Interreg France (Channel Manche) England

European Regional Development Fund

SB&WRC

Sustainable Bio & Waste Resources for Construction

SB&WRC Project

Qualitative strategy for massification and market dissemination of prototypes

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Abstract of the project

The SB&WRC *(Sustainable Bio&Waste Resources for Construction)* project, an undertaking of more than two years, aims to conceive, produce and test three innovative, low-carbon, thermal insulation materials from agricultural co-products and recycled waste. The project is supported by the development program Interreg VA France (Channel) England and its budget, estimated to be 1.8M€, is co-financed by the ERDF (European Regional Development Fund) for 69% (1.26M€ contribution).

This project, led by Nomadéis, is carried out by a cross-channel partnership which gathers academic research laboratories, private research and consulting companies, manufacturers and professional non-profit organisation of the building sector:

- Nomadéis;
- Veolia Propreté Nord Normandie;
- University of Bath;
- Ecole Supérieure d'Ingénieurs des Travaux de la Construction de Caen (ESITC Caen);
- Construction21;
- UniLaSalle;
- University of Brighton;
- Alliance for Sustainable Building Products.

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1. Introduction

The partners wanted to anchor the project in an approach allowing to eventually produce the prototypes on a large scale and to **disseminate them on the market**. Once the prototypes produced, they have thus elaborated a strategy aiming at providing any stakeholder interested in the commercial development of the prototypes with a series of key success factors.

Prospective scenarii for the commercial development of SB&WRC prototypes and their insertion on the market have been drafted. These scenarii aim at identifying how the modification of factors such as design, practical use characteristics, size, or guarantee on the project's products will help them succeed on the market. The appropriate distribution network, as well as the target prices allowing to satisfy demand have been analysed.

Finally, the **products' image**, that is the various ways through which a product identity could be built in order to foster the dissemination of the prototypes on the market (elements of the product to be highlighted, targets and angles of marketing campaigns, appropriate advertisement channels, etc.) has been studied.

The subsequent chapters present the **qualitative strategy designed for the massification and market dissemination** of each of the three prototypes developed, successively.

2. Prototype 1 – Maize pith

2.1 Prototype description

UniLaSalle has developed **insulation panels based on maize pith**, which is the core, inner part of maize stalks. Currently, in the context of maize cultivation, maize stalks are largely considered as an agricultural co-product, with little or no economic value, other than their use as a source of organic soil amendment. Maize stalks are highly abundant and available in the Interreg zone, especially on the French side. Further, harvesting maize stalks does not compete with food production or other essential uses.

UniLaSalle has shown that the porous structure of maize pith provides them with **interesting thermal properties** that can be exploited to create insulation materials for construction. They have created insulation panels that consist of 3 layers: two thin and dense outer layers (1mm and 400kg.m^3 each) enclose a thick but less dense inner layer (25 mm and 50 kg.m^3). The two outer layers essentially protect the core layer and maintain the structural and mechanical integrity of the panel. The core layer acts as the insulation material. Figure 1 below shows the 3 layers constitutive of a panel. The panels correspond to squares of 1.1 m side, thus developing a mural area of 1.21 m^2. A panel has a total mass of 2.68 kg and a volume of 34 L, resulting in a bulk density of 79 kg/m^3.

Laboratory and full-scale tests revealed a **thermal conductivity of 0.042 W/m^{-1}.K^{-1}**, within the typical range of values observed for commonly available insulants (0.035-0.045 W.m^{-1}.K^{-1}). The LCA performed on the prototype showed a **reduction of 34% and 56% in CO_2 emissions** (even not taking into account the carbon sequestration) compared to glass and mineral wools, respectively. The maize pith panel is **compostable** and undergoes a complete degradation under fire in 30 minutes.

Figure 1: Maize pith-based insulation panels consist of 3 layers bound together by a mulching film

2.2 Production scenario and target price

2.2.1 Prototype production

The following **large-scale production scenario** could be envisaged : a company sources the main raw material – maize-pith – from a specialised supplier. Currently, the company CORMO operates a process (under patent) for the separation of pith and bark from maize stalks and could supply the required raw material. Maize pith is then mixed with water and thermocompressed by a machine to form 3 layers that are bound together thanks to biodegradable mulching film. Panels are then packaged and stored until they are shipped to a building materials trader, who will sell the insulation panels directly to construction professionals.

