evaluation** of the main environmental issues, that aims to label the impact of each step and of each issue (from negative to very positive);
- **Quantitative evaluation** of the most salient issues that have been selected after the first step, according to the concept of significant contribution. The environmental ratio (flows used by the product / global flows of the activity sector in a relevant geographic area) has to be compared to the economic ratio (product cost / revenues of the sector or GDP of the area).
- **Recommendations** are then made to upgrade the product when the environmental ratio is superior to the economic one.

Strengths and weaknesses

Strengths	Weaknesses
• This simplified method allows people to perform an environmental assessment without having to collect data about the whole process and the whole impacts.	• Selective method, therefore non exhaustive; • Simplified and qualitative LCAs of different products cannot be compared.

Ad hoc matrix approach

Global principle of the method

The matrix approach consists in realizing an environmental diagnosis within a matrix. The **environmental impacts related to each step of the life cycle** have to be considered.

Main stakeholders / creators of the method

A **multidisciplinary working group** needs to be gathered to create an *ad hoc* matrix approach.

Type of method

Quali tative	Semi-quanti tative ✓	Quanti tative

Monocriterion	Multicriteria ✓

Detailed description

This method is achieved by filling a matrix with, on one axis, the different steps of the life cycle, and on the other axis the corresponding environmental issues. For each interaction between a step and an issue, an impact mark is allocated, from 1 to 10.

This rating, done by a multidisciplinary working group, aims at highlighting the steps where the environmental impact is the strongest. Therefore, both quantitative and qualitative criteria can be used.

Strengths and weaknesses

Strengths	Weaknesses
• Ease of use; • Flexibility and adaptability to a diversity of issues and products.	• Since it is an *ad hoc* method, it does not rely on existing standards and cannot be compared to existing products; • A solid background of environmental knowledges is needed.

Ecological Index Matrix

Global principle of the method

The Ecological Index Matrix is a matrix tool which allows to perform an **environmental diagnosis** of a product on its whole life cycle.

Main stakeholders / creators of the method

Type of method

Quali tative	Semi-quanti tative	Quanti tative ✓

Monocriterion	Multicriteria ✓

Detailed description

This method is based on impact factors allocated to each material and process during the different steps of the life cycle. By weighting all the impact factors thanks to the quantities used in the product, a **global score** can be drawn in millipoints.

It is an **eco-conception approach**, which can be applied thanks to different tools (Okala, Ecolizer for instance).

Strengths and weaknesses

Strengths	Weaknesses
• Quick and easy to implement (simplified life cycle assessment method); • Can evaluate a product before its manufacturing; • Quick identification of the key impacts, from where a more precise study of the steps involved can be drawn.	• Single evaluation score originating from several normalized criteria that have been weighted: this method is not suitable for an external communication; • No consensus among the specialists on this method, because of the use of aggregated impact factors; • Not convenient for very innovative products (lack of impact factors).

Life Cycle Assessment (LCA)

Global principle of the method

The LCA aims to evaluate the global environmental impact of a product, a service, a firm or a process.

This method quantifies the environmental implications of a system, including all the activities related to this product.

Main stakeholders / creators of the method

Users communities (mainly industrials) and researchers.

Type of method

Quali tative	Semi-quanti tative	Quanti tative ✓

Monocriterion	Multicriteria ✓

Detailed description

To perform an LCA, the ISO 14 040 standard can be used. An LCA is done through 4 steps:

- Definition of the **objectives** and of the **field of study**: functional unit and baseline flow, delimitation of the system limits, definition of the allocation rules;
- **Inventory of the flows** (of raw materials, energy, emissions into air / water, waste) and analysis of this inventory;
- Evaluation of the **impacts**: calculation of the impact indicators;
- **Interpretation** of the results: analysis (by step of the life cycle, by component / material), comparison with alternative scenarios.

Strengths and weaknesses

Strengths	Weaknesses
• Global vision of the environmental impact of a product (including indirect impacts); • Exhaustive and documented method; • Supervised by an acknowledged international standard; • Enables the comparison between different scenarios.	• High cost of acquisition and a lot of skills are required; • Difficulty to define the limits of the system, subjectivity in some methodological choices; • No consideration for qualitative elements; • Difficulty to result in an absolute ranking regarding the ecological quality.

