Phase 3 Smart Sustainable Plastic Packaging (SSPP) Challenge Evaluation Final Synthesis Report UK Research and Innovation April 2025





Phase 3 SSPP Challenge Evaluation Synthesis Report

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Executive Summary

Introduction

This report presents findings from Phase 3 of the evaluation of the Smart Sustainable Plastic Packaging (SSPP) Challenge.

The SSPP Challenge is the largest and most ambitious UK government investment to date in sustainable plastic packaging research and innovation. Launched in 2019, the Challenge is a £60 million programme, delivered over six years, completing in March 2025. The Challenge contributes to the UK's drive for clean growth and industrial decarbonisation and also aims to support 2025 UK Plastic Pact targets¹:

- To eliminate problematic or unnecessary single-use plastic.
- For 100% of plastics packaging to be reusable, recyclable or compostable.
- For 70% of plastics packaging effectively recycled or composted.
- For 30% average recycled content across all plastic packaging.

The Challenge has funded a diverse portfolio of over 80 projects through eight competitive funding competitions and a series of direct funding awards. Projects funded through a competitive process include feasibility studies, academic and business-led research, and late-stage, large-scale demonstrator plants. Direct (non-competitive) funding was also awarded to various other projects that helped the Challenge to meet its aims and objectives.

Method

The Challenge was evaluated in three phases, each commissioned separately:

- **Phase 1:** a baseline phase that sought to establish a framework for the evaluation and specify indicators (for individual projects and the sector as a whole) to help measure outcomes of the Challenge.
- **Phase 2**: a process evaluation seeking to understand the processes, mechanisms and approaches implemented to deliver the SSPP Challenge what worked well and what worked less well. This phase also included a progress update on outputs, outcomes and impacts achieved to date.
- **Phase 3:** a final evaluation to examine the impacts of the Challenge.

Phase 3 of the evaluation, completed by Winning Moves and Resource Futures across late 2023 through to early 2025, was designed to address the Impact Evaluation questions set out in Table 1:

¹ The UK Plastics Pact | WRAP





Table 1. Impact Evaluation (IE) questions addressed in Phase 3

Evaluation Question	
IE1	To what extent, and how, did the Challenge achieve its objectives?
IE2	Did the Challenge result in additional effects, in alignment with objectives of the programme?
IE3	Were there any unintended or adverse impacts from the activities of the Challenge that conflicted with the aims of the programme?
IE4	To what extent did the Challenge offer good value for money?

[Evaluation questions were defined in Phase 1 as part of the evaluation framework.]

Impact Evaluation question 1 (IE1) addresses the extent to which the Challenge achieved the six objectives and associated targets set in its original business case; these are summarised in Table 2.

Table 2. Challenge objectives and associated targets.

[Targets for each objective were defined at the outset of programme development and do not in all cases reflect how the programme and the portfolio of funded projects has evolved over time.]

Objective	Target
Objective 1: To unlock a significant overall increase in R&I spend (contributing to the UK target of 2.4% of GDP ²) on new forms of plastic packaging (designs, materials and technologies) with improved functionality and sustainability'.	Target 1: £60 million government investment matched by at least £149 million of industry co-investment, with a leverage target of 1:3 for demonstrators.
Objective 2: To deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets.	Target 2: Measurable progress towards achieving the UK Plastics Pact targets (detailed in the list on the previous page).
Objective 3: To increase UK plastic packaging supply chain collaboration on improving sustainability.	Target 3: Minimum of 10 significant ³ multi-stakeholder collaborative R&D projects delivered.
Objective 4: To increase understanding of the environmental impacts of existing and new plastic packaging to inform new and improved design, technologies, and processes.	Target 4: New knowledge from projects is available to influence the development of new/improved standards for plastic packaging e.g. on recyclability, biodegradability, compostability.
Objective 5: To increase understanding of behaviour on the sustainability of plastic packaging ⁴ to inform new and improved design, technologies, processes, and business models.	Target 5: UK Plastics Pact target: 70% of plastic packaging effectively recycled or composted.
Objective 6: SSPP innovation recognised internationally as a UK strength, a source of export growth and inward investment.	Target 6: An increase on the current baseline of export sales.

Source: Smart Sustainable Plastic Packaging ISC Wave 3 Business Case V3

⁴ Projects contributing to understanding behaviour on sustainability of plastics to be defined as: projects where the intention includes a focus on consumer behaviour and insights. Any project where the outcome is in part due to researching or testing things that involve consumer behaviour.





² The UK target of 2.4% of GDP was outlined in 2017, but was withdrawn in March 2023 to reflect the changing economic and business environment: [Withdrawn] Industrial Strategy: building a Britain fit for the future - GOV.UK. The Challenge objective was to contribute to this UK target.

³ With 'significant' equating to projects with at least two partners, costs greater than £250k and lasting longer than 12 months.

