



Case study report - DUO

Good practice of circular economy business models

Case study report - DUO

Good practice of circular economy business models

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 DUO, based in Manchester, UK. A total of 20 case studies will be completed, with five cases per country (The Netherlands, Germany, Belgium and the United Kingdom).

Date October 2021

Authors Rhiannon Hunt, Russell Yates

Deliverable WPT3 D2.1 Benchmarking existing circular economy (CE) business models

DUO.



This research has been conducted as part of the TRANSFORM-CE project. The Interreg North West Europe support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Programme cannot be held responsible for any use which may be made of the information contained therein. More information about the project can be found on: www.nweurope.eu/transform-ce. TRANSFORM-CE is supported by the Interreg North West Europe programme as part of the European Regional Development Fund (ERDF).

Table of contents

1. Introduction and method	4
1.1 Goal of case study	4
1.2 Company background	4
1.3 Case study process	5
2. Circularity of business model	7
2.1 Circular business model canvas	7
3. Circularity in the value chain	17
3.1 Material and value flow map	17
3.2 Circular strategies	17
4. Circularity of operational activities	21
4.1 Operational process map	21
4.2 Circular sourcing and design	22
4.3 Production process	23
5. Conclusion and recommendations	25
5.1 Strengths for circularity	25
5.2 Barriers and enablers for circularity	26
5.3 Opportunities for circularity	27
References	29

1. Introduction and method

1.1 Goal of case study

TRANSFORM-CE is an international research project, researching, amongst other topics, (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).

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

Duo is an established plastics packaging manufacturer that has been operating since 1988. The company primarily caters to the online retail market, sourcing, designing, manufacturing, printing and distributing flexible polyethylene bags, which are used by their customers to mail products to consumers. With its manufacturing and consultancy services based in Manchester, UK, and 4 international warehouses, DUO operates internationally and employs 110 people. The company is also committed to sustainability and circular economy, sourcing recycled and renewable, bio-derived plastics, ensuring all products are recyclable, operating a closed-loop recycling facility, and implementing material efficient product design strategies.

A short overview of Duo is given in table 1.

Table 1: Overview of company

Topic	Information
Company name	DUO
Website	https://duo-uk.co.uk/
Country	UK
Size of company	10-200
Mission/vision	Forward thinking packaging solutions for forward thinking businesses. From the latest sustainable solutions, to solving any challenges our clients put to us – our mixed model of consultancy, manufacturing and sourcing means we'll always have what you're looking for.
Product category	Plastic packaging
Production/operational process	Film blown extrusion
Used materials	Polyethylene (recycled post-consumer & post-industrial, bio-based)

1.3 Case study process

The case studies are being carried out between September 2020 and December 2021. The case study process is structured in four steps¹, 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 in regard to 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. In order 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 DUO.

Table 2: *Overview of interviewed people*

	Interviewed person	Function
Interview 1: Circularity of business model	Zoe Brimelow	Brand Director
Interview 2: Circularity in the value chain	Dale Brimelow	Operations Director
Interview 3: Circularity of operational activities	Tony Brimelow	Operations Manager

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).

INTERVIEW 1
BUSINESS MODEL
CIRCULARITY

INTRODUCTION

UNDERSTAND CIRCULAR BUSINESS MODEL



- Who is the company?
- What is its mission?
- What kind of products are manufactured?

- Map out business context
- Map out (circularity of) business model
- How does the BM deviate from other (linear) BMs?

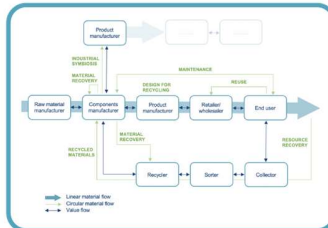
INTERVIEW 2
VALUE CHAIN
CIRCULARITY

ASSESS CIRCULARITY

		STATUS TODAY (2022)						
		NA	1	2	3	4		
1	Define the current linear model							Define the current circular model
2	Identify the current value chain							Identify the current circular value chain
3	Identify the current business model							Identify the current circular business model
4	Identify the current products							Identify the current circular products
5	Identify the current processes							Identify the current circular processes
6	Identify the current materials							Identify the current circular materials
7	Identify the current energy							Identify the current circular energy
8	Identify the current water							Identify the current circular water
9	Identify the current waste							Identify the current circular waste
10	Identify the current emissions							Identify the current circular emissions
11	Identify the current social impacts							Identify the current circular social impacts
12	Identify the current economic impacts							Identify the current circular economic impacts
13	Identify the current environmental impacts							Identify the current circular environmental impacts
14	Identify the current circularity opportunities							Identify the current circularity opportunities
15	Identify the current circularity barriers							Identify the current circularity barriers
16	Identify the current circularity enablers							Identify the current circularity enablers
17	Identify the current circularity challenges							Identify the current circularity challenges
18	Identify the current circularity solutions							Identify the current circularity solutions
19	Identify the current circularity risks							Identify the current circularity risks
20	Identify the current circularity opportunities							Identify the current circularity opportunities

- Assess current circularity state and objective
- Identify aspects that may need attention

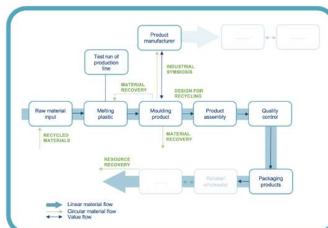
VISUALISE MATERIAL/VALUE FLOW



- Map out material/value flows
- Discuss applied circular strategies
- Identify opportunities for further enabling circularity

INTERVIEW 3
OPERATIONAL
CIRCULARITY

VISUALISE OPERATIONAL PROCESS



- Map out production process
- Understand circularity of operational activities

CONCLUSION

IDENTIFY STRENGTHS & OPPORTUNITIES

Barriers	Enablers
•	•
•	•
•	•
•	•
•	•

- Present wrap-up of results
- Identify strengths for circularity
- Summarise barriers and enablers
- Determine opportunities for further enabling circularity

Figure 1: Overview of case study process

2. Circularity of business model

The first step aims to create 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).

2.1 Circular business model canvas

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 DUO is visible in Figure 2 and a description of each element is given below.



Figure 2: CBMC of DUO Packaging

Value proposition

DUO is a trusted supplier and partner to a large customer base requiring high quality and sustainable packaging solutions (both recycled polyethylene and bio plastics), most importantly for their online retail sales.

