EUROPEAN UNION

Interreg

EUROPEAN UNION

France (Channel Manche) England

BIO-CIRC Project

European Regional Development Fund

BIO-CIRC Project

Bio(and)**C**ircular **I**nsulation for **R**esourceful **C**onstruction

Local impact of the deployment of a production chain

30th June 2022 – Final Version

EUROPEAN UNION
European Regional Development Fund

nomadéis

ASBP The Alliance for Sustainable Building Products

therma fleece Nature's finest insulation

backtoearth

EUROPEAN UNION

Nomadéis Le Havre
120, boulevard Amiral Mouchez • 76600 Le Havre • France
Phone: +33 (0)1 45 24 31 44
www.nomadeis.com

The Alliance for Sustainable Building Products
The Foundry, 5 Baldwin Terrace • London N1 7RU • United Kingdom
Phone: +44 (0) 20 7704 3501
https://asbp.org.uk

Eden Renewable Innovations Limited
Soulands Gate, Soulby, Penrith • Cumbria, CA11 0JF • United Kingdom
Phone: +44 (0) 1768 486285
https://www.thermafleece.com

Back To Earth Limited
22 Tuns Lane, Silverton • Exeter, EX5 4HY • United Kingdom
Phone: +44 (0) 1392 861763
https://www.backtoearth.co.uk/

Interreg
France (Channel Manche) England
BIO-CIRC Project
European Regional Development Fund

Abstract of the project

The BIO-CIRC Project, Bio(and)Circular Insulation for Resourceful Construction, intends to tackle the building sector's high carbon, energy and resources dependencies while taking advantage of an unused waste resource: polyester from waste bedding.

The project aims to conceive, develop, and deploy 3 prototypes of innovative low-carbon thermal insulation material made from polyester and combined with natural fibres. It intends to promote the emergence of a bespoke waste polyester valorisation industry and the use of virtuous Natural and Recycled Fibre Insulation products.

This project is carried out by a cross-channel partnership of 4 key and complementary links in the building sector's value chain:

- Nomadéis (lead partner)
- Alliance for Sustainable Building Products
- Eden Renewable Innovations
- Back to Earth

Planned over 2 years, the BIO-CIRC project receives funding from the European Regional Development Fund (ERDF). The ERDF's contribution amounts to €399,600 for a total budget of €499,500.

Table of contents

Executive summary

Within the framework of the BIO-CIRC project, for each of the 3 prototypes developed, the quantity of polyester from used duvets and pillows was estimated (report T1.1.2 on the bedding waste sector), the market opportunities were determined (report T2.2.2 on market shares) and the economic and technical characteristics of a factory that would produce the insulation were described (reports T1.6.1 on the economic model and T1.3.3 on the industrial process).

This report, through the description and analysis of the whole value chain leading to the final product (insulation for construction), aims to estimate the wealth created on the territories by the establishment of a factory or several factories in the France (Channel) England (FMA) area. More specifically, the added value, jobs and tax revenues have, where possible, been evaluated for the French and English parts of the FMA area.

Also, a reflection was carried out on the potential locations for the installation of one or more production units, taking into account the local needs in terms of construction materials, the available raw material pool, the presence of actors in the value chain and public policies.

Economic impact on the territories.

The working hypotheses set include, among others

- The supply of an insulation production unit with 500 tonnes of polyester duvet and pillow waste per year. However, the percentage of the different components varies for each prototype, so by setting the main component of interest for this study at 500 tonnes per year, the tonnage of the other raw materials as well as the total production varies;
- - At zero raw material purchase cost (i.e. supplied and delivered to the factory gate free of charge, without cost or subsidy), the modelling work produced the following results for the FMA area.

The main results for the installation of an insulation production unit including polyester from used duvets and pillows, up to 500 tonnes per year for this component, are summarised in the following table. It is important to note that within the French FMA area, it is estimated that up to 3 production units could eventually be set up. The assumptions and calculations made are presented in more detail later in the document, with the exception of CAPEX, which is presented in the economic analysis report T1.6.1.

Item			Units	Prototype 1	Prototype 2	Prototype 3
Composition		PET from waste duvets and pillows	%	65%	25%	39%
		PET from recycled bottles	%	25%	0%	0%
		PET co-binder	%	10%	10%	10%
		Wool	%	0%	65%	51%
Annual supply	Raw materials	PET from waste duvets and pillows	t/yr	500	500	500
		PET from recycled bottles	t/yr	192	-	-
		PET co-binder	t/yr	77	200	128
		Wool	t/yr	-	1,300	654
		Total	t/yr	769	2,000	1,282
FRANCE						
Economic benefits on the FCE area for the installation of one production unit		Total added value	k€ exc. VTA/yr	2,591 k€	4,811 k€	3,834 k€
		Direct jobs created	Nombre d'emplois	21	29	27
		Initial CAPEX	k€ exc. VTA	8,645 k€	13,653 k€	13,653 k€
		CVAE (CFE not calculated)	k€ exc. VTA/yr	8 k€	32 k€	19 k€
ENGLAND						
Economic benefits on the FCE area for the installation of one production unit		Total added value	k€ exc. VTA/yr	4,415 k€	6,519 k€	5,747 k€
		Direct jobs created	Nombre d'emplois	17	25	23
		Initial CAPEX	k€ exc. VTA	8,553 k€	13,034 k€	13,034 k€

For France, however, it should be noted that this analysis has focused on the supply stages of used duvets and pillows (i.e. sorting and transport), excluding the following dimensions

- The collection activity within the waste collection centres was considered negligible;
- The distribution of the insulation product, as this activity can be local as well as national (and therefore outside the FMA area);
- The production, marketing and transport of raw materials other than used duvets and pillows (i.e. sheep's wool, polyester co-bonding, and polyester from bottle recycling), some of which could however take place in the FMA area, have not been taken into account;
- Only direct jobs have been taken into account, excluding indirect and induced jobs.

For France, the economic impact within the FMA zone could therefore be greater than that calculated.