Questions IE2, IE3 and IE4 examine the wider outcomes, impacts and value for money of the Challenge. Wider outcomes assessed in Phase 3 include the extent to which the Challenge has contributed to a stepchange towards a more sustainable value chain for plastics, the environmental and economic benefits arising from the Challenge, and any unintended adverse effects.

The evaluation uses a theory-based approach, determining the effectiveness of the Challenge by rigorously testing whether the causal chains thought to bring about its intended outcomes and impacts are supported by strong evidence. This involved:

- A Challenge-level contribution assessment, considering a set of hypotheses about how the Challenge contributed to observed outcomes and impacts, compared against a set of competing hypotheses.
- **A Project-level contribution assessment**, examining the extent to which individual projects would have progressed in the absence of the Challenge.

The evaluation draws on a range of primary and secondary research evidence and analysis to evaluate the Challenge. The main work elements are summarised in Table 3:

Table 3. Overview of work elements.

⁵ Where adequate data was not available the impact of projects was not estimated. Please refer to the Limitations section.





		outcomes achieved by the portfolio
6 interviews with international	Review of published data on the	of funded projects
experts / organisations to explore	sector and market for plastics	
awareness of the Challenge and the	packaging to contextualise findings.	
UK's international reputation for		
sustainable plastic packaging.		

Throughout the report where findings are described as 'to date' this is up until December 2024 when evaluation data was collated and analysed.

IE1: To what extent and how, did the Challenge achieve its objectives?

In summary, the Challenge has made progress against all of its objectives, in the process unlocking a significant increase in Research and Innovation (R&I) spend to improve the sustainability of plastic packaging. Innovations supported by the Challenge are in line with UK Plastics Pact targets and have contributed, to at least some extent, towards improvements in understanding of consumer behaviour and the environmental impacts of new and existing forms of plastic packaging. The level of collaboration across the UK plastic packaging value chain is greater than it would have been in the absence of the Challenge. There is some evidence of the Challenge being recognised internationally, though further dissemination of Challenge insights and learnings would help to increase this recognition as the Challenge draws to a close.

The table below provides a summary of our findings and conclusions on each of the Challenge's objectives. In this table, the RAG rating is based on the extent of evidence observed, where **green**=desired outcome observed and supportive evidence for additionality identified, **amber**=some evidence of the desired outcome but not achieved in full and/or only some supporting evidence of additionality, **red**=outcome not observed and/or no evidence of additionality observed.

Objective	RAG rating	Headline findings and summary
IE1.1 To what extent, and how, did the Challenge unlock a significant increase in R&I spend on new approaches to plastic packaging with improved functionality and sustainability?	Green	 From £49.8 million of committed grant funding, projects have attracted co- investment totalling £298 million to date, surpassing the original target of £149 million. While most funded projects focus on sustainability rather than functionality, a sub-set of projects target both. There is clear evidence that the Challenge unlocked investments in R&I that would not have been made in its absence, and accelerated investment in other cases. The Challenge achieved this by de-risking investment for successful applicants and boosting the confidence of external investors in the project.

Table 4. Summary of progress against each SSPP Challenge objective.





IE1.2 To what extent, and how, did the Challenge deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets?	Green	 The focus of funded projects is well-aligned with the four Plastics Pact Targets, and the Challenge supported multiple projects aligned with each individual target. Though few projects will achieve impacts within the lifetime of the Pact, UKRI's decision to support near-to-commercialisation demonstrator projects has led to a clear increase in recycling capacity relative to what might have happened otherwise. The application process ensured applicants focussed on Plastics Pact targets from the outset, even where they were not aware of the Pact previously. Funding decisions made by the Challenge included assessment and scoring on the extent to which each project contributed to UK Plastic Pact Targets. Many projects would not have committed the same scale of R&I investment in projects that contribute to targets in the absence of the Challenge.
IE1.3 To what extent, and how, did the Challenge increase UK plastic packaging value chain collaboration on improving sustainability?	Green	 The Challenge facilitated a clear increase in collaboration, across the value chain, to improve the sustainability of plastic packaging. This included the following⁶: 24 collaborative projects between industry and academia; 46 collaborative projects between two or more parts of the value chain; 22 collaborative projects on which partners had not previously worked together. Some collaborations arose through introductions made by Innovate UK, the UK Circular Plastics Network (UKCPN), Innovate UK Business Connect (previously known as the Knowledge Transfer Network) or the Natural Environment Research Council (NERC); however, the Challenge also provided the impetus for many organisations to make their own introductions to potential partners. The Challenge also helped to sustain collaboration, evidenced in interviews with unsuccessful applicants, where respondents stated that new relationships formed to apply to the Challenge broke down when they did not receive funding. Further collaborations have also been formed during project delivery and at project closure, with Innovate UK, UKCPN, Innovate CUK Business Connect (previously KTN) or NERC involved in making these connections. The connections will help secure the ongoing success of projects and further impacts beyond the lifetime of the Challenge.