2.2.2 Sale prices

An economic study performed within the frame of the current project has demonstrated that the manufacturing process for maize pith-based insulation panels was capital-intensive because of the cost of thermocompression machines, estimated to approximately 750,000 euros. These machines account for more than a third of unit production costs. Thus, fixed costs represent a large share of total costs compared to variable costs, which implies that there are opportunities for economies of scale. According to the model developed, the company that would produce the insulation panels of 2.8 cm thick could profitably sell them to building materials and construction retailers for **165.42€ per m²** for a thermal performance ("R") of 5 m².K/W (typical comparison value for construction insulating materials), assuming a 20% margin rate (equivalent to a 25% markup). It was estimated that the retailers would then sell them for **226.62€ per m²** to construction professionals, assuming a 27% gross margin rate (equivalent to a 27% markup).

A simple strategy to improve the price-competitiveness of the insulation panels would consist in **manufacturing thicker panels (from 2.8 cm to 10 cm thick)** without significantly changing the production process. The simulation performed suggests that this simple change would **divide unit productions costs by two**, meaning that the panels could be priced at **109.73€ per m²** for a R of 5 m².K/W. This measure, combined with improvements in the productivity of the thermocompression machines, could feasibly bring down unit production costs – and hence the final price - to more competitive levels. The technical feasibility of these changes would have to be investigated in greater depth with an industrial partner to provide more accurate cost estimates and develop further optimization strategies.

The maize pith-based insulation panels produced under the conditions described above would be **more expensive** than bio-based and waste-based insulation materials with a similar level of thermal performance, whose typical prices are of approximately 4€ (straw bale and glass wool), 10€ (cellulose wadding and mineral wool), 20€ (wood fibre, sheep wool and hemp wool) and 80€ (expanded cork) per m^2 and for a R of 5 $K.m^2.W^{-1}$.

It however important to note that **cost-minimizing strategies** could be explored with industrial process experts in order to lower the production costs. In addition, the **cost of carbon** will very likely be more and more taken into account in future, providing a certain economic advantage to the prototype.

2.3 Product image and sale arguments

2.3.1 Sale arguments

The principal sale arguments for prototype 3 are as follows :

- It benefits from a particular **aestheticism,** notably in relation with **biophillya**, which can make it a **first class product** for indoor installation;
- The prototype generates reduction in CO_2 emissions compared to conventional equivalent materials such as glass and mineral wools. In addition, it is important to note that the temporary sequestration of carbon in the biomass is currently not valued in official LCA methodologies. However, in the context of climate emergency, the embodied carbon is forseen to become more and more important, thus making prototype a **climate friendly** product;
- Maize is an abundant resource in the FMA area, making it a **local product**. Moreover, the valuation of an agricultural co-product would generate additional incomes for farmers and **support rural economy**, and the use of a **renewable material** spares fossil and mineral resources jeopardized by over-exploitation;

- Thanks to its thermal and hygrometric properties, the prototype increases the **indoor well-being**. As many bio-based materials, it may also ranks at top level with respect to **indoor air quality** (this feature would however need to be assessed through future studies);
- Its light weight makes it a material easy to handle on construction sites and reduces workers arduousness. The prototype thus appears as a **socially responsible product**.

Therefore, in spite of its assumed apparent high price (under current conditions and based on the modelization performed), prototype 1 has convincing caracteristics that result in strong sale arguments.

2.3.1 Adverstising

Adverstisement could be performed based on the abovementionned sale arguments and should target the following audiences :

- **Architects**, through national and regioanl associations;
- **Construction workers**, through professional media (specialized newspapers, etc.);
- **Property developer** and **interior designers**;
- **Construction material distributors** (see below).

The producer should also join the biosourced construction professionals associations, in France the AICB (*Association des Industriels de la Construction Biosourcée* – the association of biosourced industrials) and the CF2B (C*ollectif des Filières Biosourcées du Bâtiment* - association of biosourced building sectors), and in the UK organisms such as the ASBP (Alliance for Sustainable Buidling Products).