The company produces sustainable packaging in a manner that sets out to design packaging with the full lifecycle in mind, creating a closed loop in the recycling and manufacturing process. Transparency in production is increasingly valued by its customers which is able to be ensured through European accreditation (EuCertPlast) and via visits to the factory premises to review processes and conditions. DUO also has in place ISO14021:2016 Environmental labels and declarations, to further support the company's promotion of its sustainability credentials.



Figure 3: *Film-blown extruded plastic awaits conversion into DUO's finished products.*

DUO consults and works closely with its partners to understand their specific needs and how packaging can be produced with the full lifecycle in mind. Its design and consultancy service considers resource efficiency in terms of the minimisation of materials used in production, reducing the size of packaging and designing out potentially contaminating features. DUO works

with the client to eradicate labels and paper used, or at the least minimise the negative impact on the grading of the returned materials.

A high-quality product with high production standards gives its customers brand protection through the satisfaction that their own brand's sustainability objectives are being reached. Many of DUO's customers have a variety of accreditations and management systems in place, often linked to the Sustainable Development Goals (SDGs) and Global Recycled Standard (GRS). As a result, DUO's products are aligned with these requirements, and the company also employs its own environmental and quality management systems, with accreditations, such as ISO14001.

The company provides a takeback service for its customers for their returned mail order packaging, further embellishing their clients' sustainability credentials whilst giving a value to that 'waste' which is shared by the customer in terms of a cost reduction and to DUO through reclaimed materials for reuse. The service includes staff training within the client's employee base on the types of plastic and how to separate it to retain most value for the company. DUO tracks the waste returned, calculates its value and gives the client a cost reduction on future packaging. It is not currently possible to ensure the client's own waste is reused in their own specific packaging due to the scale of operations.

Customers & users

DUO adapted its processes early to work directly with online retailers in the early 2000's, adopting new technology to anticipate the growth in e-commerce and the changing needs of the retail industry.

In addition to providing bespoke consultancy and packaging solutions for each client as required. This can increase the cost to the customer but ensures higher quality and risk reduction for the client in meeting and proving its sustainability credentials. DUO offers a packaging take-back service. DUO supplies a 3rd party bailer and educates staff how to separate the waste and increase its value to the company. The recycled materials are weighed, valued, collected by DUO and reused. Waste collected in this way currently accounts for 10% of DUO's reused materials. The service reduces costs for the client and the client understands that this waste has a value.

Key activities

DUO Packaging provides bespoke packaging solutions for large retailers. In just 3 years, production has shifted significantly away from the reliance on virgin polythene. In 2018, 73.5% of its packaging was made from virgin polythene (4,989 tonnes). Increasing the transition to sustainable packaging year on year, in 2021 DUO produced a total of 2,954 tonnes of packaging for its customers, 43% of which was produced using recycled polythene with an additional 8.4% being bio-based Green PE. Virgin polythene production now accounts for only 1,446 tonnes (49% of its total production).

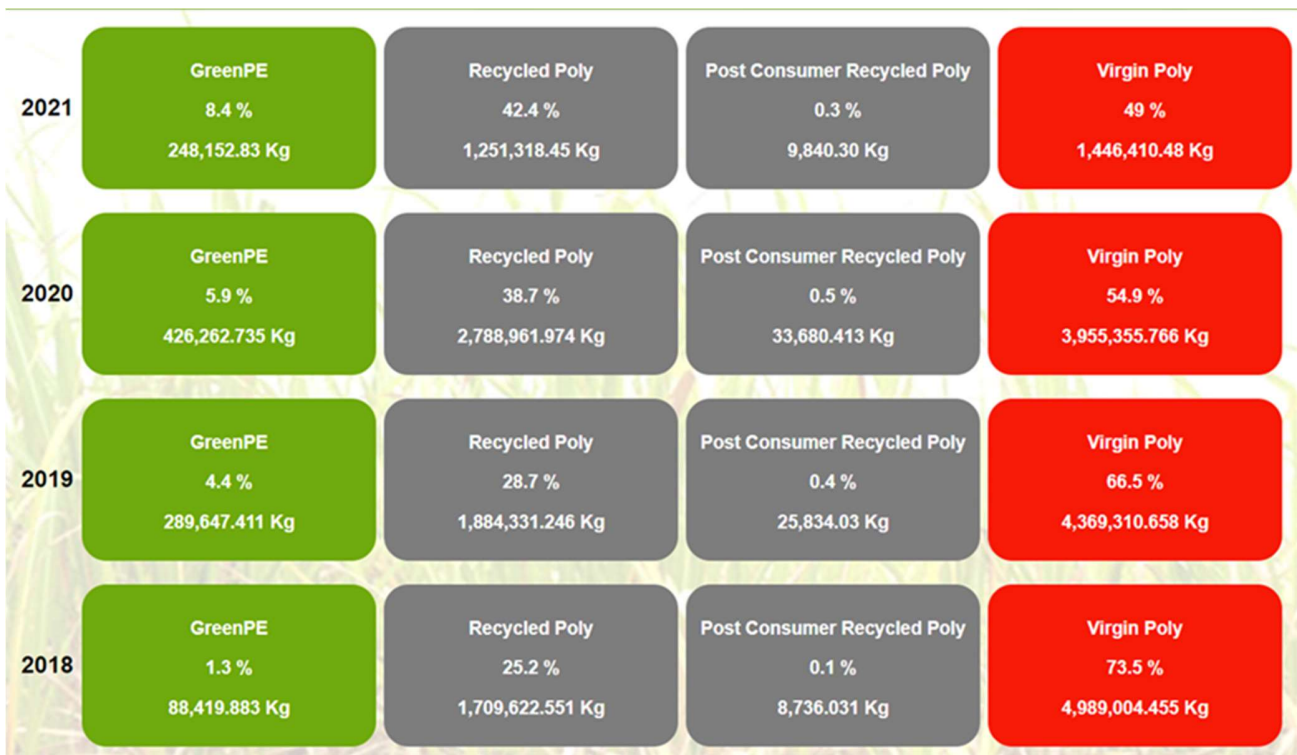


Figure 4: The evolution of DUO's raw materials 2018-2021 (Source: <http://duo-uk.co.uk>)

A key activity contributing to this transition is DUO's research and consultancy with its clients, which works to both find sustainable packaging solutions in terms of material content as well as resource efficiency in terms of finding the 'best size packaging' for the product. This service helps DUO's clients to meet their own sustainability commitments and responsibilities. This shift has removed 3,500 tonnes of virgin polythene from its packaging per year compared with 2018.