Benchmark of environmental assessment methods

Synthesis

	Semi-quantitative methods	Quantitative methods
Multicriteria methods	ERPA Matrix Simplified and qualitative LCA MET Matrix *Ad hoc* matrix approach	Ecological Index Matrix LCA
Monocriterion methods		Carbon footprint Grey energy

Synthesis

The different assessment methods which have been analyzed can be used to evaluate the environmental impacts of a **product** during its **life cycle**.

Among the methods listed, the majority are using a **multicriteria spectrum**, that takes into account the energy and climate dimensions (greenhouse gas emissions) but also other relevant environmental aspects, such as the material consumption.

Many of the 8 studied methods are semi-quantitative (ERPA Matrix, Simplified and qualitative LCA, MET matrix, *ad hoc* matrix approach). **Simplified evaluations of the environmental impacts of a product** can thus be done. The balance between the quantitative and the qualitative data is fluctuant for each of the methods.

These methods are mainly used in **eco-conception processes**, to quickly identify the "hotspots" that will require an extra attention to reduce the environmental impact of the product.

However, the semi-quantitative methods are **less rigorous and precise** than the quantitative methods. They also need the intervention of experts for the evaluation, and lay on less detailed baselines. Moreover, the **interpretation** of the results obtained by these multicriteria tools can be complex, in regard of the different biases adopted during the evaluation.

The benchmark also looked at **some quantitative methods**, based on rational figures. This type of approach reduces the subjective bias of the evaluation.

Different quantitative methods are monocriterion and focus on a **precise environmental implication** (carbon print, energy consumption).

Two quantitative and multicriteria methods have also been analyzed: the LCA and the Ecological Index Matrix.

Among these, the **LCA is the most complete method**, and has the advantage to be widely known and to be based on an international standard.

Global approach

Objective: identify the main methods used for economic assessment that can be applied to a **product**, from different perspectives:

- ***For producers,*** *a product can be considered profitable thanks to* the analysis of the production costs to identify its potential position on a competitive market;
- ***For consumers,*** *a product can be considered as a sustainable alternative thanks to* the estimation of the sale price and the characterization of the insulation performances (hence an estimation of the energy savings and of the reduction of energy bills).

Three **potentially complementary methods** have been selected to define which methodology is the most relevant within the SB&WRC project:

- Cost estimate and sale price;
- Evaluation of the profitability of a product;
- Analysis of the life cycle costs.

Cost estimate and sale price

Global principle

The **cost estimate** is the sum of all the costs aggregated during the conception and manufacturing of a product and paid by the producer.

The valuation of a cost estimate is primordial to determine the **sale cost** that will be paid by the consumer.

Detailed description

The cost estimate can be calculated thanks to the following criteria:

- **Purchase and supply price:** purchase of raw materials, commodities, consumable supply, delivery cost, etc.;
- **Production costs:** operating costs related to the manufacturing of the good or service (manpower, fixed assets, rent, insurances, maintenance, etc.);
- **Shipping costs:** marketing and advertising expenses, shipping expenses, etc.;
- **Administrative costs:** customer service, taxes, general services (accounting, legal and financial services), etc.

The **sale cost** is obtained by adding the **profit margin**.

Strengths and weaknesses

Strengths	Weaknesses
• It is a **basic method**, used for all the products.	• Production costs depend on numerous **factors that will have to be estimated by hypotheses**, since only prototypes are developed within the project (production volume, distribution strategy / logistics, size of the marketing strategy, etc.); • The **margin** mainly depends on the firm's strategy and on the type of products; • It is difficult to **allocate the indirect costs** (not immediately related to the production of a given good), especially if the analysis is based on hypotheses.

Profitability evaluation

Global principle

The profitability of a product is a wide concept that can be defined in different ways:

- The producer will evaluate under which conditions he will be able to obtain a **benefit** to compensate for the costs of the product;
- The consumer will take into account the **sale cost** and the **energy savings** induced by the product, hence the importance to evaluate the insulation performances.

Detailed description

- **For a producer,** the main concept in this approach is the **break-even point**, which relies on the balance between the different costs (fixed and variable costs) and the margin.

