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BIO-CIRC Project

European Regional Development Fund

BIO-CIRC Project

Bio(and)**Circular** **I**nsulation for **R**esourceful
Construction

Activity T1.1 - Assessment and structuring of the
waste bedding management sector

Summary report



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The Alliance
for Sustainable
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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.

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1 Objectives of this study

The BIO-CIRC project's intention is to mitigate the building sector's high carbon, energy and resource dependencies, while recycling unused polyester from waste bedding. The project aims to design, produce and deploy 3 prototypes of **innovative low-carbon thermal insulation material** made from recycled polyester combined with natural fibres.

To support the structuring of waste management of bedding items, **current production and management practices** must be examined. Further, to allow their recycling within the construction industry, manufacturers need to have an idea of the **collection, transport, sorting, sanitising opportunities and challenges**. Similarly, new or existing players need to be mobilised to structure this sector. To achieve this, partners will undertake a review of available data, interviews with manufacturers who valorise related waste in construction products and waste management companies, mobilise existing networks and respective whose scope aligns with the aim of the project and organise two multiparty workshops on waste polyester concentration, sorting and sanitisation (1 in France and 1 in the UK).

This report aims to identify **mechanisms, actors, geographic areas, and feedstocks** that will be implied in order to prepare a long-term supply of waste duvets. More specifically, it aims to understand the ecosystem dynamics and find out:

- Who the actors are;
- Where the feedstocks are and under what form;
- How actors and feedstocks can be connected.

2 Desk-based review exploring current waste management practices

2.1. Product descriptions and variations

The products the project is aiming to collect are polyester duvets and pillows. The composition being the number one factor for good recyclability, the quality of the primary material is crucial in the recycling process. The collection process should therefore aim to separate animal from polyester fibres, as well as vegetal and polyester fibres. It is to be noted that a mix of cotton and polyester in duvets and pillows poses technical challenges, but that a certain quantity of cotton remains acceptable.

The existing categories of duvets and pillows have been mapped out: the **main types of duvets and pillows** sold on the market, and in particular their **size, composition and weight distribution**.

There are two main types of duvet fillings: **polyester and feathers**. There are also duvets made of wool, silk and bamboo, but these products remain marginal. Polyester duvets are lightweight, easy to maintain and more affordable than duvets made of feathers. There are many varieties of polyester fibres (Quallofil Air, Hollofil, Cyclafill...). The more the fibres are made to contain air, the lighter they are while remaining insulating.

Standardised Duvet Sizing in France
140 X 200 cm
200 X 200 cm
220 X 240 cm
240 X 260 cm
240 X 280 cm

Filling material
Polyester
Cotton
Wool
Down
Silk

Outer shell material
Polycotton
Cotton
Polyester

Figure 1: Duvet variations (size, filling and outer shell material)

For outer shells, cotton is the most widely used material, although silk and linen shells are also available.

2.2. French framework

In France, bedding falls under the category “Furniture items”, itself made up of eleven sub-categories. Duvets and pillows are categorised as “Upholstered Seating and Bedding Products” (“Produit Rembourré d’Assise et de Couchage” or PRAC).

PRAC items encompass not only duvets and pillows, but also cushions, bolsters, mattress toppers and sleeping bags.

CATEGORIE	DESCRIPTION
1	Meubles de salon, séjour, salle à manger
2	Meubles d’appoint
3	Meubles de chambre à coucher
4	Literie
5	Meubles de bureau
6	Meubles de cuisine
7	Meubles de salle de bains
8	Meubles de jardin
9	Sièges
10	Meubles techniques, commerciaux et de collectivités
11	Produits rembourrés d’assise ou de couchage (depuis le 1 ^{er} octobre 2018)

Figure 2: The eleven sub-categories of furniture items (Source: ADEME 2020)

Every year, it is estimated that nearly **860,000 tonnes of waste furniture components** are collected in France, 80% of which are given a second life through reuse, recycling or energy recovery¹. In 2019, **2% of furniture products placed on the market were upholstered seating and bedding products**². In 2018, waste upholstery products represented about 16% of all furniture waste³, representing an annual collection of around **197,000 tonnes**.

Eco-Mobilier undertook a characterisation campaign of upholstery waste and identified the composition of the waste and gave the following estimates:

- Synthetic materials (mainly polyester) account for 50%;
- Cotton textile represents 10 to 15%;
- Feathers represent 30% of the SBP deposit.

¹ <https://www.ecologie.gouv.fr/dechets-delements-dameublement-dea>

² <https://www.ecologie.gouv.fr/dechets-delements-dameublement-dea>

³ ADEME (Philippe BAJEAT), Deloitte Développement Durable (Véronique MONIER, Manuel TRARIEUX). 2019. *Rapport annuel de la filière des Déchets d’Eléments d’Ameublement (DEA) – données 2018*

2.3. UK framework

Product information

The most common material according to WRAP used for bedding/duvets is **polyester at 58%**, followed by cotton at 17%, polyamide at 13% polyurethane at 10% and feathers at 2%. The covers on duvets and pillows are generally cotton or a poly-cotton blend. The choice between different fibre and filling types was found to be price driven rather than product performance.

Duvets in the UK are sold by tog rating which relates to the scale of the duvet's warmth and therefore the efficiency of the material's thermal insulation. The EU works on a grams per square metre basis which may encourage higher filling weights. Based on PRODCOM statistics, **approximately 5% of the duvets and pillows produced in the UK are filled with down and, as these are typically more expensive than the polyester-based alternatives, these account for nearer 10% of the value.** Recycled polyester, derived from PET bottles, is used in bedding products but is generally more expensive than virgin feedstocks.

Low-tog (less thick duvets) are generally constructed using a 'box-stitch' method, whilst thicker duvets are sometimes constructed using a 'baffle box' approach (more usual in high-end duvets). Duvets, especially those containing wool and other natural fillings, are sometimes quilted.

Depending on the tog-rating, duvets typically weigh between 1.5 kg (single 4 tog) and 3.5 kg (king 12 tog), pillows between 0.5kg and 0.75 kg. **There are an estimated 500 million units of bedding in circulation.**

Relevant legislation and standards include:

- Standard BS EN ISO 12952-2:2010: Textiles — Assessment of the ignitability of bedding items Parts 1 and 2.
- Standard BS 1425 Part 1: 1991: Cleanliness of fillings and stuffings for bedding, upholstery and other domestic furniture.
- Standard BS1877-8: 1974: Specification for Domestic bedding — Part8: Pillows and bolsters for domestic use (excluding cellular rubber pillows and bolsters).
- Standard BS 5335-2: 2006: Continental quilts – Part 2: Determination of thermal resistance for quilts filled with feather and/or down.

The sector and market size (UK)

In 2013, the total UK market value of non-clothing textiles was £3.44 billion, which equates to a market size of approximately **270,000 tonnes** (household @ 220,000 tonnes and commercial @50,000 tonnes) this includes mattresses and pillows. The non-clothing textiles market in the UK is dominated by **imports** - 82% by volume is imported. The main countries exporting to the UK

are: China (31%), Pakistan (27%) and Bangladesh (14%). Overall, an estimated 2.5-2.7 million tonnes of textiles is consumed within the UK annually.

Estimates differ for the number of duvets and pillows placed on the market. WRAP estimated around 116,100 tonnes per year. Another study indicates that around 94,000 tonnes of duvets and pillows are placed on the UK market every year – with a similar amount disposed of or hoarded. The market is worth approximately £500 million and is split 50:50 between UK production and imported products in terms of value. PRODCOM data shows that the 10 year period between 2009 and 2018, the average value of UK pillow and duvet consumption was 560 ± 70 million euros. **Non-down/feather bedding accounts for 95% of the market in terms of volume (number of units)** and the level of imports has remained roughly steady at 50% of overall value since 2009.