A takeback service is offered, encouraging DUO's customers to return their DUO waste and packaging that comes back to them in the form of retail returns. To support this, DUO provide their customers with FOC pallet covers to protect their collected waste from the elements if stored outside (as is often the case). The pallet covers are colour coded – green for clear scrap and red for mixed 'jazz' colours. DUO also help their customers with best practice advice on collection, separation and storage of these materials. The returned packaging is weighed by DUO, given a value, and returned to the client in monetary savings. Post-consumer recycled polyethylene has increased, from 8 tonnes in 2018 to 33 tonnes in 2020.

DUO provides an artwork service to its customers, to help them develop the size, shape, construction and surface detail of their packaging. As part of this, designers also work to ensure that the finished product is optimised in terms of manufacturability and where possible, minimal inks and other potential contaminants are used. By doing so, the materials within the product retain more value when it comes to recycling. DUO can either provide the required solution or

work with their customers' own design teams to co-design the finished product. In addition to the visual and functional aspects of their products' design, DUO's designers will also advise on the messaging included on the packaging around end-of-life options, including how to reuse the product for returns and how the materials can be recycled. This activity is helpful for the client, but also essential for the reputation of DUO as the producer and in ensuring it continues to satisfy its global accreditation bodies and sustainability assessments.

DUO has a specialised print dispenser unit that uses only the minimal amount of ink required for the specific packaging, reinvesting any ink wastage into the next production run. Work to reduce the use of paper labels in order to reduce contamination of the future recyclates has led to the introduction of the use of printing unique QR codes on each product which is unique to DUO. A gas capture process ensures heat produced by the machinery is captured and used on site.

Working with the client to understand future demand is essential to meeting the client's bespoke needs, as well as avoiding just-in-time (JIT) delivery so that delivery loads back be optimised in terms of load per journey. This is aided with the introduction of an online client e-portal, allowing the customer to order bags as any consumer would purchase online. This helps both to understand the peaks and troughs in the business which is important in terms of waste reduction but also, essentially, profitability. This service is backed up with an account management process.

Key resources

Access to recycled polyethylene at scale and of appropriate quality is essential to production. DUO approaches this in a number of ways:

- A takeback service is offered to clients, with sorting bags, training on separation and a third-party baler. Currently around 10% of all materials used in production come from DUO's customers. This requires subcontracting of a 3rd party baler.
- The remaining 90% is sourced from recycling companies processing post-industrial and post-consumer waste, 45% from the UK and the remaining 45% from companies in the European Union processing post-consumer waste.
- The need to have access to a secure supply of recycled polythene has led to DUO setting up its own recycling company to feed directly into its production.
- The quality of the pellets used needs to be ensured to maintain the quality (and legality) of the product.

Delivery of the packaging to the customer requires access to a number of warehouses to store the product in the engaged regions. DUO leases space from one warehouse in the UK from where its UK customers' product is stored. Additional 3rd party warehouses are used in China, Germany (Berlin) and the United States (Atlanta).

DUO's IT systems to handle online customer quoting and orders is essential, allowing clients to order their product according to future anticipated demand and enabling DUO to respond accordingly.

Access to an appropriately educated or trained employee base is essential. This includes access to people who understand the technical, environmental, social and legislative issues surrounding the plastics and packaging industry, data analysts and engineers. DUO also hires a number of apprentices in engineering, marketing and sales to grow its own talent in line with the needs of its business.

Energy supply is critical. Heat capture technology is also applied on site to feed back into the building's operations.

Key partners

Closed Loop recycling and waste management companies are essential key partners. Long standing and trusted relationships are essential and have been developed to ensure quality alignment.

DUO works in partnership with its clients through its advisory, consultation and design services to provide bespoke packaging solutions that are unique for each client. Every unique design needs a printing plate, and DUO has works with a partner to manufacture each plate.

Third party bailer companies to facilitate the waste collection and return to DUO for reuse and 3rd party warehouses across the world also facilitate DUO's key activities.

Distribution Channels

Sales are made via an online customer portal where customers can order and purchase directly, reorder stock or request additional services and consultation.

Additional services include a design and copy service to both help the client display their sustainability credentials and to ensure that the wording is accurate and that all claims made are legal, reducing any fears about claims made and removing potential future negative backlash.

A take-back service is offered to ensure any waste is sorted effectively and brought back into the supply chain and reused.

Stock is held at locations around the world to store the product in the engaged regions via 3rd party warehouses in the UK, China, Germany (Berlin) and the United States (Atlanta).

End-of-use

DUO does not currently have oversight as to how all its products are processed at end-of-use, however, the company has made an educated guess as to the key routes for their products at end of (first) life within the UK. Some polyethylene bags will be returned from consumers to retailers when products are sent back as returns. Others may be reused for other purposes around consumers' homes (e.g. as bin liners), added to at-home recycling bins, or taken to supermarkets in the case that dedicated collection bins are available. However, it should be noted that DUO's products are used to transport retail products internationally, and the company has less insights into the end of (first) life routes in these regions.

Some customers will collect these and deliver them to DUO for recycling via a 3rd party service provider. This is incentivised by DUO, who provide their customers with a per tonne price for the material. Where required, DUO will also offer some clients a free-of-charge baler to compact the waste so that it takes up less space in transport. DUO's products may also be indirectly returned in the form of the post-consumer recycled materials that the company sources from its European suppliers, although these will be mixed with other plastic waste and are not currently traceable.

Costs & revenues

At the core of DUO's business model is the treatment of waste as a resource but also the minimisation of potential waste in the manufacturing process through bespoke packaging that designs out waste for each client. This is complemented by DUO's commitment to training its staff and machine operators and investing in new and improved machine technology.

DUO can control the supply of their raw materials, working with recycling companies and investing in a new recycling facility. It purchases raw materials from a third-party supplier or through a take-back service from its customers, which is then recycled through a third-party recycling company.

A continuous drive towards automation to optimise the production process involves capital investment in machinery. Labour costs remain significant with DUO, employing 110 staff across Greater Manchester.

Transportation costs can be reduced through the redesign of packaging, minimising size per unit and also type of packaging, for example working with customers to shift from boxes to bags where possible. Transportation is aided through storage on site with the customer and at strategically located warehouses globally.

Manufacturing is heavily dependent on energy and energy supply is critical. Heat capture technology is applied on site to feed back into the building's operations.

Sales include manufactured packaging, consultation, and artwork services. The company also supplies products that they do not currently manufacture, such as paper bags. To date DUO has not explored a product as a service model.

Policies & regulations

The Plastic Packaging Tax will come into effect on 1st April 2022 and will apply to UK companies that manufacture or import 10 or more tonnes of plastic packaging within a 12-month period. Plastic packaging containing 30% or more recycled plastic is not chargeable for the tax. Whilst the announcement of the tax has been helpful, it is already impacting on the availability of recycled material as the UK's recycling infrastructure is not developed enough and too weak to deliver sufficient supply of recycled plastics to enable industry to meet the key targets for recycled content in their products.