  The break-even point can be defined thanks to different units: volume of business (meaning the necessary production for a product to be profitable), sales revenues, days of sales revenues (the so called "neutral position"), etc.

- **For a consumer,** the profitability is based on the return on investment, which mainly depends on the sale cost and on the insulation performances.

  In that case, the profitability is a balance between the initial investment of the consumer (cost of the materials and of installation) and the gains (reduction of the energy consummation).

  If the initial financial investment of the consumer is compensated (or overcome) by the reduction of the energy bills, the maintenance costs and the lifespan of the product, then the operation is profitable.

Strengths and weaknesses

Strengths	Weaknesses
• It offers the possibility to demonstrate the added-value of a biobased insulation material by considering the whole costs (including the use cost and end of life cost).	• The insulation performance of an insulation material is based on the type of building it is used for and the very use of this material; • A lot of hypotheses have to be considered (as well as for the cost estimate and sale price).

Life cycle costs analysis

Global principle

The life cycle costs analysis aims at accounting **all the costs of a product, from its purchase to its end of life**.

The life cycle costs analysis considers the costs induced during the use of the product but also during its end of life.

The nature of the life cycle costs can depend on the characteristics of product.

Detailed description

The costs analyzed by this method are to be defined at the beginning of the analysis and can be of different natures:

- **Costs borne by the user**:
  - Acquisition cost;
  - Use cost (such as energy consumption);
  - Maintenance costs (maintenance, repair or replacement);
  - End of life costs (waste management, recycling);
- **Environmental externalities** induced by the product during its life cycle (greenhouse gas emissions, other pollutants, other mitigation measures). A monetary evaluation has to be done to give a quantitative figure.

A discounting rate has to be applied to properly evaluate the expenses.

Strengths and weaknesses

Strengths	Weaknesses
• Exhaustive approach which lists all the costs induced by a product during its life; • Complementary with the LCA.	• A lot of hypotheses must be made regarding the use and the end of life of the products; • Difficulty to evaluate the environmental externalities induced by the product (the monetary evaluation requires a complex analysis).

Synthesis

The analyzed methods offer **different perspectives** of the economic assessment of a product:

- The evaluation of the **cost estimate** and **the sale price** are a key element for the producer, but also for the consumer;
- The **profitability evaluation for the producer** is linked to the two previous concepts (cost estimate and sale price). Thanks to it, the producer can evaluate the sustainability of the product production;
- The **profitability for the consumer** reveals if the product can be purchased at an affordable price and if the consumer can expect an interesting return on investment;
- The **life cycle costs analysis** focuses on the user of the product and on the environmental externalities.

All these methods require **hypotheses, to a lesser or greater extent,** on the production and shipping processes, but also on the very use of the product (which is related to the type of building, individual behaviors of the users, etc.).

Skills of each partner

Each partner of the consortium has different competences, skills and tools that can be useful for the environmental and economic assessment of the project:

	Nomadéis	University of Bath	ESITC Caen	UniLasalle	University of Brighton	Veolia
Environmental assessment	Coordination	• Experience in the application of **LCA** • **Tools** dedicated to it (SimaPro software)	• **Data** about the prototypes for LCA	• **Biodegradability analysis** (packaging) • Knowledge of the agricultural processes (**LCA**)	• **Data** about the prototypes for LCA *(Waste House)*	• Experience in the application of **LCA** (VERI)
Economic assessment	Coordination	• Experience in **economic assessment** (including life cost cycle)	• **Economic data** about the prototypes	• Economic data on the **agricultural process of production** • Links with **agricultural cooperatives**.	• **Economic data** about the prototypes	• **Experience** in the application of economic assessment • **LCC** learning in progress • **Economic data** about the prototypes

Environmental assessment

Strategic bias: the same method of environmental assessment has to be used for the 3 prototypes in order to be consistent and to allow a comparison (between the prototypes and with other materials).

The chosen methodology will be a combination between:

A **Life Cycle Analysis** of the prototypes:

LCA is a **comprehensive approach** which aims at limiting the environmental impact during the life cycle of the product, avoiding potential pollution transfers. Specific analyses can be conducted on some kind of impacts (such as the carbon).