⁶ Categories are not mutually exclusive.



IE1.4 To what extent, and how, did the Challenge increase understanding of the environmental impacts of existing and new plastic packaging to inform new and improved design, technologies, and processes?	Amber	 The Challenge encouraged environmental analyses in the application process and after project completion. For demonstrator projects, an environmental assessment was mandatory and requested in the application form. 53 projects with a value of £97.1 million undertook life-cycle analyses or other environmental assessment as part of their project. These projects have developed 18 business models, 55 designs, 5 standards and 46 processes.⁷ These environmental assessments contribute to increased understanding of environmental impact; however: Only eight projects from a total of 72 examined⁸ provided GHG emission reductions in environmental assessments or from interview data, suggesting many could be taken further. The extent to which projects have shared assessments more widely is unclear. Projects aiming to produce guidance, training or data outputs are less suited to an environmental assessment but also contribute to improvements in the understanding environmental impacts. Many of these are Direct Awards, with the Challenge choosing to fund these projects to meet the wider needs of the sector (e.g. through training or data provision) and aid progression of projects funded through competitive grants.
IE1.5 To what extent, and how, did the Challenge increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes, and business models?	Green	 There is substantial evidence of activity with focus on consumer behaviour and insight: 17 projects aimed to increase understanding of behaviour on the sustainability of plastic packaging to some extent. These projects have developed 7 business models, 12 designs, 4 standards and 12 new processes informed by their learnings. And clearly disseminated their findings through 69 academic papers and 114 UK speaking slots. Most projects seeking to understand behaviour are funded through the Enabling Research or the Future Plastics Packaging Solutions Round 1 and 2 competitions. Some have achieved impacts already, with a predicted ramp up between 2025 and 2030, but many are at an earlier Technology Readiness Level (TRL) stage where it is too early to predict what their impacts might be.

⁸ All 87 projects were not assessed as (i) some were not intended to directly generate environmental impact (e.g. knowledge/data sharing projects) and (ii) some were not interviewed and no other data on impact was available for review.





⁷ Please note: the number of publications, business models, designs and standards etc. reported for IE1.4 and IE1.5 cannot be summed as there is overlap whereby projects contribute to both aims.

	• The impact of the Challenge on the UK's reputation and international recognition is difficult to assess. International experts were often unaware of the findings from projects funded through the programme and the Challenge itself was found to be mentioned infrequently by international media outlets. However, some influence can be observed in the available evidence:	
IE1.6 To what extent, and how, did the Challenge		 A handful of commercialised projects are well known by UK sector experts and some international sector experts.
increase the UK's international recognition for sustainable plastic packaging and increase	Amber	 Several sector experts and stakeholders cited examples of the Challenge influencing / being used as a blueprint for similar and related initiatives internationally, even where the international recipient beneficiaries may be unaware of the Challenge itself. In some cases, UKRI is involved in these international activities, independent of the Challenge.
international finance (export and investment)?	1	 Further dissemination of findings would help increase UK and international awareness of the Challenge and insights arising from funded projects. Individual projects have received attention – and in some cases, investment - on an international stage:
		 Thirteen projects have secured inward investment totalling over £169 million and at least 17 have export licenses associated with their funded projects.
		 Nine projects have communicated findings at international speaking slots.

IE2: Did the Challenge result in additional effects, in alignment with the objectives of the programme?

Interview and secondary evidence shows that approximately half of unsuccessful applicants were unable to proceed with their projects at all in the absence of Challenge funding, suggesting most reported impacts are additional to what would have been realised in the <u>same time</u> period in the absence of the Challenge. Of the 46 projects where sufficient data was available to complete a project level assessment:

- 20 were unlikely to have progressed at all in the absence of the Challenge.⁹
- 25 would have progressed but at reduced scale and / or over a longer timescale.
- One would have progressed anyway with no changes.

Analysed from the data available to the evaluation team, Table 5 below shows that reductions of <u>at least</u> 32.2 ktonnes CO₂e GHG emissions have been achieved to date by funded projects; these have arisen from 18.2 ktonnes of virgin fossil-based plastic being avoided and 21.5 ktonnes of plastic packaging being recycled. Of the 32.2 ktonnes CO₂e GHG emissions reductions, 37% are achieved by projects that would not have progressed outside the Challenge and 61% are achieved from those that were able to run at larger scale, higher specification and / or faster timescale as a result of securing Challenge funding.

⁹ One of the 20 projects assessed as fully additional would have proceeded with a different project with some overlapping benefits. This was considered in the assessment with some benefits included as fully additional and some as partially additional.