It should be noted that measures, such as the Plastic Packaging Tax can have unexpected, negative impacts. Although aimed at encouraging the uptake of recycled plastic, reducing the UK's dependence on petroleum based virgin plastic and, in turn its carbon footprint, the regulations do not take into account other, more sustainable alternatives, such as Green PE. As Green PE is bio-based, carbon dioxide is sequestered as plants grow, resulting in a carbon-negative material. Whilst recycled plastic has a lower carbon footprint compared to petroleum based virgin plastic, it is not carbon-neutral nor negative. As a result, the tax has meant that innovative sustainability leaders within the industry have been forced to create a less environmentally friendly product.

A lack of guidance from government on how to document usage and alongside no indication of accreditation to be adopted are impacting on the ability to plan effectively within the business or to enable DUO to advise its customers.

DUO recognises that this is not a long-term solution as there are incentives built into to the legislation that could potentially lead to more carbon intensive production methods that include greater amounts of waste (for example only focusing on the negative effects of using plastic can lead to more carbon intensive production methods being implemented, as seen in the case of some 'bags for life' designs or the case with larger and heavier cardboard packaging. This in turn has the potential for companies to adopt the wrong position to be seen to be doing the right thing whilst increasing their carbon footprint and that of the region.

There is a view that locally, in Greater Manchester, there exists a drive to remove plastic alongside contradictory targets to reduce the volume of waste and questions around the ability and capacity of Greater Manchester to both sort and recycle plastic and cardboard waste. Whilst it is accepted that the sorting and recycling of domestic waste is a difficult issue to solve, more could be done by Local Authorities to work with businesses through education and opportunities to effectively sort and recycle to improve the supply of recyclate to industry. An effective forum to develop an ecosystem for recycled plastic would be welcomed to start to address supply issues for recycled plastics.

That said, it is accepted that the Plastics Packaging Tax could lead to greater transparency and a greater understanding of the issues and an identified need for appropriate education for businesses and the community at large. With no understanding of what the plastic tax revenues will be spent on, there may be opportunities to ensure it is reinvested in improving recycling infrastructure including sorting, separation and collection.

Trends

DUO was an early adopter of technology to adapt to online sales and technology continues to feature as essential to the success of the company. Most recently, this is evidenced in the adoption of new digital kit purchased in Germany and Italy to quickly repair machinery during breakdown. The technology removes the need for transportation of an engineer to fix the problem, requiring dial in and remote solutions only leading to quicker fix of faults and the application of predictive maintenance, optimising the machine's productivity and reducing transport related carbon emissions. The introduction of new machinery and technologies are reducing energy consumption as inefficient machines are decommissioned.

Embedded technology in manufacturing machines is also facilitating the quicker fixing of faults, with predictive maintenance and digital twin capabilities.

New technologies that are helping with the production process are being introduced. These include technologies that use UV lighting to sort materials, automating the process and increasing retention. As the cost of chemical recycling becomes more prohibitive, new innovations in printing and labelling are enabling greater use of water-based inks that reduce contamination. Print On Demand (POD) technologies are aiding the design process and bringing efficiencies.

As a business, horizon scanning is being done around the potential impact of the Plastics and Packaging Tax and its potential impact on the industry. However, DUO continues to be alert to larger brands' desire, and often need to dictate requirements to suppliers to mitigate against the potential for negative publicity and continues to work with its customers to achieve this.

Positive and negative impacts

DUO is able to effectively control its own supply of raw materials in the form of recycled plastics using takeback schemes, effective partnerships with recycling companies and, more recently, in an investment in its own recycling plant.

Companies switching to polyethylene bags from cardboard can achieve reduced transportation and associated costs from bespoke, best fit polyethylene packaging which can also assist with local authorities' waste volume reduction strategies and targets. The nature of the problems that exist around potential to develop relationships between businesses.

The Plastics and Packaging Tax could be seen as a driver for improving the infrastructure of the recycling industry.

Negative

Biodegradable components and additives into plastics at any stage can contaminate the product, leading to additional waste that cannot be reused. Traditional water-based inks are possible to use but the slow drying process makes it not appropriate for manufacturing although technology is developing all the time and being explored.

The Plastics Packaging Tax is having an impact on the availability of recycled plastics which will take some time to respond to and resolve issues that are leading to less recycled materials being available.

Misinformation in the media such as for example that all plastic is bad, cardboard is more sustainable and bags for life are better are distorting perceptions in a way that can lead to even greater carbon emissions. A lack of oversight and understanding of the bigger picture, including the lifecycle of a product, can lead to a move to more carbon intensive production and consumer demand. A lack of guidance on accreditation associated with the UK Plastic Packaging Tax is also potentially forcing businesses into reactionary, less-than-optimal, decision making, processes and delivering poor outcomes. More consultation from government would be welcomed.

Finally, investing in sustainable innovation and significant changes to business as usual can be difficult when many businesses, such as DUO, are already facing sharp increases in staff costs, energy, transport and raw materials.

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 and value within the company's value chain. The material and value flow map of DUO is presented in Figure 3. The value flows (blue) indicate that value is being exchanged between actors and enables an analysis of the relationships amongst key partners. The circular material flows (green) show where the materials come from, where it goes and how it may return into the cycle.

