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Case study report - Reprocover

Good practice of circular economy business models

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As part of the TRANSFORM-CE project, several case studies are done to benchmark existing circular economy business models. This document covers the results of the case study conducted at Reprocover, based in Belgium. A total of 20 case studies will be done, with five cases per country (The Netherlands, Germany, Belgium and the United Kingdom).

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REPROCOVER Sustainable Solutions

MATERIA NOVA

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1. Introduction and method

1.1 Goal of case study

TRANSFORM-CE is an international research project which researches amongst others successful applications of circular business models, barriers, enablers and needs for circularity, and offers in-depth support for the uptake of recycled feedstock by businesses. A core part of the project is to provide advice to businesses on their way to transition towards a circular economy (CE).
In order to help businesses with developing circular business models (CBM's), it is first important to benchmark existing CBM's of companies. This is done by conducting case study projects with 20 selected businesses throughout North-West Europe. The aim is to provide participating businesses with an in-depth analysis of their current situation and business model, to identify opportunities and provide recommendations for facilitating the transition towards a CBM for these and other companies. The case studies also present a unique opportunity to study barriers, enablers and needs for circularity (and recycling) in more detail.

1.2 Company background

Reprocover is a small company located in Verviers, province of Liège, Belgium. It manufactures multiple solutions in reprocessed thermosets proposed mainly for railways and roads. Its activity started in 2017 after identifying thermoset waste flows that were not valued. Looking for a way of valorisation, the Reprocover team discovered that those materials showed useful properties, especially in infrastructure applications, having mechanical resistance similar to that of concrete though being far much lighter, and found out a way of recycling them. In this way, local waste collectors (distance < 500 km) provide Reprocover with used thermosets, to be transformed into usable objects.

Table 1: *Overview of company*

Topic	Information
Company name	Reprocover
Website	https://reprocover.eu/
Country	Belgium
Size of company (0-10, 10-200, 200-500, 500+ employees)	0-10
Mission/vision	"Reprocover recovers your waste in order to give them a new life in useful products for your company" "Reprocover might design with you all type of solutions as part of its production"
Product category	Road and railway solutions (gutters, fire hydrant, level crossings, etc.)
Production/operational process	Mixing and compression moulding
Used materials	Recycled thermoset from post-industrial waste

1.3 Case study process

The case study has been carried out between June and September 2021. The case study process is structured in four steps[1], with an iterative approach at the end of each step. The first step (circularity of the business model) aims at creating a general overview of the company, the context and its (circular) business model, to capture how the company creates and delivers value. The second step (circularity in the value chain) involves a circularity assessment of the company and its activities in the value chain. The third step (circularity of operational activities) is focussed on the circularity of the company's operational activities. The last step involves a wrap-up of the results and concludes with the case company's strengths regarding circularity, an overview of the barriers and enablers for circularity, and opportunities for further enabling circularity. The final result is a case study description, covering the previously established information.

An overview of the case study analysis process is shown in figure 1 on the next page. To obtain the results, each of the three steps is divided into four sub steps: 1) desk research and preparation; 2) interview; 3) reporting results; 4) iteration of results. More information about the process and the steps needed for receiving the results can be found in a separate document ('case study methodology') explaining the case study process in more detail. Three interviews are conducted for this case study, with one interview per step and the interviewed persons each having a different function and responsibility within the company. Table 2 gives an overview of the interviewed persons for Reprocover.

Table 2: *Overview of interviewed people*

	Interviewed person	Function
Interview 1: Circularity of business model	Charles Göbbels	Chief executive officer
Interview 2: Circularity in the value chain	Philippe Sante	Quality manager
Interview 3: Circularity of operational activities	Jérémy Albert	R&D and Production chief officer

[1] We make grateful use of insights and methods derived from previous research, in particular the case study method of R2π (2017, 2019), the work of Circulab (2020) and the Ellen MacArthur Foundation (2017, 2019). TRANSFORM-CE case studies' methodology and templates were developed by TRANSFORM-CE partner Hogeschool Utrecht (NL).