This method is well known thanks to its international standards. It could therefore participate in reinforcing the **credibility** of the analysis conducted in the framework of SB&WRC project.

LCA is the **reference method** used to create French FDES (Fiche de Déclaration Environnementale et Sanitaire) and EPDs (Environmental Product Declarations), and is therefore crucial to be able to communicate on the environmental impact of a product.

Finally, LCA can be used to test different scenarios, in an **eco-conception perspective**.

A **biodegradability analysis**:

To complete the LCA, UniLasalle will offer it expertise regarding biodegradability. This will be used to study the end of life of the prototypes and the different options (landfill or composting).

This analysis will offer data about the opportunity to **close the carbon loop of the materials**, by returning the carbon contained in agricultural coproducts and agroresources into the ground.

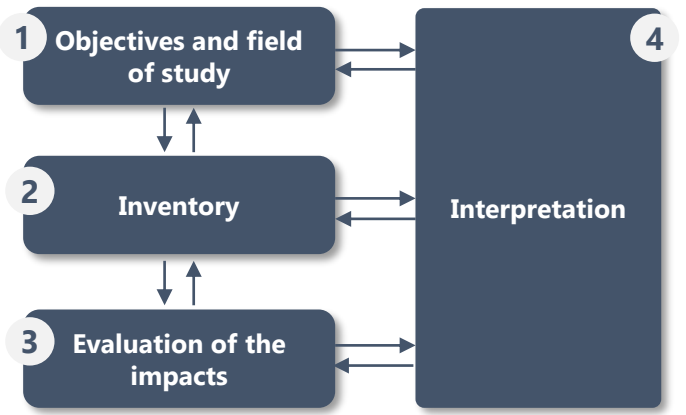
This approach, already used for some products such as packaging, is still an **experimental approach** within the building sector; this project could be an opportunity to offer new perspectives.

As a matter of fact, the end of life of the biobased materials is still under documented, mainly because of the recent expansion of this kind of materials.

Environmental assessment – Life Cycle Assessment

Main principles of the methodological approach

- Reminder of the 4 steps of an LCA:



Environmental assessment – Life Cycle Assessment

1 Objective and field of study

Objectives

- Objectifying the environmental impact of the prototypes (with an objective of a carbon footprint that will be at least 25% lower than that of standard products currently on the market);
- Contributing to the environmental conception of the materials, by highlighting their strengths and weaknesses regarding environmental impact.

Functional unit

*The functional unit will have to be defined during the project, depending on the **type of materials** that will be developed. The lifespan and the insulation performances of the prototypes will have to be defined throughout the project.*

For a insulating panel, for instance, the functional unit could be described the following way:

"Provide a functional thermal insulation on 1m² of the wall with a reference lifespan of … years and with a thermal conductivity of λ = … W/m.K while providing the given performances of the product".

Scope of the life cycle taken into account

For each prototype, according to the considered materials and production processes, a **synthetic schematic of the steps of the life cycle** of the product will be elaborated. Each schematic will describe each step of the process (upstream agriculture and raw materials, first and second transformations, manufacturing of the product, shipping, use, end of life). They will also have to consider each step of the transportation.

These schematics have to be formulated throughout the project, once the characteristics of the prototypes and their production processes have been defined.

Environmental assessment – Life Cycle Assessment

1 Objective and field of study

Impact categories and characterization methodology

Within an LCA, several approaches can be chosen: either a **global approach**, taking into account the largest panel of environmental impacts, either a **more partial approach** with a focus on one or several types of impacts.

The **EPD 2013 method** will be used, with 6 main indicators and 1 additional indicator.

This method is currently used for the EPDs (Environmental Product Declarations) and the indicators are quite similar to the ones used for the French FDES.

Cumulative Energy Demand is commonly used in the literature and will allow comparisons.

EPD 2013 method	Additional indicator
Acidification potential	Cumulative Energy Demand (CED)
Eutrophication potential	
Global warming potential	
Photochemical oxidant creation potential	
Ozone-depleting gases - optional	
Abiotic resource depletion - optional	

Environmental assessment – Life Cycle Assessment

1 Objective and field of study

Allocations

Primary and secondary raw materials

The prototypes will be created from agricultural co-product (rapeseed stalks, maize, wheat and pith elements), wheat straw, textile and terracotta waste.