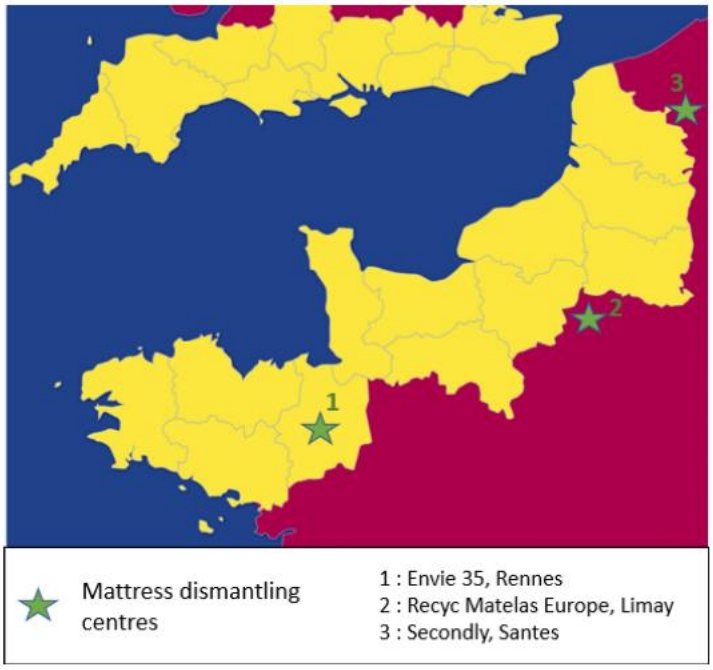
Finally, it is recalled that within the French FMA area, it is estimated that up to 3 production units could eventually be created.

Preferred location areas

In view of the chosen supply scenario (from household waste deposited at waste collection centres and collected in Eco-mobilier skips dedicated to mattresses), in order to limit costs and CO_2 emissions during the insulation production process, the most favourable areas for setting up production are probably close to a mattress dismantling centre that would carry out the second sorting.

There are 3 mattress dismantling centres in or near the French part of the FMA area:

- - Envie 35, located on the outskirts of Rennes (35, Brittany);
- - Recyc Matelas Europe (RME) in the town of Limay (78, Ile-de-France, about 18 km from the administrative boundary of the FMA area);
- - Secondly, which has a centre in Santes (59, Hauts-de-France, about 13 km from the administrative boundary of the FMA area).



In England, if used quilts were to be sourced from the Salvation Army in the UK, it would make sense to locate the manufacturing facility within a reasonable distance of the Salvation Army's 55,000 square foot (5,110 m^2) purpose-built processing centre in Kettering. Kettering is about 30 miles from Peterborough, which is in the FMA programme area.

1 Context, objectives, and methodology

1.1 Objectives of the report

As part of the BIO-CIRC project, the amount of accessible PET was estimated (report T1.1.2 on the waste bedding sector), the market opportunities were determined (report T2.2.2 on market shares) and the economic and technical characteristics of a factory that would produce the insulants were described (reports T1.6.1 on economic model and T1.3.3 on industrial process).

This report, through the description and analysis of the whole value chain leading to the final product (insulation for construction), aims to estimate the wealth created on the territories by the establishment of one or more factories in the France (Channel) England (FCE) area[1]. More specifically, the added value, jobs and tax revenues have, where possible, been evaluated for the French and English parts of the FCE area.

Also, consideration was given to potential locations for the installation of one or more production units, taking into account local needs in terms of building materials, the availability of raw materials, the presence of value chain actors and public policies.

This information should help investors, sector agencies, interest groups and regional public agencies to understand the benefits of investing in these industries in terms of value creation and employment opportunities and to have a clear vision of the main scenario for the supply of raw materials (duvets and pillows) and the production of insulation.

1.2 Methodology

The assumptions and input data used in the preparation of this report were collected through

1. A thorough desk-based review.
2. Qualitative interviews with various players of the sector as well as local authorities.
3. Focus groups in France and Great Britain which assembled a variety of stakeholders.

A series of economic modelling exercises were then carried out to assess the key economic data: value added, employment and tax revenues.

[1] The territories belonging to the FCE area are, for France : Finistère, Côtes d'Armor, Ille-et-Vilaine, Morbihan, Manche, Calvados, Orne, Eure, Oise, Seine-Maritime, Somme and Pas de Calais; and for England : Cornwall and Scilly islands, Devon, Dorset, Hampshire, Western Sussex, Eastern Sussex, Kent, Essex, Suffolk, Norfolk, Wiltshire, Swindon, Somerset, Surrey, Cambridgeshire, Peterborough , Plymouth, Torbay, Bournemouth and Poole, Isle of Wight, Portsmouth, Southampton, Brighton and Hove, Medway, Thurrock, Southend-On Sea.

2 Description of the value chain

2.1 Scenario for France

2.1.1 French regulatory context

In Europe, extended producer responsibility (EPR) – Responsabilité Elargie du Producteur (REP) 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 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.