The UK businesses involved in this sector include filling and cover textile producers and importers, manufacturers, and retailers. Some businesses are involved with more than one stage of the value chain. **SMEs dominate the manufacturing stage** and key players include: John Cotton Ltd, Comfy Quilts Ltd, Soak and Sleep Ltd, Downland Bedding Ltd, Empress Quilts Ltd, and many more. Some of these produce duvets and quilts for branding by third parties including major retailers, others specialise in products for the hospitality or services sectors. The major retailers in the UK of non-clothing textiles are: Dunelm, IKEA, John Lewis, Marks & Spencer, Matalan and Tesco.

3 Structuration of the value chain

3.1. French legal framework

3.1.1. Extended Producer Responsibility

In France, an **Extended Producer Responsibility** obliges waste managers to selectively collect and sort certain types of waste, among which furniture products. The implementation of producer responsibility serves to give responsibility for furniture waste management to companies, manufacturers and distributors of furniture, so that they integrate into the design and manufacturing phases the ecological impact of the end-of-life of the products they place on the market.

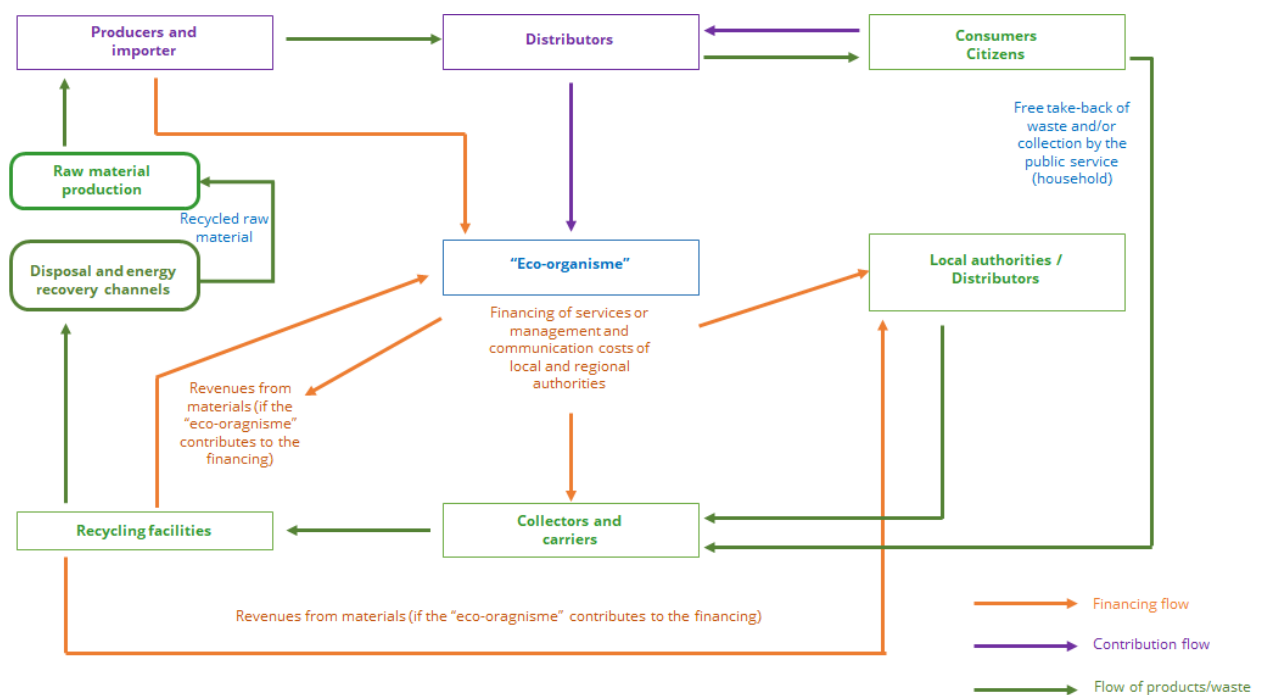


Figure 3: Simplified operation of the Extended Producer Responsibility (Source: ADEME, 2017)

Since January 1st, 2018, **the scope of application of the Extended Producer Responsibility has been extended to upholstered seat and bedding products** (cushions, pillows, duvets, etc.). There are two non-profit environmental organisations which are financed by an "eco-contribution" scheme paid by all customers when they buy one of the new products for which these organisations are responsible:

- **Eco-Mobilier**, for private individuals (households);
- **Valdelia**, for professionals. It provides a collection system *via* a network of voluntary drop-off points and takes back directly from the holders the waste they make available as soon as the quantities and volume concerned exceed a minimum threshold set by the approval specifications⁴.

⁴ Ademe, (2017), Les Filières à Responsabilité Elargie du Producteur – Panorama

These two Production Responsibility Organisations work with furniture companies, regional authorities and waste treatment providers to ensure that citizens' and professionals' used furniture can be collected, sorted and recycled or reused as energy.

The current plan for collection is for companies and individuals to be able to deposit it in specific skips located in **sorting centres** or specific **gathering/pooling centres** (for example: near a distributor's point of sale). Valdelia also organises collections of bedding waste directly with producers.

Throughout France, 170 logistics sites have been selected to receive Eco-mobilier's skips dedicated to furniture waste. Spread over the whole of France, these sites receive waste from thousands of waste collection centres and other collection sites under agreement with Eco-mobilier. The furniture is consolidated there and sent for treatment to the selected sites.

The national targets for recycling are **regularly revised upwards**: for instance, the law of February 2020 on the fight against waste and the circular economy set new targets for waste reduction by 2030:

- **15% of household waste per inhabitant**, and
- **5% of waste from economic activities**⁵.

3.1.2. Initiatives for waste bedding collection

Recent initiatives have been undertaken in partnership with "Eco-Mobilier" to collect waste bedding:

- The furniture manufacturer distributor **Ikea** has organised collection operations for used duvets: customers were invited to bring in their used duvets in stores in December 2018 and January 2019. The Production Responsibility Organisation "Eco-Mobilier" stepped in by organising the collection of the products with its partners in charge of waste collection and treatment. Part of the products collected during this recovery operation were transformed into energy sources;
- An experiment was conducted in Bordeaux in partnership with "**Yoyo**", a local association which strives to entice citizens to sort their waste. They launched a project for the **separate collection of duvets and pillows**, in order to preserve the quality of the material and thus ensure optimal recycling and recovery. In 2019, an initial test was carried out with more than 350 participating Bordeaux households and resulted in the **collection of 2.3 tonnes of used products**.

3.1.3. Outlets

Eco-Mobilier estimates that approximately **1,000 to 1,200 tons of bedding waste are collected each year** by Social and Solidarity Economy stakeholders for reuse. The majority of these products are exported to developing countries.

The rest goes to landfill storage. However, for the portion that was not collected separately, was refused in the sorting line, was mixed with other waste, the proportion of bedding and upholstery in these streams is not known.

⁵ <https://www.vie-publique.fr/loi/268681-loi-lutte-contre-le-gaspillage-et-economie-circulaire>

3.1.4. Feedstock supply

In 2019, it is estimated that 47,332,000 PRAC items were put on the market, representing around 47,000 tons of PRAC items. It is estimated that PRAC with synthetic upholstery represent between 1% and 3% of the total amount of furniture items put on the market annually, amounting to between 28,000 and 84,000 tons. It is estimated that pillows represent about 75% of PRAC items put on the market, whereas sleeping bags only represent 2%⁶.

