



Delivered by
Innovate UK

Smart Sustainable Plastic Packaging

Celebration Report



March 2025

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Executive Summary

This report gives an overview of UK Research & Innovation's Smart Sustainable Plastic Packaging (SSPP) Challenge, delivered by Innovate UK with the involvement of the Natural Environment Research Council, and details the projects, impacts and benefits of this transformative programme.

SSPP's aim was to drive a step change in our relationship with plastic packaging, eliminating plastic waste and supporting clean growth and industrial decarbonisation across the UK's plastics, packaging and retail supply chains in line with the UK's commitment to achieving net-zero greenhouse gas emissions by 2050.

To achieve this, the Challenge funded both business-led and academic-led research and innovation to tackle the technical, commercial and behavioural challenges associated with plastic packaging waste to:

- Deliver a reduction in unnecessary and single-use plastic packaging.
- Increase the viability and uptake of reuse and refill systems.
- Support new and improved recycling technologies and systems.

The £60 million funding has to date leveraged in excess of £274 million in co-investment, demonstrating the significant level of supply chain engagement and support. The projects funded will deliver an estimated CO₂ saving of over 1.5 million tonnes between 2025 and 2030 and include a number of world-first innovations that significantly increase the UK's high quality recycling capacity for difficult-to-recycle packaging formats. The Challenge has also prioritised the facilitation of industry collaboration and knowledge sharing to support the success, commercialisation, and adoption of the innovations it has funded.

Foreword

As we stand at the intersection of innovation, clean growth, and consumer demand, it is clear that the future of packaging must embrace solutions that are not only intelligent and effective but also sustainable. UKRI's Smart Sustainable Packaging Challenge (SSPP), delivered by Innovate UK has proved a vital catalyst in driving forward these crucial conversations and actions, fostering collaborations across industries, and supporting the development of pioneering technologies that are shaping the next generation of packaging.

The packaging sector has a pivotal role to play in a world that increasingly needs greater sustainability. Packaging is a cornerstone of modern commerce, ensuring products are protected, transported, and delivered to consumers with minimum product damage and wastage. However, its environmental impact – from the vast quantities of plastic waste to the carbon footprint associated with production and disposal – has long been a pressing challenge.

This is why the SSPP Challenge was launched: to accelerate the development of smarter, more sustainable packaging solutions that contribute to the UK's net zero commitments, helping to decouple economic growth from environmental harm and creating wealth, investment, growth, and employment in the UK.



The £60 million state funding deployed by SSPP has provided essential support to a wide range of businesses and research teams across the UK. By de-risking innovation, SSPP has enabled them to explore novel approaches to packaging that are sustainable, recyclable, reusable, and, in many cases, designed to tackle issues such as plastic pollution, carbon emissions, and resource waste. The Challenge had to operate during a pandemic, massive supply chain disruption, and a cost-of-living squeeze but it is these moments of disruption that can often provide the opportunity for innovation to take hold and flourish.

This report presents the exciting progress made through the funded projects, highlighting the creativity, ambition, and impact of the teams who have been working tirelessly to make packaging smarter and more sustainable. We have witnessed the convergence of cutting-edge technology, novel materials, and circular economy principles that are beginning to transform the packaging landscape. From bio-based materials and advanced recycling technologies to intelligent systems that reduce packaging waste and enhance product life cycles, these projects exemplify the power of innovation in giving plastics a more sustainable future.

As you read through the pages of this report, you will encounter the stories of these trailblazers — from small businesses taking their first steps towards sustainability to large-scale manufacturers adopting scalable solutions. SSPP was set the ambitious target of leveraging £149 million of co-investment against its £60 million funding; at the time of writing, it is on track to exceed £250 million of co-investment. The results are a testament to the ingenuity of UK businesses and the role of targeted Challenge-based funding in tackling the most pressing global problems.

While we celebrate the success of these initiatives, it is important to remember that this is just the beginning. The journey towards a truly sustainable packaging industry is ongoing, and the path forward will require continued collaboration, investment, and a relentless commitment to innovation. The insights gained through the SSPP Challenge offer a model for scaling solutions, creating new opportunities for business growth, and contributing to the long-term health of our planet.

I would like to extend my congratulations and heartfelt thanks to all the project teams and partners involved. Your dedication to innovation is helping pave the way for a brighter, more sustainable future for the packaging industry — and for all of us who rely on it.

I would also like to thank the members of SSPP's Programme Board and Advisory Group, who have provided invaluable guidance and insights throughout.

Paul Davidson
SSPP Challenge Director



SSPP Overview



The Smart Sustainable Plastic Packaging (SSPP) Challenge was created and launched by UK Research and Innovation (UKRI) in July 2019 as one of eight clean growth challenges supported by the Industrial Strategy Challenge Fund. Part of the greatest single increase in UK science and innovation funding for over 40 years¹, these Challenges were developed in partnership with the private sector to address the UK's primary industrial and societal challenges – finding new solutions, creating jobs and building prosperity.

Delivered by Innovate UK, the SSPP Challenge evolved in part out of the growing imperative to bring about a step change in our relationship with plastic packaging, particularly the single-use plastic packaging that is ubiquitous in modern society.

In 2017, David Attenborough's Blue Planet II series had already focused attention on the damage being done by plastic pollution to marine ecosystems. At the same time, the wider contribution of fossil-fuel based plastics to climate change was also being recognised in terms of resource and energy consumption, greenhouse gas (GHG) emissions, and growing concern about microplastics. In 2023, the United Nations Environment Programme² reported that plastics generated 1.8 billion tonnes of GHG emissions in 2019 – 3.4% of the global total – and identified the packaging sector as the largest global generator of single-use plastic waste.

Importantly, the business case for the SSPP Challenge was also underpinned by a willingness across the plastic packaging supply

chain to come together to drive packaging circularity and built on the success of UKRI's £20 million Plastics Research & Innovation Fund. SSPP's scope and objectives were developed in consultation with stakeholders from across the plastic packaging supply chain, as well with the academic community through UKRI's relevant research councils.

Against this backdrop, the £60 million SSPP Challenge became the largest and most ambitious UK government investment to date in sustainable plastics research and innovation. Focused on de-risking and driving cleaner growth across the UK's plastics, packaging and retail supply chain, its aim was to:

- Deliver a reduction in unnecessary and single-use plastic packaging.
- Increase the viability and uptake of reuse and refill systems.
- Support new and improved recycling technologies and systems.

The Challenge has also supported the progress towards the 2025 targets set out in the [UK Plastics Pact](#), led by WRAP.

1 UKRI-140621-IndustrialStrategyChallengeFundBrochure.pdf

2 UNEP: Everything you need to know about plastic pollution

SSPP Challenge portfolio

Taking a collaborative, cross-sector approach, the SSPP Challenge has brought together academia, industry and the third sector to tackle the technical, commercial and behavioural challenges associated with plastic packaging waste.

Having set a strategy underpinned by the waste hierarchy, SSPP then funded over 80 innovation projects from early stage research to large-scale demonstrator plants. These awards were made via nine funding competitions:

- Feasibility Studies & Industrial Research competition.
- Feasibility Studies for Demonstrators competition.
- Large Scale Demonstrators competition rounds 1 & 2.
- Business-led R&D competition.
- Future Plastic Packaging competition rounds 1 & 2.
- Enabling Research competition, managed by the Natural Environment Research Council (NERC).
- Flexibles Collection Design competition.

The Challenge has also made direct awards to a number of significant and highly collaborative projects on flexible packaging, refillable milk packaging and smart packaging data, as well as international work including supporting the establishment of the India Plastics Pact and funding the appointment of a NERC Agenda-Setting Fellow on plastic pollution.