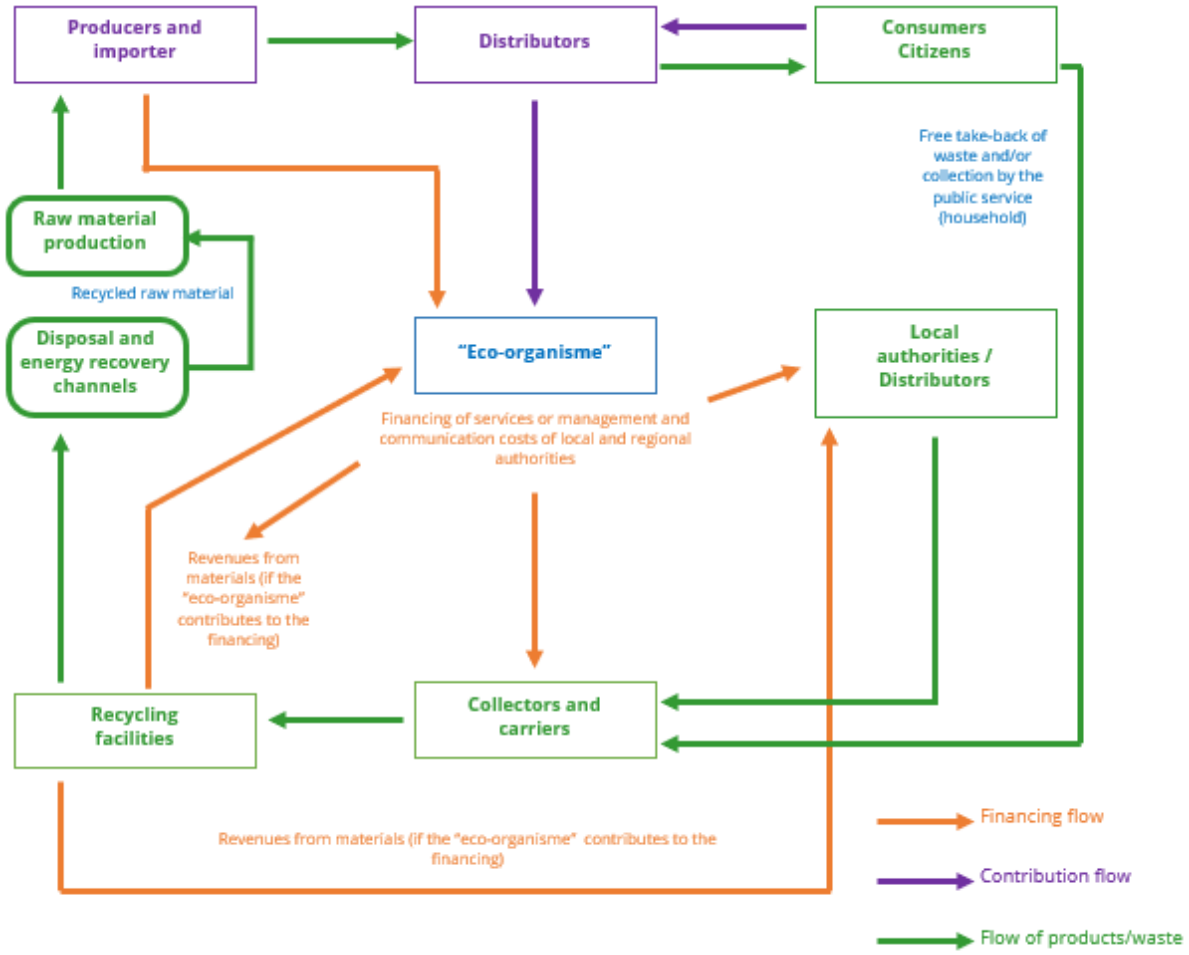


Figure 1 – Scheme of the "Responsabilité élargie du producteur" (ADEME, 2017)

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" - WEEE) 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 (PRAC), to which duvets and pillows belong, have been brought within the scope of the ERO DEA. 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.

2.1.2 Structure of the bedding waste-to-insulation industry in France

During the BIO-CIRC project, several potential sources of bedding waste supply in France were approached: sources linked to waste produced by households (i.e. mainly via collection at waste collection centres), professional sources (hotels, etc.) and from collective housing in the administration (universities, boarding schools, firemen & military barracks, prisons, etc.), and finally professional laundries.

Apart from Valdélia, the eco-organisation in charge of managing professional waste, no actor from this sector, nor from the administration or professional laundries, responded to Nomadéis' requests, perhaps because these sectors are not yet actively involved in managing the end-of-life of bedding waste. Thus, although these sources could potentially represent a significant contribution of raw materials in the long term, the scenario adopted for France is initially that of a supply of household waste from waste collection centres.

In view of these elements, the used bedding recovery sector in France could be structured with the following links:

1) Collect of the bedding waste in a waste disposal centre with specific Eco-mobilier containers for bedding waste.
2) Transport by truck 1.
3) First sorting of bedding waste to keep only the intending ones.
4) Transport by truck 2.
5) Second sorting in a mattress dismantling centre to keep only the polyester bedding waste.
6) Transport by truck 3.
7) Factory design of insulation from polyester fibres.
8) Transport by truck 4.
9) Insulation products distribution.

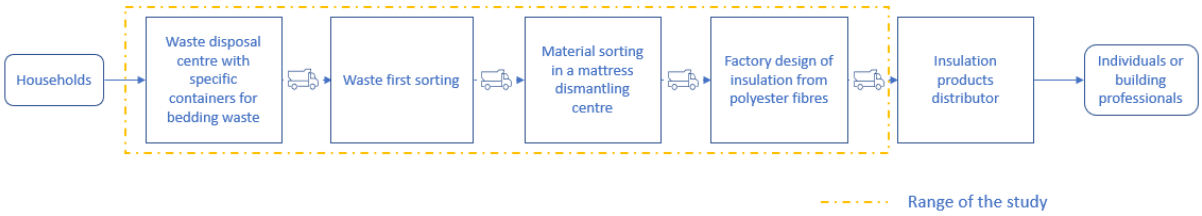


Figure 2 – Structure of the bedding waste-to-insulation industry (France)

This report will focus on the steps 1 to 8, leaving apart the distribution of the insulation product, as this activity may be at local or national scale (and therefor outside the FCE area). Also, the production, marketing and transport of raw materials other than waste duvets and pillows (i.e. sheep's wool, polyester co-linen, and polyester from recycled bottles) were not taken into account, but could represent an increase in the wealth brought to the territories (added value, jobs, tax revenues). Finally, only direct jobs were taken into account, excluding indirect and induced jobs.

2.1.3 Deposit of bedding waste

The French waste operator Eco-mobilier estimates the deposit of households bedding waste in France to 10,000 tons and that approximately 2,000 to 4,000 tons could be collected in the next few years. Since there is around five to ten mattress dismantling centres in France, each one could theoretically collect and sort approximately 200 to 800 tons of bedding waste each year. However, no precise data exist on the actual potential, although this order of magnitude seemed reasonable to the key players interviewed.

Veolia has already conducted experimentations for the collect of bedding waste in 2016 and 2017. He developed special bedding waste containers, where they can be wrapped in plastic bags, to preserve them from humidity. They conducted a characterisation of the collected products that allowed to know their general state (cleanness, humidity) and the material proportions.

It was found that 35% of the waste collected was duvets and 35% was pillows, of which 80% and 65% respectively were polyester, i.e. a total of polyester duvets and pillows of the order of 51% of the total deposit. Thus, as a first approach, each mattress dismantling centre in France could theoretically collect and supply a total of around 100 to 400 tonnes of polyester duvets and pillows per year over the next few years, considering a capture of only 20 to 40% of the total deposit (2,000 to 4,000 tonnes out of a total of 10,000 tonnes per year), and excluding the professional, administrative and industrial laundry deposits. By way of comparison, it is estimated that the minimum tonnage required to create a new production line within an existing plant would be in the order of 100 to 150 tonnes/year, and to create a new site in the order of 400 to 500 tonnes.

Thus, it seems reasonable to assume that only one insulation production site could be located near each mattress dismantling centre.