2.4 Distribution channels

Given that the panels can i) be massively produced in a factory and ii) be handled, stored and sold to individual construction workers, the most appropriate distribution channels appear to be **common construction material distributors** such as:

- In B to B (approximately 4,000 distribution points in France) : Point. P, Brossette, CEDEO, Asturienne, PUM Plastiques, La Plateforme, BMSO, DMBP, Trouillard, La Méridionale des Bois et Matériaux, Distribution Aménagement et Isolation, BMCE, BMRA, Sté de Négoce de Normandie, Asturienne, DMTP, Docks des Matériaux de l'Ouest, Gedimat – Gedibois, Tout Faire Matériaux, Tout Faire Bois,Samse, Doras, M+ Matériaux, Henry Timber, BTP Distribution, Les Comptoirs du Bois, Socobois, Bois Mauris Oddos Armand, Bill Mat, Célestin Matériaux, Roger Cléeau, Remat, Carréo, Ollier Bois, Chausson Matériaux, BigMat, Starmat, Réseau Pro et Panofrance ;
- In B to C (approximately 6,000 distribution points in France) : LeRoy Merlin, Bricorama, Lapeyre, Castorama, and Mr Bricolage.

2.5 SWOT analysis

As a conclusion, a SWOT analysis (Strenghs, Weaknesses, Opportunities and Threats) has been performed.

Strenghs	Weaknesses
➢ **Thermal performance** ➢ **Low carbon footprint** ➢ **Indoor well-being** ➢ **Aestheticism** ➢ **Local production** ➢ **Support of rural economy** ➢ **Renewable material** ➢ **Reduced work arduousness** ➢ **Compostable**	➢ Currently **high production costs** and **sale prices**
Opportunities	**Threats**
➢ **Temporary carbon sequestration** to be more valued in a context of climate emergency ➢ Potential for **cost-minimizing strategies** through further studies mobilizing industrial process experts	➢ Maize pith is **water consuming**. **Future climate change** may jeopardize such crops

3. Prototype 2 – Polyester from waste duvets

3.1 Prototype description

The University of Brighton and ESITC Caen have developed an insulation material prototype for construction that uses **waste bedding**. The rationale is that duvets are part of a waste stream that is under-exploited in the circular economy, since most duvets and pillows in France and in the UK are currently not reused or recycled. Indeed, they are either sent to landfills or used as an energy source as part of waste-to-energy schemes. Unfortunately, these two solutions may generate pollution and make an unefficient use of materials. Therefore, the idea developed as part of the SB&WRC project is to exploit the interesting thermal properties of the duvets by re-using them as an insulation material for the construction sector.

The waste bedding can be used as a non-load bearing insulation material that would **fill a typical timber stud module** (or OSB frame) in a wall. A Tyvec membrane can also be added to deal with the air permeability of the external wall system. **Polyester duvets** were prefered to duck feather ones, who have the potential for mouldering.

The prototype developed consists in a reused duvet which has been collected, sorted and cleaned, and then hung and stapled into a wooden frame that form a **prefabricated unit**. The deployment tests revealed a performant intrinsic thermal conductivity in the order of **0.043 $W.m^{-1}.K^{-1}$** (within the typical range of values observed for commonly available insulants - 0.035-0.045 $W.m^{-1}.K^{-1}$) in the tests performed by partners ESITC Caen and University of Bath, although the results done at the Waste House by the University of Brighton led to a lower performance of 0.069 $W.m^{-1}.K^{-1}$, potentially related to either a different density or to the experimental set up used.

The LCA performed on the prototype showed a **reduction in the order of 93% to 95% in CO_2 emissions** compared to glass and mineral wools, respectively. Polyester is not compostable and undergoes a complete degradation under fire in 2 minutes.

Figure 2: Reused polyester duvet in a full-scale testing unit

3.2 Production scenario and target price

3.2.1 Sector's context

In Europe, **extended producer responsibility** (EPR – Responsabilité Elargie du Producteur in French) schemes are extensively used to reduce the environmental impacts associated with a product's entire lifecycle. Under this policy approach, producers of consumer goods are financially and/or physically responsible for the collection, transport, treatment, re-use, recycling or final disposal of goods that are disposed of by consumers. The objective is, by making producers are accountable for the negative environmental and social impacts associated with the waste flows they generate, to prevent excessive waste production, promote more environmentally compatible product design and foster the collection, re-use and recycling of products at their end-of-life.