[Find a selection of SSPP case studies here](#)

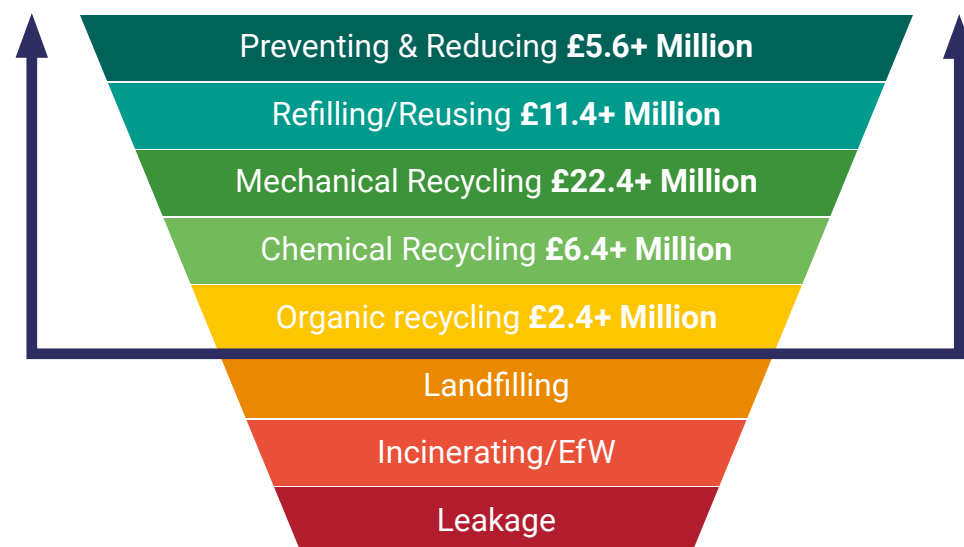


Figure 1: SSPP funding commitments mapped against the Waste Hierarchy



SSPP Challenge Director **Paul Davidson** talks about how the Challenge has worked to drive plastic packaging sustainability.

Priority areas

As part of its approach, SSPP targeted a number of specific, acknowledged barriers to greater plastic packaging circularity.

Films & flexibles

Films and flexible packaging makes up around 25% of all UK consumer packaging but less than 8% is currently recovered for recycling. This complex, lightweight and frequently contaminated waste stream, which often comprises a mix of polymers and other materials, presents barriers to circularity at every stage of its lifecycle, from design through to collection and recycling.

Reuse & refill

Current models for fast moving consumer goods (FMCG) retail and 'fast food' have been almost exclusively developed and optimised on the basis of single-use packaging. As a result, while reuse and refill are recognised as having the potential to deliver significant progress towards circularity, introducing these models at scale and with interoperability across the retail and catering sectors, along with the associated behaviour change, is extremely challenging.

Food-grade recycling

While food-grade recycling of plastic packaging is critical to increasing circularity – about 50% of all plastic packaging is food packaging – it comes with a host of technical and regulatory challenges. With the UK Plastic Packaging Tax driving up demand for recycled content in food and contact-sensitive packaging, innovations funded by SSPP are set to increase the UK's food-grade recycling capability by around 50,000 tonnes/year.



In 2020, SSPP awarded £8 million in funding for 10 university-led research projects through its Enabling Research Programme. Managed by NERC, the aim of the programme was to fund innovative and multi-disciplinary research to support more sustainable plastic packaging by addressing widely understood problems and knowledge gaps and overcoming barriers to fundamental systems change.

The universities worked with partners across the plastic packaging supply chain to ensure solutions respond directly to industry needs. The projects encompassed a range of research areas, including bio-based polymers, reuse and refill, system optimisation for plastic packaging recycling and communications and behaviour change. The specific objectives were to:

- Deliver research and Innovation to support delivery of the UK Plastics Pact targets.
- Increase UK plastic packaging supply chain collaboration.
- Increase understanding of environmental impacts of, and behavioural response, to existing and new plastic packaging to inform more sustainable designs, technologies, and business models.



[Find out more about the Enabling Research Programme here](#)

Supporting growth and employment

Contributing to UK-wide and regional growth, over 75% of SSPP's grant funding was awarded to projects outside London and the South East. SSPP's large-scale demonstrator programmes have resulted in commercial scale infrastructure development and jobs in the Midlands, North East and North West of England, and Scotland, including:

- Mura Technology Ltd/ ReNew ELP Ltd in Teesside.
- Impact Recycling Ltd in Peterlee.
- Berry Circular Polymers in Royal Leamington Spa.
- Reposit Ltd in Wishaw.

Across the whole portfolio, the SSPP-funded projects have demonstrated revenue growth in excess of £20.6 million and significant further revenue gains are predicted for the 2025-2030 period as infrastructure comes online and market penetration increases.

The Challenge has also supported the creation of 260+ jobs and the upskilling of professionals working across the plastic packaging supply chain, both in the UK and internationally.

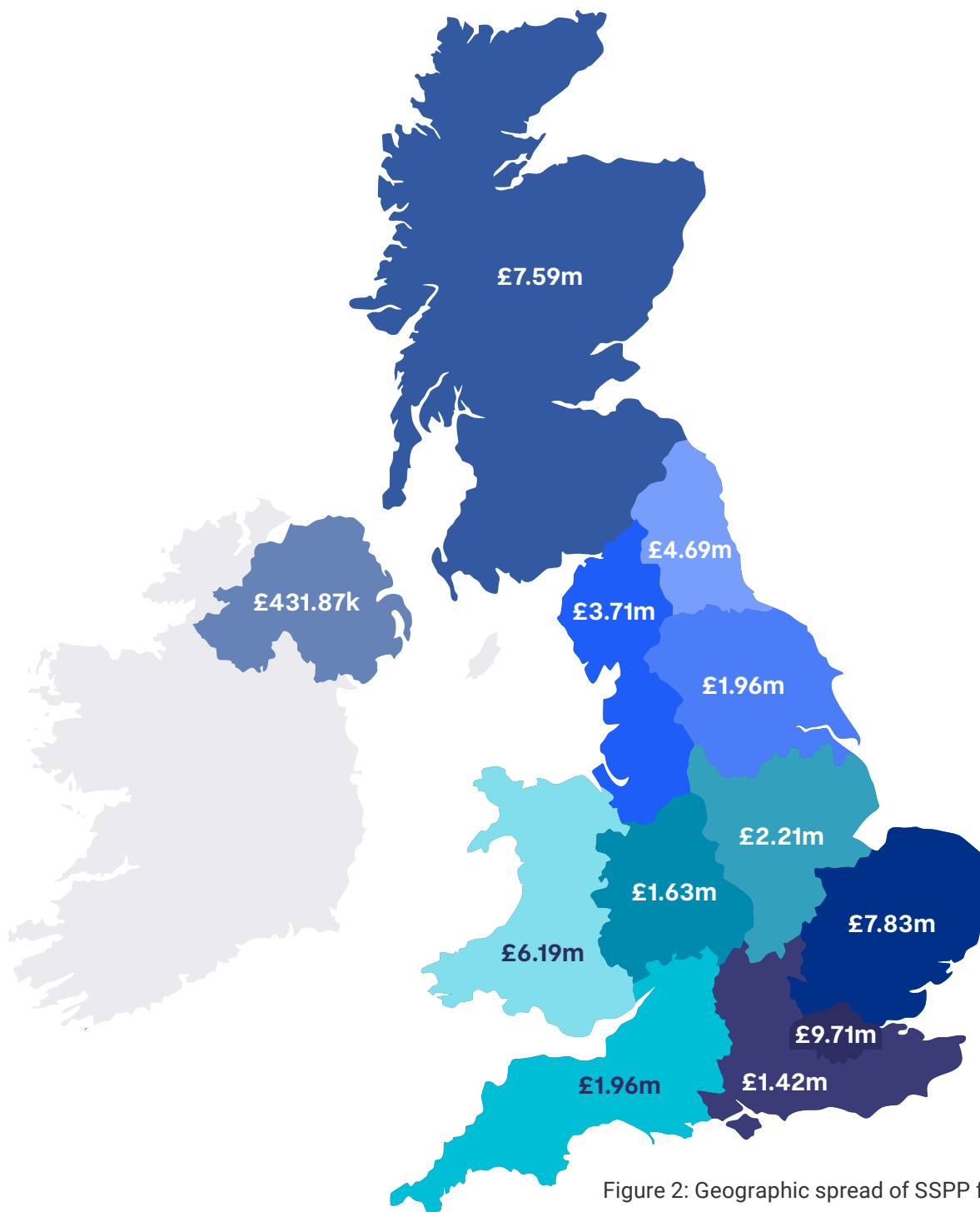


Figure 2: Geographic spread of SSPP funding

Knowledge sharing and collaboration

From the beginning of the programme, SSPP has worked in partnership with Innovate UK Business Connect, NERC, the plastic packaging supply chain, and many other key partners to support engagement and collaboration and maximise knowledge sharing.