2.1.4 Collect of the bedding waste in waste disposal centre

Rennes Metropole has just started to collect bedding waste in some of its waste disposal centres. At the moment, 4 out of 18 of its waste disposal centres collect them in dedicated containers from Eco-mobilier. In the rest of them, bedding waste are mixed with other waste and are used as solid fuel.

We can assume that the impact of the generalization of this collection would have a negligible impact on job creation as it would only require a few more minutes of work per centre. However, the supplementary costs are significant, as it would require additional logistic effort.

Waste disposal centre functioning
The waste disposal centres are largely owned by the territorial collectivities. They are divided in two parts : the “top of the dock” part (“haut de quai” in French) that group guarding activities and customers reception, and the “down of the dock” part (“bas de quai” in French) that concern the dumpsters collection. The top of the dock is usually operated by the territorial collectivity and the down of the dock by a private operator.

2.1.5 Bedding waste sorting

The collected bedding waste will then be transported to a first sorting centre, where the pillows and duvets can be separated from the other waste that individual might have put in the containers (cushions and others, that represents 30 % of the total weight). It is assumed that these sorting centres are on average 70 km away from the waste disposal centre.

2.2 Scenario for the United-Kingdom

2.2.1 British context

In the UK, waste management is slightly different. The polluter pays principle and extended producer responsibility is also a driver of waste management, but there is no eco-organism dealing with bedding waste. Currently, non-clothing household textiles are not collected due to their low or non-existent market value. Bedding is neither targeted in collections for reuse/recycling since it is considered low grade in quality with a very limited end market. Thus, textile banks, charities and other textile collectors usually ask the public not to give them duvets and pillows. But they receive duvets and pillows anyway and often dispose of them at a loss. In the context of the BIO-CIRC project, it was decided to **enage with the Salvation Army to supply duvets and pillows**.

2.2.2 Structure of the bedding waste-to-insulation industry in the UK

Considering this regulatory context, the following figure shows the structure that would be in place in UK if a dedicated recycling stream for used duvets and pillows were set up with the help of the Salvation Army. The following steps would occur:

1) Collection of waste bedding from the Salvation Army (this is largely through donations through clothing bins from households e.g https://www.salvationarmy.org.uk/clothing-bank.
2) The clothes banks collected and transported by Truck 1.
3) First sorting of bedding at a central reuse/recycling facility, keeping the clean polyster based duvets.
4) Transport by Truck 2.
5) Further sorting at refiberising factory and then refiberising, turning it into an insulation product.
6) Transport by Truck 3.

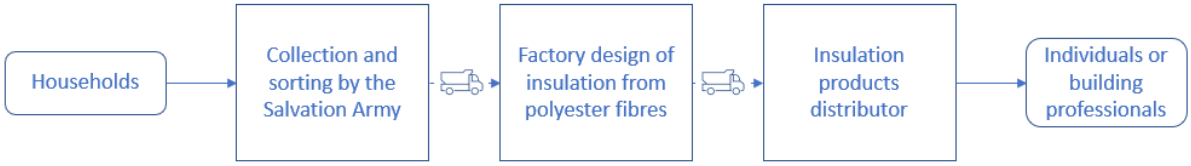


Figure 3 – Structure of the bedding waste-to-insulation industry (UK)

2.2.3 Deposit of bedding waste

Bedding waste can be deposited in either three ways via the Salvation Army : via clothing banks, of which there are around 8,000 in the UK ; brought to Salvation Army Charity Shops (of which there are 400) and lastly, through donation centres (of which there are 20). They reuse and recycle up to 50 million items a year and 50,000 tonnes of textiles, of which 2% is unsaleable with less than 0.25% sent to landfill. An unknown but small proportion will be bedding A study by WRAP suggested that there are around 61,900 tonnes of pillows and duvets arisings as waste every year (with around 90% polyster based). E It has been estimated that only 5% of non-clothing textiles is currently collected in the UK for reuse and recycling, with 20% of those being reused and 80% being downcycled into a low value end market of wipes and stuffing. These are mainly collected mixed with clothing and footwear.

2.2.4 Collect of the bedding waste

The bedding would be collected from the Salvation Army from the aforementioned clothing banks, charity shops and donation centres in dedicated vehicles. These collections are already occurring for clothing, so would not be new as such, however depending on the amounts collected, more journeys may need undertaking.

2.2.5 Bedding waste sorting

The collected bedding will then be transported to a central sorting centre, where the pillows and duvets can be separated from the other items i.e. clothing. It is assumed that these sorting centres are on average 70 km away from the collection points. This sorting centre can reprocess over 45,000 tonnes of clothing per year

3 Impact on local employment and wealth

3.1 General assumptions

Raw material assumption

Following the economic analysis (T1.6.1 report), these computations assume that the amount of polyester processed each year in one factory is the same for each scenario and equal to 500 tons a year. Using the composition of each insulant prototype (P1, P2 and P3), the raw material quantities can be computed and the results are presented in the following table:

	P1		P2		P3	
	%	t/year	%	t/year	%	t/year
PET from duvets & pillows	65%	500	25%	500	39%	500
rPET	25%	192	0%	0	0%	0
Wool	0%	0	65%	1300	51%	654
Bi-Co PET Binder	10%	77	10%	200	10%	128
Total raw materials	***100%***	***769***	***100%***	***2 000***	***100%***	***1 282***

Table 1 – Raw material quantities for the production

Economic assumption

The commercial gross margin is taken to be 20 % at all steps of the value chain as it is done in the economic analysis.

Gross margin definition

Gross margin is the difference between revenue and cost of goods sold, divided by revenue, and is expressed as a percentage. Its purpose is to determine the value of incremental sales, and to guide pricing and promotion decision.

Gross margin (%) = (Revenue − Cost of goods sold) / Revenue

Collection in waste disposal centres

The added value and employment generated by the first step of collection of the bedding waste in waste disposal centres is not taken into account as numerous centres are involved in such a way that this extra-work is marginal in their activity.

3.2 Sorting centres

3.2.1 French scenario

Quantity of bedding waste to sort

According to the estimates provided by Veolia, we assume that 30 % of the collected bedding waste are eliminated during the first sorting operation and 27,5 % during the second one. This gives the following quantities of bedding waste to sort.

Bedding waste to sort (sorting 1)	985 t
Bedding waste to sort (sorting 2)	690 t

Table 2 – Quantity of bedding waste to sort for a year of production (in tons)

Rental costs

The costs of running and renting the sorting centre are highly dependent on where it is located. Necessarily these costs are different between the centre modelled in France and the UK. There is a significant differential between the French and UK scenarios due to the cost of rent being almost 5 times higher in South East UK. The rental cost per m² was estimated after an online benchmark in the different regions.