Material and Value Flow Map

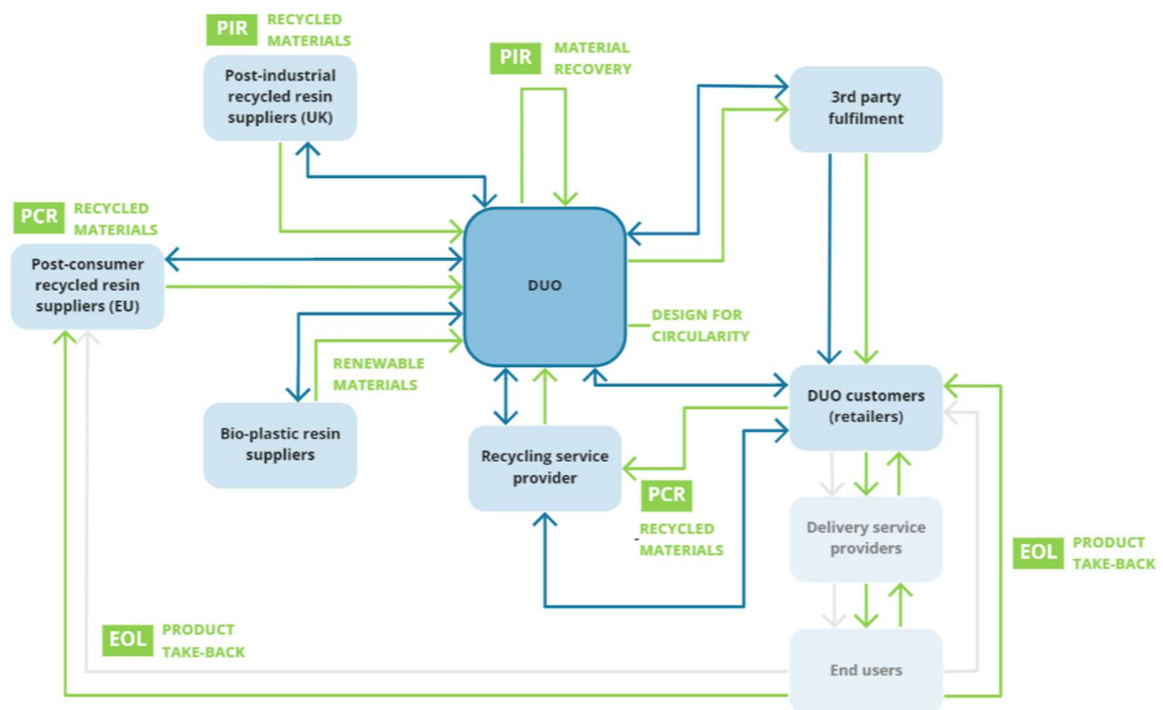


Figure 5: Material/value flow map of DUO
(with PCR: post-consumer resin, PIR: post-industrial resin and EOL: end-of-life materials)

3.2 Circular strategies

As shown in figure 3, DUO applies multiple circular strategies: Renewable (bioplastic) materials, recycled materials, material recovery, product take-back and recycling (via 3rd parties) and design for circularity.

Each of the strategies is further explained below.

Renewable materials

Bio-based materials make up 12 percent of DUO's total material extrusion by weight; a percentage that is increasing year on year. These materials are derived from sugar cane and are currently marketed as a separate product. As they are chemically identical to traditional, petroleum-based plastics, they can be successfully blended with standard recycled and virgin plastic materials. This feature will be important in helping DUO to prepare for the soon-to-be-implemented UK Plastic Packaging Tax in 2022 that applies to plastic packaging with less than 30% recycled content. A further benefit is that these bio-based materials are also able to be recycled using existing plastic recycling processes and infrastructure.

They are not biodegradable and can therefore be recycled, DUO's bio-based materials are renewable, meaning that they can be replenished through natural cycles. As the sugarcane sequesters carbon dioxide as it grows, these materials will also play a significant role in DUO meeting their carbon reduction requirements.

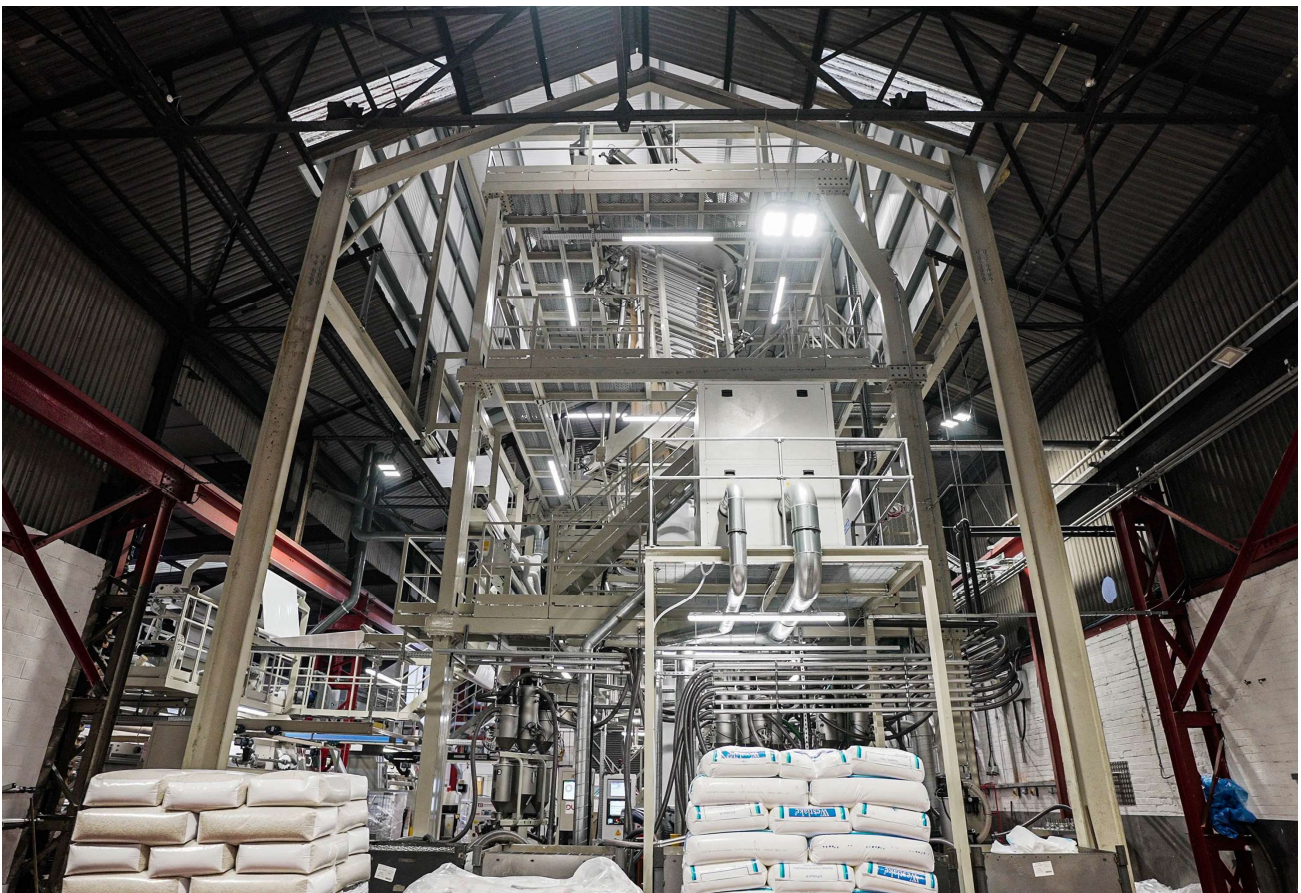


Figure 6: Co-extruder facility at DUO.