Theoretically, 10,000 tonnes per year of used upholstered seating and sleeping products (PRAC) could be mobilised. In practice, only a fraction could be collected (between 2000 and 4000 tonnes). Considering the distribution of the types of PRAC and their composition, **the deposit of recoverable polyester duvets and pillows in the coming years is between 1,000 and 2,000 tonnes per year in France.**

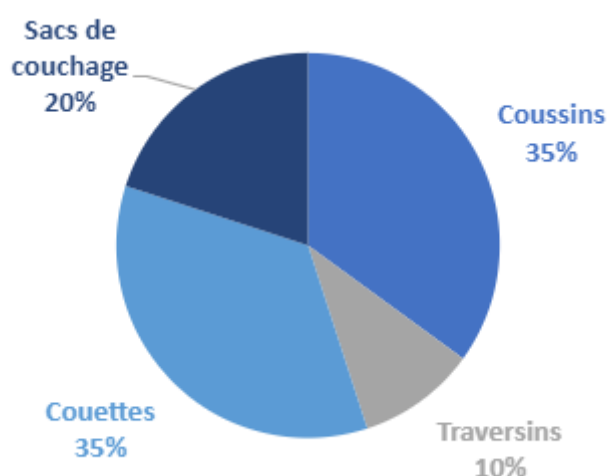


Figure 4: Distribution of the PRAC waste stream

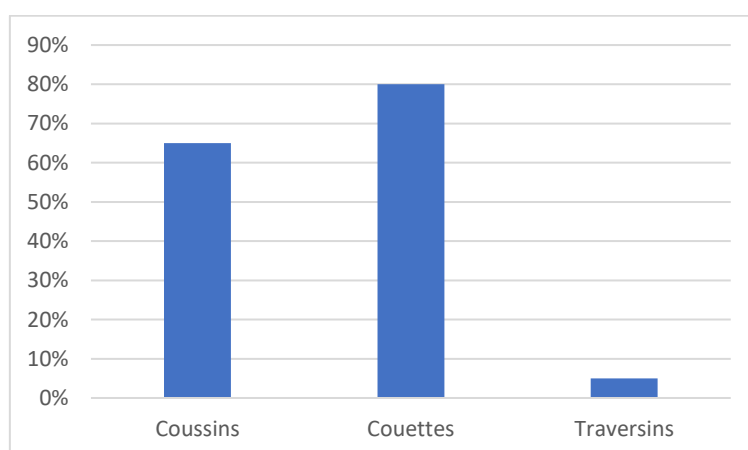


Figure 5: Polyester ratio of cushions, duvets and bolsters

In France, 75% of duvets sold are synthetic, and more generally, 80% of the duvet and pillow market are made up of synthetic materials⁷.

⁶ <https://www.francebleu.fr/emissions/la-minute-conso/recycler-ses-couettes-et-ses-oreillers-usages>

⁷ <https://business.ladn.eu/news-business/actualites-annonceurs/loulenn-couette-laine-ecoresponsable-made-in-france/>

As of now, the PRAC collected are mainly turned into Solid Recovered Fuel. The most voluminous waste stream of PRAC comes from waste disposal centres. Separate collection of duvets and pillows at waste collection centres does not seem feasible as of now. It therefore seems more interesting to collect mattresses together with duvets in the skips provided by Eco-mobilier at municipal waste collection centres. The establishment of an insulation manufacturing plant should depend on the identification of and coordination with a mattress dismantling centre.

3.2. UK framework

3.2.1. Waste generation and management

WRAP estimated in 2010, that there was **61,900 tonnes of pillows and duvets arising a waste per year in the UK** (71% from England (excluding London); 1% from London and the remainder from Wales (5%), Scotland (9%) and Northern Ireland (3%). Research conducted in 11 UK household waste recycling centres (HWRCs) showed that 3.6–10.7% of the residual waste stream was non-clothing textiles including upholstered bedding.

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. From interviews with reuse organisations approximately 20% of non-clothing textiles collected are subsequently reused. The market for reuse is overseas in Pakistan, Sub Saharan Africa and Eastern Europe. A very small proportion (less than 100 tonnes) is being re-used in the UK through charities and social enterprises.

Currently no collections exist only for non-clothing household textiles due to no or low commercial end market value. Bedding is not targeted in collections for reuse/recycling since it is considered low grade in quality with a very limited end market. The bulk nature of bedding also makes it an undesirable product for recycling as it can easily fill up a textile bank leaving no room for more valuable clothing donations. With very little recycling infrastructure in the UK, it has been estimated that at most 3% of bedding is currently being recycled. According to WRAP market research between 35% and 45% of duvets and pillows are discarded through household (or HWRC) residual waste, whilst 45%-50% is 'recycled' or donated to charity.⁸ The remainder is stored, given away, sold or reused in the home. However, given the lack of recycling infrastructure it is highly unlikely that many of the duvets and pillows sent for recycling are actually recycled. Other studies indicate that these items are predominantly disposed of to the kerbside residual waste stream as they fit in domestic waste containers. There's probably a lot of in-use accumulation as they're the type of products people keep 'just-in-case'.

For textiles, the **main collections routes** are:

- **Kerbside collection services** – where households are asked to gather textiles for re-use, and leave them for collection at the kerbside. These services can be run either by a local authority – as part of their overall kerbside recycling service – or by charities or commercial collectors.

⁸ Non-clothing textiles: consumer purchasing, use and discard practices:
<http://www.wrap.org.uk/sites/files/wrap/REC601-001%20NCT%20Final%20Report.pdf>

- **Bring/textile banks** –often in public spaces such as car parks of village halls or community centres, or household waste recycling centres (HWRC). These can be provided either by the local authority itself, charity or community organisations or commercial collectors. This is well established in the UK with an estimated 12,000 to 15,000 banks nationwide with 140,000 tonnes collected. In general, duvets and pillows are discouraged.
- **Community re-use initiatives** – this covers a wide range of ways in which textiles can be collected, exchanged or sold, from charity shops to schools and group collections, swishing, on-line exchanges, jumble sales etc.

Textile banks, charities and other textile collectors generally ask the public to not give them duvets and pillows. The main reason being their **bulkiness and low value**. Nevertheless, textile collectors do still receive duvets and pillows and often dispose of at a loss (but at a loss less than if they had to pay for their waste disposal costs). Down and feather products are exported to Europe (mostly Poland) for recycling and polyester products are sent to Pakistan (also for recycling it is assumed). Generally, charities do not sell donated duvets and pillows in their retail outlets. Though it is reported that some can be donated to homeless shelters and animal charities accept a small number for use as animal bedding.

According to studies, the most reliable way to ensure the high quality in waste textiles collected, is to organise the **collection indoors and with personal customer service**. Collection points in the residential area showed also better outcome than other collection types compared. When collecting textiles in HWRC's, there emerged bigger amounts of other waste materials in the collection containers, and moisture in textiles, caused by failures in customers' sorting, unsuitable containers and too long emptying intervals. None of the container types examined protected the textiles fully from getting damp. The quality of waste textiles collected can be improved by advising customers to pack the textiles as waterproof and with frequent emptying the containers. Also, the circumstances in reception and storing can be crucial for the quality of textile.

WRAP has investigated **different collection options** being used for non-clothing textiles from both households and businesses in the UK. Key findings include:

- Collecting non-clothing textiles for re-use or recycling can be cheaper than sending them to landfill. It may become cheaper still if landfill costs rise further in future.
- There are limited UK re-use markets for pillows and duvets, some options for re-use & recycling abroad and energy recovery in the UK.
- Revenue from the sale of items for re-use and materials for recycling is too low to offset costs alone. Commercial collectors rely on service charges to make services viable; local authorities and third sector organisations may charge for collections or in some cases benefit from grant funding to help establish services. Potential future increases in the value of materials could reduce reliance on the service charge.
- Viability can be increased by separating items at the collection point – allowing reprocessors or re-use organisations the opportunity to take only the materials they can use.
- Locating reprocessing points in close proximity to major sources of arisings, or using bulking points reduces transport costs.