The SSPP/NERC Enabling Research Programme alone brought together over 120 organisations – including UK and international industry bodies, universities and businesses. These projects have resulted in over 100 academic publications and over 250 public engagement activities.

SSPP projects have been recognised around the world with over 40 international awards, nominations, speaking slots, and consultations involving the funded businesses. Further communication and networking activities have included:

- SSPP Challenge Summits in 2022 and 2023.
- Knowledge sharing webinars hosted by WRAP.
- Topic specific workshops in collaboration with Innovate UK Business Connect.
- Stakeholder briefings across the UK.
- Video and written case studies.
- Thought leadership articles and over 40 presentations at online and in-person events, both in the UK and internationally.

SSPP's involvement in major industry events - including **Packaging Innovations**, **Recycling & Waste Management** and **Global Research**



The SSPP Challenge at Packaging Innovations 2024

in Plastics Sustainability (GRIPS) has showcased the work of the Challenge and its projects in front of over 40,000 visitors and delegates.

UK Circular Plastics Network

Since its inception, SSPP has also co-funded the UK Circular Plastics Network (UKCPN), a 5000+ strong community of professionals from business, academia, government and non-governmental organisations with a shared goal of shaping a more innovative, sustainable economy for all plastics.

UKCPN also provides a platform for networking and knowledge-sharing, including events such as the **GRIPS** conference where the UK and international plastics community can come together to build relationships, share knowledge and innovation to drive plastics circularity.

100,000 tonnes/year
of new UK recycling capacity funded

An increase of over

10% in the UK's 2020 recycling capacity

an increase of almost
25% in the UK's 2020
processing capacity

All capacity targeted
at improving plastic
packaging circularity
for formats that are
typically downcycled,
incinerated or
landfilled

50%

targeted at hard-to-
recycle mixed films &
flexible packaging

50%

targeted at meeting demand
for recycled content in food-
grade and contact-sensitive
applications

SSPP projects
recognised
around the
world with



nominations,
speaking
slots, and
consultations

over
150,000 tonnes/year
overseas recycling capacity enabled

including

日本
Japan

Suomi
Finland

한국
Korea

भारत
India

Deutschland
Germany

Predicted

CO₂e

saving of

1.5m⁺
tonnes

between 2025
and 2030 as
SSPP projects
come online

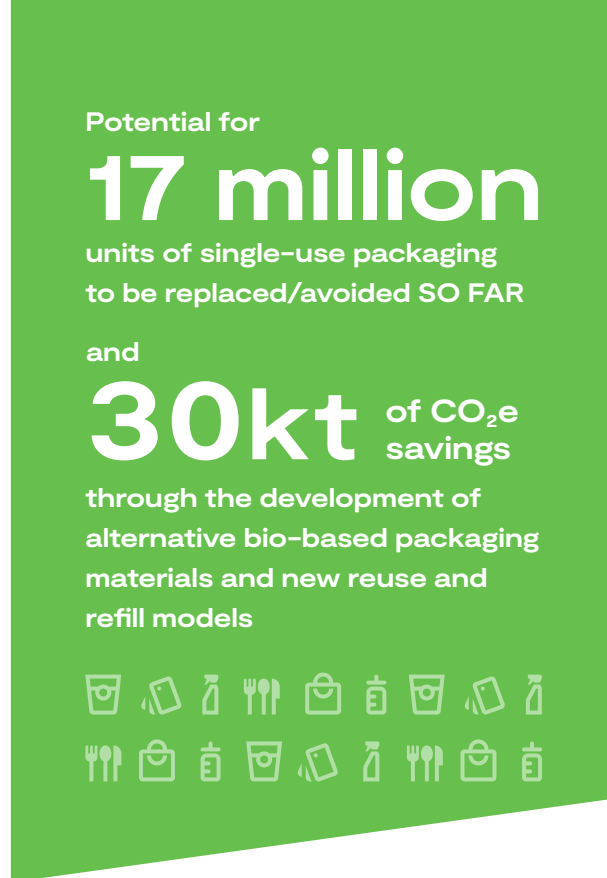
over

100
academic
publications

and over
250 public
engagement
activities

leading to positive outcomes
over
80%

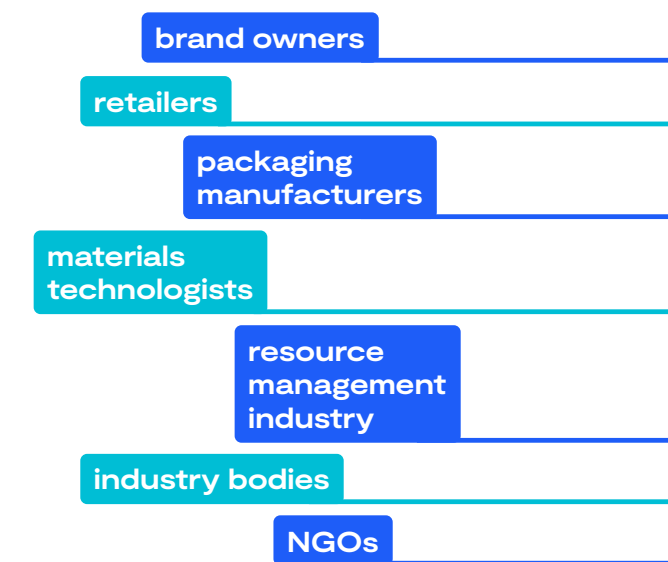
from SSPP's Enabling Research projects



Full supply chain engagement



cross-sector collaboration involving



Reduction & Replacement

The imperative to reframe our relationship with fossil-fuel-based plastics is under the spotlight like never before and the size of the challenge is significant.

Due to its functionality, versatility and light weight, plastic has become ubiquitous in the modern world – from packaging to medical devices and from building products to aerospace components. However, with environmental and climate change considerations coming to the fore, there is a growing focus on reducing and replacing virgin fossil fuel-based plastics from a resource efficiency, GHG emissions, and pollution perspective.



Reduction & replacement

Many of the SSPP-funded projects outlined in this report contribute to the goal of reducing plastic consumption and waste – for example through the mainstreaming of reuse and refill models ([see Reuse & Refill chapter on p16](#)) or advanced modelling to directly reduce material consumption ([see Blow Moulding Technologies case study on p33](#)).

However, one of the key areas of innovation has been in alternative bio-based packaging materials with similar functionality to plastics. Some of these alternative materials – derived from different natural sources including seaweed, algae and fish waste – dissolve and breakdown during or after use, leaving no harmful chemical residues, while others are compostable. Emerging as one of the main areas of market potential are high performance plastic-free coatings for paper or cardboard packaging that are compatible with existing recycling processes.