In order to fulfil their obligations under the EPR principle, the producers can either develop i) individual schemes or ii) collective schemes through the creation of an entity call "**eco-organism**". In that latter case, the eco-organism is in charge for the collection of funds from the producers and the management of the proper end-of-life of the products, through financial support to the municipalities and/or direct contracts with waste operators. The Figure below shows the typical organisation of an EPR with an eco-organism.

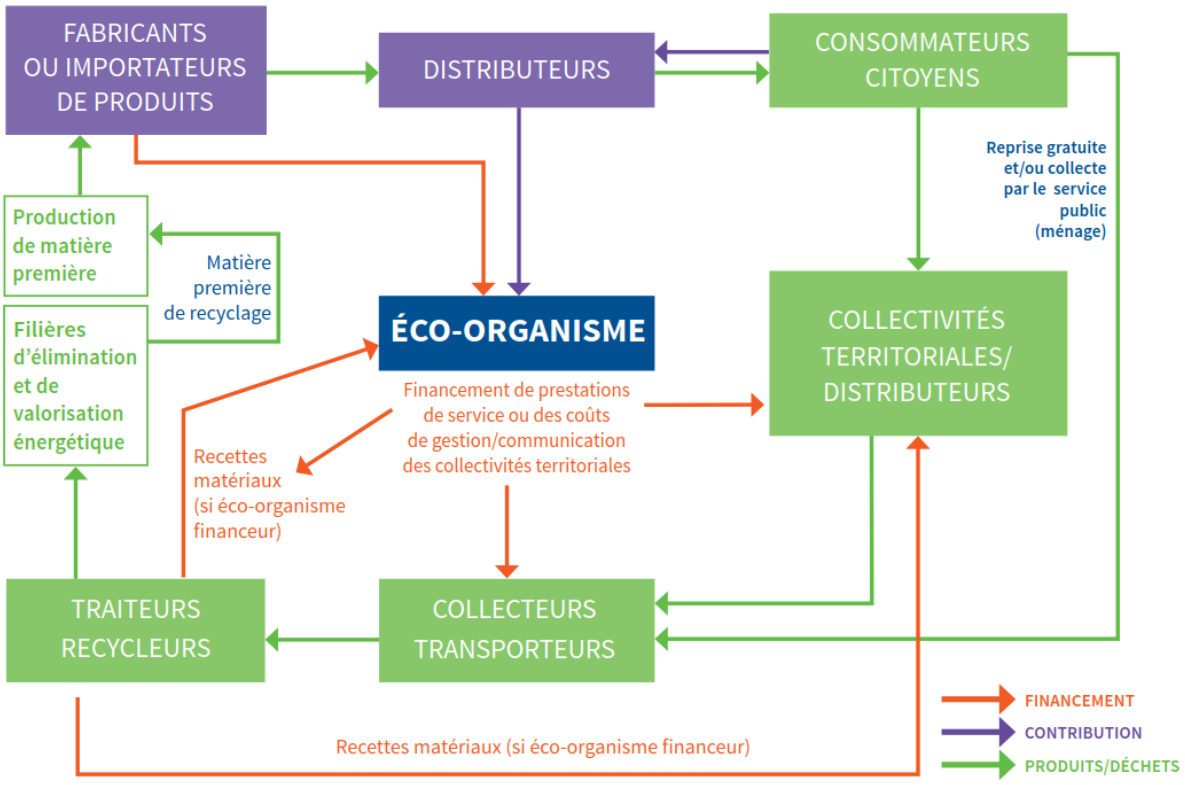

Figure 3: Simplified scheme of an EPR

In France, since 2011, the law has required issuers on the market of furniture components to take charge of the collection, sorting, reuse and disposal of these products (called "waste furniture components" – *déchets d'éléments d'ameublement*, DEA) in the form of an ERP channel. Two eco-organizations, Éco-mobilier (focusing on household furniture and bedding) and Valdelia (focusing on professional furniture), were accredited by the State at the end of 2012. Since 1 **October 2018**, upholstered seating or sleeping products (*produits rembourrés d'assise et de couchage* - PRAC), to which **duvets** belong, have been brought within the

scope of the **DEA ERP**. The first call for tenders for the collection and management of used sleeping bags was recently launched by Éco-mobilier and the companies' bids are currently being evaluated. **The emerging ERP sector for the management of this waste is therefore in the process of being structured.**