Some of these materials are from multifunctional processes, that create a range of secondary products and materials (co-products, waste).

Depending of the materials that will be used for the prototypes, the recommendations from the ISO 14 040 and 14 044 standards will be followed. Thanks to this, the inclusion modalities of the multifunctionality of the processes will be determined (allocation at the point of substitution, physical or economic allocation).

End of life

Different hypotheses about the end of life of the product can be chosen:

- Landfill;
- Incineration (with possible recover of energy);
- Composting.

In the case of multifunctional processes (recycling, energy production thanks to the incineration, etc.), several allocation rules can be considered: recycled context approach, avoided burden approach; value-corrected substitution.

Depending on the choices done throughout the elaboration of the prototypes, it will be necessary to define an end of life hypothesis (or several hypotheses that can be compared).

During this stage, the leading partner on each of the prototypes will prepare a first proposition on each field of study, as soon as a more precise definition of the prototype will be available.

This first proposition will be discussed and validated by all of the partners, in order to asset the validity of the hypotheses. Nomadéis and University of Bath will ensure the consistence of the approaches chosen for the 3 prototypes, to enable their comparison.

Environmental assessment – Life Cycle Assessment

2 Inventory / 3 Impact evaluation

Tool

The University of Bath will use the **SimaPro software** to carry out the LCA. This software complies with the ISO 14 000 framework.

Data sources

The LCA will use different data sources:

- Specific data collected by the project partners throughout the project and then centralized via emails and interviews;
- Literature data;
- Specific databases: SimaPro databases (Ecoinvent, Agri-footprint, ELCD, etc.), Agribalyse®, etc.

Length

A maximum of 4 to 6 weeks should be needed to undertake the LCA of each prototype, when the design and the process of production of the prototypes will have been defined.

University of Bath and Nomadéis will draft a questionnaire to allow each partner to clearly identify which data have to be collected during the project. Nomadéis and the leading partners for each prototype will gather the data as the project and the development of the prototypes will advance.

University of Bath will then enter all the data in the SimaPro software.

Environmental assessment – Life Cycle Assessment

4 Interpretation

The results will be analyzed, especially those concerning the **greenhouse gas emissions** of each prototypes.

Several scenarios will be tested and compared (especially different end of life scenarios).

The LCA results will be analyzed by all the partners of this project, under the coordination of Nomadéis and of the University of Bath.

Main limitations of this approach

- A lot of hypotheses will have to be made since the project aims at producing **prototypes in an experimental way**. The supply, production and shipping processes will have to be estimated as the products will not be produced in an industrial way during the project (contrary to the products already available on the market). Some of the co-products do not have yet any channel of collection clearly structured, which will also lead to assumptions;
- Some methodological choices can be considered as **subjective** and can affect the results obtained by the LCA;
- The LCA does not take into consideration the **temporary storage of carbon** during the use of the material, which is erased by the outputs / inputs statement. However, carbon storage is a key asset for biobased materials, especially if the materials can be recycled or reused several times.

Complementary to the LCA, the **evolution of carbon storage and emission** (throughout the whole life cycle of the product) **will be analyzed** to demonstrate the very potential of carbon storage of these materials during their use.

Environmental assessment – Biodegradability analysis

Global objectives

- Studying the **opportunity of the biodegradation of the prototypes,** producing knowledge about the end of life of biobased materials (which is under documented), bringing an innovative perspective on the materials created within the project;
- Taking an approach based on **circular economy**. The waste materials could be qualified as resources after their biodegradation.

Involved partners

The biodegradability of the prototypes will be evaluated by UniLasalle which already has an expertise considering this kind of analysis.

UniLasalle owns all the necessary equipment to conduct the biodegradability tests according to the ISO framework.

The other partners will be included in the choice of the hypotheses and will benefit from the analyses results that might then be included in the LCA if this end of life hypothesis is selected.

Analysis methodology

The biodegradability analysis aims at identifying the percentage of mineralization, that is to say the CO_2 quantity produced by each gram of degraded carbon.