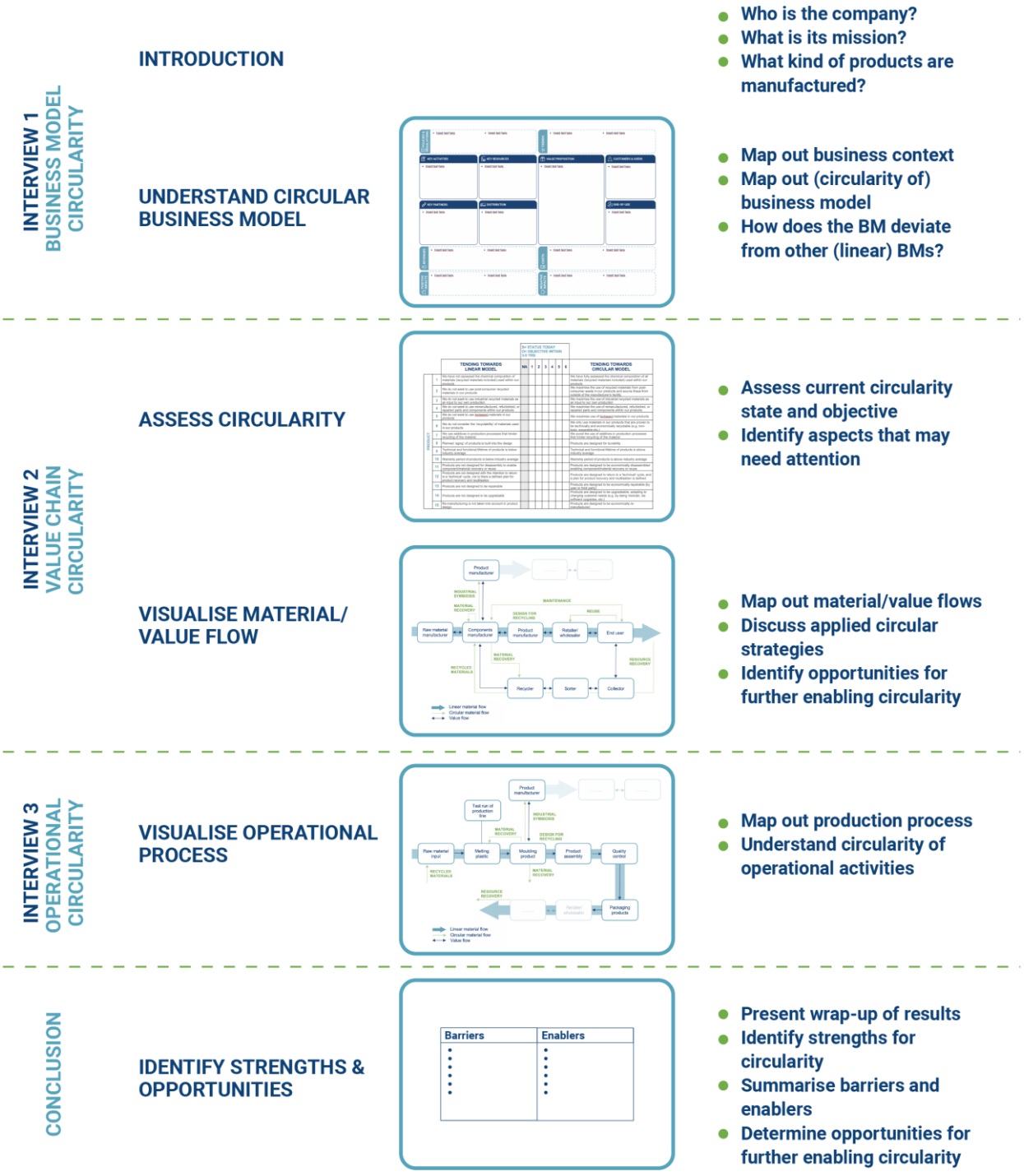

Figure 1: *Overview of case study process*

2. Circularity of business model

The first step aims at creating an overview of the company's business model and the context in which it operates, to capture how the company creates and delivers value for circularity.

The circularity of the business model is investigated by using a circular business model canvas (CBMC). This model is created for the purpose of this study and shows how the company creates, delivers, and captures value, highlighting circularity aspects of the business. The CBMC of Reprocover is visible in figure 2 and a description of each element is given below.