Many projects will generate impact beyond the closure of the Challenge and beyond the lifetime the UK Plastics Pact. By 2030, calculations of pipeline impact indicate that 1.6 million tonnes CO_2e GHG emissions reductions could be realised, associated with:

- Avoiding the production of 228.2 ktonnes of virgin fossil-based plastics.
- The recycling of 608.6 ktonnes of plastic packaging.

Revenue gains derived from the aforementioned achieved impacts are over £20 million, of which nearly all is achieved by projects that would not have proceeded in the absence of the Challenge, with a further £329 million predicted between 2025 and 2030. A total of 263 jobs have been created; many of these jobs may, in time, have been created in the absence of the Challenge, but at least some are likely to have been created <u>outside the UK</u>.

Quantified impact estimates are conservative and likely to underestimate the full potential of the Challenge. This is because:

- **Data was only available for a sub-set of projects.** As might be expected, much of the impact has been achieved by projects that were working at higher TRLs i.e. at a stage where they could run large scale trials or reach commercialisation. Most pipeline impact is achieved by business-led demonstrator projects that were funded to demonstrate innovation at commercial scale.
- Projects funded by the Challenge have potential to generate more impact over the next 10 years, beyond the estimated impact presented for 2025-2030. The precise impacts that might be generated will be subject to projects advancing TRLs, securing additional funding and/or changes in market conditions. Potential impacts of this nature have not been quantified, due to the significant level of uncertainty involved, as well as some projects targeting the same market.

Impact Metric	Units	Achieved to date	Pipeline (2025-2030)	No. of projects that have achieved impacts to date	No. of projects expected to achieve impacts within the 2025- 30 pipeline
Climate Change:					
GHG emissions reduction	tonnes- CO2e	32,169	1,602,720	12	18
Reduction in plastic packaging and resource use:					
Virgin fossil-based plastic packaging avoided ¹⁰	tonnes	18,174	228,248	7	14
Other virgin fossil- based plastics avoided (non-packaging)	tonnes	1,248	126,988	1	3
Waste:					

Table 5. Overview of Quantified Impacts

¹⁰ Assumed to be a 1 to 1 displacement effect.





Additional plastic packaging recycled	tonnes	21,511	608,564	7	10
Waste reduction	tonnes	20	16,193	4	5
Other environmental impacts (including increased resource use):					
Water used	tonnes	60,170	701,117	3	6
Chemicals used	tonnes	5,000	30,000 ¹¹	1	1
Waste production	tonnes	4,022	32,351	2	6
Additional land / aquaculture requirements	hectares	0.6	759	1	4
Economic and Growth impacts:					
Revenue	£	27,501,357	392,970,748	9	16
Jobs created	FTE	263	N/A	25	N/A
People upskilled/trained	FTE	239	N/A	65	N/A
People Upskilled/trained through Challenge funded BPF courses	FTE	539	N/A	1	N/A

Through funding a diverse portfolio of projects, the Challenge has supported R&I activity that moves toward a more sustainable value chain. The Challenge has directly funded facilities that will contribute 102,350 tonnes of UK recycling capacity by 2030. Funded projects also have roll-out plans that, if followed through, could contribute a further 445,000 tonnes of UK recycling capacity per annum, moving the UK forward in meeting the estimated additional 789,000 tonne capacity requirement within the best-case desired scenario (assuming all existing capacity remains in operation). ¹²

Various barriers remain, with some areas of interest to the UK Plastics Pact more difficult to achieve change in than others. Upcoming legislation enactment, such as Extended Producer Responsibility and Simpler Recycling, will create further incentives for change, putting Challenge-funded innovations in a good position to take advantage of favourable market conditions as they arise. The unexpected delays in these policies were cited as potentially slowing down project progression, as some decision makers in the value chain were holding off making decisions to adopt or invest in innovations until policy was enacted.

¹² Plastics Market Situation Report 2022





¹¹ One project gave data required for quantification for this metric.

The ongoing media coverage of plastics has helped project progression, keeping a value chain focus on the need to improve the sustainability of plastics.

IE3: Were there any unintended or adverse impacts from the activities of the Challenge that conflicted with the aims of the programme?

The evaluation found limited evidence of unintended adverse impacts arising from the activities of the Challenge. As shown in Table 5 above, a small number of projects have generated negative environmental impacts such as waste production and / or demand for natural land resources. The balance of environmental costs and benefits is often a subjective one; for example, it is difficult to directly compare waste production to land-use change. However, on a pure tonnage basis, the 'virgin fossil-based plastic packaging avoided' figures are an order of magnitude greater than the 'waste production' figures, suggesting a quantifiable net positive.

IE4: To what extent did the challenge offer good value for money?