3.2.2 Prototype production

The following **production scenario** could be envisaged : A company collects polyester duvets from a supplier, who would most likely be a waste management operator. The supplier has already collected, transported, hygienized and sorted the duvets so that polyester duvets are separated from duck feather ones (duck feather duvets represent a large part of the products available on the market). Once they reach the company, the material is cleaned, packed and shipped to building materials retailers.

In addition, the reader is invited to consult the report *Legal analysis regarding waste valorisation activities*, produced within the frame of the SB&WRC project, for more information on the regulatory context for waste.

3.2.3 Sale prices

An economic study was performed within the frame of the current project to assess the marketability of the product. Given that the sector is currently in the process of being structured, **very limited to no data was available on the up-stream value chain**. Therefore, to estimate the unit production cost and final price of an insulation product based on reused polyester duvets, a model based on a top-down approach, starting from the typical final price of current biobased and conventional insulation materials back to the purchase price of the duvet, was developed. This model focused on the duvets themselves exclusively and did not take into account the prefabricated unit, neither from a cost point of view nor from a sale comparison one.

Taking into account a distributor gross margin of 27% and a producer net margin of 20% (equivalent to markups of 37% and 25%, respectively), and aiming to sell the reused duvets at typical market prices for similar products of 4€ (straw bale and glass wool), 10€ (cellulose wadding and mineral wool) and 20€ (wood fibre, sheep wool and hemp wool) per m^2 and for a thermal resistance ("R") of 5 $K.m^2.W^{-1}$, the **duvets** (already collected, sorted and hygienized) **should be supplied for free** and a **subsidy** of 2.53€, 1.81€ or 0.61€ per kilogram of duvet, respectively, should be granted to the producing company. It should be noted that a final sell price of 25.04€ per m^2 and R=5 $K.m^2.W^{-1}$ would allow the producer to run its business without receiving any subsidy, but still receiving the duvets for free.

This scenario appears feasible given than eco-organisms contract the down-stream actors of the waste management value chain in order to have them collect, sort, and reuse or recycle wastes. The company would then perfectly fit within this down-stream ecosystem of actors, providing a second life to the duvets.

In order to optimize the business model, this semi-industrial activity could be registered as a part of a **social and solidarity economy** framework that would enable the producer to benefit, on one hand from cheaper workforce and on the other hand, from complementary subsidies.

3.3 Product image and sale arguments

3.3.1 Sale arguments

The principal sale arguments for prototype 3 are as follows :

- The prototype generates reduction in CO_2 emissions compared to conventional equivalent materials such as glass and mineral wools. The prototype thus appear as **climate friendly**;
- The reuse of waste duvets lies within the **circular economy** and, as such, makes a fair use of materials and spares fossil and mineral resources jeopardized by over-exploitation;

- Thanks to its thermal and hygrometric properties, the prototype increases the **indoor well-being** ;
- Given the potential for the prototype to lie in the social economy, it may appears as a **socially responsible product**.

3.3.2 Adverstising

Adverstisement could be performed based on the abovementionned sale arguments and should target the following audiences :

- **Architects**, through national and regioanl associations;
- **Local authorities**, who would notably be interested to support this production given its potential for creating employment in the social economy;
- **Public owners with large construction and retrofitting operations**, such as public housing operators or hospitals;
- **Property developer**.

3.4 Distribution channels

Given that the panels can i) be massively produced in a factory but ii) will assembled as a prefabricated unit, the most appropriate distribution channels appear to be either i) **specialized gross construction material distributors** or ii) **direct sale** to construction professionals through the producer's own network.

3.5 SWOT analysis

As a conclusion, a SWOT analysis (Strenghs, Weaknesses, Opportunities and Threats) has been performed.