According to the workshop with Envie35, it is estimated that the surfaces needed to sort the 1050 tons of bedding waste in the first centre is 200 m² and that it is 120 m² for the 625 tons of the second sorting operation.

Size of the site	200	m²
Rental cost per m² per year	40,75 €	€/m²/year
Charges per m² per year	14,00 €	€/m²/year
Rental fees	30%	
Total rental cost per year	**14 235 €**	**€/year**

Table 3 – Rental costs of sorting centre 1 (France)

Size of the site	120	m²
Rental cost per m² per year	40,75 €	€/m²/year
Charges per m² per year	14,00 €	€/m²/year
Rental fees	30%	
Total rental cost per year	**8 541 €**	**€/year**

Table 4 – Rental costs of sorting centre 2 (France)

Employment and labour costs

In line with the workshop with Envie35, it is assumed that the first sorting operation takes 5 times less time than mattress dismantling and that the second one takes 3 times less time. An employee can thus sort 1,000 tons of waste as part of sorting operation 1 and 600 tons for sorting operation 2.

Waste to sort (tons)	985
Number of employee	1
Monthly wage/employee	1 600 €
Employer contributions/employee	672 €
TOTAL labour costs per year	**26 861 €**

Table 5 – Total employment and labour costs (sorting 1)

Waste to sort (tons)	690
Number of employee	1,15
Monthly wage/employee	1 600 €
Employer contributions/employee	672 €
TOTAL labour costs per year	**31 338 €**

Table 6 – Total employment and labour costs (sorting 2)

Added value

Because there is no intermediate consumption in the sorting centres at first approximation, we can here identify the added value with the revenues generated. In particular, rental costs are not deduced from revenues to obtain the added value.

	Sorting centre 1	Sorting centre 2
Rental costs	14 235 €	8 541 €
Labour cost	26 861 €	31 338 €
Total cost	41 096 €	39 879 €
Margin	20%	20%
Added value	**49 315 €**	**47 855 €**

Table 7 – Added value of sorting operations

	Sorting center 1	Sorting center 2
Number of employee	1	1,15

Table 8 – Employment in sorting centres

3.2.2 UK scenario

Quantity of bedding waste to sort

As with the French scenario and in line with the study made by Veolia, we assume that 30 % of the collected bedding waste are eliminated during the first sorting operation and 27,5 % during the second one. This gives the following quantities of bedding waste to sort.

Rental costs

Warehouse space is in high demand in the UK with prime rent for 'bix box' warehouses in London and the South East currently at £16.75 per square foot which equates to c.£180 per square metre. [2]

The size of the sites, no. of sites required, charges per m2 per year and rental fees are assumed to be the same as the French scenario for the purpose of this study.

Size of the site	200	m²
Rental cost per m² per year	£180.00	£/m²/year
Charges per m² per year	£12.00	£/m²/year
Rental fees	30%	
Total rental cost per year	**£49,920.00**	**£/year**

Table 9 – Rental costs of sorting centre 1 (UK)

Size of the site	120	m²
Rental cost per m² per year	£180.00	£/m²/year
Charges per m² per year	£12.00	£/m²/year
Rental fees	30%	
Total rental cost per year	**£29,952.00**	**£/year**

Table 10 – Rental costs of sorting centre 2 (UK)

Cost savings could be made if the bedding was sorted in other areas within the programme area such as the South West (rent costs roughly 50% less). Opportunities for sufficient collection would decrease in these areas due to lower population numbers. However, fostering a new industry is areas with lower employment rates would help stimulate the local economy.

Employment and labour costs

Pay rates in the UK and France are comparable so labour costs are assumed to be the largely the same, with a small uplift of 15% to reflect higher wages in London and the South East. Wages in East Anglia and the South West are assumed to be comparable to France, if not lower.

[2] https://www.statista.com/statistics/323030/prime-industrial-rent-costs-in-the-united-kingdom-uk/

Added value

Because there is no intermediate consumption in the sorting centres at first approximation, we can here identify the added value with the revenues generated. In particular, rental costs are not deduced from revenues to obtain the added value.

	Sorting centre 1 (UK)	Sorting centre 2 (UK)
Rental costs	£49,920.00	£29,952.00
Labour cost	£26,697.25	£31,128.20
Total cost	£76,617.25	£61,080.20
Margin	20%	20%
Added value	**£91,940.70**	**£73,296.24**

Table 11 – Added value of sorting operations

3.3 Factory design of insulation

This part is based on the T1.6.1 report, which analysed in detail the economics of the manufacturing phase of the insulant.

3.3.1 French scenario

Value added is calculated as follows: VA = turnover (total costs excluding taxes + margin + taxes) - raw materials - transport - other expenses.

The added value therefore depends on many parameters, including the final selling price of the product.

As a reminder, given that bedding waste does not currently have a market price, the economic analysis (report T1.6.1) consisted of a back-calculation aimed at determining the purchase price of this waste (or, where applicable, the amount of subsidies required to cover it), based on 3 target prices representing the average of the 3 main groups of insulating products (excluding bulk and insulating concrete) present on the market: 12 € HT (glass wool and rock wool), 22 € (expanded polystyrene, wood fibre, sheep's wool, flax or recycled textiles) or 31 € (polyurethane, cellulose wadding, hemp or extruded polystyrene) per m2 wall of insulation for a thermal resistance (R-value) of 5 m^2. $K.W^{-1}$).

In the present modelling, for the sake of simplicity, the purchase price of these wastes has been set at 0€/t at the factory entrance, i.e. delivered and sold free of charge, without cost but without subsidy either. The corresponding target market price is thus about 16.50, 20.00 and 20.75 € excl. tax / m2 R=5 for prototypes 1, 2 and 3 respectively.

However, in reality, the added value will depend on many variables (waste supply cost, producer and distributor margins, target market price, etc.), for which assumptions have been made in the modelling in report T1.6.1 (economic analysis) and in this report.