Unlike conventional fossil fuel-based plastics, which benefit from decades of established global infrastructure and economies of scale, novel bio-based alternatives are still in a relatively early stage of development. SSPP's funding helped projects to overcome the significant challenges associated with pre-commercial trialling, the cost and technical hurdles associated with scaling up to commercial production, and the development of robust Life Cycle Analysis (LCA).



“The Smart Sustainable Plastic Packaging grants enabled us to de-risk the manufacturing scale-up by doing early trials and testing things out of the lab. The market would be averse to funding these activities, except on terms that would be very disadvantageous to you.”

Pierre Paslier, Co-founder, Notpla

[See Case Study Here](#)

Key achievements



Alternative materials supported to reach commercial scale production



Several projects nominated for or recipients of the Earthshot prize



International supply agreements for SSPP-supported bio-based coatings signed with major brands

Funded projects

SSPP funded projects developing alternative materials, from academic and lab-scale research to product trials and commercial scale-up, including:

- **Cambridge University's** development of a bio-compostable cellulose-based film packaging material that meets the criteria for mechanical and barrier properties required for perishable goods.
- **SPP Ltd's** SeerPak™ Freezer Pouch, a new, super-strength paper with a compostable coating that provides the necessary heat seal performance combined with high grease, water, and moisture vapour barrier properties for a range of everyday frozen foods.
- **The MarinaTex®** coating for paper and paperboard food packaging, made from seaweed and seafood waste otherwise destined for energy-intensive post-processing or incineration.

Understanding the potential of compostables

Reflecting the fact that all materials come with environmental impacts, and that substituting plastics with other materials is not a straightforward process, SSPP has also co-funded research by University College London into one of the most common alternatives to conventional plastic packaging - compostable packaging.

The 'Compostable plastics: unlocking existing barriers to systems change' project investigated how compostable plastics are currently being used and how they perform. It mapped out



how these plastics could be introduced into existing waste management infrastructure, including:

- Investigating new micro-organisms capable of degrading different compostable plastics in industrial scale processes.
- Developing a method for identifying compostable plastics using near-infrared imaging and machine learning and running successful trials.
- Researching consumer behaviour and communication, including language and labelling.

The project also carried out a citizen science experiment to investigate home compostable plastics, with 1,648 people performing experiments to test the performance of compostable plastics in home compost. The results indicated that home composting is not currently a viable end-of-life option for compostable packaging.

Several industry consortium meetings and policy workshops were convened, bringing together stakeholders from across the UK plastics packaging supply chain to identify opportunities and barriers for change to improve the system for compostable plastics in the UK.



Hot off the shelf solution

Waddington Europe, a Novolex brand, has developed a new polyethylene terephthalate (PET) formulation for hot food packaging containers which is easier to recycle than traditionally used materials, helping to reduce demand for virgin PET.

Unlike polypropylene (PP) and crystallised polyethylene terephthalate (CPET) containers, which are heavier, opaque, and are mainly downcycled, rPET220 is light, clear, and easily recyclable back into food-grade plastic. Microwavable and capable of withstanding temperatures of up to 220°C, is suitable for applications including sauces, soups and ready meals.

Unlocking the power of plant-based materials

Xampla has developed a range of world-first materials made from plants, including films, coatings and microcapsules which offer exciting opportunities to replace plastic. With two rounds of SSPP funding, initially to develop an edible film packaging and then a natural plant polymer coating for paperboard, the company has gone from strength to strength, forming partnerships with major brands including Gousto, Britvic and ELEMIS.



In 2023, Xampla launched Morro™, its range of plastic-free and PFAS-free materials and has scaled up production of Morro™ materials through a manufacturing partnership with the 2M Group of Companies. Since then, 2M and Huhtamaki have announced a multi-year supply deal to use Morro™ Coating for a range of takeaway boxes, which aims to replace up to 25,000 tonnes of plastic coating by 2023. A further multi-year commercial supply agreement with Transcend Packaging was announced in October 2024.

[Find more SSPP case studies here](#)

Personal & home care in a pod

PlantSea-Pack is a seaweed-derived film technology developed by PlantSea for home and personal care products. This innovative packaging solution consists of water-soluble pods designed for single-use or refill applications for products such as laundry pods, oils and shampoos.

The SSPP funding allowed PlantSea to assess the feasibility and accelerate the scaling-up and production of the capsules, working with partners including Bangor University, Olew and leading FMCGs in laundry and home care to develop the concept further and assess its technical and market potential.

Reuse & Refill

While reducing unnecessary packaging should always be the highest priority in a Net Zero economy, it is critical to acknowledge the important role that plastic packaging plays in modern society, not least keeping food and beverage products protected and fresh as they move through the retail and hospitality supply chains to the consumer.

In this context, reusable packaging offers the single biggest opportunity to move away from single-use plastics and retain packaging in the economy as an asset, maximising its value, reducing virgin plastic consumption and other resource impacts, and eliminating waste.



Reuse & Refill

However, while reusable packaging has been around for several decades for a few iconic products and in niche applications, mainstreaming reuse and refill models is recognised as one of the toughest challenges to crack. There are barriers across the supply chain, including price and optimisation in the retail environment, consumer buy-in, logistics, hygiene and cleaning, and tracking.

To address these, the projects funded by SSPP sought to find answers to some of the key issues and barriers, including:

- Which products/categories make the best sense from a first-to-transition perspective?
- How can the functional and economic performance characteristics of traditional plastic packaging be met by reusable packaging?
- What is needed to manage reusable packaging as an 'asset' and ensure key criteria such as traceability and hygiene are met?
- What system design and implementation is needed to integrate reusable packaging operationally within retail supply chains?
- What systems and technology will incentivise consumers to switch to reusable alternatives?

[Find a selection of SSPP case studies here](#)



How it works
“M&S has expanded from 6 stores with 8 products to 23 with 10 products and will further expand to 25 stores and 12 products due to the learnings and successes. This would not have happened without SSPP funding.”

Stuart Chidley, Co-founder, Reposit

Key achievements



UK's first
refillable
plastic
milk bottle



UK first
large-scale
trials of reusable
packaging with
a major online
grocery retailer



UK's first
shared cleaning
infrastructure
for reusable
packaging

Funded projects

SSPP's reuse and refill projects are supporting the mainstreaming of reusable packaging in the retail and hospitality supply chains in a number of ways.

Large-scale demonstrator trials of both in-store and online reusable and refillable packaging systems with major UK retailers including M&S, Aldi, and Ocado. Led by **GoUnpackaged/ The Refill Coalition & Reposit**, these two projects have:

- Achieved strong and sustained sales shares compared to single-use packaged equivalents.
- Delivered good levels of operability, with high levels of staff engagement and low equipment 'downtime'.
- Addressed common consumer barriers (hygiene and convenience), leading to high consumer satisfaction.
- Amassed valuable learning across the board, including packaging formats, reverse logistics, and smart tech to support consumer engagement.

Cleaning and hygiene

SSPP projects addressing the important issue of hygiene and contamination include **Again**, which has developed commercial scale cleaning technology capable of handling different reusable plastic bottle formats. Taking a different approach, **KluraLabs Ltd** has developed and trialled its Codipac hygienic reusable food packaging, which uses the firm's novel antimicrobial technology Cydal. The packaging has performed well in tests, showing high antimicrobial efficacy and a 20% reduction in washing chemicals.

Track and trace

SSPP has supported the development of packaging identification and tracking technologies that underpin the asset management systems needed for reusable packaging, including Reuse.ID, a standardised 'digital passport' for tracking reusable packaging created by **Reath** and released as an **Open Data Standard** for the benefit of the packaging supply chain.