- There is a need for wider education – of both consumers and businesses – about the options for re-using/recycling non-clothing textiles. In particular, raising awareness of alternative options for disposal locally, and of the importance of keeping items dry when waiting for collection, as the value to collectors, reprocessors and resellers can drop when they become wet.

Textiles are sorted mostly manually which enables separation of high value re-useable items from lower value products. Textile recycling is currently focusing on mechanical recycling and pre-consumer textile fractions often into low value applications. Most of the recycling processes are sensitive or selective to the fibre type, but manual sorting does not provide high accuracy nor high volumes. Almost all textile waste fractions need to be pre-processed for recycling. Knowing the origin and the history of a material makes it easier to decide how to process it. Used textiles might have been contaminated during use or collecting and transportation phases, which might be risk for personnel in recycling process or limit the possibilities for utilize such materials altogether or in selected applications

There are some examples of mattress recyclers, but generally they do not collect duvets and pillows. A study indicated that two mattress recyclers are offering take back of duvets and pillows from the hospitality sector (and have, in the past charged between 0p and 25p per pillow depending on the price of polyester). They then sell them on to one of a handful of reprocessors.

3.2.2. Barriers

The main barriers to duvet and pillow recycling identified in the literature and from interviews are:

- **Economic:** The intrinsic low value of pillows, and even more so, duvets, at end of life is limiting, together with a lack of a commercially attractive market. Revenue for selling the material for reuse is low and does not cover collection costs.
- **Technical:** Processes to separate the fillings from the covers and then clean and reprocess the materials for available markets would need to be developed further (and both the economics and environmental case validated). It can also be time-consuming to deconstruct for closed loop recycling. They can absorb a large amount of water, if they get wet, as such they need to be kept clean and dry. There may also be an issue with fire retardants, though this is limited if missed with other materials. The range of fillings could also complicate recycling routes.
- **Logistical:** Addressing the consolidation and transportation challenge of pillows and duvets (unless baled) is key to making any take-back economic. As the products are light, they are expensive to transport on a weight basis.
- **Perception:** Public awareness of recycling routes would have to be addressed to increase collection and, if the recycled content was to be reprocessed for use in other products, then the public would have to be reassured as to the hygiene of the recycling processes employed.
- **Health:** The use of biocidal chemicals in anti-allergy products may prove an issue if large scale duvet and pillow take-back and recycling were to develop. Similarly pillow fillings, not duvets,

must meet the testing requirements as set out in the UK (fire safety) furniture and furnishings regulations, which, for synthetic fibres, may require the application of flame retardants.⁹ People may be exposed to harmful chemical compounds existing in the textile products via skin and by inhaling and swallowing textile dust. If the material to be processed contains skin or eye irritating substances or sensitizers, exposure via unprotected skin and eyes is possible. If textile dust is not properly managed during processing, it may cause an occupational health risk.

- **Metrics:** drivers and pillows are comparatively low weight relative to other non-clothing textiles. This means they are not considered a priority area by authorities seeking to achieve increases in weight-based recycling rates, or by waste management companies seeking to segregate materials to reduce their landfill disposal costs (charged by weight).

3.2.3. Opportunities

Opportunities identified in the literature and from interviews include:

- Developing contract hire and leasing for commercial mattresses, duvets and pillows in university halls, hotels and holiday accommodation. Anecdotal evidence indicates that commercial mattresses, such as those used in hotels, are often disposed of prematurely due to corporate replacement or refurbishment policies. There is a high potential for re-using these mattresses as they have not reached the end of their useful life and additionally have usually been regularly cleaned to maintain hygiene standards. Capturing lightly used commercial textiles would provide a homogenous feedstock for re-use.
- There is the potential to re-use (and send for energy recovery) pillows from the hospitality sector (hotels, university accommodation) where, due to the size of the institutions, sufficient quantities can be collected at one location to make it viable. Items could be sorted by quality prior to collection or at the bulking stage, and distributed for re-use through third sector organisations, or sold on to the market for energy recovery.
- The co-collection of pillows with other materials from hotels and universities on a 'milk round' service can be cost neutral, however co-collection of duvets and pillows with clothing and other household linens through bring banks is unlikely to be viable. The use of third party logistics and spare capacity on existing rounds helps to make the collection more efficient and cost effective.
- If more substantial end markets developed in the UK, an option could be separate (specialised) banks, operated by businesses that have a dedicated duvet/pillow collection and reprocessing service.
- Co-collection of duvets and pillows with mixed carpet waste or soft furnishings at HWRC sites could be investigated as an option for these items, followed by their shredding for

⁹ One biocidal treatment reported for pillows is (mineral salts of) titanium dioxide and silver chloride. Authors unsure of what flame retardants are used in pillow fillings but antimony trioxide is a common treatment for polyester based furniture fabrics.

open loop recycling. In particular it may be possible to use the resulting material as void filler in long term applications, providing an insulating benefit which itself may exceed the environmental benefit of keeping the material in a closed loop.

3.2.4. Case studies

Theoretical case study for the collection of duvets and pillows alongside clothing in clothing banks (WRAP)

Pillows and duvets are brought to textile banks by residents. Each bank is normally emptied at least two to three times per week by the collector; though the addition of bulkier materials may lead to a higher frequency of collections. Materials from the bank are collected by one driver using a 3.5 tonne van. Duvets and pillows are separated from the clothing during the emptying of the bank. They are easily identifiable and can be loaded separately into the collection vehicle, reducing sorting costs. It was assumed that the proportion of duvets and pillows to clothing was low, with the duvets and pillows being taken to a bulking point and on to a central depot for further bulking to allow for more efficient transport.

On arrival, the duvets and pillows would be hand sorted, approximately 50% are re-used as bedding, while the remainder is recycled as textile into other products. The main end market for the export of such products is India and Pakistan, where there is demand for low-cost stuffed bedding for re-use as bedding. The Southern Asia area also has a sizeable shoddy industry, where used textiles are shredded to reclaim their fibres before being spun into recycled yarn and woven to make recycled textile products such as low-quality blankets.

By collecting these difficult items alongside clothing, there may be the potential to run an operation which is financially viable overall, though subsidised by the value of the clothing component. However, this viability would be affected by the proportion of clothing to duvets and pillows in each bank. The use of existing banks and reprocessing infrastructure could also help to reduce costs. The costs are from:

- One 3.5 tonne van for collection.
- Use of a warehouse for bulking. Premises would be shared with clothing sorting activities.
- Specialised equipment: A bulking point for collectors such as an articulated trailer.
- Dedicated staff: 1 driver and a proportion of time from clothing sorting staff for loading and bulking.
- Collection costs.
- Sorting costs.

The cost of collecting textiles from multiple collection points means textile bank collection of pillows and duvets is comparatively expensive. Although this collection system is viable for clothing due to their high market price and comparative higher density, the cost of collecting duvets and pillows in this manner is far higher than their resale value. There is a risk that co-collecting duvets and pillows with clothing would result in the clothing collection being unviable rather than it

subsidising the bulkier material. If more substantial end markets are developed in the UK, another option could be separate (specialised) banks, operated by businesses that have a dedicated duvet/pillow collection and reprocessing service.