		P1	P2	P3
Manufacturing costs	**Labour**	408 960 €	518 016 €	518 016 €
	Raw materials	609 615 €	4 485 000 €	2 336 538 €
	Manufacturing	606 212 €	1 183 068 €	1 030 805 €
	Transport	331 515 €	766 181 €	490 929 €
	Plant costs	535 800 €	535 800 €	535 800 €
	Other expenses	70 000 €	70 000 €	70 000 €
Revenue	TOTAL manufacturing costs ex-tax	2 562 102 €	7 558 065 €	4 982 089 €
	Manufacturer gross margin (20 %)	512 420 €	1 511 613 €	996 418 €
Taxes		154 664 €	404 462 €	275 663 €
Added value		**2 218 056 €**	**4 152 959 €**	**3 356 702 €**

Table 12 – Costs and added value of the manufacturing

	P1	P2	P3
Number of employee	15	19	19

Table 139 – Employment generated for the three scenarios

3.3.2 UK scenario

A similar approach to that undertaken for the French scenario above, was carried out for the UK case.

In this modelling, for simplicity, the purchase price of this waste was also set at 0€/t at the plant gate, i.e. delivered and given away free of charge, without cost but without subsidy either. The corresponding target market price is thus about 27.00, 39.00 and 29.00 € excl. tax / m^2 R=5 for prototypes 1, 2 and 3 respectively.

However, in reality, the added value will depend on many variables (waste supply cost, producer and distributor margins, target market price, etc.), for which assumptions have been made in the modelling in report T1.6.1 (economic analysis) and in this report.

		P1	P2	P3
Manufacturing costs	**Labour**	315 168 €	429 775 €	429 775 €
	Raw materials	630 000 €	5 148 000 €	2 670 000 €
	Manufacturing	602 721 €	1 031 026 €	1 030 805 €
	Transport	617 828 €	919 432 €	916 344 €
	Plant costs	2 020 105 €	2 020 105 €	2 020 105 €
	Other expenses	70 000 €	70 000 €	70 000 €
Revenue	TOTAL manufacturing costs ex-tax	4 255 822 €	9 618 339 €	7 136 473 €
	Manufacturer gross margin (20 %)	851 164 €	1 923 668 €	1 427 295 €
Taxes		161 721 €	365 497 €	271 186 €
Added value		**3 950 879 €**	**5 770 072 €**	**5 178 610 €**

Table 1410 – Costs and added value of the manufacturing

	P1	P2	P3
Number of employee	11	15	15

Table 15 – Employment generated for the three scenarios

3.4 Transport

3.4.1 French scenario

There are four phases of transportation under study: waste disposal centre to first sorting centre, first sorting to second sorting, second sorting to the manufacture and manufacture to distributor.

Assumptions

It is assumed that each truck can carry 80 m^3 of goods (the useful capacity of a semi-trailer is 90 m3 but a margin has been retained, about 10 %, to take into account the impossibility of optimising this space to the maximum). These 80 m^3 correspond to a weight of 3 tons by truck taking the bedding waste density to be 37,5 kg/m^3.

As it is done in the Economic analysis T1.6, the price for such a shipment is set to 1,38 €/km. Moreover, the average distance between waste disposal centres and the sorting centres is supposed to be 70 km, based on the workshop with Veolia and Envie35. The fuel cost per litre is taken to be the average of the 2021-2022 gasoil price.

Added value computation

By dividing the weight to sort each year by the tonnage per truck, we obtain the number of trips made each year. Given that 985 tons of bedding waste need to be sort at the first stage, this means that 328 trips are required every year. The cost of the 22 989 km ride is therefore 31 701 €, to which the fuel cost and other expenses cost are subtracted to obtain the added value of this transportation phase.

Employment computation

The average weekly hours worked (46 hours) by truckers and the mean distance they drive per day (363 km) were found in the statistics of the French work department. They were needed to compute the number of days worked to transport the bedding waste, and then the number of yearly employment necessary.

Tons transported per year (t)	985
Number of truck rides per year	328
Average distance of a ride (km)	70
Total distance per year (km)	22989
Number of day worked	63
Number of employment	**0,30**
Fuel cost	10 939 €
Other expenses	1 000 €
Total revenue per year	31 701 €
Added value	**19 763 €**

Table 1611 - Employment and added value generated by transport 1

The added value and employment of the phases 2, 3 and 4 are computed in the same way.

Tons transported per year (t)	690
Number of truck rides per year	230
Average distance of a ride (km)	200
Total distance per year (km)	45977
Number of day worked	126
Number of employment	**0,60**
Fuel cost	21 877 €
Other expenses	2 000 €
Total revenue per year	63 403 €
Added value	**39 526 €**

Table 17 – Employment and added value generated by transport 2

Tons transported per year (t)	500
Number of truck rides per year	38
Average distance of a ride (km)	20
Total distance per year (km)	769
Number of day worked	2
Number of employment	**0,01**
Fuel cost	366 €
Other expenses	33 €
Total revenue per year	1 061 €
Added value	**661 €**

Table 18 – Employment and added value generated by transport 3

	P1	P2	P3
Number of rolls produced each year	40469	97982	62809
Number of truck rides per year	601	1389	890
Average distance of a ride (km)	400	400	400
Total distance per year (km)	240400	555600	356000
Number of day worked	660	1527	978
Number of employment	**3,16**	**7,30**	**4,68**
Fuel cost	114 390 €	264 373 €	169397
Other expenses	10 458 €	24 152 €	15475
Total revenue per year	331 525 €	766 728 €	491280
Added value	**206 677 €**	**502 355 €**	**321 883 €**

Table 19 - Employment and added value generated by transport 4

	P1	P2	P3
Total transport added value	266 627 €	562 305 €	381 833 €
Total transport employment	4,07	8,21	5,59

Table 20 – Total added value and employment generated by transport

3.4.2 UK scenario

Fuel prices across Europe have been particularly volatile in 2022 due to the Ukraine war with fuel prices in the UK reaching record highs in 2022. At the start of January 2022, fuel prices were largely the same between UK and France with a 6.5% difference (UK – 145 p/litre equivalent, France – 136 p/litre equivalent[3], whereas in June 2022 fuel prices in France were slightly higher. Taking into account this volatile nature of fuel prices it is assumed that fuel prices in the UK and France are the same for the purpose of this study. All other assumptions are the same as the French scenario.

3.5 Added value and employment generated in the FCE region by the implantation of a production line

3.5.1 French scenario

Adding the added value generated by the sorting, manufacturing, and transportation phases, we find the following numbers, for prototypes 1, 2 and 3.