Smart tech

Innovative digital technology that supports the delivery of reusable packaging schemes in hospitality and catering settings has been another highlight of the SSPP portfolio, including **CauliBox's** development and trialling of its Cauli Reuse System (CRS) supply chain and tracking technology – featuring a digital customer interface, admin panel, and smart return kiosks – which is now running in over 30 sites.

Consumer research

Behavioural insight is integral to successful adoption of reusable packaging, and SSPP funded research into consumer perceptions, engagement and behaviour, including:

- The Many Happy Returns project led by the **University of Sheffield**, researched consumer reactions to reusable packaging and the role of language in encouraging reuse.
- Working in partnership with **Asda** and **Unilever**, **WRAP** explored citizen behaviours around reuse and refill across the whole of the participants' shopping journey.



Acing reusable packaging

CLUBZERØ is an award-winning Reuse Deposit Return System that provides core technology for tracking returnable packaging, drop point infrastructure for quick returns, and servicing (washing and repair) to enable reusability.

In 2024, for the second year running, CLUBZERØ partnered with Barclays at the Wimbledon Championships 2024 to offer customers ice cream in their Perfect Pots, diverting an estimated 50,000 single-use items from landfill. The firm also unveiled its new and improved Drop Point Boxes, designed to support large sporting events, and has been working with leading food service company Aramark for BP.

A recent independent life-cycle assessment reported that CLUBZERØ reusable packaging delivers CO₂ reductions of up to 93% versus single-use packaging.

Scaling up the refill proposition

The **Refill Coalition** is led by reuse and refill experts GoUnpackaged. Formed in 2020, the coalition has partnered with Aldi UK, Ocado Retail, CHEP, Digi, Eden Trade Fixtures and Berry to develop a standardised solution for in-store refill and home delivery of consumer returnables.

This ambitious initiative has developed two standardised, full supply chain solutions to deliver refills at scale for key food staples (e.g. cereals) and household products (e.g. personal care products).

Since October 2023, Aldi UK has trialled the in-store refill solution in two stores and is showing strong results. In August 2024, Ocado Retail became the first major online grocery retailer to pilot the new reusable packaging in a scheme designed for online shopping and sales are exceeding expectations.



UK's first refillable plastic milk bottle

Abel & Cole and **Berkeley Farm Dairy** have delivered a ground-breaking innovation, creating the UK's first ever refillable polypropylene (PP) milk bottle for the launch of its Club Zero Refillable Milk.

Having decided plastic rather than glass was the best material for the job using life-cycle assessment, the 1 litre reusable bottle took three years and seven teams of experts – including Berry Global, Campden BRI and Berkeley Farm Dairy – to develop. The bottle design is optimised to facilitate superior cleaning and to suit Berkeley's existing filling equipment and can be refilled up to 16 times before being recycled.

Since the launch, the refillable bottle has seen a significant uplift in sales. The average return rate since product launch is now above the target of 75%.

Mechanical Recycling

Mechanical recycling typically takes plastic waste that has been sorted by type (and often colour), shreds it, cleans and dries it, melts it down and turns it into pellets that can be used to make new plastic products.

UK infrastructure for this type of recycling has grown over the last two decades but has seen a degree of volatility in recent years, reflecting current market conditions. Most market assessments highlight an infrastructure gap that is set to widen, due to the implementation of more ambitious government recycling policies and predicted increases in the amount of plastic packaging placed on the market and ending up in household recycling bins.

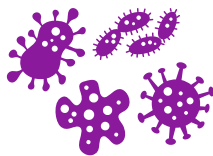
Mechanical Recycling

Market barriers have also constrained mechanical recycling from playing a bigger role in increasing circularity for plastic. With the price of virgin polymer linked to the price of oil and the significant volatility in these markets, recycled polymers often struggle or fail to compete against virgin, leading to low profit margins for recyclers. As a result, investment and innovation in mechanical recycling has been focused primarily on plastic waste streams that offer the lowest process costs and highest value end markets, with limited progress made on more challenging waste streams such as films and flexibles.

Key achievements



**'First of a kind'
food-grade
polypropylene
recycling
process**



**Novel
decontamination
of films and
flexibles for
food-grade
recycling**



**World-leading
advanced
sorting and
analytics
systems**



The food-grade challenge

The infrastructure gap is particularly acute for food-grade mechanical recycling capacity. Stringent criteria need to be met for the material to be certified and there needs to be confidence sorting, washing and testing systems are robust.

Progress has been made in this area, especially for polyethylene terephthalate (PET) drinks bottles and high-density polyethylene (HDPE) fresh milk bottles, but there is significant scope for further innovation to drive food contact circularity for other packaging formats, notably polypropylene (PP) which is used in many pot, tub and tray packaging formats.

Set against the technical hurdles associated with food-grade recycling, demand for this higher quality material is also growing, in large part due to the UK Plastic Packaging Tax, which is driving up recycled content across all packaging formats.

Funded projects

To address these barriers and support UK mechanical recycling, SSPP has funded a number of potential breakthroughs in high quality food-grade plastics recycling.

These include:

- The **University of Manchester**'s One Bin to Rule Them All project, which aimed to improve recycling through a systemic approach to plastic waste management, including interventions to maximise the value of materials and support mechanical recycling as the lowest 'footprint' option for plastics.
- **Nextek Ltd**'s novel waterless decontamination process which supports food-grade recycling of post-consumer polyolefin films ([see case study on page 30](#)).

Testing for safety

Ensuring that recycled content in plastic packaging is safe is the most important part of developing and commercialising a novel recycling process. Integral to this is a suitable Challenge Test, where plastic flakes are carefully exposed to known chemicals before being recycled, then tested to ensure safe removal.

Innovate UK, with SSPP's involvement, is funding **WRAP** to develop a new Challenge Test, specifically designed to test polyolefin recycling processes, which can then be used by the Food Standards Agency and other regulators around the world.



Case study

Closing the loop for polypropylene

Berry Circular Polymers' new CleanStream® plant in Leamington Spa is the world's first closed-loop system to mechanically recycle post-consumer polypropylene (PP) packaging waste back into contact-sensitive recyclate, improving circularity for food, homecare and industrial packaging.

The CleanStream® process improves on traditional mechanical recycling through major innovation in Artificial Intelligence (AI)-based sorting to separate out food-grade PP, advanced washing and decontamination, and stringent material testing to deliver ultra-high levels of recycled polymer purity. The new facility can recycle nearly 40% of all the available sorted PP waste in the UK and regulatory approvals for use in food-contact packaging applications are now being actively sought.



[Watch the video](#)

Sorting innovation

Improving circularity and recycling rates for plastic packaging also relies heavily on the quality of sorting achieved, due to the range of different polymers and polymer combinations used in packaging. The ability to distinguish and separate different polymers dictates the quality of recyclate that can be achieved through mechanical recycling and impacts on the amount of material rejected and sent for disposal.

Understanding the composition of packaging waste streams sent for recycling will also be essential as the new Extended Producer Responsibility for Packaging (EPR) Regulations come into force – bringing the need for far more granular data on what is and isn't recycled.

Funded projects

The SSPP Challenge has been supporting the development of more sophisticated sorting technologies.

- **Recycleye and Greyparrot:** By combining nascent and established digital technologies, including AI, machine learning, near-infra-red (NIR) and robotics, SSPP-funded projects are delivering greater levels of efficiency, accuracy and throughput, as well as sophisticated analytics that will support the growing data needs of entire packaging supply chain.
- Harnessing a novel density separation technique, **Impact Recycling** is revolutionising the sorting of mono and multi-layer films ([see case study on page 30](#)).



