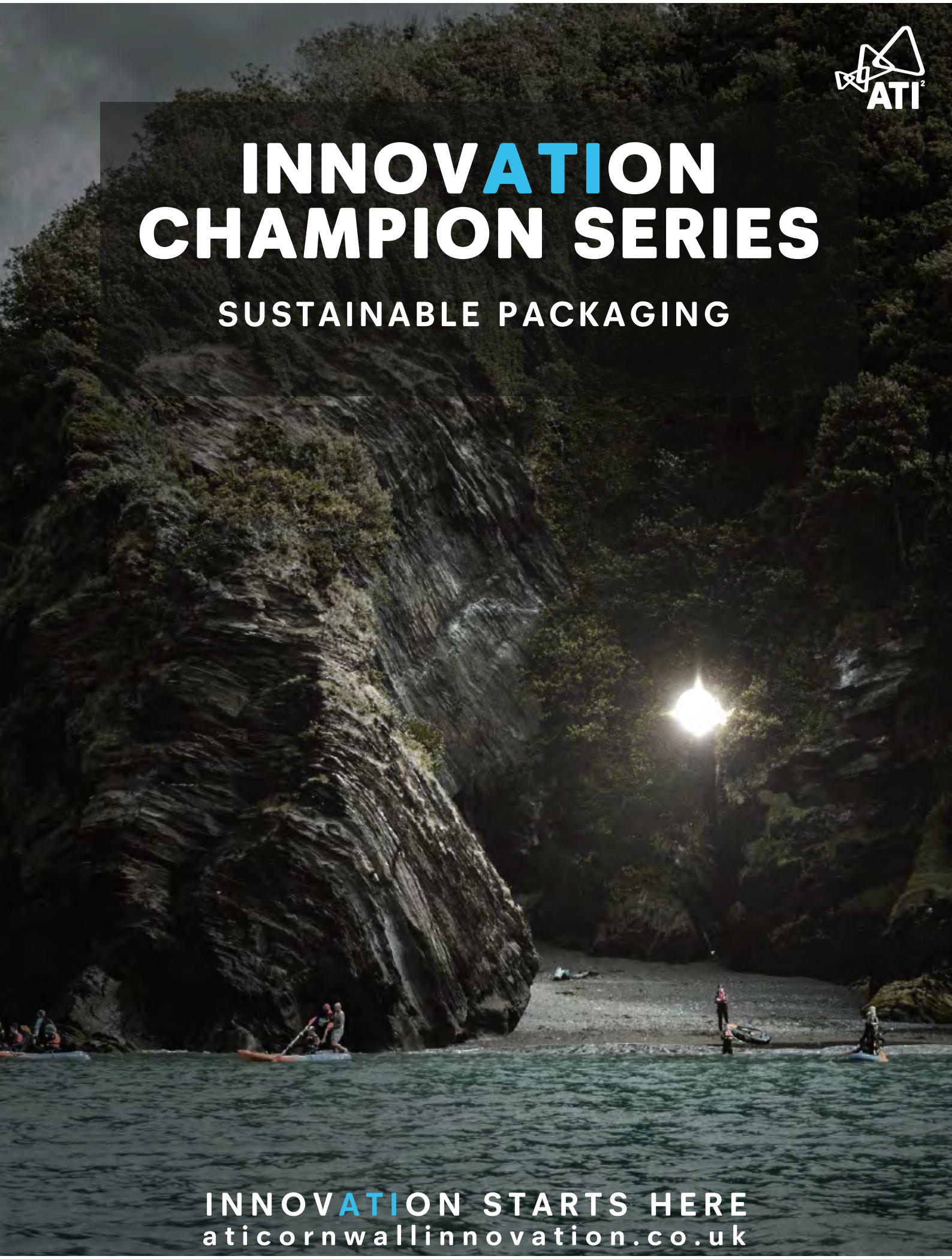

# INNOVATION CHAMPION SERIES

## SUSTAINABLE PACKAGING

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ACCELERATION THROUGH INNOVATION

UNIVERSITY OF PLYMOUTH
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INNOVATION CHAMPION SERIES
Sustainable Packaging

## About the Innovation Champion Series

Innovation is an integral part of developing a resilient and diverse business. In today's changing business landscape, understanding key trends within sustainability practices, funding, collaboration and innovation development are pivotal in ensuring a business is able to fortify itself in changing market conditions. This report forms part of the Innovation Champion series. Developed by the Acceleration Through Innovation's Innovation Champion in collaboration with university academics, it services as a reference guide for businesses on relevant trends that have proven popular over the last two years, which can enhance the innovation journey. Innovation Champion reports on the following areas are available through ATI2's digital platform: The Innovation Studio:

- Beginning your Innovation Journey with Stakeholder Mapping
- Understanding your Market with a Competitor Analysis
- The importance of Life Cycle Assessment
- Research and the Importance of Horizon Scanning
- Efficient Supply Chain Management for Businesses
- Universities as a Collaborative Partner
- Students as a Valuable Resource
- Sustainable Packaging
- Legislation and British Standards

If you would like any more information about The Innovation Champion Series, please email ati.research@plymouth.ac.uk

## ABOUT THE ACCELERATION THROUGH INNOVATION PROGRAMME

Acceleration Through Innovation 2 (ATI2) is a three year £3.4 million European Regional Development Fund (ERDF) project which supports business innovation across Cornwall and Isles of Scilly. Led by the University of Plymouth, the project drives a culture of innovation, supporting businesses who are looking to adopt innovative processes or who have aspirations to bring a new product or service to the market.
Businesses working with ATI2 benefit from fully funded support in a number of areas, including access to: valuable university resources, world-class research and innovation expertise, market research, specialist consultancy, guidance on IP and prototyping, and innovation grants.

# INTRODUCTION

## to Sustainable Packaging

Today, as the world looks to becoming more sustainable the consumer market is more aware of the impact the packaging and materials they buy. In turn, ths is affecting manufacturers' choice of packaging materials. However,there is a lot of confusion surrounding the different types of sustainable packaging and this report highlights those different types with examples of types of material that are used within the UK.

The UK government has set out its 25 year Environment plan which pledges to eliminate avoidable waste of all kinds by 2050 with an ambitious goal of a 75% recycling rate for packaging by 2030. The aim is to become a circular economy, which would eliminate the need for single use packaging. As a result there are many initiatives to enable sustainability, with many supermarkets pledging to reduce their plastic waste by 50% by 2025. With the COVID-19 pandemic, these targets may be moved but there needs to be a plan in place if you are using single use plastics within your production.

**"No challenge poses a greater threat to future generations than climate change."**

*Barack Obama*

# WHAT IS A SUSTAINABLE PACKAGING?

As defined by Wikipedia "Sustainable packaging is the development and use of packaging which results in improved sustainability. This involves increased use of life cycle inventory (LCI) and life cycle assessment to help guide the use of packaging which reduces the environmental impact and ecological footprint." [1]

In terms of sustainable packaging there are different methods of creating a circular economy:

- Recyclable packaging – ensuring all packaging can be infinitely recycled.
- Compostable packaging – the waste product goes back to the earth (in two different ways)
- Reusable Packaging – deposit return schemes and use and re-use schemes

Ultimately the plan is to reduce packaging waste and this will take time and effort but these are the alternatives you could start to implement.

## The Circular Economy

The Circular Economy is a very popular subject at the moment. The new buzz word that many in government and academia are using to highlight the problem of waste within society. For business it is going to be very important and something to look at in terms of the government attitude and following legislation concerning waste and the environment. The whole concept looks at overall system health, in which resource input, waste, emission and energy leakage are minimised and products are still kept the same in quality and price. Its aim is to make businesses and industries more environmentally sustainable.

It has been designed for both small and large businesses, locally and globally and is based on three principles:

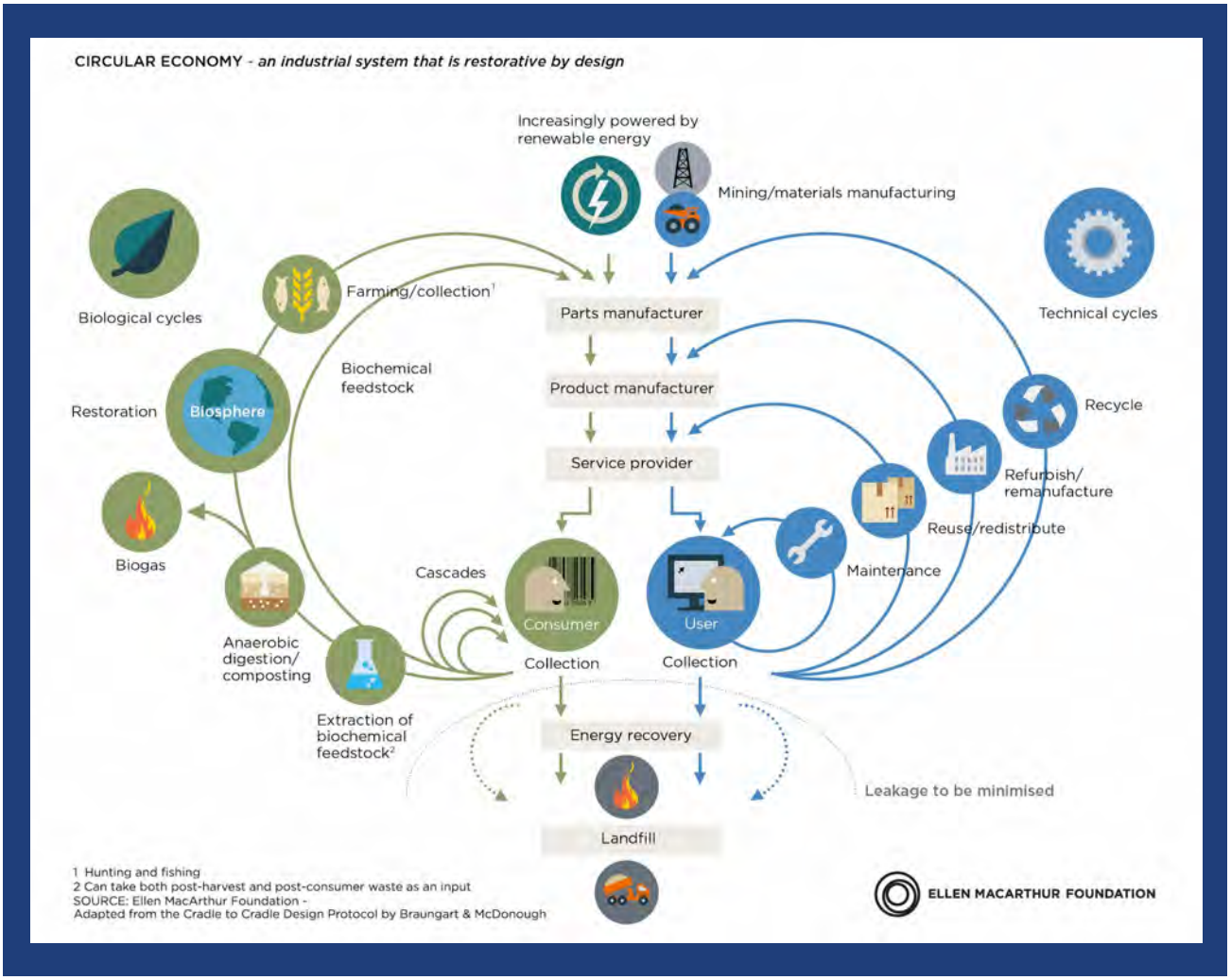
- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

[1] Wikipedia - https://en.wikipedia.org/wiki/Sustainable_packaging

# SUSTAINABLE PACKAGING

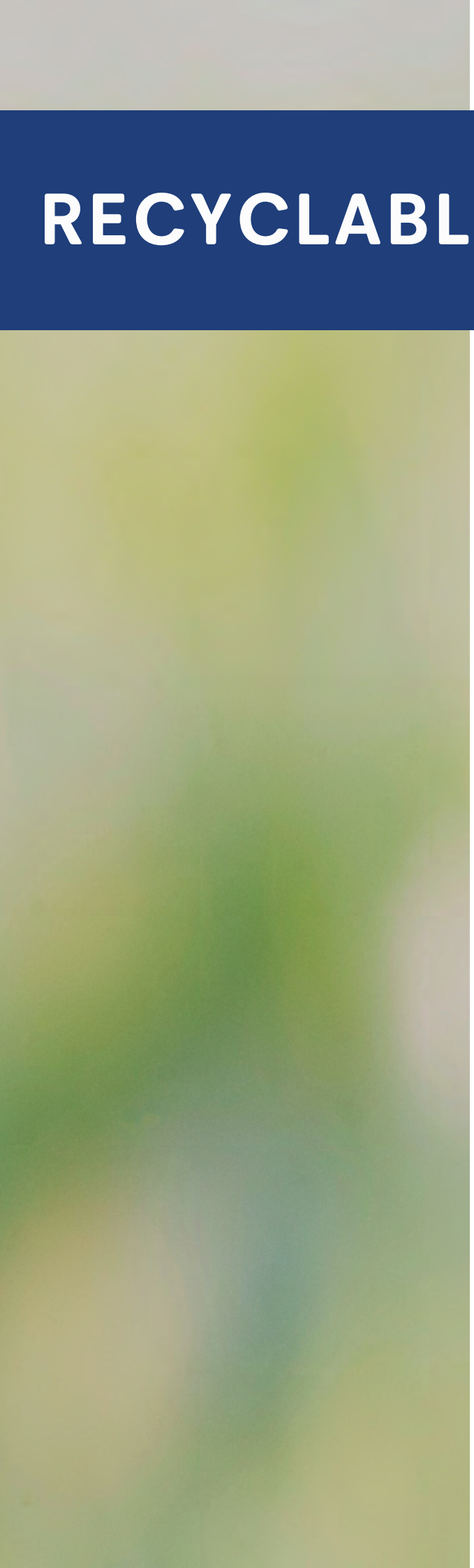
In theory the circular economy will end up with no new plastic and environmentally harmful products being produced: being replaced by products that are recycled and reused so that we do not produce any more waste.