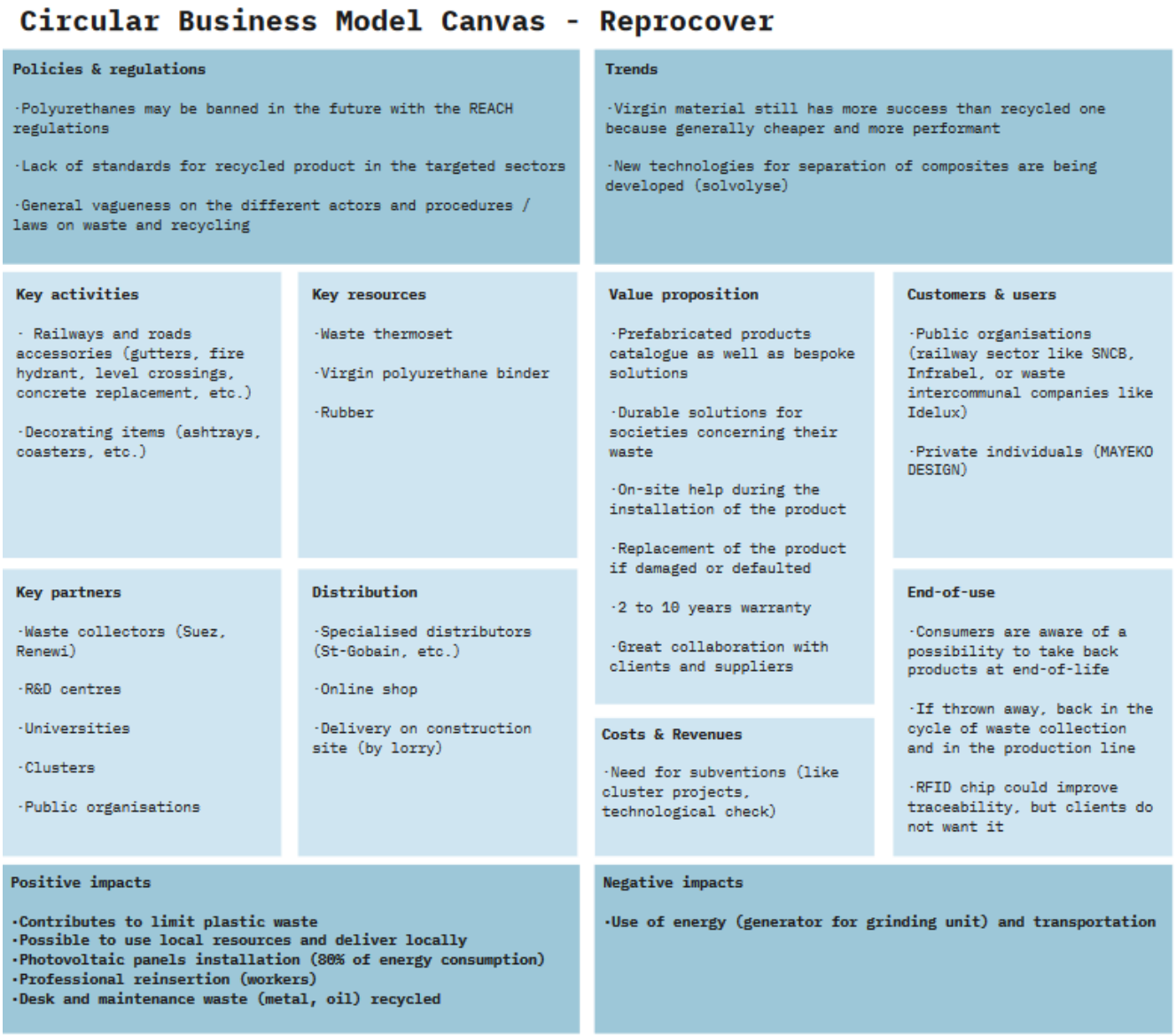

Figure 2: *CBMC of Reprocover*

Value proposition

Reprocover proposes solutions based on compression moulding of waste thermosets. The raw material comes from sorting organizations, after being collected by public services, with all the other waste, within a radius of 500 km. The main target is transport sector, with railway and road accessories, such as gutters, level crossings, fire hydrant, where Reprocover's products are good alternatives to concrete, which, because of its weight, constitutes a bigger risk to the workers (security and health). Reprocover accompanies workers during the placement of their merchandise, which is up to 10 years warrantied. Replacement in case of default is also included.

Figure 3: *Examples of products proposed by Reprocover (left: flowerpot – right: cable gutter)*

Customers & users

The main customers for current products are from public sector: railway (SNCB, Infrabel) or road field. New applications in urban design (benches, flowerpots) are also aimed at, through collaboration with intercommunal waste management companies (e.g. Idelux). Some of the clients are also providers: they pay for their waste to be treated and expect finished products in return. Now, individuals can also be concerned thanks to the online shop MAYEKO Design which proposes different decorating items and everyday use objects made from process waste (figure 4).

Figure 4: *Glass coasters made with Reprocover waste dust – MAYEKO Design*

For the time being, the user segment is limited to specific finished products pieces, but Reprocover would like to also find customers for recycled granulates as intermediate products for other manufacturers of moulded products.
Products are often developed together with customers and knowledge from both parties is combined (e.g. knowledge of transport company is combined with Reprocover knowledge of the thermoset properties). This way, it is not just a product that is delivered, but new products are developed together with the customer.

Though Reprocover proposes circular products, customer's will is generally focused on technical quality (mechanical properties, lightness, etc.) and price/quality ratio first. The circularity argument is a good asset to establish a contact with a potential customer, but it remains a marginal decision item, especially for public procurement. Therefore, sometimes the customers' choice goes to companies providing less expensive products with virgin material.

Key activities

The activity of Reprocover originates from the observation that no or few ways of revaluation of thermoset waste were available at significant scale (excepting obviously energy recovery). Though, recycled thermosets exhibit interesting properties in terms of mechanical resistance on one hand and lightness on the other hand. Those properties make thermoset waste a good candidate as a replacement of concrete for some applications, first identified in the railways and roads sectors. The dominant model of Reprocover consists of acquiring post-industrial thermoset waste, shredding this waste to obtain a granulate freed from impurities, and use this granular recyclate as a main component to produce objects (80-90% recyclate with 10-20% virgin resin). All Reprocover products have a lifetime of ten to fifty years and are completely recyclable.

Reprocover's catalog scans many uses: from flowerpots to fire hydrant, but they also develop bespoke pieces in collaboration with the client. As they are a small company, it is not always technically possible or economically advantageous to meet the customer's requirement, for example concerning the colour of the proposed object. Networking (through Ecopreneur network or Plastiwin cluster) enables to make relevant contacts to identify needs and propose specialised solutions, that can further be adapted to the needs of other clients.

Reprocover aims at extending activity to the recycling of composites such as the wind turbine blades or printed circuit boards.
In order to succeed in all these strategies, Reprocover is constantly improving both with R&D projects, with the support of GREENWIN cluster, and process optimisation.

Key resources
Three types of physical resources are key to Reprocover's activity: raw material, infrastructure (including equipment) and energy.
80 to 90% of the raw material consist of post-industrial thermoset waste and 10 to 20% of a synthetic binder, virgin polyurethane or epoxy for most applications. Solutions are under investigation to use a polyurethane binder that would be circular itself, either from renewable resources or from chemical recycling process. Supplies arrive in bulk, packaging lower scale is big bag.
The plastic waste is collected by public services and sent to sorting companies (Suez, Renewi), which supply the recycling firms. All secondary material used by Reprocover is collected within a 500 km radius. Reprocover receives its raw material already separated from other waste, such as thermoplastics, wood… However, some pollution may remain, and a further on-site post-grinding sorting step is necessary.
Machinery can be listed by describing the process. First, conveyor belts transport the waste to the shredder. The grinding unit is located on a different site than further steps, relocation should be considered depending on the evolution of business volume. This step is very energy intensive. After grinding, the aggregates are removed from residual ferrous contaminants using magnets and induction machines. The thermoset granules are then sealed together by adding virgin polyurethane in a continuous process through a mixing screw. Finally, the mixture is compressed in a mould to obtain the final product.
Energy supply for process and facilities comes mostly from own photovoltaic panels (80%).

Reprocover being a small entity (10 full-time workers), employees have to show versatile abilities. Nevertheless, a quality manager has been hired, as well as a production manager in order to optimize roles, especially with regards to the standards to be respected. The emphasis is mainly focused on technology and product formalization through quality procedures since circularity is an integral part of all business activity.

Key partners

Apart from the customers (SNCB, Infrabel, etc.), the important stakeholders for Reprocover are the R&D centres, which allow an improvement or adaptation of the products, the competitivity clusters and associations of entrepreneurs, which put in touch and give contacts, the organizations that collect and sort waste (Suez, Renewi), and the Walloon Region that provides subsidies on a project basis.

Distribution

Clients are all located in Belgium or neighbouring countries (except Germany for the time being, but this should change soon). Either products are delivered by lorry directly on sites by Reprocover, or specialized distributors have some Reprocover products in storage. Some products are also available online.