The methodology is framed by **several standards** targeting plastic materials (mainly ISO 13 432, 14 855 and 14 852), which define the mineralization threshold at which the product can be considered as biodegradable. These standards could be used for the building materials since no *ad hoc* standards do exist.

The analysis methodology depends on the way of eliminating the material:

- Direct elimination in soil after crushing the materials;
- Elimination by composting after deconstruction;
- Elimination in aqueous medium (mud, sewage).

A priori, the best option seems to be biodegradation by composting because:

- It uses existing valorization chains, whereas no soil valorization chain currently exists;
- It can be done in a relatively short time (45 days), which is consistent with the temporality of the project, whereas a soil biodegradability test lasts 6 months.

Economic assessment

Strategic bias: the same method of economic assessment should be applied to the 3 prototypes in order to secure the consistence within the evaluation and to enable the comparison (between the prototypes, but also with other materials).

The economic assessment methodology that has been chosen will be based on:

Cost estimate and sale price

Since only prototypes will be produced, a **simple economic assessment** seems more relevant.

Performing a life cost cycle analysis (which is an in-depth analysis) does not seem relevant regarding the number of hypotheses that would be assumed and the difficulty to quantify the externalities within a research project.

This assessment will be conducted thanks to **the data collected by all the partners** throughout the project. The **hypotheses** made within the LCA will be used in order to frame the cost estimations (supply, production, large-scale shipping, etc.).

To estimate the **sale price**, a minimal **margin** has to be considered so a firm producing this material can balance the production costs and be cost-effective. This estimation could be done by interviewing experts.

Nomadéis will coordinate the assessment, with the help of the leading partner of each prototype who will gather data.

Assessment of materials affordability for the consumers

This assessment will be done thanks to the evaluation of:

- The **sale price**: regarding its competitiveness compared to other available products (and by taking into account the installation costs and the lifespan of the production, thanks to a comparable functional unit);
- The **thermal performances** of the prototypes (thermal conductivity λ and thermal resistance R).

The aim is to asset if the product can be affordable and effective for the consumers.

The term of the return on investment for the users will not be calculated because it has to be done regarding the housing or building scale, which require many hypotheses on the characteristics and the diversity of the buildings in the Interreg area. Moreover, the return on investment is strongly dependent on the consumer behavior, which is complex to anticipate (bouncing effect, etc.).

Environmental assessment

In order to compare the impact of the prototypes to standard products, the foloowing method will be used:

Comparison to the environmental declaration data

The data calculated thanks to the LCA could be compared to accessible data:

- **EPDs** (***Environmental Product Declaration***), used on the European and international level;
- **FDES** (***Fiche de Déclaration Environnementale et Sanitaire***), the French equivalent of the EPDs, available online on INIES (1 979 references, including 574 insulation materials).

These declarations are based on LCAs and constitute a reliable resource.

SimaPro can also provide comparative data.

Data should be compared with materials of the **same type, use and performances** than those of the prototypes, but based on mineral resources (i.e. the materials that the prototypes intends to replace on the market).

The similarity criteria of the standard products and materials will be defined throughout the project, once the characteristics of the prototypes have been defined (bricks / panels / etc.).

Economic assessment

To compare the economic assessment of the project and the prototypes to standard products available on the market, several methods will be used:

Comparison of the sale price

The comparison will be lead by taking the **sale price** as a referential, which is a crucial criterion for the consumers as well as for the producers. The prices can be collected by looking on the website of the distributors or by interviewing professionals of the construction sector (economists, etc.).

*Data on the **cost price** are difficult to collect, this kind of information being highly confidential because of their strategic value for the manufacturers.*

Besides, estimating the margin of the manufacturers is complex. The margin depends on the firm strategy, but also on the type of products, the distribution channel, etc.

The sale price of the prototypes will have to be compared to the price of materials made from mineral resources with the **same type, use and performances** as the prototypes.

Comparison of the insulation performances

Meanwhile, the thermal performances of the prototypes will have to be compared to the standard products on the market.

The thermal performances will be evaluated by looking at the **thermal conductivity** (λ) or the **thermal resistance** (R) of the material.

This information will be identified thanks to the FDES / EPDs.