The Challenge has already achieved good value for money. As of December 2024, the £41.6m of claimed SSPP Challenge funds had leveraged **£354.1m** of further funding (**£298m of co-investment** including all forms of co-investment, as reported under IE1.1, and a **further £56.1m in additional funds raised**) which includes investment outside the UK and investment into related projects to improve the sustainability of plastic packaging. This equates to **£8.51 of further investment / funds raised per £1 spent.** The Challenge also supported the **creation of 263 jobs.**

Taking the total spend by the Challenge but only the impacts from the sub-set of interviewed projects that we deem unlikely to have progressed at all without funding, the analysis still shows £68.5m of coinvestment and further funds raised, leveraging £1.64 per £1 of Challenge investment. This suggests that the Challenge delivered good value for money, even if all other funded activity would have gone ahead anyway – particularly given the potential of these investments to deliver significant environmental and economic impacts for the UK across future years.

Summary

The balance of evidence shows the Challenge worked as intended, stimulating a significant increase in R&I spend to improve the sustainability of plastic packaging across the UK value chain. Some impacts will arise beyond the lifetime of the Challenge and the UK Plastics Pact. To maximise the impact of the Challenge and realise this potential, it will be important to continue engagement with projects and support dissemination of findings as projects come to close (where the protection of intellectual property allows). This will ensure the Challenge leaves a greater legacy and potential for future impacts beyond those that successful applicants achieve within their own organisations and operations.

Stakeholders considered a unique element of the Challenge was the allocation of a substantial proportion of funding to late-stage demonstrator projects. This decision proved successful, helping the Challenge to realise impact more quickly than would otherwise have been the case.

Several projects and wider experts felt continuation funds would be necessary to help successful applicants to the SSPP Challenge and the wider sector progress further in realising the potential impacts of earlier-stage innovation within the UK and overseas. For some successful applicants, securing further





investment is necessary for future roll out and/or commercialisation. This would also bolster recognition of the UK as a leader in innovation to improve the sustainability of plastic packaging.

Some projects would benefit from further support in establishing the relationships necessary for commercialisation. As the Challenge draws to a close, it continues to facilitate follow on events and help with match making. Such events could help to maximise the impacts of the Challenge, at relatively low cost, as market conditions become more favourable.

Beyond the closure of the Challenge, UKRI could continue to capitalise on its momentum through further dissemination efforts and continuing to amplify the message for ongoing action and innovation to improve the sustainability of the value chain for plastic packaging.





Introduction

This section introduces the Smart Sustainable Plastic Packaging (SSPP) Challenge, the purpose of this evaluation and the evaluation approach. A glossary of terms and definitions used throughout the report can be found in the Appendix.

The Smart Sustainable Plastic Packaging (SSPP) Challenge

Established at the end of 2019, the SSPP Challenge is a £60 million programme¹³ delivered by UKRI over six years, completing in March 2025. It contributes to the UK's drive for clean growth and industrial decarbonisation. By funding research and innovation to make plastic packaging fit for a sustainable future, the Challenge also supported the achievement of targets established by the UK Plastics Pact.¹⁴

Challenge funding supported projects with the aims of:

- Driving research and innovation to develop more sustainable plastic packaging materials and new designs.
- Reducing reliance on single-use plastic.
- Developing new recycling processes and technologies supporting the establishment of recycling infrastructure.
- Establishing circular supply chains, including the funding of collaborative projects between different parts of the supply/value chain.
- Understanding and, where possible, encouraging positive behavioural change in consumer relationships with plastics.
- Increasing the viability and uptake of reuse and refill systems.

In achieving these aims, the SSPP Challenge intends to reduce the negative environmental impacts caused by plastic packaging.

As shown in Table 6 below, the original business case for the Challenge outlined objectives and targets for delivery. The reader should be aware that targets were set when producing this original business case; as time has progressed, some targets are less well aligned with the portfolio of projects funded. For example, many projects that contribute to Objective 5 focus on consumer behaviour and their uptake of reuse and refill, so would not be expected to make material difference against the Plastics Pact target on recycling and composting.

¹⁴ The UK Plastics Pact | WRAP





¹³ The programme made £55.6m of grant funding available, with the remaining balance allocated to operating expenses.

Table 6. Challenge objectives and targets.

Objective	Target
Objective 1: To unlock a significant overall increase in R&I spend (toward UK target of 2.4% of GDP) on new forms of plastic packaging (designs, materials and technologies) with improved functionality and sustainability'.	Target 1: £60m government investment matched by at least £149m of industry co-investment, with a leverage target of 1:3 for demonstrators.
Objective 2: To deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets.	Target 2: Measurable progress towards achieving the UK Plastics Pact targets (100% reusable, recyclable, compostable, 70% effectively recycled or composted, eliminate problematic or unnecessary single-use, 30% average recycled content).
Objective 3: To increase UK plastic packaging supply chain collaboration on improving sustainability.	Target 3: Minimum of 10 significant multi-stakeholder collaborative R&D projects delivered. Where significant includes projects with at least 2 partners, costs greater than £250k and that last longer than 12 months)
Objective 4: To increase understanding of environmental impacts of existing and new plastic packaging to inform new and improved design, technologies, and processes.	Target 4: New knowledge from projects available to influence the development of new/improved standards for plastic packaging e.g. recyclability, biodegradability, compostability.
Objective 5: To increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes, and business models.	Target 5: UK Plastics Pact target 70% of plastic packaging effectively recycled or composted.
Objective 6: SSPP innovation recognised internationally as a UK strength, and source of export growth and inward investment.	Target 6: An increase on the current baseline of export sales.