Case study

Getting to grips with AI-powered sorting

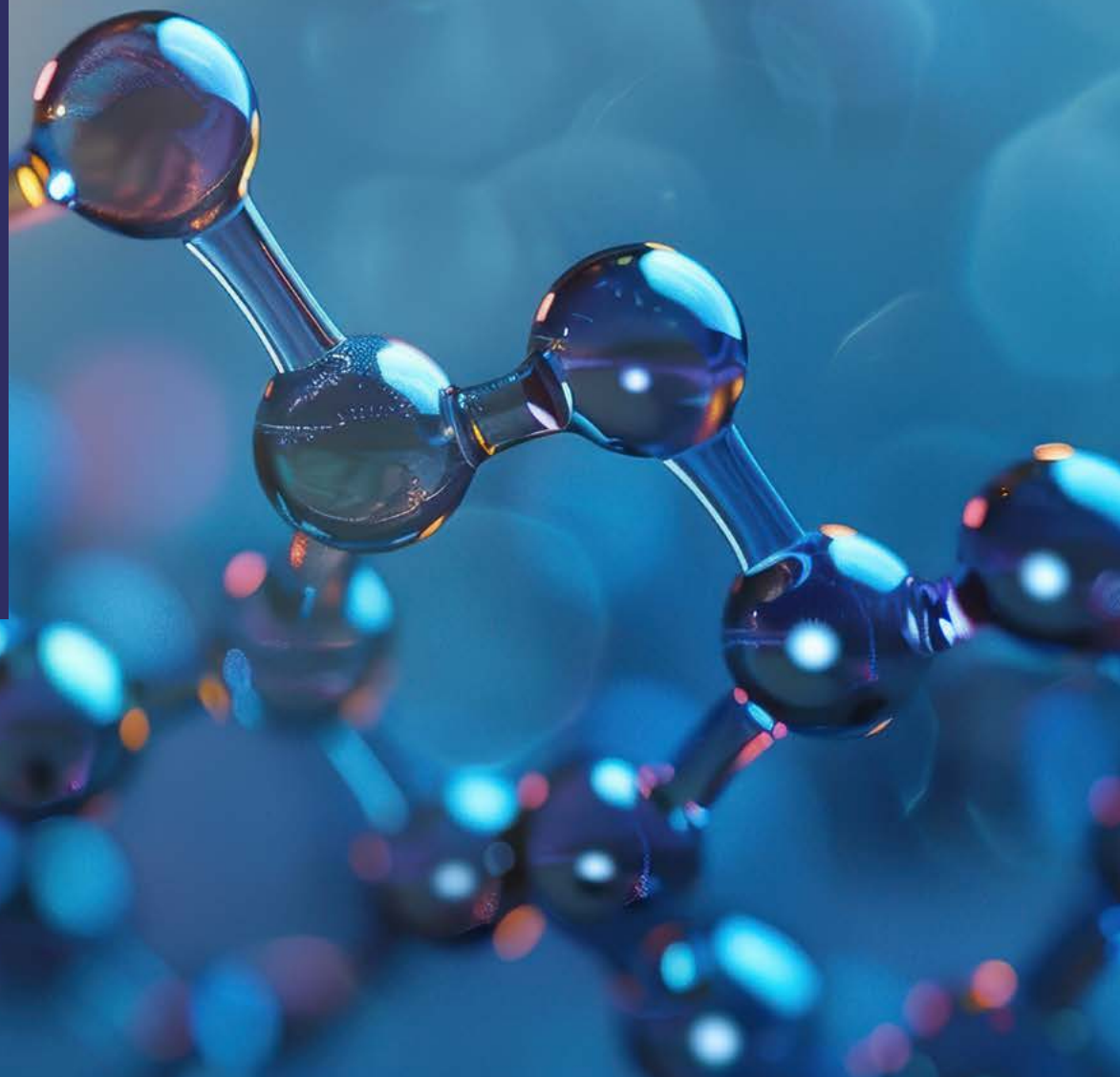
Project ADER (Automated Detection, Ejection & Recovery), led by Recycleye, deployed the company's low-cost AI-powered system, which replicates the power of human vision, with near-infrared technology to sort packaging waste for recycling.

With the aim of increasing the recovery and quality of recyclable materials, Recycleye used advanced machine learning algorithms, robotics and Recycleye's WasteNet - a visual database of over 2.5 million items – to sort packaging waste to a higher granularity, speed, and affordability than ever possible before. Recycleye also redesigned its gripping and pneumatics system and developed the GRIP-R robotic arm, which addresses the challenges posed when sorting films and flexible packaging by reducing blockages and improving efficiency.

Chemical Recycling

Complementary to mechanical recycling, a range of chemical recycling processes have emerged over the last two decades but are only now starting to scale up.

They deal with plastic packaging waste that is unsuitable for mechanical recycling – either because of the technical challenges associated with some packaging formats like bags and pouches, and/or because it is not possible to produce a commercially viable output.



Chemical Recycling

There are a range of processes that fall into the chemical recycling category, but the common factor is that most are designed to convert plastic packaging waste back into the pre-cursor chemicals from which new virgin-quality plastic can be made. However, while some forms of chemical recycling are increasingly being acknowledged as a preferred option to the incineration of plastics, there are environmental impacts associated with all of these processes, particularly in terms of energy consumption and the use of solvents.

In this context, SSPP has funded a number of projects to develop cleaner and more efficient chemical recycling technologies that have the potential to play an important role in increasing circularity for plastic packaging waste, in particular for those plastic waste streams such as mixed films and flexibles that are difficult to recycle through conventional mechanical recycling processes. With Life Cycle Analysis (LCA) forming a key part of the project deliverables, SSPP has also supported improved and accessible data to support market confidence in these processes.

Key achievements



World-first
supercritical
water process



Significant
improvements
in energy
and process
efficiency



Improved
availability of
LCA data



Informed the
adoption of
Mass Balance
for UK Plastic
Packaging Tax

Advanced recycling for challenging packaging formats

SSPP's work with Mura Technology has resulted in a world-first commercial scale demonstration plant using the firm's Hydro-PRT® (Hydrothermal Plastic Recycling Technology) process. This advanced process uses supercritical water to convert plastic packaging waste, including difficult-to-recycle formats, into shorter chain hydrocarbons that form the building blocks for the manufacture of new plastics.

Now fully commissioned, the ReNew ELP Hydro-PRT® plant in Teesside will place 20,000 tonnes/year of circular hydrocarbons on the market. As well as providing a circular solution for plastic packaging waste, the process has been subject to an independent LCA and delivers an estimated 80% CO₂ saving by diverting 'unrecyclable' plastic away from incineration.

The funding from SSPP unlocked venture capital and other investment from blue chip companies across the plastic recycling value chain – including Dow, KBR and CP Chem – that made the establishment of this first-of-a-kind plant possible. Other project successes include:

- International licences of the IP to Japan, S Korea, and Germany.
- First chemical recycling process to be listed on ecoinvent.
- 50 direct jobs & c. 250 indirect jobs created.

[Watch the video](#)



Case studies

Microwave assisted pyrolysis

Sylatech Ltd has developed a new microwave pyrolysis process to recycle mixed and contaminated plastic films and flexibles. This highly energy efficient technology heats waste in the absence of oxygen to break molecular bonds, producing a pyrolysis oil from which new virgin-grade plastic can be manufactured. Having been supported by the SSPP Challenge, Sylatech is now working to commercialise the new system.

Water-powered recycling

Stopford Ltd and the **University of Birmingham** are co-developing a recycling process (Solvergy™) which uses hot compressed water as a green solvent to chemically recycle plastic packaging waste. The aim is to help increase plastic recycling rates and decarbonise plastic production. A prototype reactor for hard-to-recycle polyolefin-based plastic packaging is already operational, and the project is now adapting the process to polyethylene terephthalate (PET) plastic waste.