Product take-back and recycling

Some of DUO's customers collect and return waste mailer bags to them in return for a set price per tonne of material. Customers may get these back from end users through product returns that are packaged in the original mailer bag. Alternatively, deposit schemes may be set up so that end users can deposit their waste mailer bags in store.

These recycled post-consumer materials account for 10% of DUO's raw materials, providing an example of a truly circular business model. The returned waste is sent to 3rd party recyclers for cleaning, sorting, and processing. There is currently a lack of UK based companies set up to provide these services, which, as DUO explained, limits the availability of recycled post-consumer plastics in the country (UK).

To overcome the challenges surrounding a lack of local, UK recyclers, DUO are embarking on a major development, establish a plastic recycling and wash plant facility. Due to a lack of space and suitable land at their current premises in Greater Manchester, UK, DUO is establishing this facility in Leeds as a separate trading entity. As most plastic waste collectors serving their industry export their materials for processing overseas, DUO is limited to a single service provider with EuCertPlast accreditation. The new entity will be become EuCertPlast accredited themselves, whilst also providing Duo with gaining more control and visibility over their products at end of life. This will help them to guarantee a long-term, local supply of recycled materials, particularly when there is likely to be increased demand following the introduction of the UK Plastic Packaging Tax.

Recycled materials

DUO's remaining raw material feedstocks are sourced from both European recyclers of post-consumer plastic waste (45%) and UK recyclers of post-industrial and post-consumer plastic waste (45%).

Material recovery

Onsite, DUO routinely recover and recycle any production offcuts, helping to reduce waste, conserve resources and save on costs. However, they note that onsite recycling of a company's own waste is somewhat of a grey area in terms of the UK Government's legislation on what constitutes recycled plastic content. DUO understand that they would need to send their waste to a 3rd party for processing if they were to count this within the 30% minimum recycled content in line with the new UK Plastic Packaging Tax. Nevertheless, the on-site recycling of manufacturing waste represents best practice and is a straightforward means of conserving raw materials and saving on the cost of both material sourcing and waste disposal.

Design for circularity

Design for circularity by DUO manifests itself in 2 ways: *design for recyclability and design for reuse*.

Design for recyclability

All of DUO's mailer bag products are recyclable at the point of production, although the company has limited oversight as to what percentage of their products are actually recycled by end users. The recyclability of their products can also be inadvertently reduced by their customers through the addition of printed labels and other additions. This is because the presence of excessive ink can change the colour of the resulting recycled pellet to one that is less marketable, with natural or light colours being the most in-demand. Any residual paper remaining in the recyclate can also create undesirable odours and discolouration when heated through mechanical recycling and subsequent extrusion processes, as the paper carbonises. This can also create blockages in machinery, resulting in costly breakdowns and loss of time.



Figure 7: Recycled polyethylene pellet being blended on site at DUO.

DUO have been exploring several solutions to further improve the recyclability of their products post-use. One of these is engaging with the labelling industry to explore alternatives that are optimised for recycling, such as the direct printing of QR codes onto bags, however, this has proven quite difficult as many stakeholders are resistant to change. This challenge is in part due to the vast range of fulfilment operation requirements put forward by their clients. Within their own internal processes, DUO are working to gradually replace oil-based printing inks with water-based

alternatives, as these have a lower carbon footprint. Currently, 30% of their printing processes use water-based inks, however, it can be difficult to change as their existing machinery is set up for oil-based inks.

Design for durability

All of DUO's products are carefully designed so that they are durable and fit for purpose, safely transporting goods to the required location in a variety of weather conditions. They can also be designed to allow end users to re-seal and reuse them for product returns, extending product life prior to recycling. For more rugged packaging, required for certain applications, DUO have developed a specialist, super strength film that only uses minimally more polythene, conserving raw materials without a loss in performance.

"Innovation has been key in DUO's development of competitive, circular solutions and continues to lead its future strategy."

Dale Brimelow, Operations Director of DUO

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 has been completed. 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 made, see Figure 4. This includes circular sourcing of materials, the production process and quality assurance of products. Each of the steps will be further explained below.

Operational Process Map

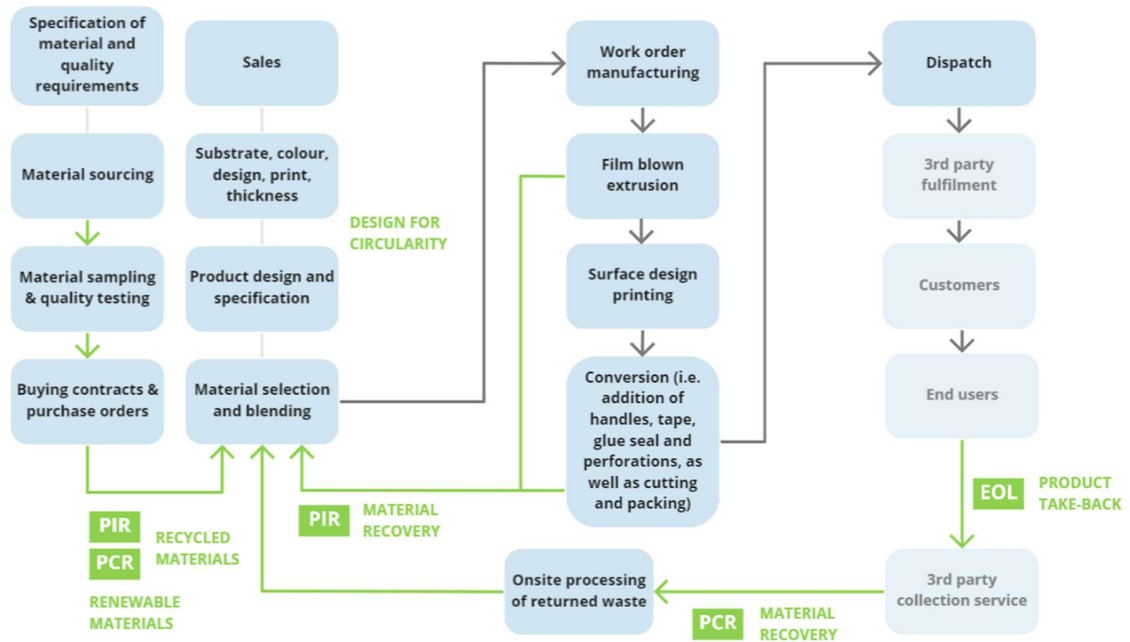


Figure 8: Operational process map of DUO (with PCR: post-consumer resin, PIR: post-industrial resin, EOL: end-of-life materials and design for circularity)

4.2 Circular sourcing and design

Material specification, sourcing and buying

DUO source their raw materials from a variety of suppliers. These include returned post-consumer products from their own customers (10%), which are recycled through a 3rd party service provider, UK suppliers of post-industrial and post-consumer recycled plastic (45%), EU suppliers of post-consumer recycled plastic (45%), and Brazilian suppliers of bio-based plastic materials derived from sugar cane, the latter of which can be used to make a designated, separate product, or blended with virgin and recycled materials.