Source: Smart Sustainable Plastic Packaging ISC Wave 3 Business Case V3

Portfolio of SSPP supported projects

The SSPP Challenge has invested in a wide-ranging portfolio of projects across eight funding competitions. Across the competitions, there were opportunities to access funding for:

- Different actors in the value chain, including businesses and Research and Technology Organisations.
- Project ideas at different Technology Readiness Levels (TRLs), from early-stage research through to projects ready for commercialisation (in proof-of-concept trials or through large scale demonstrators).

Recent priority areas for the SSPP Challenge have included reuse and refill (and attempts to mainstream reuse and refill models), food grade recycling, and films and flexibles (often referred to as the 'final frontier' of plastics recycling). The Challenge is funding innovation at every stage of the lifecycle, from design through to material innovation, curbside collection, and new recycling solutions.

Table 7 below provides details on each of the eight Challenge competitions, including their completion dates. Each competition was launched as a competitive call for applications, with the exception of funding through Direct Awards and the funding awarded to the to IUK Business Connect (previously known as KTN).





Table 7. Overview of funded projects by competition (December 2024)

Competition	Description	Total Awarded	Completion	Number of
521 - SSPP -	UK businesses were invited to apply for funding	Grant value	uate	projects runded
Feasibility Studies	current state-of-the-art packaging demonstrating	£209.000	November	6
for Demonstrators	close-to-market solutions in smart sustainable	1209,000	2020	0
(FS4D)	plastic packaging.			
530 - SSPP-	UK businesses and Research and Technology			
Feasibility Studies	Organisations (RTOs) were invited to apply for	6475.000	December	-
and Industrial	early-stage projects in smart sustainable plastic	£175,000	2021	5
Research (FS&IR)	packaging.			
ISCF Future Plastic	UK businesses were invited to apply for share of		Mariah	
Packaging	£2m for early-stage projects on smart sustainable	£1,710,000	March	14
Solutions Round 1	plastic packaging.		2025	
1480 - ISCF SSPP	UK registered organisations were invited to apply			
Collecting flexible	for funding to develop innovative ideas that help	6244.000	February	(
plastic packaging	with the collection of flexible packaging waste	£244,000	2024	6
waste at home	from households.			
	UKRI National Environment Research Council			
SSPP - Enabling	(NERC) fund to support academic-led research and	C9 400 000	Amril 2024	10
Research (ER)	development that addresses widely understood,	18,490,000	April 2024	12
	but unresolved, problems with plastic packaging.			
	UK businesses were invited to apply for funding			
JZZ - JJPP -	for practical projects demonstrating innovation at	SE 140.000	March	2
Demonstrators	a commercial scale that addresses plastic	15,140,000	2025	Z
	packaging problems in consumer products.			
ISCF Smart				
Sustainable Plastic	UK businesses were invited to apply for funding		March	
Packaging:	for bold and ambitious demonstrator projects in	£20,000,000	2025	5
Demonstrators	smart sustainable plastic packaging.		2025	
Round 2 Full Stage				
ISCF Smart	UK businesses were invited to apply for a share of			
Sustainable Plastic	funding for R&D projects with potential to impact	£7.830.000	March	13
Packaging:	UK Plastic Pact Targets		2025	10
Business-led R&D				
	UK businesses were invited to apply for funding			
	for early-stage and mid-stage projects in smart			
SSPP Future Plastic	sustainable plastic packaging. The competition		March	. –
Packaging Solutions	supported feasibility studies, industrial research	£3,160,000	2025	17
Round 2	and experimental developments that addressed			
	widely known problems in relation to plastic			
	packaging for consumer products.			
D . (A B	Funds directly awarded to projects outside of the		March	<i>,</i>
Direct Award	competitive process, with aims that support the		2025	6
·	achievement of SSPP Challenge objectives.			
	Funds directly awarded to the Knowledge	C2 717 000		
IUK Business	I ransfer Network to set up the UK Circular	£2,517,000		
Connect (previously	Plastics Network, a collaboration building partner		March	1
KNOWN AS KIN)	working to engage innovators, scientists, and		2025	
ACTIVITY	changemakers to move towards a circular			
Total		I		07
Iotal				8/





Purpose of the evaluation

UKRI's SSPP Challenge Team decided to commission the evaluation in three phases, each with competitive tendering processes.