	P1	P2	P3
Sorting	97 170 €	97 170 €	97 170 €
Manufacturing	2 218 056 €	4 152 959 €	3 356 702 €
Transport	266 627 €	562 305 €	381 833 €
Total	2 581 853 €	4 812 434 €	3 835 705 €

Table 2112 – Total added value generated

Adding the numbers of employment generated by the sorting, manufacturing, and transportation phases, we find the following numbers, for prototypes 1, 2 and 3.

	P1	P2	P3
Sorting	2,15	2,15	2,15
Manufacturing	15	19	19
Transport	4,07	8,21	5,59
Total	21,22	29,36	26,74

Table 22 – Total employment generated

[3] https://www.rac.co.uk/drive/travel/advice/european-fuel-prices-petrol-and-diesel-prices-in-europe/

Local taxes generated

The two main local taxes for businesses in France are the property tax for businesses ("cotisation foncière des entreprises" – CFE) and the contribution on the added value of companies ("cotisation sur la valeur ajoutée des entreprises" – CVAE), that constitute the territorial economic contribution ("contribution économique territoriale" – CET).

The property tax for businesses is based on the rental value of real estate assets of the company but is too complex to compute in this case because the applicated rate depend of each municipalities and companies' revenues.

The contribution on the added value of companies concerns companies that makes more than 500 000 € of revenues with a variable tax rate depending on the company's revenues.

Revenues	Tax rate
Less than 500 000 €	0%
Between 500 000 € and 3 millions €	0,25% x (revenues - 500 000 €) / 2,5 millions €
Between 3 millions € and 10 millions €	0,25% + 0,45 % x (revenues - 3 millions €) / 7 millions €
Between 10 millions € and 50 millions €	0,7% + 0,005% x (revenues - 10 millions €) / 240 millions €
More than 50 millions €	0,75%

Table 23 – Tax rate of CVAE depending on the company's revenues

Some assumptions on the different companies involved in the value chain are made to compute an estimation of the CVAE.

Companies	Revenues assumption
Sorting centre 1 and 2	5 millions
Transport 1, 2, 3 and 4	More than 50 millions
Manufacturer	Between 3 millions € and 10 millions €

Table 24 – Assumed revenues of companies involved

	Tax on the added value		
	P1	P2	P3
Sorting	362 €	362 €	362 €
Transport	2 081 €	4 220 €	2 866 €
Manufacturing	5 872 €	27 667 €	15 414 €
Total	**8 314 €**	**32 248 €**	**18 642 €**

Table 25 – Tax on the added value generated

The CFE goes entirely to the municipalities and the CVAE is split as follow: 25 % for the municipalities, 25 % for the Region, and 50 % for the Department.

3.5.2 UK scenario

Through the addition of the added value generated by the sorting, production and transportation phases, the following figures are obtained for prototypes 1, 2 and 3.

	P1	P2	P3
Tri	186 337 €	186 337 €	186 337 €
Fabrication	3 950 879 €	5 770 072 €	5 178 610 €
Transport	277 415 €	562 635 €	382 163 €
Total	4 414 631 €	6 519 044 €	5 747 110 €

Table 13 – Total added value (UK)

Through the addition of the jobs created by the sorting, production and transportation phases, the following figures are obtained for prototypes 1, 2 and 3.

	P1	P2	P3
Tri	2,08	2,08	2,08
Fabrication	11	15	15
Transport	4,04	8,18	5,56
Total	17,12	25,26	22,64

Table 14 – Total jobs created (UK)

Local taxes generated

Companies operating in the UK are subject to national taxes on their profits such as corporation tax (for limited companies). Unlike income tax which is payable by individuals, companies do not benefit from any kind of personal allowance, so tax must be paid on all profits. Corporation tax has a flat 19% charge, regardless of how much profit the company makes.

At a local level, businesses that operate from a warehouse or shop are liable to be charged business rates. In a similar way to council tax, business rates bills are calculated and sent out by local authorities. Business rates are calculated on the property's 'rateable value' meaning its estimated rental value on the open market.

Business rate reliefs are available to businesses setting up in 'enterprise zones'. There are 48 Enterprise Zones established across England with a focus upon a wide range of business sectors, including more than 10 within the Channel Manche programme area.

3.6 Limits of the modeling

The results presented in this report should be treated with caution, as they are estimates derived from a simple modelling exercise. Cost and price estimates are inaccurate because some of the data we use and some of the assumptions and calculations we have made are imprecise. These issues are inherent to any modelling or forecasting work. One should bear in mind that the polyester-based insulation module remains at the prototype-stage, it is not yet produced or commercialised.

The goal of this wealth and employment creation estimation is to emphasis that the implantation of a production line in the FCE region would create a lot of local benefits. Indeed, this production chain is by essence a local industrial project as it is based on the collection of households' bedding waste.

Below are some reasons why these estimations can be inaccurate:

- The price of fuel has been highly fluctuating these last couple years and could have a certain influence on the transportation added value.
- For France, the following dimensions were not taken into account
    - The collection of bedding waste at waste disposal centres was considered as nil as it represents a very small part of the activity of many waste disposal centres;
    - Distribution of the insulation product, as this activity can be both local and national (and therefore outside the FMA area);
    - The production, marketing and transport of raw materials other than used duvets and pillows (i.e. sheep's wool, polyester co-bonding, and polyester from bottle recycling), some of which could however take place in the FMA area, have not been taken into account;
    - Only direct jobs have been taken into account, excluding indirect and induced jobs.

  For France, the economic impact within the FMA area could therefore be higher than calculated.

4 Opportunities for implantation

4.1 French scenario

4.1.1 Best geographical zone for the factory

Given the supply scenario retained (from households waste disposed off in household waste recycling centres and collected in Eco-mobilier bins dedicated to matresses), in order to limit the costs and the emitted during the production process of the insulants, the bests areas for the implantation of the manufacture are without a doubt nearby a mattress dismantling centre that would carry out the second sorting operation.

The other potential criteria (local construction / renovation needs, potential for innovation and support from local government and agencies) appear secondary with respect to the election of a location for the implementation of a production facility.

There are 3 mattress dismantling centres in or nearby the French FCE region:

- Envie 35, located in the outskirts of Rennes;
- Recyc Matelas Europe (RME) in the city of Limay;
- Secondly, which has a centre in Santes.