End-of-use

Customers are informed of the possibility of returning the product to Reprocover once it has been removed or at the end of use. However, no specific and systematic recovery scheme has been implemented, hence it is expected that in most cases discarded products would not be treated as a specific flow but will enter the general waste treatment system. A specific recovery scheme would be difficult however since several players are involved, from purchase, installation and extraction of used products, then sometimes the communication is not sufficient. Traceability is even more difficult in the case of export. Reprocover had started to place RFID chips in the products, so that all the information can be directly consulted, enhancing current traceability system where only limited information is written on aluminium labels. However, clients are rather reluctant to this new idea, especially as not all of them have an RFID chip reader.

In theory, there is no technical obstacle to the reintegration of used products as a raw material in Reprocover's process. A strong washing step may have to be considered however since most products are buried underground (road applications). This loop is only possible on the assumption that the products pass the sorting stage and do not end up in energy recovery (economically more advantageous), and if the regulations (Reach) do not change between the installation of the product and its collection as waste allowing Reprocover to still use this material. To date, no recycling loop of past products has occurred, since Reprocover's products have a lifespan of between 10 and 50 years and the company is still quite young (since 2017).

Costs & revenues

Main fixed costs are due to raw materials and quality control. However, the investments costs for new technologies such as recycled thermoset valorisation are not negligible: costs for process optimisation, equipment adaptation, research and development, etc. Financial support from public

authorities, such as technological checks, subsidies for R&D projects or public subventions for reinsertion programs are therefore appreciated.

Policies & regulations

Reprocover is ISO 9001 certified.

There is a lack of clear regulation for the use of recycled materials in target applications, and in some cases standard tests have to be adapted to the specificity of recycled products. Leaching and fire resistance tests are usually performed by Reprocover. Verification by a certification body is sometimes requested by the customer.

The raw materials for binders are scrutinised by REACH, and it is expected that polyurethane may be banned within a few years, at least for some application sectors. Through participation to several federations and clusters, Reprocover performs a proactive regulatory watch.

In terms of policies, Reprocover regrets that public institutions do not make a systematic use of environmental and social clauses in the public procurement procedures, that would give a premium to companies who try to produce locally with a circular process even if the prices may be higher. It may be however difficult, even with LCAs, to compare different tenders on an objective basis for environmental criteria.

Trends

Recycled products may show very good performance, high enough for the applications' needs, but products based on virgin materials may in some cases perform better. This problem tends to cool down the customer, even if his needs would be completely satisfied by the recycled product. Recycled products are also often more expensive (this may depend on the application, level crossings for example are really cost competitive). Recycled products must perform better AND be cheaper to really attract attention. However, the public sector is more open to recycled products than the private sector, which does not yet have the need to play up its ecological image to such an extent.

New technologies for recycling thermosets and composites, such as solvolyze, are currently under development, but not yet perfected. This would allow a separation of the various components of the composite allowing them to be upgraded one by one. Reprocover is involved in such projects, for example for the recycling of printed circuit boards.

Positive and negative impacts

Reprocover makes a big deal of its impacts. In order to reduce its energy costs, the site is equipped with 540 kVA photovoltaic panels that produce 80% of the energy required. Office waste is sorted, as well as maintenance waste, such as metal parts and oils, replaced during the repair of

equipment. Reprocover is also trying to reduce its footprint by favouring local purchases (Europe), both for raw materials and machinery. Finally, the socio-professional impact is also important, by promoting professional reintegration in the engagement of staff.

3. Circularity in the value chain

After analysing the company's current (circular) business model, a more detailed circularity assessment of the company and its activities in the value chain is made. The material and value flow map is presented, together with its adopted circular strategies.

3.1 Material and value flow map

The ultimate goal of a CE is for resources to flow in circles, with limited leakage out of the system. To evaluate this, it is important to map and visualise the current flow of materials within the company's value chain. The material flow map of Reprocover is presented in figure 5. The circular material flows (green) show where the material comes from, where it goes and how it may return into the cycle.