Strenghs	Weaknesses
➢ **Thermal performance** ➢ **Low carbon footprint** ➢ **Indoor well-being** ➢ **Support of social economy** ➢ **Circular economy scheme and materials use efficiency** ➢ **Reduced work arduousness (prefabricated)**	➢ Current business model needs to receive **subsidies** to sale the product at a competititve price
Opportunities	**Threats**
➢ **Low carbon footprint** to be more valued in a context of climate emergency ➢ **Extended Producer Responsability** recently enlarged to waste duvets: **sustainable outlets required for that waste stream**	➢ **Economic simulation** does not take into account the prefabrication of wooden frames. ➢ **Further research** tests should be undertaken to refine the prototype design.

4. Prototype 3 – Optimized wheat straw bale

4.1 Prototype description

Current balers produce straw bales with sub-optimal insulation properties, because straw stems are totaly or partly oriented parallelly to the heat flow, and hence a large amount of insulation material is needed to attain a desirable level of thermal resistance. Therefore, straw-bale based constructions require a large volume of insulation material and are thus characterised by excessively thick walls. The **fundamental innovation** proposed by the University of Bath is to improve the thermal performance of straw bales while maintaining their structural integrity by using a **process that orientates straw stems perpendicularly to the heat flow**. The optimised straw bales produced following this method benefit from a lower thermal conductivity (so a better thermal resistance, « R », for a given level of thickness) compared to standard bales.

As the manufacturing process is relatively simple and flexible, optimised straw bales could be produced with **different dimensions**. For example, the standard bales used as raw material could be cut in larger chunks, while the hydraulic press and the wooden case could be modified to produce larger or more compact bales. However, Platt et al. (2019)[1] point that there is a constraint on the dimensions of the optimised bale: the width to height (i.e. thickness) ratio must remain smaller than 2. Given that the width to thickness ratio (0.47/0.37) of a standard agricultural bale is lower than 2, the optimised bale could be produced with the same dimensions as a standard bale. The optimised bale would benefit from a lower thermal conductivity however, owing to its optimised straw stem orientation.

It should be noted that, at the **laboratory scale**, partner University of Bath produced a small handmade sample which achieved a **thermal conductivity of 0.044 $W.m^{-1}.K^{-1}$** (within the typical range of values observed for commonly available insulants - 0.035-0.045 $W.m^{-1}.K^{-1}$), above the common range of values usually observed for straw bales (in the order of 0.052 to 0.08 $W.m^{-1}.K^{-1}$), consisting in a success from that point of view. However, the tests carried out on larger prototypes produced using a hydraulic press revealed thermal conductivities in the order of 0.053 $W.m^{-1}.K^{-1}$. The LCA performed on the prototype showed a **reduction of 50% and 67% in CO_2 emissions** (even not taking into account the carbon sequestration) compared to glass and mineral wools, respectively. The wheat straw bale is **compostable** and undergoes a complete degradation under fire in 80 minutes.

Figure 4: Optimised straw bales

[1] Platt S., Walker P., Maskell D., Laborel-Préneron A. (2019) Re-baling straw for better insulation, 3rd International Conference on Bio-based building material, June 26th – 28th 2019 Belfast (UK)

4.2 Production scenario and target price

4.2.1 Prototype production

Two production scenarios can be envisaged, a **large-scale and a small-scale scenario.**

Large-scale scenario

By changing the way that bales are compressed by agricultural balers, **modified balers could produce optimised straw bales directly in the field**, instead of standard straw bales that are characterised by sub-optimal thermal properties. This modified baler would be bought by a farmer who produces straw bales for construction purposes. Optimised straw bales would then be sold directly to construction professionals or indirectly via straw merchants. It is indeed standard practice for construction professionals to source straw bales directly from farmers or straw merchants in a 50km radius around the construction site to minimise costs. As such, **the market for straw bale insulation is rather decentralised**, since any cereal cultivator could potentially produce optimised straw bales for construction if there is sufficiently high demand for straw-based construction materials. The « large-scale » is called this way because, by modifying the balers themselves, the global decentralized optimized straw bales production has a potentially significant magnitude.

Small-scale scenario

A smaller scenario that may be considered consists in a local small company who sources wheat straw from local farmers and stores it. Baling twine and packaging products (plastic wraps, europallets, carboard boxes) are also bought. The manufacturing process is simple: wheat straw is compressed into the final product – the optimised straw bale - thanks to a special hydraulic press. Baling twine binds the straw bale. Bales are then packaged and piled on a europallet and wrapped in plastic. As with the large-scale scenario, the final product is stored and then sold directly on the premises to local construction professionals or to straw merchants.