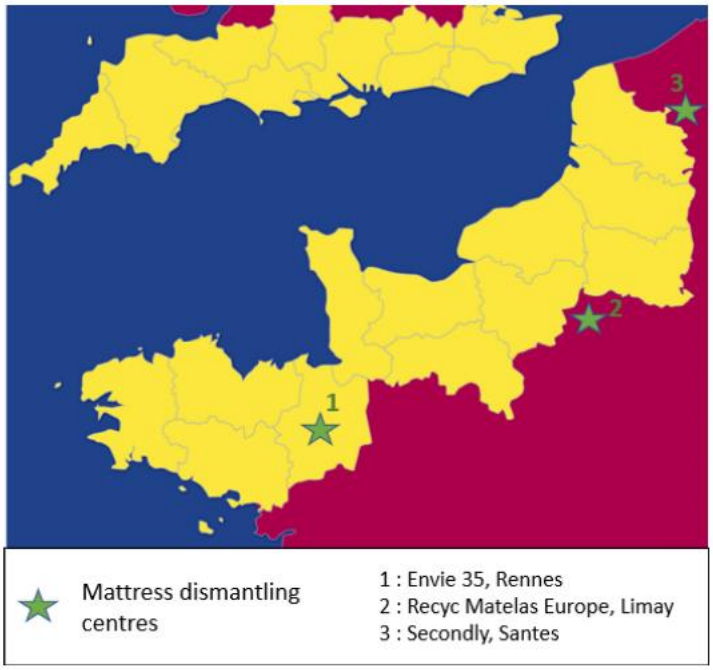


Figure 4 – Location of the three mattress dismantling centres in the French regions under study

The Envie 35 dismantling centre is located in the outskirt of Rennes. It is the only centre inside the French FCE region, and the proximity to a big city makes the transport logistic easier.

The two other centres (RME and Secondly) are located outside the French FCE region but are close to it (at approximately 18 and 13 km from the administrative delineation, respectivelly), enabling the manufacture to be inside the FCE region and close to its sorting centre.

Although in this scenario (B), the local added value and employment generated would not be as much as for the scenario in which the manufacture is located close to Envie 35. Indeed, in this case, we can assume that the first steps (3 first transports and both sorting phases) of the value chain take place outside the region, and we need to subtract the added value and employment that they would have generated in the region.

Scenario B: Manufacture located near RME or Secondly as its second sorting centres

	P1	P2	P3
Added value	2 435 191 €	4 655 314 €	3 678 585 €
Employment	18,16	26,3	23,68
Local tax on the added value	1 629 €	3 768 €	2 414 €

Table 28 – Corrected added value, employment and taxes generated in the French FCE region for scenario B

However, most of the added value and employment being generated by the manufacture and fourth transport, this alternative scenario still generate a significant wealth on the French part of the FCE area.

4.1.2 Potential local public support

Rennes metropole

With regard to the potential establishment of an insulation production site near the Rennes mattress dismantling centre, several considerations, sometimes antagonistic, can be taken into account.

On the one hand, it appears that the Rennes area is already well endowed with economic activities, and the local officials wish to promote territorial solidarity by avoiding economic polarisation. Also, the price of land can be high. These elements could therefore encourage the exploration of areas other than the Rennes metropolis, while remaining reasonably close to the Envie35 centre.

On the other hand, local officials wish to reconvert the former PSA Stellantis site of La Janais, located about 2 km south-southwest of Rennes, into a centre of industrial excellence. A reindustrialisation plan has been initiated, including a sustainable building component.

In the medium term, an industrial incubator will be set up.

In general, the Rennes Métropole Economic Development Department aims to support investment and job creation, through the establishment of new companies or the development of existing economic activities.

Currently, the aids are being redesigned in order to integrate the various dimensions of the ecological and solidarity-based transition.

It should be noted that the creation of a regional circular economy loop, including an industrialist, a cooperation agreement for access to raw material deposits, and a public order with a leverage effect, may take time.

Brittany Region

The ambition of the Brittany Region is to support the change of scale of bio&geobased building materials.

The Regional Council has several levers of action for this:

- Technical assistance via a call for projects carried out by the Brittany federation of biobased sectors, with 8 sectors (including Métisse) supported to date;
- - Public procurement on its own assets, through the construction and renovation, for example, of high schools.

4.1.3 Demand opportunities

It is assumed that the insulation produced would be intended for national distribution in France. Following the estimated demand calculation in report T2.2.2 (market study), it can be seen that in the reasonable case that these insulations could take 5% of the biobased insulation market, the demand would be equal to more than 2,000 tonnes per year, i.e. more than the 769 or 1,282 tonnes/year produced by the plant for prototype 1 or 3, and corresponding to the production capacity of a plant producing prototype 2. Moreover, the market for bio-based insulation is set to grow, whether due to new building standards (RE2020 in particular) or the acceleration of renovation.

In particular, the local needs for retrofitting insulation will be consequent, as the mean "Diagnostique de Performance Energétique (DPE)" – Energy Performance Diagnosis of houses in the region is higher than the mean at national level. Indeed, the French government is engaged in great efforts for these high energy consuming houses to be insulated: the Climate law of 2021 ("loi Climat et Résilience du 22 août 2021") will prohibit them for rent from January 2023.

4.2 UK scenario

4.2.1 Best geographical zone for the factory

If waste duvets were to be sourced from Salvation Army in the UK, it would be logical to locate the manufacturing facilities within a reasonable distance of the Salvation Army's purpose-built 55,000 square foot processing centre located in Kettering.[4] Kettering is approximately 30 miles from Peterborough which is in the Channel Manche programme area.

[4] https://www.youtube.com/watch?v=IuiEL2OvapQ

4.2.2 Demand opportunities

As highlighted in the market intelligence study of the BIO-CIRC project, the UK has the least energy efficient housing stock in Europe with 26 million homes in need of retrofit. need to be retrofitted in order to meet the UK's net zero targets.

The current market share for NRFI in the UK is not as significant as in France (c.1%), but it is the fastest growing insulation segment in the UK achieving CAGR of 10-20% for the past 3 years, and its share of the market is expected to grow significantly over the coming years. At its current market share of 1% this represents nearly 100,000 attics within homes to be insulated with NRFI.

Supply of construction materials is becoming an ever acute issue and there are calls for an increase in UK manufacturing of bio-based materials, such as the Welsh Government's recent prospectus calling for investment in woodfibre insulation manufacturing in the region.

EUROPEAN UNION

Interreg

EUROPEAN UNION

France (Channel Manche) England

BIO-CIRC Project

European Regional Development Fund

The BIO-CIRC project is part of the cross-border European Territorial Cooperation (ETC) Programme Interreg VA France (Channel) England and benefits from financial support from the European Regional Development Fund