DUO performs periodic material sampling and quality checks on the raw materials that they purchase, however, they also rely on the information and certification provided by their suppliers, as it would not be feasible to test every batch.

Material specifications and quality requirements are aligned with demand and product design requirements as stipulated by DUO's customers.

Sales

DUO have an in-house and field sales team, who work with customers to understand their packaging requirements and to explain the varied materials and products available. Customers are increasingly stipulating recycled and/or renewable content requirements, aligned with their own sustainability policies and the government regulations applicable to their industry. As the vast majority of DUO's products are made-to-order, sales occur prior to production.

Product design

DUO work closely with their customers, providing in-house product design services, to ensure that DUO's final mailer bag products are fit for purpose. This includes adjustments to the size, shape and colour of the mailer bags, as well as the inclusion of seals and handles, and the design of surface patterns, such as logos, information and QR codes.

4.3 Production process

Material selection and blending

Different combinations and quantities of DUO's plastic raw materials are blended according to individual customer requirements, such as the percentage of recycled and renewable, bio-derived content stipulated.

Film-blown extrusion

Following blending, the materials are put through a process called blown-film extrusion. In this process, air is used to stretch the plastic as it emerges from a tubular-shaped die head. Once the desired thickness has been achieved, the air is removed, and the plastic is flattened as it passes through rollers to create the thin, flexible plastic film material.

Surface printing

Having provided customers with product design services, Duo prints the agreed surface pattern designs onto the plastic film. The majority of Duo's printing uses solvent-based inks (currently 70%), as this is what their current equipment is set up to use, however solvent emissions are captured through a recovery system. The company is gradually switching to water-based inks (currently 30%) as their equipment is replaced and upgraded over time. Water-based inks provide additional recycling benefits, as they tend to float to the surface during the recycling process, however, they can present difficulties in the manufacturing process, such as extended drying times.

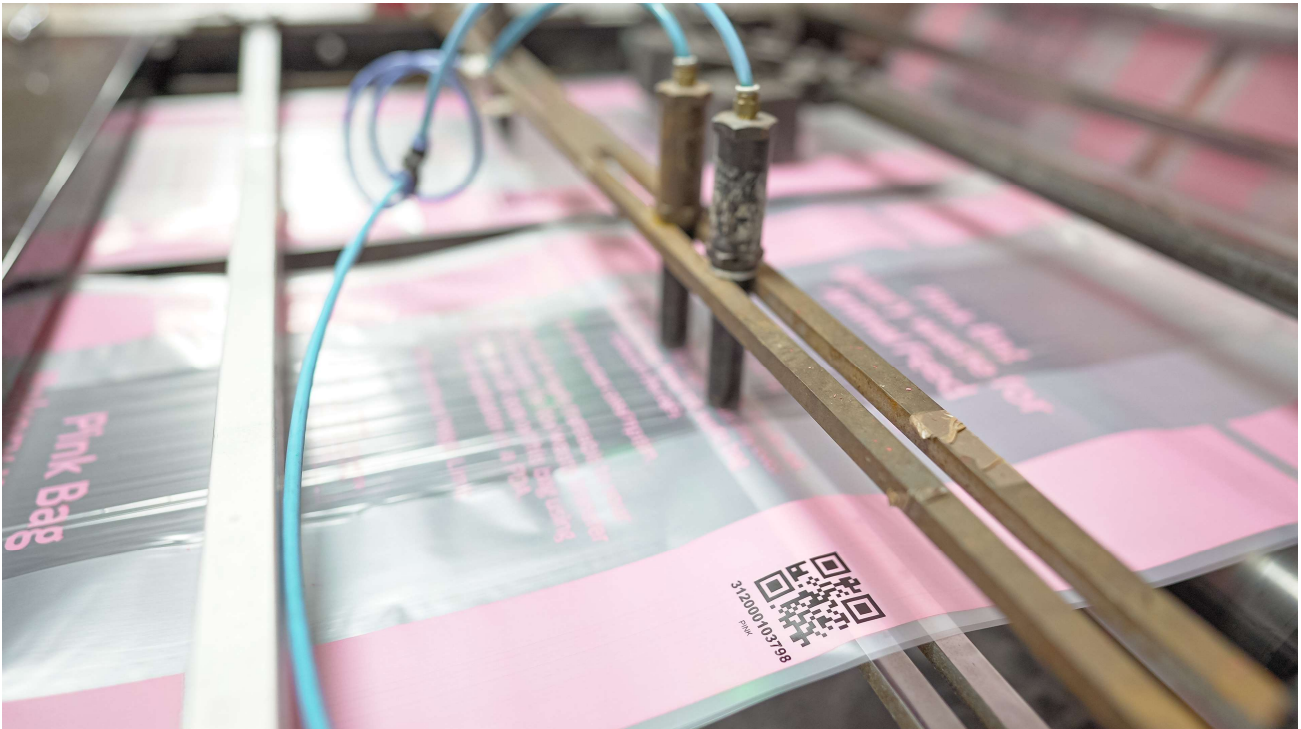


Figure 9: Printing of DUO's products, incorporating a QR code to reduce the volume of ink required for messaging.

Conversion

The printed plastic film is then converted into the final packaging product, as designed. This may involve cutting the film to size, application of glue and adhesives, the addition of handles and perforations, and packing.

Dispatch

Duo's plastic packaging products are distributed to their customers via a 3rd party fulfilment service provider.

"As many of the processes required to create DUO's products are carried out in-house, including material blending, design, manufacture and conversion, the company has a lot of control over the finished article and how it performs within a circular economy."

- Zoe Brimelow, Brand Director, DUO

5. Conclusion and recommendations

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

5.1 Strengths for circularity

Business model

DUO engages with customers at the design stage, where there is the greatest opportunity to implement circular economy solutions and strategies. They offer design and consultancy as an additional service, in-house, which also generates revenue.

DUO was an early adopter of renewable, recyclable and recycled materials, and the first UK manufacturer to use Green PE to produce mailing bags, establishing the company as a market leader in sustainable packaging. This has helped to grow their business, particularly as environmental awareness amongst customers and the general population has increased in recent years.