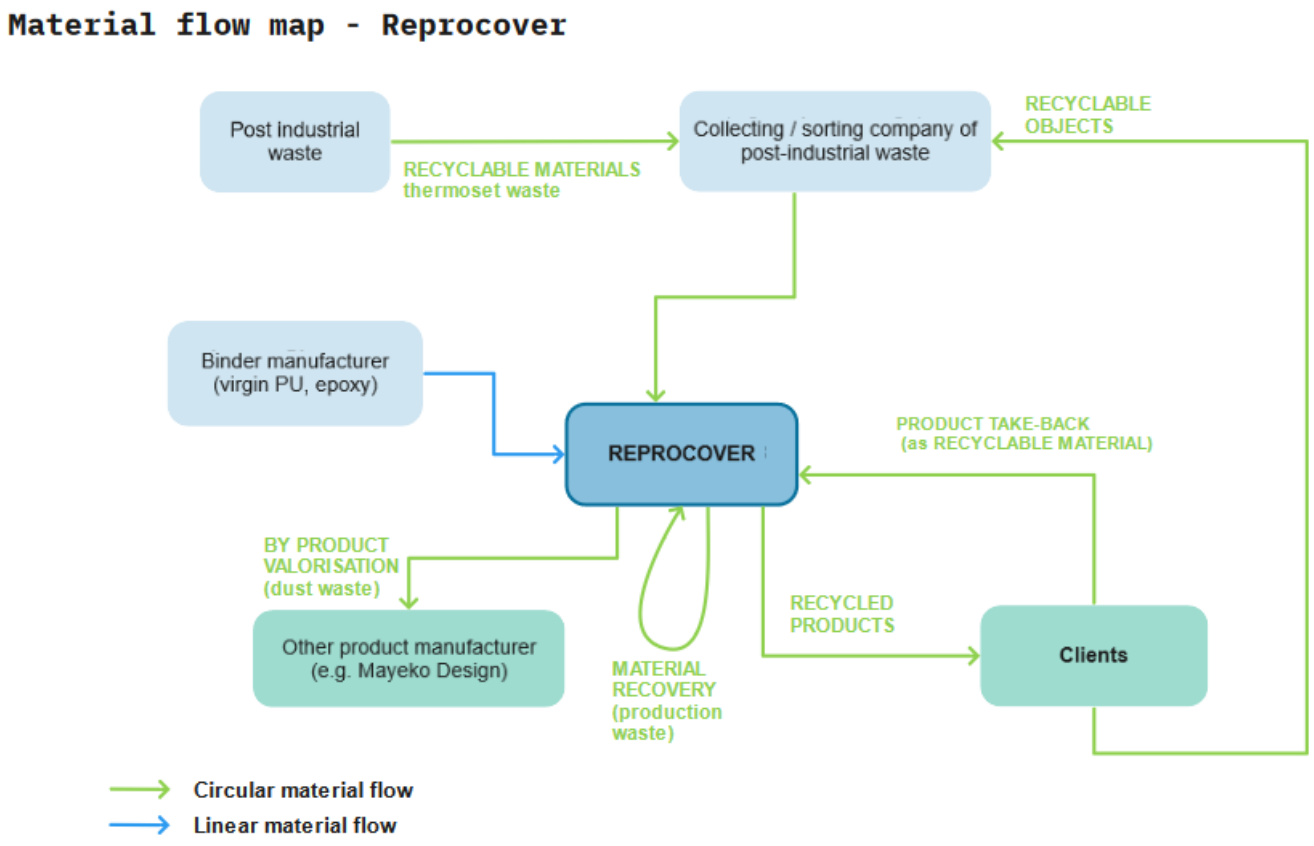

Figure 5: *Material/value flow map of Reprocover*

3.2 Circular strategies

As shown in figure 5, Reprocover applies multiple circular strategies: use of *recyclable and recycled materials*, *material recovery* of their own waste, *valorisation of by-products* into final products and possible *product take-back* at end-of-use. Each of the strategies is further explained below.

Recyclable and recycled materials

Reprocover works mainly with waste thermoset. A small proportion of virgin material (10 to 20% binding resin) is used to reshape this recyclable waste into a recycled product (agglomerate of crushed, glued thermosets). Alternatives are being studied to further reduce this proportion of virgin material, for example by adding 50% recycled polyurethane, or even to use bio-based polyurethane. Binders other than polyurethane are also being studied in order to guard against a possible regulatory ban (Reach).

Reprocover's thermoset raw materials generally come from industrial waste. They are first collected, then sorted by approved organizations (municipalities, Suez, Renewi, etc.) before being sent to recycling companies such as Reprocover. Thermoset resins are known to be difficult to recycle, which is why Reprocover's activity is both innovative and useful, providing an alternative to least wanted energy recovery. In addition, even as waste, thermosets still retain properties that can be exploited in sectors requiring technical materials, for applications of high resistance and durability. Once the product is installed, it will fulfill its role for a period of 10 to 50 years, before returning to the path of production, as a raw material this time, either through customer feedback or through the classic waste route. Thus, raw materials, like products, are both recyclable and recycled.

Material recovery

Waste from Reprocover’s production process (mostly from compression moulding or product assembly steps, see process map of figure 7) is reused, and put back into the production line. Moreover, the containers in which the raw materials are received (big bag) are reused for new supplies.

Valorisation of by-products

One of Reprocover's great feats of strength is to have been able to add value to the last production waste, initially non-recoverable, such as the dust formed during shredding process. These production waste are valorised through a partnership with a company that sells online eco-designed products made of fine dust waste from Reprocover as a filler in epoxy binder (MAYEKO Design).

Figure 6: *Coasters from Reprocover's by-product dusts – MAYEKO Design*

Product take-back

As mentioned previously, the customer is informed of the possibility of returning the product once it has become useless or defective; it will then return to the start of the production chain, if its composition is still authorized. However, this information explicitly written on the product. Given the long lifespan of the objects, it may most likely be forgotten or lost. In such case, the product will go through the classic waste treatment chain again (best case: collection, sorting, resale to recyclers; more likely: energy recovery) and anyway make a longer journey to become a new raw material again.

Ongoing investigations aim at improving product traceability and thus recovery rate.

4. Circularity of operational activities

After assessing the circularity of the company's activities within its value chain, a more detailed assessment of the circularity of the company's operational activities is done. A visualisation of the operational process is presented, together with its adopted circular strategies.

4.1 Operational process map

To get a better understanding of how the company's operational activities are affected, an overview of the process is shown in figure 7. This includes circular sourcing of materials, the production process and quality assurance of products. Each step is further explained below.