The collection of duvets and pillows could be made more efficient by the compaction of these items before transport. Collecting them from HWRCs and baling them before transport could offer a solution for part of the waste stream. Around 50% more duvets and pillows can be fitted into the same space if baled. However, baling is an additional cost due to the equipment and staff time necessary to bale the items.

Pillows are fairly easy to deconstruct but extracting stuffing materials from duvets for recycling is time consuming and expensive. If this was undertaken in the UK by paid employees it is assumed that the labour cost would be such that the recycled product would be unlikely to compete with virgin product. Additionally, it is difficult to predict the level of quality of any recovered materials. It is possible to divert duvets and pillows from landfill into recovery and use small quantities of combustible material as refuse-derived fuel. However, in all cases the collection costs may be higher than the revenue from the product.

Collection of commercial duvets and pillows

As part of the portfolio of services it provides, Veolia Environmental Services collected pillows and duvets from sites including hotels and university accommodation during refurbishments for re-use and energy recovery. In 2012/13 they collected pillows from 505 sites, totalling 48,000 rooms and approximately 64 tonnes. A pilot project with a third sector partner in 2011 aimed to divert items directly to local third sector organisations for local re-use. This was not successful for duvets because the collected items were not of a suitable quality for re-use.

When a refurbishment is identified, Veolia requests that site staff and contractors sort items by quality if possible, collect the pillows in bin bags and keep them in a sheltered but accessible area to allow for collection. These instructions aim to ensure that the items do not become dirty or wet, maximising their re-use potential. Veolia operates a number of curtain-sided vehicles all over the UK in a "milk round" arrangement, transferring a variety of materials to reprocessors. In order to drive environmental and commercial efficiency, depending on the location of the hotel or university site and the reprocessor, Veolia arranges the collection of pillows by a third party or uses the spare capacity on their own vehicles.

Processing of polyester

A demonstration was held to determine the possibility of processing bed linen without sorting and separating the outer layers from the filling of pillows and duvets. The sorting and separating process was omitted to save on the handling costs. The pillows and duvets were processed into small and fairly homogeneous particles using a crusher at the Materials laboratory of Lahti University of Applied Sciences (Finland). Unfortunately, the used crusher was not suitable, because bits of the pillows and duvets tended to stick to the surface of the crusher. This is actually a typical problem when handling materials that are powdery and/or get static. Possible further studies would include use of blow aids in the crusher or opening fibres using tearing and combs.

Recycling of polyester wadding

Pennine Blending Ltd recycle EoL mattress polyester wadding for conversion into low grade animal bedding and industrial felt products, through blending fibre.

Use of recycled fibre

During 2018, total of 129,225 kg of recycled fibre as the filling fibre for the pillows and duvets was used for Familon (Finland) products. About 35 PET bottles are needed to produce one kilogram, which means that in total around 4.5 million PET bottles were used. The recycled polyester grades used were mostly (68%) eco-labelled polyester filler fibres, with accompanying LCA studies and the EU Ecolabel granted to the materials. [Watch a recycled fibre production video on YouTube.](#)

Take back of duvets

A number of companies in the UK are offering the take back of duvets. This includes Dunelm, where textile waste including bedding and duvets can be taken to stores for reprocessing. The items need to be clean. The items are sorted by their re-use partner, reusing as much as they can, ensuring that the items promote a circular economy and second life. All feather filled items will be turned into a new product, and where items cannot be reused, they'll be recycled - nothing goes to landfill. Ikea (in Belgium) is trialling a project to encourage customers to bring old or unused pillows and duvets filled with down or feathers. To motivate customers to participate, they will receive a 15 % discount voucher per submitted product during one month. The trial project is part of the broader sustainability goals of Ikea, which aims to become a 100 % circular company by 2030.

4 Value Chain

4.1. General Decomposition

- **Production chain:** duvet manufacturing, distribution and sales.
- **Consumption chain and waste production:** households, professionals, administration (army, prisons, public housing for civil servants), schools (boarding schools, university housing)
 - With a distinction between clean waste (factory reject) and dirty waste (brought by consumers and collectors).
- **Collectors:** public and private waste disposal facilities; voluntary collection points; collection points in stores; bulky waste (door-to-door collection); illegal waste dumping; collection by specialised operators.
- **Sorting facilities** (if duvets have not been collected separately).
- **Outlets:** dump, burning, reuse.

4.2. French framework

The French legal framework is characterised by the existence of the **Extended Producer Responsibility** which obliges waste managers to selectively collect and sort certain types of waste, among which furniture products.

The implementation of producer responsibility serves to give responsibility for **furniture waste management to companies, manufacturers and distributors of furniture**, so that they integrate into the design and manufacturing phases the ecological impact of the end-of-life of the products they place on the market.