Circular strategies in the value chain

DUO's commitment to sourcing renewable and recycled raw materials and developing recyclable products has helped them to prepare for regulatory and legislative instruments aimed at reducing plastic waste.

By putting in place take-back schemes and on-site recycling, DUO are actively conserving resources and avoiding the generation of waste. The integration of circularity principles into their design process has also optimised their products for a circular economy and helped to create a joined-up, circular business model that is as efficient as possible.

Operational process

Operationally, DUO have established important relationships with suppliers of recycled and bio-derived raw materials. They also benefit from the ability to select and blend custom mixes of materials according to customer requirements, which enables DUO to offer a wider range of finished products.

In terms of their surface design and conversion processes, the company is taking a pragmatic approach and gradually moving to more sustainable and circular printing and gluing technologies, as existing machinery is replaced.

The dispatch of their products is conducted by a third party, so DUO have limited agency to make changes in this respect. However, DUO do optimise their box and pallet loads and avoid just-in-time (JIT) deliveries, minimising the number of journeys that need to be made to deliver their products.

5.2 Barriers and enablers for circularity

To ensure circularity for DUO and its value chain, several barriers and enablers can be pointed out. The biggest barrier for DUO is the lack of EuCertPlast accredited suppliers of post-consumer recyclate within the UK. It is assumed that this is due to a lack of incentives for domestic recyclers and the ease and cost efficiency of exporting waste from the UK to overseas recyclers for processing. There may also be a lack of confidence in new and innovative solutions that require long standing industries to change significantly. Additionally, as there is currently no industry standard or agreed accreditation body, customers request different accreditations from companies like DUO. It then becomes costly for them and other manufacturers to achieve several different accreditations at the same time. The fact that there are multiple standards also works to dilute their effectiveness, as manufacturers attempt to employ high-level commitments that meet them all. To overcome this challenge, DUO is investing in a recycling facility where they will be able to recycle waste plastic packaging into the raw materials for their products. By doing so they may generate additional income through the provision of waste processing services for generators of plastic waste, and they may also sell recycled raw materials to other companies for manufacturing into products.

The biggest enabler is growing demand for sustainable plastic packaging solutions and DUO's position as an early adopter of renewable, recycled, and recyclable products.

Other barriers and enablers have been mentioned and explained before and are summarised in table 3 below.

Table 3: Barriers and enablers for enabling circularity at DUO

Barriers	Enablers
<ul style="list-style-type: none"> • Lack of information provided by suppliers of recyclate (traceability of scrap material due to process demands – use many different types of scrap to arrive at a final product) • Grey areas and loopholes in new government legislation (e.g., Plastic Packaging Tax) • The cost of upgrading to more sustainable solutions and equipment (e.g., water-based ink printing) • Excessive contaminants (e.g., dyes, inks, adhesives) in recyclate, producing discolouration and odour, as well as causing blockages in machinery leading to down-time. • Transportation costs and emissions limit reuse and return options • A lack of established collection and return routes for flexible plastic films, such as polythene 	<ul style="list-style-type: none"> • Growing demand for recycled and renewable materials • New government legislation (e.g., Plastic Packaging Tax) • Partnerships with customers and delivery companies to collect and return waste for recycling • Technological advancements in recycling (e.g., the development of antioxidant additives to improve polymer chain length in recyclate) • Increased acceptance (and even desirability) of plastic materials that appear 'recycled' • Embedding sustainability and circular economy within the company's core strategy • Employees with the necessary skills and experience to implement new innovations (e.g., the onsite wash & recycling facility)

<ul style="list-style-type: none"> • A lack of local, UK companies collecting, washing, and recycling post-consumer waste • Customer preferences for light coloured materials, although apparent ‘recycled’ materials are gaining in popularity • The cost of replacing capital with more sustainable alternatives (e.g., switching to water-based inks) • The required performance qualities of e-commerce packaging (e.g., must protect contents from rainwater and movement during transportation) • Unwillingness from labelling industry to explore options that won’t lead to the contamination of plastic packaging (e.g., direct printed QR codes) • A lack of environmental awareness and education within the wider supply chain • Country specific legislation and more legislation in future, e.g., the Triman logo and extended producer responsibility (EPR) 	<ul style="list-style-type: none"> • ISO14001 promoting continual improvement of environmental performance • The availability of bio-derived materials that are chemically identical to traditional plastics, allowing them to be recycled together. • Embedding circular principles into the design phase • The ability to reuse manufacturing offcuts internally – (Note - this won’t count towards the 30% recycled target as stipulated by the UK Plastic Packaging Tax 2022). The current system makes it more valuable for a company to send these materials off site for recycling so that they can bring them back as ‘recycled material’. • Partners willing to facilitate in-store take-back schemes of plastic packaging, creating a pure and aggregated source of potential recycle • Providing customers with financial incentives for returning products to them for recycling • Chemical recycling opportunities to improve the quality of materials following numerous mechanical recycling cycles • ISO14001 as an important promoter of continual improvement
---	---

5.3 Opportunities for circularity

As an established packaging manufacturer, with a reputation for innovating sustainable solutions, several circular opportunities have already been explored and acted upon, however, there remains a range of opportunities for furthering the circularity of DUO.

With the plastic packaging tax being introduced within the UK, and measures to tackle plastic pollution emerging in other regions globally, the demand for recycled plastic as a raw material is expected to increase significantly. DUO’s plans to invest in their own, UK recycling facility presents an opportunity to not only secure a reliable source of raw materials in the long term, but also to improve traceability within their supply chains. This may provide DUO with the information necessary to offer their customers an end-to-end closed loop solution, where their customer’s own waste can be recycled back into their products, specifically. By recycling domestic, UK waste locally, , DUO will also be able to reduce the carbon footprint of their raw materials and move from

a UK source of post-industrial recycled plastic to post-consumer recycled plastic. A further opportunity associated with the development of a UK recycling facility is the opportunity to provide additional, circular products (i.e., recycled plastics) and services (i.e., plastic recycling) to other companies, diversifying DUO's circular business model.

With their own, in-house material blending, product design, surface printing and conversion processes, DUO is also well placed to adapt their product ranges and business models. This will help them to exploit opportunities arising as a result of changes in end user requirements and customer demands. These may include circular economy opportunities, such as influencing end-user behaviour with on-bag messaging or through the bags' design or material composition.

A further circular economy opportunity exists for DUO to apply their circular material and recycling innovations to develop new products and expand their business, helping to improve the sustainability of other industries.

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