In terms of practise, it is seen by some as 'nice to have' and something for the future, due to the related expense and the lack of recycled products on the market at present. If you would like to know more please read the Innovation Champion Report entitled: "The Importance of Life Cycle Assessment"




Source: The Ellen Macarthur Foundation https://www.ellenmacarthurfoundation.org/circular-economy/concept

# RECYCLABLE PACKAGING



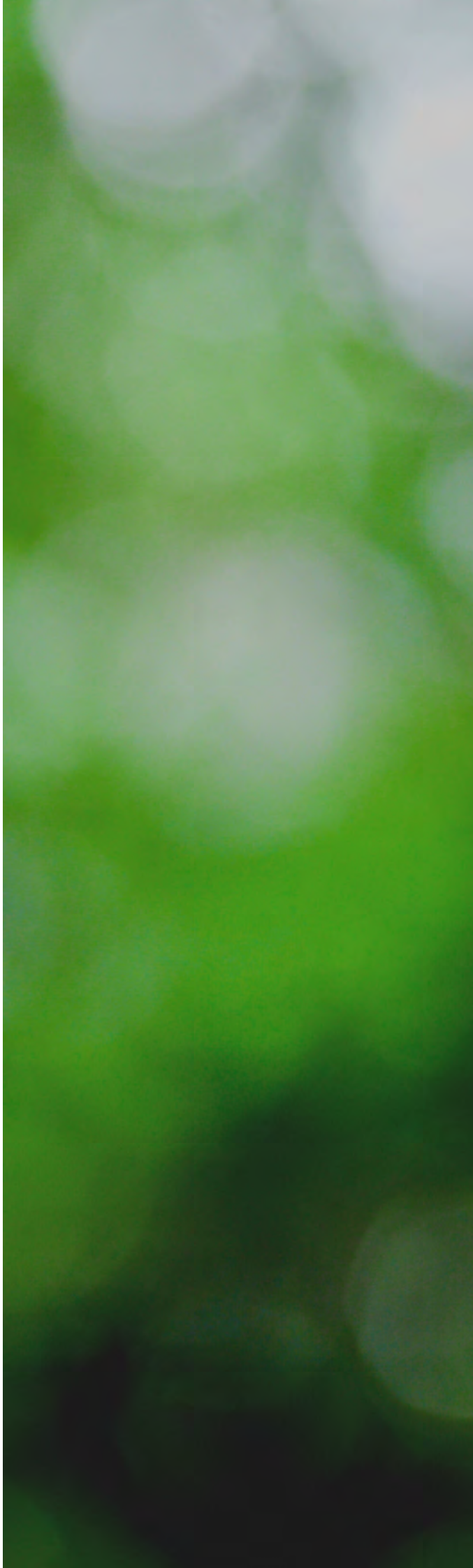
Technically every type of plastic can be recycled, however the extent to which they are recycled depends upon a number of economic and logistical factors. The most widely recycled plastics are Polyethylene Terephthalate (PET) and High-density polyethylene (HDPE). These two plastics are able to be 'traditionally recycled' through recycling schemes across the country. Traditional 'mechanical recycling' is the method by which waste materials are recycled into "new" (secondary) raw materials whilst preserving the basic molecular structure. It is also known as material recycling, material recovery or, related to plastics, back-to-plastics recycling. Recycling rates in the UK have come a long way in recent years and continue to grow year on year. For example, in the year 2000 only 13,000 tonnes of plastic bottles were recycled [1]; the UK now recycles over 370,000 tonnes a year

Recently Waste management firm Viridor has agreed a Memorandum of Understanding (MoU) with chemical recycling company Plastic Energy to explore a system that treats non-recycled plastic waste using low-carbon electricity to create recycled plastic feedstocks (https://www.viridor.co.uk/who-we-are/latest-news/2020-news/viridor-plastic-energy-circular-economy/). This would use a technology known as 'chemical recycling' which would mean mixed batches of all types of plastic could be recycled.

## POLYETHYLENE TEREPHTHALATE (PET)

Polyethylene Terephthalate, commonly known as PET is a cost-effective and environmentally friendly packaging option free from BPA (bisphenol A). All type 1 PET bottles can be recycled according to the UK Household Plastics Collection Survey 2014, and almost 60% of PET plastics are being collected for recycling from households. Although 60% does not sound a lot in comparison to the 3% that was collected in 2001 it shows recycling is increasing as society becomes more aware of the plastic problem. When recycled, PET bottles can be remade back into bottles for soft drinks or transformed completely into carpets, totebags and fibrefill stuffing for coats.