Chemical recycling and the Plastic Packaging Tax

The UK Plastic Packaging Tax aims to drive up the use of recycled plastic, but until recently there was no accepted methodology in the legislation to account for chemically recycled plastic feedstocks used to make new plastic for packaging. This was constraining investment in advanced chemical recycling and excluding processes



“Innovate UK and SSPP have been incredibly useful. Obviously they provided the all-important funding to help us with the R&D... [and] they are also very well connected, so they have been extremely useful in putting us in contact with many companies and people that are relevant to what we are trying to do.”

Charlie Breese, Managing Director, Sylatech

[Watch video](#)

that are capable of delivering food-grade recyclate, which can be difficult to achieve using mechanical recycling techniques.

SSPP was able to inform the discussion about the use of mass balance accounting for chemically recycled plastic, which culminated in a government consultation and a change to the legislation to allow this approach.

Films & Flexibles

Often called the final frontier of plastics recycling, films and flexible packaging are under the spotlight like never before. They make up almost a quarter of all the plastic consumer packaging and approximately 895,000 tonnes are put on the UK market every year, equal to around 215 billion packs or individual products every year. However, less than 8% of this material is recovered for recycling³ and it is one of the plastic waste streams most likely to escape into the natural environment.

In a move to address this, England's new Simpler Recycling regulations will require films and flexible plastics to be collected for recycling from all English households by March 2027, accentuating the need for significant progress in the collection and recycling of this type of packaging waste.



Films & Flexibles

The low recycling rate to date is in part due to the technical challenges associated with recycling plastic films and flexibles. They can be complex materials – with several layers of different polymers, barrier materials and coatings to meet performance criteria, as well as adhesives and inks. In addition, these materials have largely not been collected separately for recycling in the UK, ending up as a mixed and often contaminated waste stream that existing sorting and mechanical recycling infrastructure is not well adapted to handle.

To address this challenge, SSPP portfolio of films and flexibles projects are delivering against a number of important outcomes, including:

- Creating films and flexibles that are more recyclable as a result of better design, innovative material composition, or reduced complexity.
- Establishing the most efficient and cost-effective methods of collecting films and flexibles separately from households across the UK.
- Developing improved sorting techniques to increase the amount of material that can be recycled from this waste stream.
- Researching efficient techniques to decontaminate and recycle films and flexibles to allow higher quality recycling, including to food-grade quality.



Key achievements



Novel technology to separate mono- and multi-layer films to 95% purity for recycling



World-first advanced recycling process to recycle films and flexibles back into virgin-quality plastic



Largest ever programme of household collection pilots of films and flexibles



Funded projects

SSPP has funded innovations at every stage of this packaging format's life cycle to increase circularity, from design and material choice to collection and novel sorting and recycling techniques.

Design for recyclability

- **Circular Economy for Flexible Packaging (CEFLEX)** is major European collaboration of over 180 European companies, associations and organisations with the aim of making all flexible packaging in Europe circular by 2025. With SSPP support, it has been running an extensive testing programme to generate robust independent data to inform future flexible packaging design guidance.
- Working collaboratively on the Recycle Ready project, **Interface Polymers Ltd** and **Flexipol Ltd** have developed an additive that allows them to produce low density polyethylene (LDPE) multi-layer barrier films for food contact flexible packaging that can be repeatedly recycled using existing sorting and processing plants. Interface now has a pilot plant operating in India.

Collection

The largest pilot ever undertaken for local authority collection and recycling of flexible plastic packaging, **FPF FlexCollect** will inform future local authority collections and support the latest policy measures designed to increase recycling (see case study overleaf).

In conjunction with this project, SSPP also funded six projects to design easy-to-use solutions for householders to capture and store flexible plastic packaging. One of the main design objectives was to effectively compact this voluminous and springy waste stream for easy storage and presentation for recycling.

Several projects have gone to commercialise their designs and have had the opportunity to trial them as part of the FPF FlexCollect project.

Sorting & decontamination

- With support from SSPP, **Recycleye** has developed the GRIP-R, an attachment for the firm's robotic sorting arm to create a system that can pick and separate films and flexible packaging more efficiently than ever before.
- By separating single and multi-layer films to 95% purity using its novel BOSS 2D process, **Impact Recycling**'s demonstrator plant, one of SSPP large-scale demonstrators, will deliver high purity polyolefin material streams for recycling back into new plastic packaging and the technology is now being exported.

“With SSPP's support, our new sorting plant will process 25,000 tonnes/year at full capacity, over double the amount of plastic films and flexibles collected for recycling in the UK in 2019.”

David Walsh, Impact Recycling

[See case study here](#)

Recycling

In addition to innovation in the mechanical recycling of films and flexibles, SSPP has also funded other advanced recycling processes, including **Mura Technology**'s Hydro-PRT® (Hydrothermal Plastic Recycling Technology) process.

One of SSPP's large-scale demonstrators, the Hydro-PRT® process uses supercritical water to convert plastic packaging waste, including difficult-to-recycle formats such as multi-layered films, into shorter chain hydrocarbons that form the building blocks for new plastics and other products (see Chemical Recycling chapter for more on this project).

Case studies

Greener cleaning for films & flexibles

Nextek's COtooCLEAN™ is a highly innovative waterless decontamination technology that supports the recycling of post-consumer polyolefin films back into food-grade film without the need for depolymerisation. The process combines super-critical CO₂ with green co-solvents to effectively remove odours, oils, fats and printing inks. Requiring no water or corrosive chemicals, it can also delaminate and de-metallise multi-layer films.

Informing future collection of films and flexibles

The co-funded £2.9m **FPF FlexCollect** project is the most extensive pilot for household collection and recycling of flexible plastic packaging ever undertaken in the UK and supports the new Simpler Recycling regulations for flexible plastics to be collected from English households by 2027.

Managed by a consortium comprising Ecosurety, SUEZ recycling and recovery UK, RECOUP and WRAP, FlexCollect is working with 10 local authorities to run a series of innovative kerbside collection and recycling pilots through to March 2025, covering some 200,000 households.

These will build vital operational and cost data to inform future best practice across different geographies, demographics and collection services.

Systems, Behaviour & Data

The ubiquitous nature of plastic packaging in our modern society, and the scale of the challenge to reduce single-use plastics, has focused attention on the need to challenge many of the underpinning models, data, assumptions and behaviours that have shaped the system to date.

Action is needed at every level – global, national and local – to deliver meaningful reduction, increased recycling and an end to plastic pollution in both the terrestrial and marine environment.



Systems, Behaviour & Data

Harnessing the power of collaboration

The complexity of the plastic packaging supply chain, and the integral part it plays in our everyday lives, means that a range of interventions are needed to drive better outcomes. These interventions often need to be developed using a holistic approach; changes made in one part of the supply chain need to be understood and acted upon by stakeholders elsewhere in the system, for example through different labelling to stimulate altered consumer behaviour.

With millions of products and packaging formats and multiple stakeholders involved, effective change also requires shared, multi-disciplinary understanding and collaborative action. For this reason, a common characteristic of the SSPP-funded projects aimed at system or behaviour change is that they bring together retailers and brands, the packaging industry, academia, NGOs, local authorities, the waste management sector, and citizens.

Improved data and modelling

Another recognised barrier to systemic change is the quality, availability, and flow of information through the system to support informed decision-making and collaborative action.

Better data and digital innovations including AI and predictive modelling are increasingly recognised as playing a critical role in driving plastic packaging sustainability. Improved digital

capability can deliver better outcomes by providing insights into the environmental impact of current packaging practices and identifying areas for improvement and action. It can facilitate greater information sharing and transparency, and support informed decision-making. It is also essential for the supply chain in meeting the ambitions and data reporting requirements in the UK's ongoing packaging legislation reforms.

Global knowledge sharing

Notwithstanding the uncertain future of the proposed UN Treaty to end plastic pollution, many countries are already taking national action and remain committed to creating a global framework that addresses the full lifecycle of plastics and the multi-national nature of the supply chains involved.