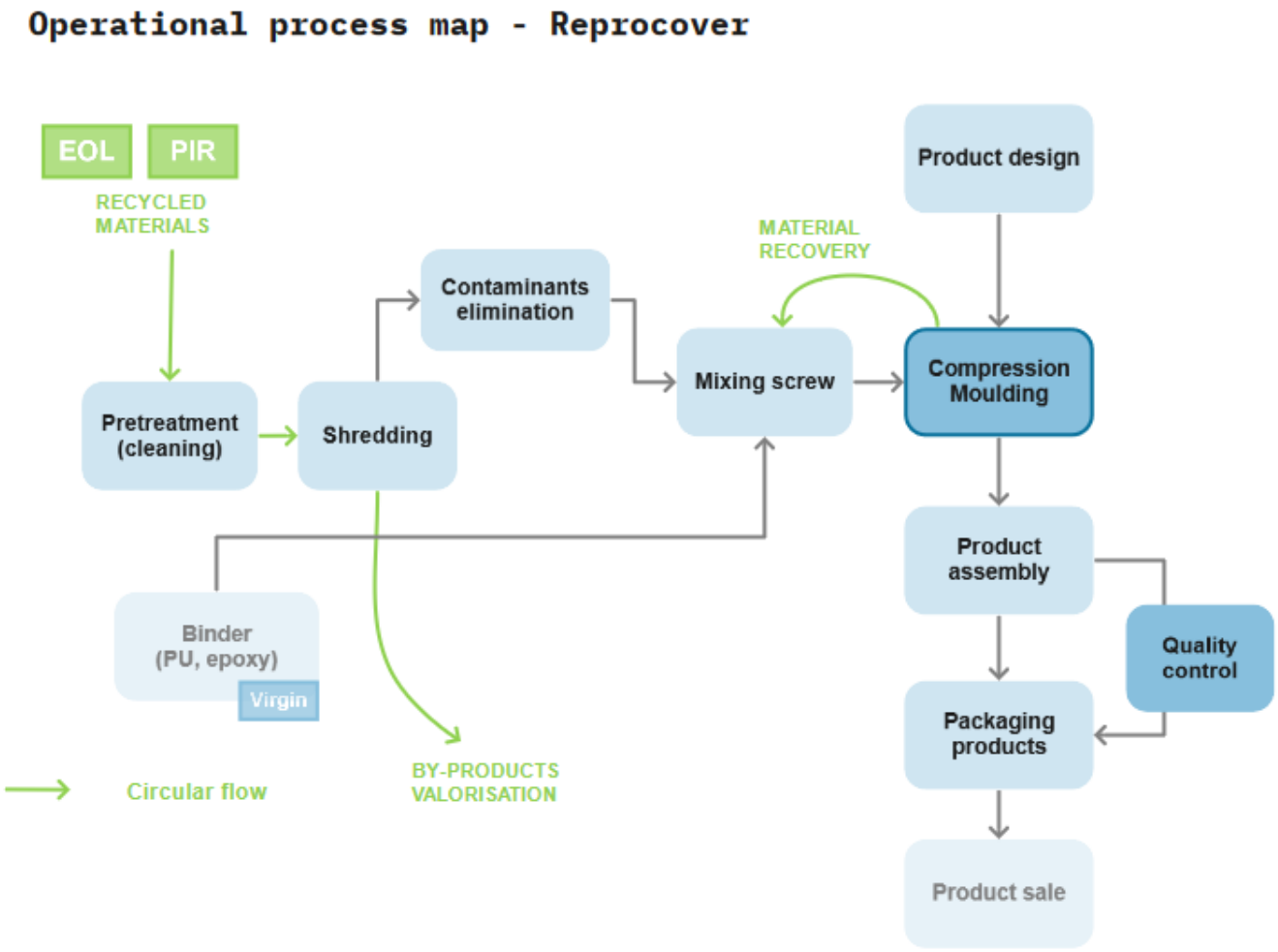

Figure 7: *Operational process map of Reprocover (PIR: post-industrial resin and EOL: end-of-life materials)*

4.2 Circular sourcing and design

The first production steps at Reprocover involve the selection and preparation (cleaning, grinding, sorting) of the raw material as well as the design for new products or bespoke solutions.

Material sourcing

Recycled material, mostly post-industrial waste, may come from different sources. Three main suppliers currently provide material of stable quality from different waste flows among which electric meters, electric sockets and car engine induction parts. The global amount of raw material (12-13 tons per month) from these suppliers is however not sufficient for the entire production. Therefore, there is a continuous search for new suppliers. Various flows are tested, recently tests have been carried out on industrial waste from billiard ball production.

A questionnaire is proposed to the potential material suppliers to ensure that the waste would comply with relevant regulations. The waste shall contain no halogenated or no-Reach-compliant additives, shall not produce ATEX dust etc... It may happen that waste providers would not have all required information; the decision of testing or not such material is then taken by Reprocover on a case-by-case basis.

When waste flows pass the compliance test, samples are received, and processed at lab scale (R&D) into sample plates for testing (mechanical properties, fire properties, resistivity, etc.). In some cases, the raw material may contain components (e.g. hygroscopic fillers) that induce undesired side reactions with the binder during the moulding process, leading to deformations of the product. If the material is promising, it is scaled up to production.

It may happen however that the behaviour of the material formulation developed at small scale is not representative of industrial scale behaviour, especially if the raw material is quite heterogeneous.

Raw materials are generally documented by technical datasheets, but those sometimes contain very little and lacunar information. The more detailed they are, the better, but the traceability of the products is sometimes complicated, especially when they come from general waste collection system, as the waste supplier is not the manufacturer of the initial product. In addition to these datasheets, a visual inspection is carried out by a worker when the lorries arrive at the shredding unit. If the product shows too many (metallic) contaminants, it can be rejected. Raw material tests are also systematically carried out (fire test, etc.).

Virgin polyurethane resin binder is currently provided by a unique supplier.

Product design
Reprocover offers finished products with existing designs as well as on-site support. Bespoke solutions can be offered to customers depending on specific requirements and properties of the material.

4.3 Production process

Pre-treatment
Pre-treatment would essentially consist of cleaning of the raw material, if it comes directly from a return of finished and installed product, as most of the objects manufactured by Reprocover are intended to be partially buried in the ground. But given the youth of the business, this has not yet happened.

Shredding/grinding
Since the raw material is not virgin, but has been collected as waste, it comes in the form of objects or parts of objects, defective or not, sometimes combined with other materials. In order to recover it, it will have to be homogenised and the first step in this homogenisation is shredding.
Each waste flow is currently isolated to go through the production process, due to a large variety of composition and properties. The aim however for the long term is to be able to mix all types of thermoset waste both in the shredding unit and the production unit. This current flow-specific procedure allows reproducible results on the products but lowers the yield below what could be expected with a mixed-flows process.