4.2.1. Material streams

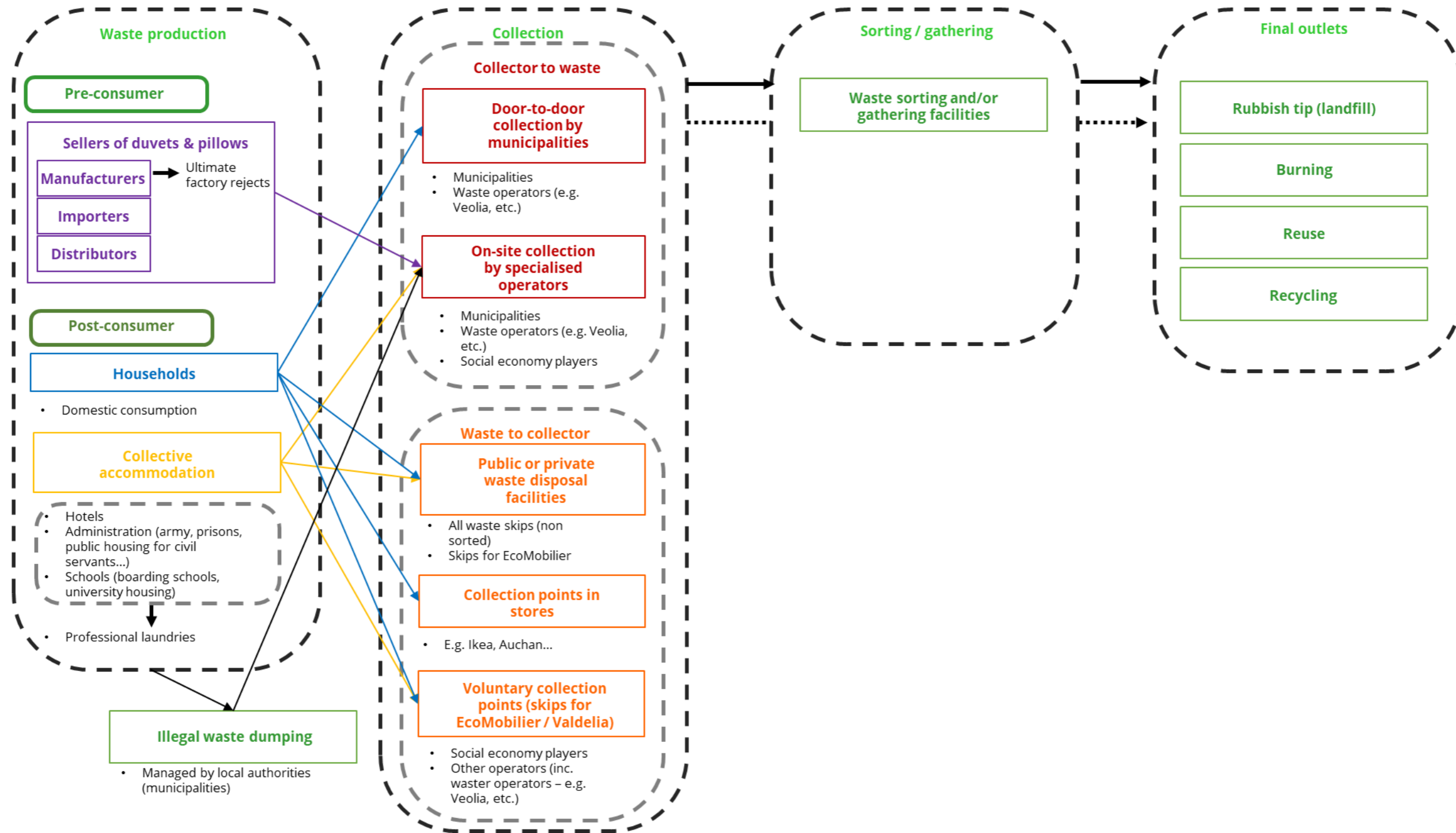


Figure 6: Waste bedding ecosystem and value chain in France: material streams

4.2.2. Financial streams

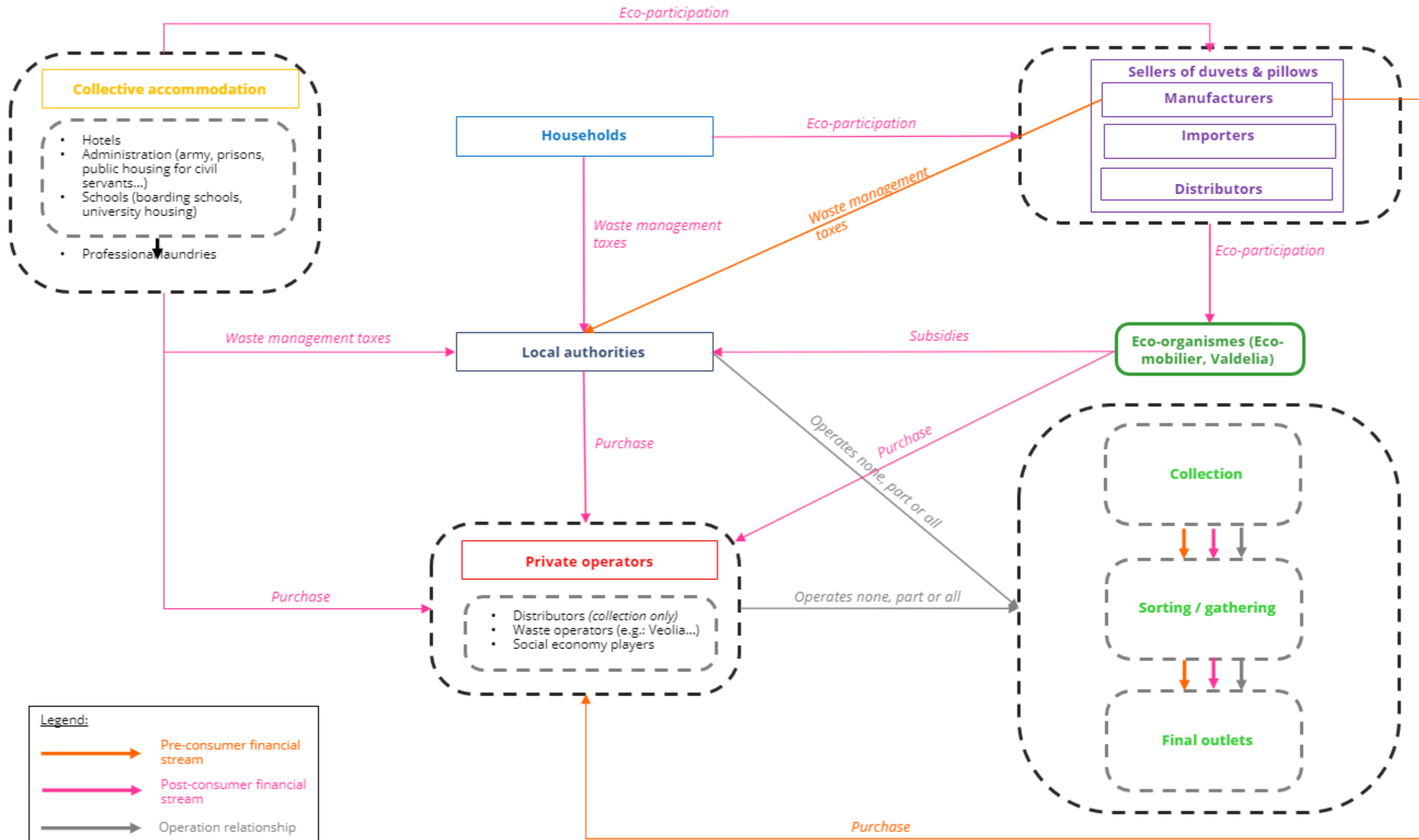


Figure 7: Waste bedding ecosystem and value chain in France: financial streams

4.3. UK Framework

Figure 8 shows the UK framework and the financial flow is shown in Figure 9.