PET is a polymer of ethylene glycol and terephthalic acid. Pellets of PET resin are heated to a molten liquid, which can be easily extruded or moulded into almost any shape. PET was first synthesized in the U.S. during the mid-1940s by DuPont chemists searching for polymers that could be used to make new textile fibers. A recent Life Cycle Analysis (LCA) conducted in the USA by the Allied Development Corporation determined how the environmental footprint and greenhouse gas emissions of manufacturing and transporting PET relates to alternative forms of packaging. The study found PET was the most favourable alternative when compared to aluminium cans and glass bottles for a 355 ml carbonated soft drink application. When measuring greenhouse gas emissions and energy consumption, PET containers had the best performance.

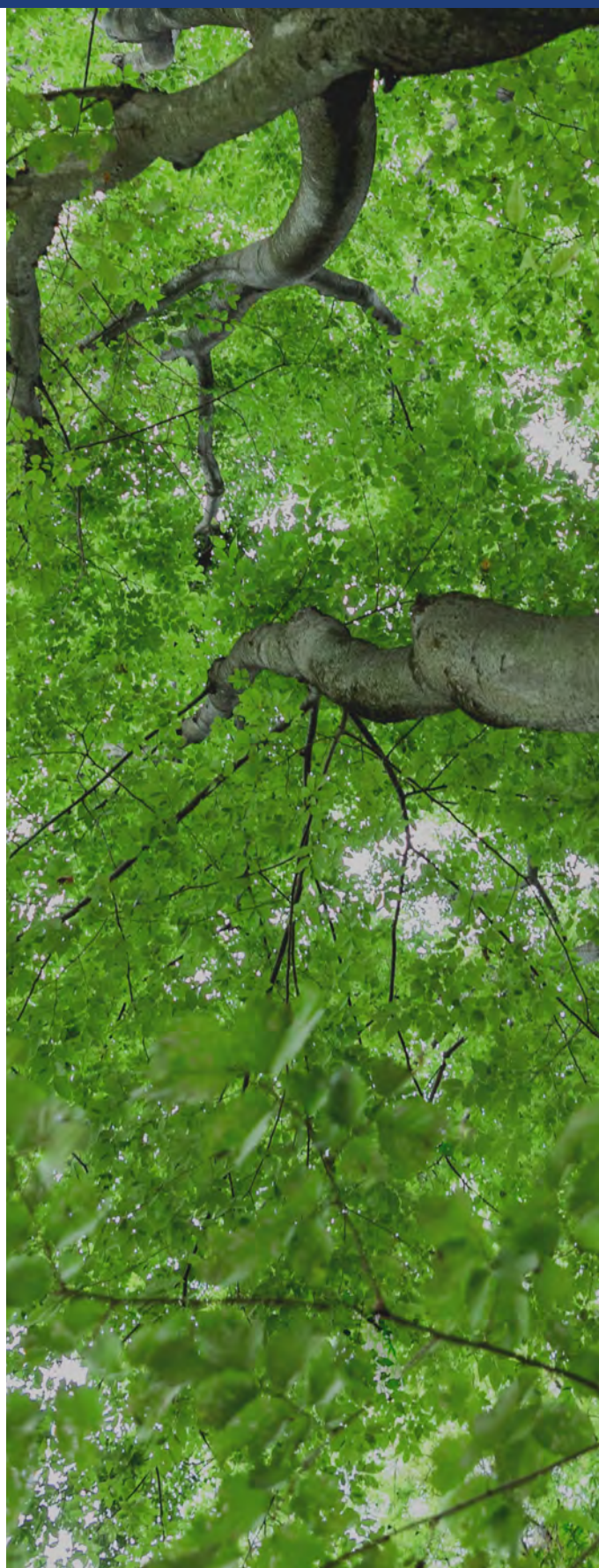


## HIGH-DENSITY POLYETHYLENE (HDPE)

High-density polyethylene (HDPE) is a thermoplastic polymer produced from the monomer ethylene. HDPE has a comparatively high density compared to other polymers, with a specific gravity of 0.95. HDPE is relatively hard and resistant to impact and can be subjected to temperatures of up to 120 °C without being affected. HDPE is made under controlled conditions by applying intense heat to petroleum. This process, also known as “cracking,” helps create ethylene gas. During its production, the gas molecules will attach to form polymers, which then produce polyethylene.