SSPP has supported a range of voluntary agreements in several countries and funded collaborative research and targeted innovation to contribute to the body of knowledge needed to harness this global push for change.

Key achievements



Multi-disciplinary research to understand complex systems and behaviour



Open 3P Data Standard for packaging, which is gaining international endorsement



UK's first Agenda-Setting Fellow for plastic pollution research and innovation



Reducing plastic packaging and food waste through product simulation

This project, led by **City St Georges, University of London** in partnership with WRAP and the universities of Greenwich, Kent, and Sheffield, expanded and enhanced WRAP's Household Simulation Model to focus on plastic food packaging.

The project used new methods and data to quantify the potential waste impacts of changes to packaging formats, product portions, or householder behaviour. By predicting the outcomes of different variations, the model helps manufacturers to provide the right type of packaging to reduce both food and plastic waste.

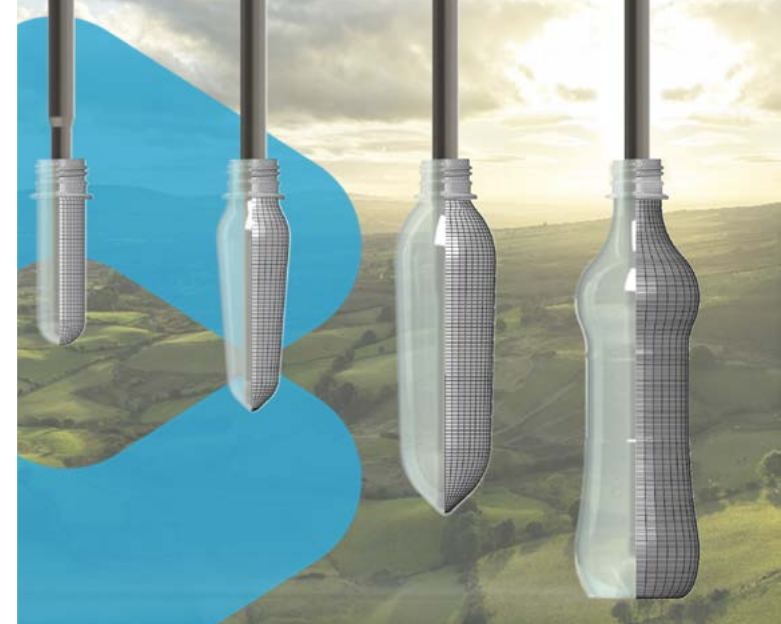
Increasing citizen participation in reuse and refill systems

Working with **Asda** and **Unilever**, **WRAP** led this collaborative project to explore citizen behaviours around reuse and refill across the whole shopping journey.

The project evaluated how trial participants interacted with refill zones and developed and tested a series of in-store behaviour change measures to improve their experience. It identified three key priorities:

- Clear communication of price differences between packaged and refill products to inform the purchasing decisions.
- Well-located and easy to understand guidance on using the equipment to reassure first time users.
- Promotional brand activities with a staff presence to make the experience fun and enjoyable.

Read the findings [here](#) or watch the webinar



Streamlining sustainable packaging design

Blow Moulding Technologies (BMT) is revolutionising the £129 billion plastic bottle industry, where 1 million bottles are consumed every minute. It has developed software that combines advanced measurement systems, digital simulation, AI, and machine learning to optimise bottle design and manufacturing.

By replacing traditional trial-and-error testing, BMT's solution de-risks and shortens packaging design cycles, paving the way for faster innovation and empowering manufacturers to create smarter, more sustainable bottles while lowering costs and environmental impact.

Supporting global understanding and action

In autumn 2020, the SSPP Challenge supported funding to enable WRAP to establish the [India Plastic Pact](#). India was the first Asian country to develop a plastics pact of this kind and the support enabled WRAP to initiate the set-up of the Pact, engage the Indian government, and develop the appropriate targets and priority work streams. Other Pacts in countries including Mexico, Columbia and South Africa were also supported.

SSPP also funded the appointment by NERC of an Agenda-Setting Fellow on plastic pollution in 2023. Professor Steve Fletcher, Professor of Ocean Policy and Economy and Director of the Revolution Plastics Institute at the University of Portsmouth, was appointed to develop a transformative plastic pollution research framework.

Understanding how to tackle plastic pollution without causing worse environmental, social or economic outcomes through unintended consequences is a complex interdisciplinary area of research and innovation. Professor Fletcher is taking a systems approach and producing an overview and framework for future plastic pollution research and innovation for a range of stakeholders including academia, industry, policy makers and research organisations.

The framework will detail the evidence gaps, opportunities and priority areas for plastic pollution research across UKRI, the UK and internationally and will strengthen the science-to-policy interface to support informed decision making.

Case study

Mapping plastic pollution in our oceans

Using satellite data and AI, and working with industry leaders including Seven Clean Seas, The Ocean Cleanup, and the Sea Cleaners, **Plastic-i** has built a platform to facilitate the identification and removal of marine plastic on a global scale. By detecting, mapping, and classifying floating debris, it provides decision makers and clean-up operators with actionable insights to boost effectiveness and measure the success of interventions.

The platform, now called the Plastic-i Observatory, was recently made available for open beta testing and the technology is estimated to reduce clean-up costs by 20% while increasing plastic removal by a factor of 20.



Plastic-i's model applied to a coastline near the Dominican Republic, with a large debris accumulation visible on the right.

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What Next?

The objectives of the Smart Sustainable Plastic Packaging Challenge are even more relevant and important today than when the Challenge came into being in 2019. With global annual plastic production predicted to double by 2050 on the current trajectory, our understanding of the impact of plastic waste on the environment, and the associated resource consumption and GHG emissions, has grown apace. In parallel, there has been a proliferation of industry- and academic-led roadmaps and frameworks for plastics to become a net zero sector, as well as international efforts to develop a UN Treaty to end plastic pollution.

While delivering change at this scale is a lengthy journey, the SSPP Challenge has accelerated innovation to tackle plastic waste that could otherwise have taken much longer or may not have been possible at all. The funded projects are providing real-world breakthroughs, solutions and insights that will help to shape and inform a more sustainable future for plastic packaging.





What next?

The Challenge has:

- Supported alternative bio-based materials to reach commercial scale production and achieve market penetration both in UK and international markets.
- Funded the development and trialling of in-store and online reuse and refill solutions that meet the needs of the entire supply chain and provide a blueprint for scalable and interoperable systems in the future.
- Tackled some of the key barriers that have restricted the capability and growth of mechanical recycling, with breakthroughs including a 'first of a kind' food-grade polypropylene recycling process, a novel solvent-free decontamination process to allow food-grade mechanical recycling of films and flexibles, and significant advances in AI-assisted sorting and analytics systems.
- Helped chemical recycling to move to commercial scale, with processes that deliver significant improvements in energy and process efficiency, including a world-first advanced recycling plant using supercritical water.
- Delivered innovations that overcome the challenges associated with films and flexibles, including a novel technology to separate mono- and multi-layer films for high quality recycling and the UK's largest ever programme of household collection pilots.
- Catalysed systemic change by supporting multi-disciplinary research, smarter and more sharable packaging data, and UK's first Agenda-Setting Fellow for plastic pollution.

The conclusion of the SSPP Challenge does not signal the end for these innovations and solutions; many are going from strength to strength. Across the whole portfolio, the funded projects have demonstrated revenue growth in excess of £20.6 million and further significant revenue gains are predicted for the 2025-2030 period as new infrastructure comes online and market uptake of the innovations increases.

The numerous collaborations fostered between innovators, academics, and thought leaders will also ensure that this continues to be an active and passionate area of research and innovation well beyond the completion of the Challenge.



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[Find out more: Smart sustainable plastic packaging – UKRI](#)



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