4.2.2 Sale prices

An economic study was performed within the frame of the current project. It should be noted that this analysis was based on the optimized thermal conductivity of 0.044 $W.m^{-1}.K^{-1}$ acheived for hand-made samples but not for larger samples produced with a hydraulic press.

The economic modelling demonstrated that the two different scenarios yield different results in terms of economic performance, according to the cost-estimation model developed, to the data available and to the hypotheses made in the assessment. Optimised bales would be priced at **3.33€** per m² for a thermal performance (« R ») of 5 m².K/W (commonly used comparison unit) under the **large-scale scenario**, that is, **cheaper than any other type of conventional or bio-based or waste-based insulation material, including standard straw bales for construction.** On the other hand, in the **small-scale scenario**, optimised bales could potentially be sold at **21.68€** per m² (also for a R of 5 m².K/W). These two prices include a 20% margin for the producer (that is, a markup of 25%).

This analysis shows that the large-scale scenario, where standard agricultural balers are modified to directly produce optimised bales, would be preferable to the small-scale scenario in terms of economic performance. However, several strategies to reduce the unit production costs associated with the small-scale scenario were identified, focusing on labour productivity and raw materials mainly. Economies of scale are limited in this scenario because fixed costs represent a small proportion of total costs.

4.3 Product image and sale arguments

4.3.1 Sale arguments

The principal sale arguments for prototype 3 are as follows :

- The prototype generates reduction in CO_2 emissions compared to conventional equivalent materials such as glass and mineral wools. In addition, it is important to note that the temporary sequestration of carbon in the biomass is currently not valued in official LCA methodologies. However, in the context of climate emergency, the embodied carbon is forseen to become more and more important, thus making prototype a **climate friendly** product;
- Wheat straw is an abundant resource in the FMA area, making it a **local product**. Moreover, the valuation of an agricultural co-product would generate additional incomes for farmers and **support rural economy**, and the use of a **renewable material** spares fossil and mineral resources jeopardized by over-exploitation;
- Thanks to its thermal and hygrometric properties, the prototype increases the **indoor well-being**. As many bio-based materials, it may also ranks at top level with respect to **indoor air quality** (this feature would however need to be assessed through future studies);
- Wheat straw is particularly appropriate for retrofitting of ancient building, making it an asset for **cultural and historical patrimony saveguard**.

4.3.2 Adverstising

Adverstisement could be performed based on the abovementionned sale arguments and should target the following audiences :

- **Architects**, through national and regioanl associations;
- **Construction workers**, through professional media (specialized newspapers, etc.);
- **Farmer associations and syndicats**, such as the FNSEA;
- **Agricultural baler manufacturers**.

The producer should also join the wheat straw construction professionals associations, in France the RCFP (*Réseau Français de la Construction Paille* – French network for the construction with straw).

4.4 Distribution channels

Given that the straw bales can i) be locally produced by farmers and ii) be handled, stored and sold to individual construction workers, therefore resulting in a rather decentralized market, the most appropriate distribution channels appear to be construction professionals themselves or straw merchants.

4.5 SWOT analysis

As a conclusion, a SWOT analysis (Strenghs, Weaknesses, Opportunities and Threats) has been performed.

Strenghs	Weaknesses
➢ **Thermal performance** ➢ **Low carbon footprint** ➢ **Indoor well-being** ➢ **Local production** ➢ **Support of rural economy** ➢ **Renewable material** ➢ **Compostable** ➢ **Suitable for ancient buildings retrofitting** ➢ **Wheat straw already known and accepted as a building material by public authorities and ensurances**	➢ Best thermal performance achieved on **hand-made sample** only at this stage
Opportunities	**Threats**
➢ **Temporary carbon sequestration** to be more valued in a context of climate emergency	➢ Current changes in **social expectations toward agricultural practices** (mostly on pesticides use) may reduce the availability of wheat straw in future

The SB&WRC project is part of the Cross Border European Territorial Cooperation (ETC) Programme Interreg VA France (Channel) England and benefits from financial support from the ERDF (European Regional Development Fund).