After this process, the polyethylene will have a sludgy appearance, but once it is put through a series of molds, it forms into granules. Once the molding process is complete, a strong polymer material is produced

# COMPOSTABLE OR BIODEGRADABLE PACKAGING



Historically, the first plastic materials used industrially by man were of natural origin. Their durable properties, strength, stiffness, density, heat resistance, electrical conductivity, led to innovations within technological industries. All plastics whether naturally occurring or synthetically produced are composed of very large molecules called polymers. Constructed from relatively small molecular fragments known as monomers that are joined together. Rubber, cellulose and casein, all plant derived were used in the past for packaging prior to the increased use of petrochemical plastics during world war two, when naturally based materials were in short supply. The cost and versatility of synthetic plastic led after World War Two to the wide usage of synthetic plastics on a consumer market. However in the 1990s rapid technology of green and white chemistry in the recovery of biomass led to bioplastics such as PLA, PHAs or even plasticised starches to be introduced. In the current climate, as the consumer becomes more aware of the costs to the environment, bioplastics and natural materials have been seen as a major alternative to the petrochemical plastic and increasingly packaging manufacturers are looking to PLA and PHA – commonly known as biodegradable plastics - as an alternative to the widely

Used Polyethylene Terephthalate (PET, PETE) and, High Density Polyethylene (HDPE). These biodegradable plastics can be degraded by microbial action to produce natural end products, like water and carbon dioxide, in a reasonable period of time.

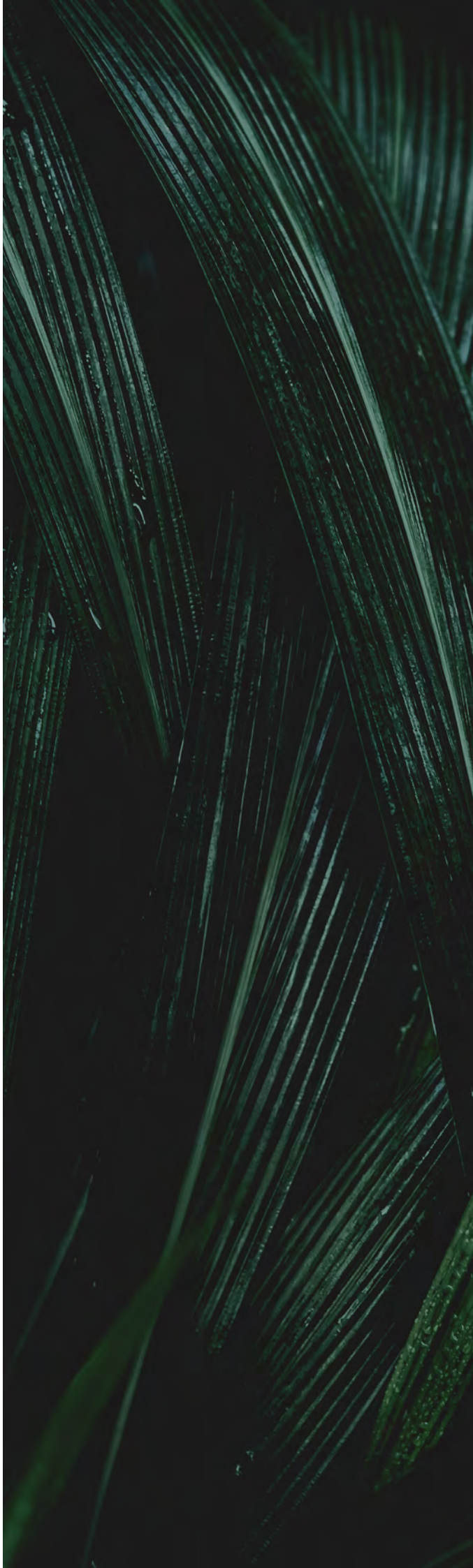
## POLYLACTIC ACID (PLA)

Plant based Polylactic Acid is the most common compostable bioplastic. Derived from plant sugars it can be made from any sugar, such as corn starch, cassava, sugar cane or sugar beet. Starch is extracted from milled corn plants to form glucose. The glucose is then fermented to produce the lactic acid, which then is chemically transformed into the polymer base, in the form of pellets (the resin base). The resin can be then melted and moulded into a variety of different applications. Most of the PLA corn starch used in manufacturing derives from a non-food grade corn plant with no or little wastage from the plant.

The problem with PLA is the disposal methods. While PLA is recyclable, it cannot be recycled with other types of plastics due to its lower melting temperature that can cause problems at recycling centers. PLA needs to be industrially composted, but is not easily composted from home. In the future if there is a major increase in bioplastic volumes, then waste sorting facilities could be calibrated to recognise and sort using near-infrared identification as PLA is suitable for mechanical recycling into new PLA.

## POLYHYDROXYALKANOATE (PHA)

Polyhydroxyalkanoate is a polyester produced naturally by bacteria and Genetically Modified Organisms (GMO) plants, but there is research to suggest it can be made from food waste. PHAs are expensive to make as only limited quantities can be produced from bacteria. In the industrial production of PHA, the polyester is extracted and purified from the bacteria by optimizing the conditions of microbial fermentation of sugar, glucose, or vegetable oil. PHA can be completely compostable in environments that are rich in microbes and fungi, especially soil. These microbes breakdown the PHA with the help of enzymes. The time necessary to degrade depends on the concentration of microbes in the environment



The problem with both the biodegradable bioplastics is their unsuitability for recycling as they are designed to break down completely. There is much confusion concerning compostable or biodegradable packaging as there is a difference in how they are disposed of.  For an item to be deemed compostable in practice it must be:
1. Certified to BS EN13432 (requirement for packaging recoverable through composting and biodegradation) or meet requirements of an appropriate home composting specification.
2. Widely collected and sent to appropriate organic waste treatment sites for processing (or be suitable for home composting}

There are other materials that use the composting methods, paper and bamboo are the most commonly used.