Phase 1 established an evaluation framework (including a Programme Logic), alongside a set of Challenge and project-level baseline indicators.

Phase 2 consisted of two constituent parts:

- 1. **A Process Evaluation** to assess the effectiveness of key processes / mechanisms / approaches implemented to successfully deliver the Challenge.
- 2. **An Interim Evaluation of progress** to assess whether the Challenge was on track to deliver expected benefits.

UKRI commissioned Winning Moves and Resource Futures to undertake **Phase 3**, the final phase of the evaluation – to assess the outcomes and impacts of the Smart Sustainable Plastics Packaging (SSPP) Challenge. Building on the work completed during Phases 1 and 2 of the SSPP evaluation, the main goal of Phase 3 was to complete a more extensive impact evaluation of the Challenge and, more specifically, to provide answers to the following Impact Evaluation Questions (IEQs) (IE1-4), detailed in Table 8. As shown below, the first six evaluation questions are associated with Objectives and Targets for the Challenge set out in the original business case for the fund.

Table 8. Impact Evaluation Questions.

High-level and specific IEQs	
IE1	To what extent, and how, did the Challenge achieve its Objectives?
IE1.1	To what extent, and how, did the Challenge unlock a significant increase in Research & Innovation spend on new approaches to plastic packaging with improved functionality and sustainability?
IE1.2	To what extent, and how, did the Challenge deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets?
IE1.3	To what extent, and how, did the Challenge increase UK plastic packaging value chain collaboration on improving sustainability?
IE1.4	To what extent, and how, did the Challenge increase understanding of environmental impacts of existing and new plastic packaging to inform new and improved design, technologies and processes?
IE1.5	To what extent, and how, did the Challenge increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes and business models?
IE1.6	To what extent, and how, did the Challenge increase the UK's international recognition for sustainable plastic packaging and increase international finance (export and investment)?
IE2	Did the Challenge result in additional effects, in alignment with Objectives of the programme?
IE2.1	To what extent, and how, is the Challenge on target to contribute to a step change towards a more sustainable value chain (e.g. through thought leadership, trailblazing, reaching critical mass)?
IE2.2	To what extent, and how, can the projects supported by the Challenge be expected to bring about a reduction in the environmental impact associated with plastic packaging, and over what time frame? I.e., impacts beyond the UK Plastics Pact targets.





IE2.3	To what extent, and how, has the Challenge facilitated the innovation of "smart" sustainable plastic packaging? What are the expected benefits of this?
IE2.4	To what extent, and how, has the Challenge benefited the UK plastic packaging and related business sectors and contributed to clean growth? Was the timing or scale of projects improved because of the Challenge intervention?
IE2.5	Were there any unexpected barriers or facilitators to desired impact?
IE3	Were there any unintended or adverse impacts from the activities of the Challenge that conflicted with the aims of the programme?
IE3 IE4	Were there any unintended or adverse impacts from the activities of the Challenge that conflicted with the aims of the programme? To what extent did the challenge offer good value for money?

Source: Final Evaluation Framework Report March 2021 (Note: Some changes to wording were made as part of the Phase 3 method to ensure all terms were defined)

This report provides a synthesis of evidence collated in Phase 3, summarising the achievements of the Challenge against each of the high-level evaluation questions, and therefore assessing to what extent the Challenge has achieved what it set out to do.





Method

Theory-based evaluation

Winning Moves assessed the outcomes and impacts of the SSPP Challenge with support from Resource Futures, using a theory-based approach. In line with HM Treasury Magenta Book¹⁵ guidelines, this required us to evaluate the Challenge with reference to a Theory of Change (ToC), setting out: 1) the intended outcomes and impacts; and 2) how the Challenge would achieve these outcomes and impacts i.e. the potential causal chains. An overview of the Theory of Change is shown in Figure 1 below.

¹⁵ The Magenta Book is the HM Treasury guidance on what to consider when deigning an evaluation. It provides guidance on evaluation in government its scoping, design, conduct, use and dissemination as well as the capabilities required of government evaluators.





Rationale: The Smart Sustainable Plastic Packaging (SSPP) Challenge is intended to establish the UK as a leading innovator in smart and sustainable plastic packaging in consumer products by funding, supporting and catalysing research and innovation with the potential to transform the design, production, supply, recovery and sustainability of plastic packaging across the entire value chain.



Figure 1. Summary of Core Components in the Theory of Change.

Phase 3 research

To inform the Phase 3 evaluation we conducted:

- A scoping stage that included review of the outcomes and learnings from Phase 2 and revising work elements to ensure they remained relevant. As part of this stage, the ToC, evaluation questions and the indicators were revised, and the portfolio of funded projects reviewed in depth;
- A programme of **primary research** comprising interviews with key groups;
- A programme of **secondary research** reviewing existing data held by UKRI, published data and wider information in the public domain.