The grinding unit is separated from the main production site. This unit is energy intensive and generates significant noise that can be a nuisance to the neighbourhood. The workers have standard personal protective equipment (PPE), which is why certain materials must be avoided (see questionnaire submitted to new suppliers). The shredder currently in use is a hammer mill. Other technologies could offer less nuisance, but the wear and tear induced by the use of thermosets offers few alternatives to solve this problem. At the end of the shredder, granules of 1 to 8 mm in length and dust are obtained.

Contaminant elimination and sieving
As already mentioned, the raw materials are very often associated with metal parts that need to be removed. An induction machine is dedicated to this work, however this machine does not have a very large capacity, so sometimes pieces of metal are still found in the shredded material on the production site. In this case, the grinded material is returned to the shredding unit for a second pass through the induction machine, because metal particles would influence the resistivity properties, which could become a danger for rail application. The recovered metal fraction is sold to a third party for recycling.

Once the shredded material is free of metal contaminants, it is sieved to ensure that the final product is always produced with a homogeneous grain size. Therefore 1 to 8 mm length granules are produced. The dust and particles smaller than 1 mm are used as raw material for other applications.

Compounding

Unlike thermoplastics, thermosets cannot be reshaped by heating. They are temperature stable and must be incorporated as filler in a virgin, unreacted resin matrix to produce shaped objects. Thus, the thermoset grind is mixed with 10-20% virgin polyurethane binder in a cold screw. The result is a kind of molasses, black or very dark (due to the PU glue), which will go to the next production step. The dark colour may be an obstacle for some customers who want products that have an aspect as similar to concrete as possible. Besides, absorption or reflection of light and heat may be important. Therefore, grey (concrete-like) products can be proposed by addition of titanium dioxide.

Compression-moulding

The mixture of ground thermoset and virgin polyurethane is fed into a mould where it is pressed at room temperature. The pressing process lasts ten minutes, which is the curing time for the polyurethane binder to crosslink. Polyurethane is good candidate as binder with its high speed of crosslinking, without any exterior source (such like UV or heat). Reprocover is open to use other binders, but the possible alternative resins have drawbacks: polyester binders are slower to crosslink and require more specific personal protective equipment, and epoxy is much more expensive.

As for the preparation of the raw material, compression-moulding is made with specific material flows, and no mixing of materials seems possible yet.

In winter, the rooms must be heated, as excessive temperature changes are detrimental to the quality of products.

The production process allows for the addition of RFID chips directly into the moulded objects, that can simply by put into the starting molasses. Those RFID chips allow for better product traceability, with the opportunity to recover the product at the end of its life, provided the customer has a suitable reader.

4.4 Quality assurance and product sale

The last part of the operational process consists of quality assurance and sale of the end-product to Reprocover's customers.

Quality control

It is necessary to separate quality control of the finished product from quality control of the incoming material, especially when there are new suppliers. The controls are more succinct on the raw material (fire tests, Shore hardness) than on the finished products. As already mentioned, some raw materials may be problematic, for example, by reacting with virgin binder because of water adsorption, causing deformation, and are then temporarily eliminated from production until a solution is found (internal R&D). Similarly, a critical eye is always kept on the equipment, in order to find solutions for optimisation (e.g.: grinding to be improved as granulometry may differ significantly, dispersion is controlled by a check-up every 5 big bag with a sieve, giving an informative granulometry curve).

In addition to fire and hardness tests, mechanical tests are carried out on the sheets produced and, once a month, additional tests, such as electrical resistance, are carried out on the batch.

Reprocover is ISO 9001 certified and aims at reaching ISO 14001 certification, but this requires a lot of administrative resources. They rely on standards, which have to be adapted to the products, as there is no clear procedure to follow for their specific activity yet. Indeed, it is neither classified in plastic nor in concrete, there are no protocols for this intermediate material, even less when it is recycled. EN 124 is used as a reference guide for quality tests. Customers may be satisfied with those tests or call a certification body to check the data on the final product data sheet. Reprocover also accepts customers visits to their production site to get an insight into the quality of the products. Such visits provide also customer a better understanding on the specificities of working with recycled material.

Reprocover regularly submits its samples to an independent laboratory to compare and verify the results of their own tests. This allows them to assess the reliability of their machines and methods, without the need for accreditation.

Product sale

After the last quality checks the product is ready for sale and is delivered to the customer, either by Reprocover or by a specific distributor. A datasheet accompanies the product, but all information is also available via the RFID chip. Some products can be purchased online by private individuals and are in that case supplied by traditional delivery systems (DHL, etc.).

As most customers are public institutions, Reprocover has to answer public calls for tenders first to have a chance to sell their products. This tendering system may also side-line Reprocover, for example when the initial specification is conservative and explicitly directed for concrete, even if their product would meet all the functional requirements. Calls for tenders based on functional properties rather than material designation could open markets.

5. Conclusion and recommendations

Based on the outputs derived from all three interviews with ..., strengths of the business model and operational process in regards to circularity are identified, barriers and enablers for circularity are summarised, and opportunities for circularity are described.

5.1 Strengths for circularity

The first two aspects that strengthen Reprocover's circular business are innovation and quality. Indeed, the environmental need to recycle thermoset waste is well established and Reprocover offers an unprecedented solution. However, none of this would have been possible if the starting material had no industrial interest. On the contrary, the material demonstrates mechanical and fire-retardant properties that can be used by the public sector, while not being harmful to health. Thus, it is the combination of these two aspects that makes this circular strategy viable.

Furthermore, to add even more value, Reprocover offers customer support during the installation of their products, as well as the development of tailor-made unique solutions in case their catalogue does not satisfy the consumer. This close cooperation builds loyalty and a reliable network.

From a practical and technical point of view, the equipment needed to process the material does not differ much from that of virgin material, except for the unavoidable need for a shredding and decontamination unit. Working with recycled material can lead to specific problems (premature wear of equipment, surprise deformation in the final products, etc.), but these can be early identified in a research unit at the arrival of a new component. Reprocover's reactivity and adaptation allows them to get out of these problematic situations and even to turn them to their advantage, for example by valorising co-products, such as grinding dust.