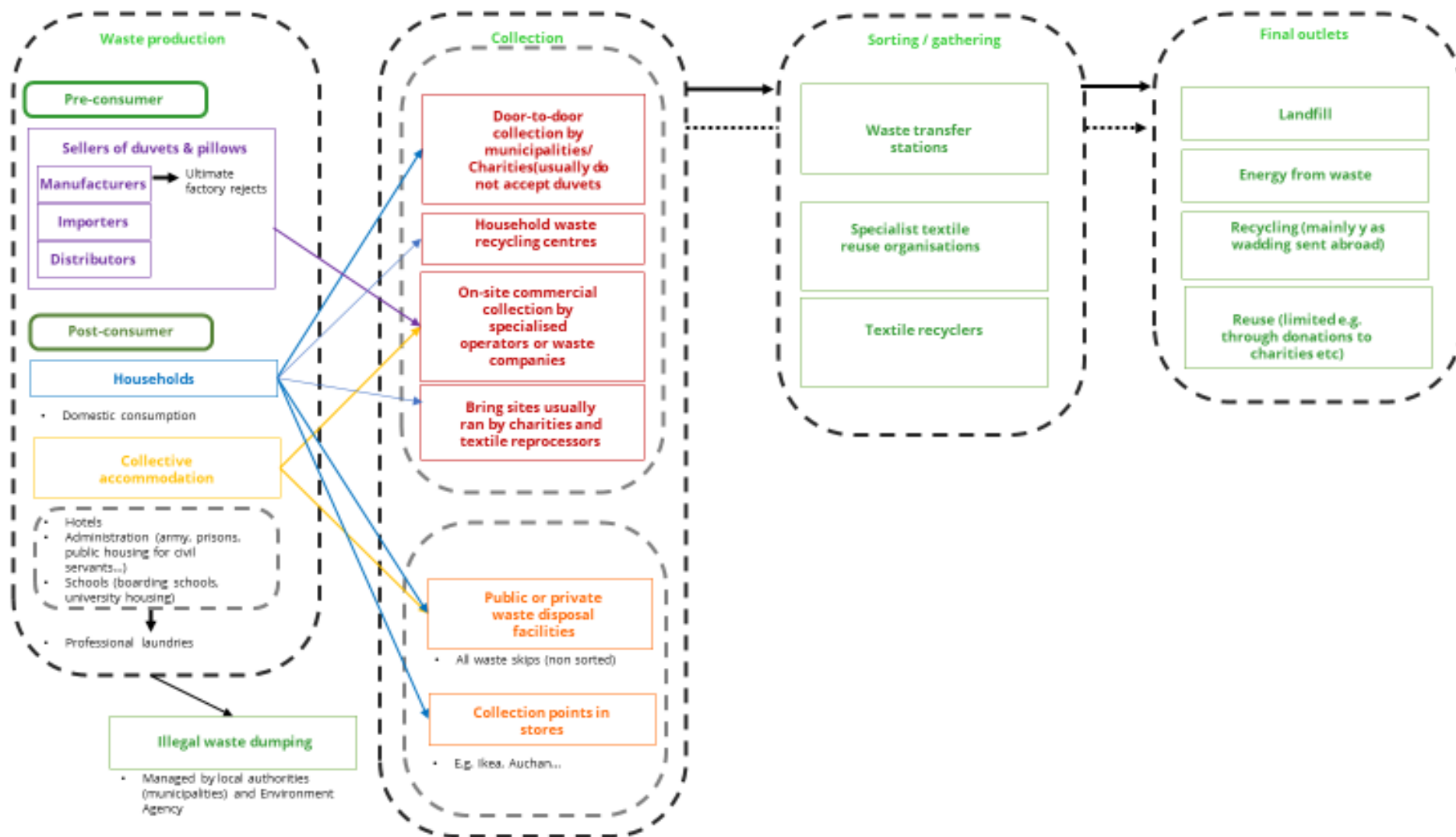


Figure 8: Waste bedding ecosystem and value chain in France: material streams

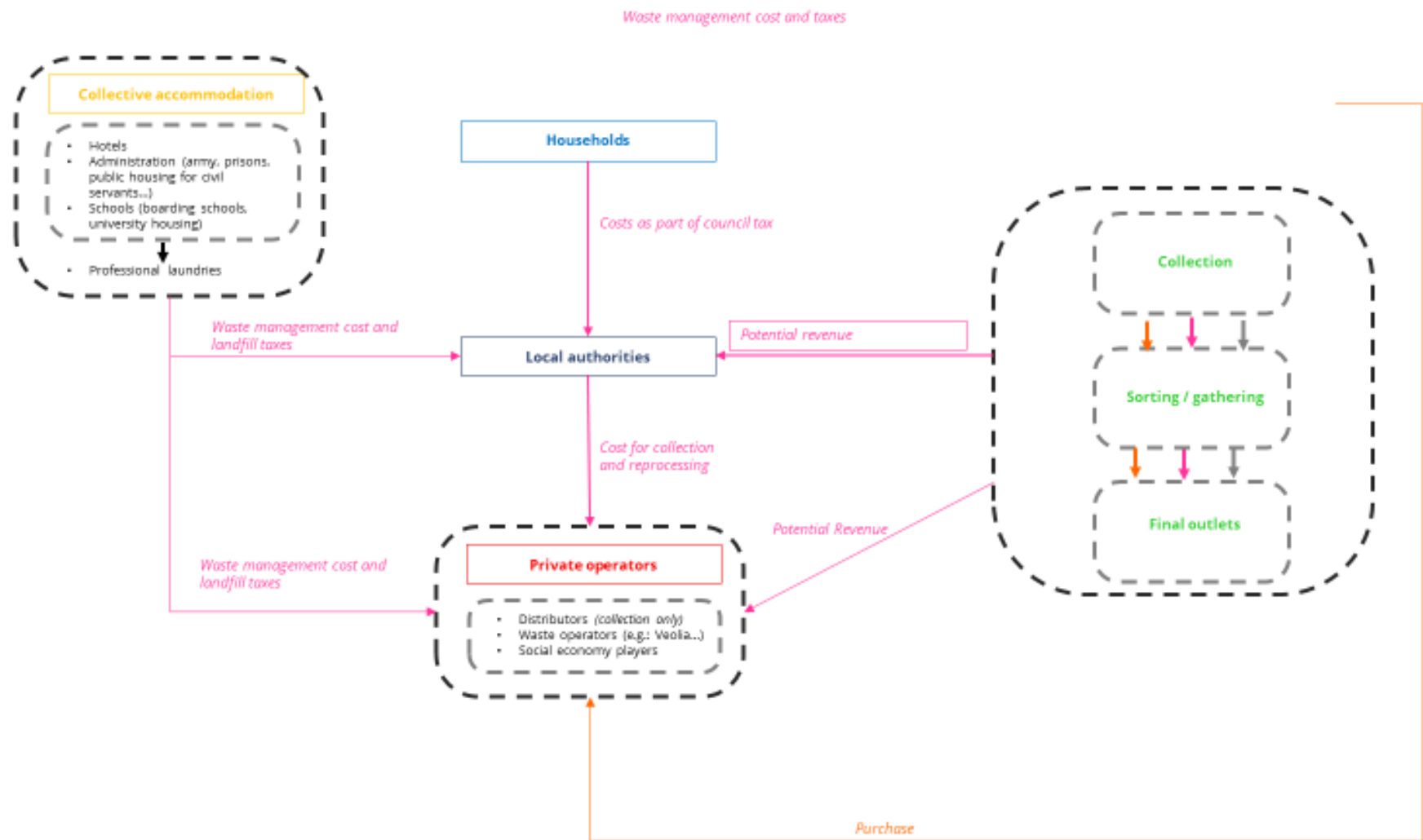


Figure 9: Waste bedding ecosystem and value chain in France: financial streams

5. Proposed supply scenario

5.1 France Hypotheses

PRAC waste passing through waste collection centres (coming mainly from households) should be captured as it is the most voluminous. It is important to capture the waste stream before it reaches a waste sorting centre, where it may be mixed, damaged, soiled, etc.

Separate collection of duvets and pillows at waste collection centres does not seem feasible at present. Separate collection of duvets and pillows at waste collection centres does not appear to be feasible as it stands. It would therefore be appropriate to **collect them together with mattresses** in the skips provided by Eco-mobilier at waste collection centres.

For the establishment of an insulation manufacturing plant or the development of a line within an existing plant, it would be necessary to identify a dismantling centre, for coordination in this specific territory.

The cost of transport could jeopardise the development of the sector. To optimise logistics costs, it would be advisable to:

- Pooling the collection with other material flows: in this case, mattresses already collected by Eco-mobilier in the dedicated skips made available at waste collection centres;
- Densify the material, by baling it with a small press, which would make it possible to go from about 3 to 4 tonnes per truck for bulk to about 13 to 14 tonnes for bales. However, baling duvets and pillows would risk soiling the material if done with the usual machines.

An optimised plan would require one insulation manufacturing plant per mattress dismantling site to limit transport, i.e. one plant near **Rennes** (operated by Envie35, in the Ille-et-Vilaine department), one near **Limay** (operated by Recyc Matelas Europe, in the Yvelines department), and/or one in the **Santes** (operated by Secondly, in the Nord department).