## BAMBOO

Bamboo is a sustainable alternative. A member of the grass family, found in everything from food to flooring, it is now a sustainable packaging solution alternative.  Bamboo packaging is seen by many as an alternative packaging, using natural sustainable resources rather than a chemical man-made polymer.

Bamboo is one of the fastest growing woody plants in the world. It has the ability to group up to 24" (nearly 61 cm) a day. It can be harvested in three to seven years and although it prefers tropical climates, it can grow on different altitudes and under various climate conditions. Bamboo releases 30% more oxygen into the atmosphere and absorbs more carbon dioxide compared to other plants. Bamboo can withstand lots of stress while being stretched or pulled. It's used for boats, construction scaffolding and other items that require strength and flexibility. Bamboo can also withstand heat up to 400 degrees Fahrenheit. The only problem again is the disposal method, where there are a lot of issues. Bamboo is compostable but the method depends on the manufacturing process utilised.

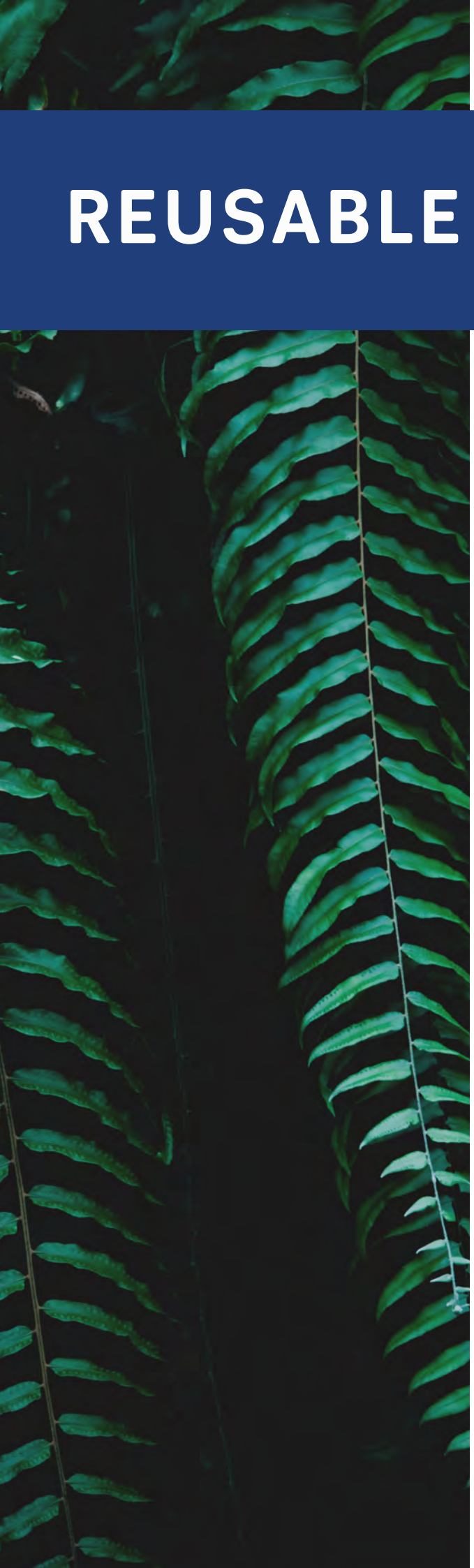
## COMPOSTING METHODS

### Industrial Composting

Industrial compostable packaging is an established process with commonly agreed requirements concerning temperature and timeframe for biodegradable waste to metabolise to stable, sanitised products (biomass) to be used in agriculture (humus/fertiliser). This process takes place in industrial plants, of which there are 170 plants within the UK. These plants provide controlled conditions, i.e. controlled temperatures, humidity, aeration, etc. for a certified composting process, as set out in the European standard EN 13432. EN 13432 requires the compostable plastics to disintegrate after 12 weeks and completely biodegrade after six months. That means that 90 percent or more of the plastic material will have been converted to CO2. The remaining share is converted into water and biomass – i.e. valuable compost. Materials and products complying with this standard can be certified and labelled accordingly. In the UK, the Association for Organics Recycling operates a certification scheme in partnership with the German certification body Din Certco, aligned to the requirements of BS EN 13432. Packaging certified to BS EN 13432 is an acceptable input material to commercial composting systems, including those that comply with BSI PAS 100 for composted products as well as the Compost Quality Protocol.