Economically, even if recovering recycled material is more expensive than producing from virgin material, here the accumulation of thermoset waste makes the supply of raw material sustainable, although these vary greatly, giving products of different quality. However, it is the financial support that makes the business viable, particularly as customers pay for their waste to be processed, in addition to the subsidies available through research projects.

5.2 Barriers and enablers for circularity

The main barrier, without surprise, is first economical. It is still expensive and time consuming to deal with recycled material, rather than with virgin one. People with specific qualifications have to be hired to solve on one hand the technical problems caused by the variability of waste flows, and on the other hand to master the quality standard and regulations; equipment have to be

adapted or regularly changed because of the input material; customers have to be convinced of the equal properties of the product despite the fact that it is recycled because circularity has not the priority over the quality/price ratio, etc…

The second one is regulatory. Few information is available concerning the functions of the different stakeholders in the recyclable line. Communication is difficult and not clear between the organisms (producers, collectors, sorters, recyclers) and moreover the regulation is not uniform in Europe or even within the country. This is even more time consuming and more difficult for innovative activity. There is no precedent to rely on or to imitate. There is no back-up both technically and procedurally.

The last barrier is more practical. Raw material is very heterogenous as they come from varied sources. Either it is technically possible to blend them all, or separation is necessary, giving birth to a large range of products but not always cost-effective. Problems may occur during production process because of the nature of the raw material and still, as innovative, few back-ups exist to help with known solutions.

Table 3: *Barriers and enablers for enabling circularity at Reprocover*

Barriers	Enablers
• Regulations that are too little or unclear • Additional time for preliminary work (sourcing recycled materials) • Uncertainties about consistency of quality • Lack of material knowledge for recycled materials • Missing datasheets for recycled materials (material passport) • Sufficient volumes of the same nature for recycling products at PIR • Premature wear of shredding equipment (expected to be worse with fibre material) • Lack of priority to the circular aspect in specifications of public calls for tenders • Calls for tenders sometimes based on the typology of the material rather than on functional properties may disqualify the circular alternatives proposed.	• Developing tailor-made products together with customers • Accompanying client on site • Post-industrial waste that already contains good properties • Sustainable PIR supply • Independent research institute collaboration for recycled materials • Knowing material properties • Providing material traceability • Designing products for durability (10 to 50 years) • Closed loop recycling (use of local waste to create products to be used in 500 km around)

5.3 Opportunities for circularity

The business model and the products offered by Reprocover are based on circularity from the inception. There is therefore little room for circularity improvement in the case of Reprocover, since a large fraction of raw material is recycled, product take-back is offered (with means of making the product as traceable as possible already implemented with RFID chips), and most by products or production waste are either reinjected back to the process line or used in other businesses (dust, metal fraction of incoming material after decontamination…).

The main remaining direction for more circularity would be to investigate the possibility of using binder resins that would also be circular, either bio-based or from chemical recycling. The environmental relevance of such a direction should however better be estimated from a life cycle perspective by LCA studies.

References

Circulab. (2020). *Circular Canvas: The tool to design regenerative business models.* Retrieved from: https://circulab.com/toolbox-circular-economy/circular-canvas-regenerative-business-models/

Ellen MacArthur Foundation. (2017). *The circular economy in detail.* Retrieved from: https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail

Ellen MacArthur Foundation. (2019). *Circulytics – measuring circularity.* Retrieved from: https://www.ellenmacarthurfoundation.org/resources/apply/circulytics-measuring-circularity

R2π. (2017). *Circular Economy Business Model Case Studies: Introduction and Methodology.* Retrieved from http://www.r2piproject.eu/wp-content/uploads/2018/08/R2Pi-D3-35775-63432.2a-Case-Study-Methodology_v1.0.pdf

R2π. (2019). *Methods and tools.* Retrieved from http://r2piproject.eu/circularguidelines/methods-tools/

About the project

The problems associated with plastic waste and in particular its adverse impacts on the environment are gaining importance and attention in politics, economics, science and the media. Although plastic is widely used and millions of plastic products are manufactured each year, only 30% of total plastic waste is collected for recycling. Since demand for plastic is expected to increase in the coming years, whilst resources are further depleted, it is important to utilise plastic waste in a resourceful way.

TRANSFORM-CE aims to convert single-use plastic waste into valuable new products. The project intends to divert an estimated 2,580 tonnes of plastic between 2020 and 2023. Two innovative technologies – intrusion-extrusion moulding (IEM) and additive manufacturing (AM) – will be used to turn plastic waste into recycled feedstock and new products. To support this, an R&D Centre (UK) and Prototyping Unit (BE) have been set up to develop and scale the production of recycled filaments for AM, whilst an Intrusion-Extrusion Moulding Facility, the Green Plastic Factory, has been established in the NL to expand the range of products manufactured using IEM.

Moreover, the project will help to increase the adoption of technology and uptake of recycled feedstock by businesses. This will be promoted through research into the current and future supply of single-use plastic waste from municipal sources, technical information on the materials and recycling processes, and circular business models. In-depth support will also be provided to a range of businesses across North-West Europe, whilst the insights generated through TRANSFORM-CE will be consolidated into an EU Plastic Circular Economy Roadmap to provide wider businesses with the 'know-how' necessary to replicate and up-scale the developed solutions.

Lead partner organisation
Manchester Metropolitan University

Partner organisations
Materia Nova
Social Environmental and Economic Solutions (SOENECS) Ltd
Gemeente Almere
Save Plastics
Technische Universiteit Delft
Hogeschool Utrecht
Hochschule Trier Umwelt-Campus Birkenfeld Institut für angewandtes Stoffstrommanagement (IfaS)
bCircular GmbH

Countries
UK | BE | NL | DE

Timeline
2019-2023

www.nweurope.eu/transform-ce