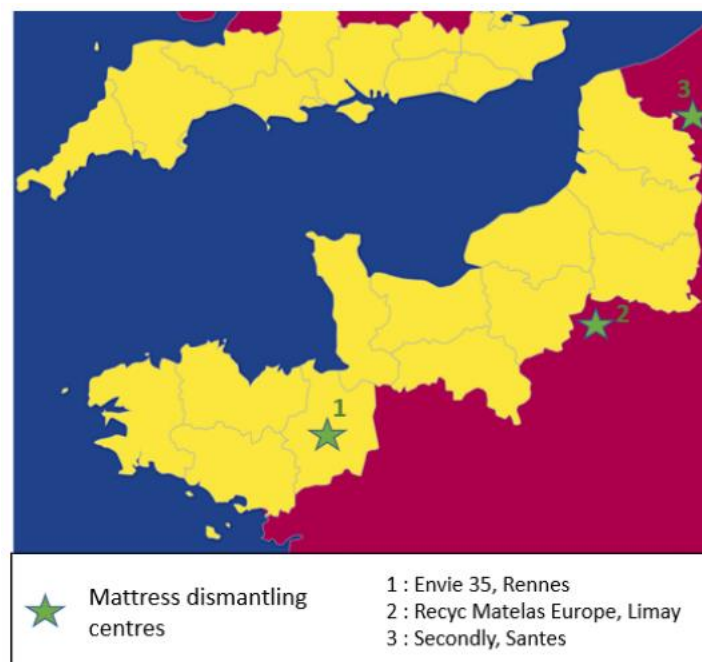


Figure 10 – Location of the three mattress dismantling centres in the French regions under study

There could be only one factory around a single mattress dismantling site, i.e. a total of 3 factories, owned by the same manufacturer or by two or three different manufacturers, or no factory at all. **The estimated quantity of polyester needed to open a production line in an existing factory amounts to 150 t/year whereas the quantity of polyester needed to open a new factory: 450-500 t/year.**

Separating the casing and filling of polyester duvets is a costly and time-consuming operation: it is therefore intended that both elements be used in the refibration process. Because of the difficulty of separating the different materials in a duvet, the manufacturer accepts that the raw material is a mixture of polyester, cotton and, in small quantities, polypropylene.

The manufacturer recommends targeting **at least 90% polyester** in the raw material pool to ensure the thermal performance of the insulation materials and the consistency of the production line.

It should be noted that French **professional** (industrial laundries, hotels, etc.) and **administrative** (university accommodation, collective accommodation such as barracks, prisons, etc.) sources of used polyester duvets and pillows did not respond to requests during the course of this project. Therefore, the study on the supply of used polyester duvets and pillows has therefore focused on waste generated by **private individuals (households)**. However, it is not excluded that professional and administrative sources could potentially represent an interesting source, if mobilisable.

5.2 Supply scenario

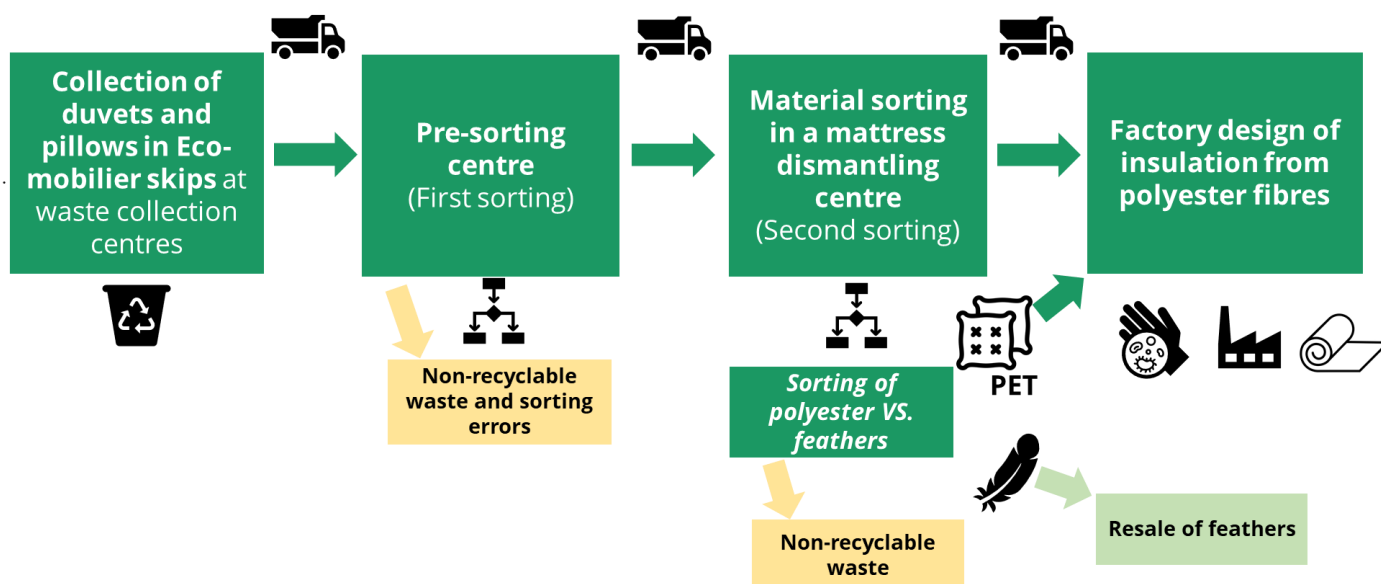


Figure 11: Proposed supply scenario from collection of duvets to manufacturing

5.3 UK Hypotheses

The route proposed is using duvets which have been collected via textile collection schemes which are either run by **charities** as a commercial revenue or **textile recyclers**. These are most likely to be unwanted duvets from **householders**.

Currently, charities such as a Salvation Army, collect textiles mostly through **bring banks** and then have **reprocessing centres**, where the textiles are sorted for reuse and recycling. Whilst they do not encourage the deposit of duvets and pillows into their bring banks, they do not disallow it. Therefore, there is an established collection route. However, the **revenue** earned from selling these duvets for recycling is minimal.

The reuse centre has the ability to **sort** duvets based on their **label** i.e. polyester versus feather and remove those that are **dirty**. They can be **baled** and sent to the manufacturing plant to be refiberised. This involves **further sorting** to ensure minimal contamination with other materials, slitting them open and shredding them. The fibre can then be bonded in the oven with other materials added as required then cut and packed in rolls. This could already utilise production lines that are used to produce sheep wool and PET insulation (from recycled bottles) in a manufacturing plant in the North West of England.

This route does not require the polyester duvets being subject to any sanitisation requirements. This process could also work with duvets obtained from the commercial waste stream, as long as there is a textile reprocessing collecting and sorting.

5.4 Supply scenario (UK)



Figure 12: Proposed supply scenario from collection of duvets to manufacturing

6. Sources of information

6.1. Interviews

France

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- Mr Sebastien BRANCOURT, PEG, on 27th May 2021;
- Mrs Ludivine POHER, Valdelia, on 9th June 2021;
- Mr Gwendal MICHEL, Eco-Mobilier, on 28th July 2021;
- Mr Timothée COISNE, Secondly, on 10th June 2022;
- Mrs Zoé HENRY, Mr Florian BESNIER, Mrs Nathalie WRIGHT, Rennes Métropole, on 28th June 2022;
- Mr Benoît DUFRAICHE, Région Bretagne, on 29th June 2022.

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- Mrs. Emma Davies, Cambridge City Council, EMAIL, on 22 June 2022 (Conducted by Richard Broad, ASBP)
- Mr. Tarrandip Bains, WRAP, ZOOM, on 13 December 2021 (Conducted by Katherine Adams/Richard Broad, ASBP)
- Mr. Marcus Turner, Biffa Waste, TELEPHONE, in Period 2 (Conducted by Mark Lynn, ERI)
- Mr. Howard Witham, McAndrew Textiles, TELEPHONE, in Period 2 (Conducted by Mark Lynn, ERI)
- Mr. Michael Pelegrinis, John Cotton Group, TELEPHONE, in Period 2 (Conducted by Mark Lynn, ERI)
- Mr. John Shaw, Fred Singletons Textiles, TELEPHONE, in Period 3 (Conducted by Mark Lynn, ERI)
- Mr. Bernie Thomas, Salvation Army, TELEPHONE, in Period 3 (Conducted by Mark Lynn, ERI)
- Mr. Bernie Thomas, Salvation Army, SITE VISTS, (Conducted by Mark Lynn, ERI and Katherine Adams, ASBP)
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- University of Northampton, TELEPHONE

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European Regional Development Fund

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