## Home Composting

Home compostable refers to any product that has been certified as such (either through an independent scheme or via self assessment and compliance via the labelling standard ISO 14021). Currently there are no international standards stating the conditions for home composting of biodegradable plastics. However, there are several national standards, such as the Australian norm AS 5810 “Biodegradable plastics – biodegradable plastics suitable for home composting”. Belgian certifier TÜV Austria Belgium had developed the OK compost home certification scheme, requiring at least 90% degradation in 12 months at ambient temperature. Based on this scheme, the French standard NF T 51-800 “Plastics — Specifications for plastics suitable for home composting” was developed, specifying the very same requirements for certification.



# REUSABLE PACKAGING

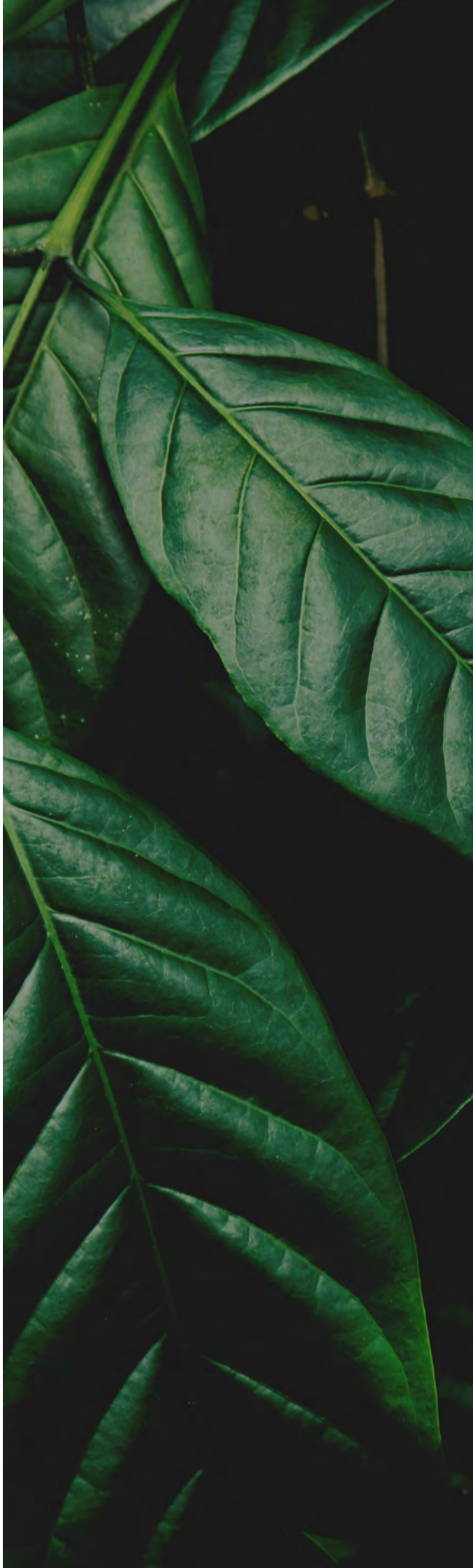
Reusable packaging is packaging that is used more than one time. It is often designed to promote durability, ease of use, ease of cleaning, ease of repair, and collapsibility or nestable design to provide an inexpensive return when empty. Reuse can also be opportunistic, utilizing packaging that is not necessarily designed for reuse such as lightweight plastic shopping bags or cardboard boxes.

Closed loop systems are in place such as the initial 'bag for life' scheme implemented in supermarkets which has led to the plastic bag fee for single use plastic bags being introduced in 2015. Manufacturers of food packaging are now being further including Nestle's introduction of the Häagan Dazs subscription home delivery service for foods and household goods with reusable packaging.

## Deposit and Return Scheme

As part of the Resources and Waste Strategy the UK Government pledged to look at introducing and implementing a Deposit Return Scheme: a service that allows consumers to recycle drinks and other containers by either placing a monetary deposit upon purchase or receiving cash or other rewards upon recycling.  Currently there is a feasibility study going on to understand the implications and infrastructure needed to implement such a strategy.

A DRS will be introduced in Scotland; with the potential to help cut plastic waste, specifically within the drinks sector.  As of March 2020 the scheme's implementation date has been pushed back to July 2022 following Corona Virus concerns.



The Acceleration Through Innovation programme can support you further on undertaking the Life Cycle Assessment for your products as part of our service on process and product innovation.
Please contact your Innovation Business Advisor for further information.

If you have any questions or comments regarding the contents of this paper, please contact ati.research@plymouth.ac.uk

The views expressed within this paper are those of the Innovation Champion and are not necessarily representative of the University of Plymouth.

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