These work elements are described further in Table 9 below, with further details included in a separate Technical Appendix submitted to UKRI.

Table 9. Overview of work elements.

Primary research	Secondary research	Analysis
Interviews with <u>successful</u> <u>applicants</u> to the Challenge covering 49 projects (supplemented by 17 online proformas returned by a sub-set of projects also completing interviews) collating data on outcomes and impacts and the contribution of the Challenge to these achievements. 10 interviews with <u>unsuccessful</u> applicants to understand project progression outside of the Challenge. 12 interviews with <u>SSPP</u> <u>stakeholders and staff</u> to gather perceptions of Challenge-wide achievements and examples of projects achieving outcomes and impact. 9 interviews with <u>sector experts in</u> the UK to understand their awareness of the Challenge and its portfolio, and thoughts on sector- wide changes over time. 6 interviews with international experts / organisations to explore awareness of the Challenge and the UK's international reputation for sustainable plastic packaging.	 Review and analysis of data held by UKRI including: Successful applications Unsuccessful applications Environmental Assessments completed by projects. Monitoring data on investment and benefits achieved by funded projects. Survey data collected at project closure (through the Project Closure Form and qualitative interviews). Web-scraping and secondary research of media coverage of the Challenge to understand prevalence and tone of articles/media coverage. Desk-research on the applicant organisations to understand project progression outside the Challenge. Review of published data on the sector and market for plastics packaging to contextualise findings. 	 Challenge-level contribution assessment to assess the impacts of the Challenge as a whole. Project-level contribution assessment to understand whether individual projects would have progressed in the absence of Challenge funding. Environmental and economic impact analysis to calculate the impacts of funded projects (where adequate data was available from primary and secondary research¹⁶). Cost Effectiveness Analysis to understand achievements of the Challenge per pound of UKRI funding spent. Calculation of specific indicators defined in the Evaluation Framework produced in Phase 1. Indicators were designed to track changes in the plastics packaging sector as a whole and to understand outcomes achieved by the portfolio of funded projects

¹⁶ Where adequate data was not available the impact of projects was not estimated. Please refer to the Limitations section.





The work elements described above fed into a series of analytical tasks, outlined in Table 10 below. In general, quantitative data was used in the reporting of achieved outcomes and impacts, with qualitative data used to:

- Verify details about the project, such as TRL level, type (i.e. what part of the plastics packaging lifecycle the project is influencing, for example, design and manufacturing or mechanical recycling) and whether the project reached the conclusion that the innovation could be commercialised;
- Understand how outcome and impact data were calculated / arrived at by respondents (e.g. in the case of environmental impact data, gathering further details on assumptions);
- Gain a better understanding of if and how the Challenge influenced the outcomes and impacts realised.

These insights fed into a project-level contribution assessment (described further below); this also drew upon: (a) available evidence about what happened next in the case of unsuccessful applications to the Challenge; (b) secondary research to assess additionality. Further details on how data were combined from different sources for each analytical task are provided in the table below.

Analysis **Purpose and description** This was used to assess the impacts of the Challenge as a whole and involved a synthesis of Challengelevel evidence for Research Questions IE1.1- IE1.6. The analysis looked to confirm whether contribution outcomes of interest for the six programme objectives were observed and then to test a series assessment of hypotheses to confirm (or disconfirm) the contribution of the Challenge to observed outcomes. The Challenge-level assessment considers wider evidence captured in the evaluation, including both sector-level indicators and gualitative evidence from applicants, stakeholders and sector experts. Qualitative interview findings were analysed for themes, and agreement / disagreement between themes, from distinct audiences; these are reported in the narrative for each evaluation question. Qualitative findings are reported in general terms throughout this report (i.e. "some", "most", "all") rather than using percentages or precise numbers as: It is not appropriate to infer conclusions about the precise number of organisations or individuals in the applicant, stakeholder or sector expert populations who would share the same attitudes or behaviours. Doing otherwise may be disclosive and compromise respondent confidentiality (particularly in the case of small populations), where UKRI and other readers may know the individuals consulted and be able to determine the views of individual respondents. Project-level Fourteen individual evidence tests were applied to interviewed projects to assess the contribution likelihood that individual projects (or aspects thereof) would have proceeded in the absence of assessment the Challenge. Each test included a description of what we would expect to see if the project was 'fully additional' versus 'partially additional', with some tests deemed necessary for a project to 'pass' such that full or partial additionality could be claimed. The tests covered a range of themes, including: The status of comparable unsuccessful applications;

Table 10. Overview of analytical tasks.





	• The opportunity / ability for Challenge beneficiaries to secure alternative funding if they were unsuccessful;
	• The influence of the Challenge on project idea generation and formation of partnerships;
	Changes to the project at application or within delivery;
	Intentions to roll out Challenge generated ideas.
	Although a self-reported counterfactual was captured and included within the tests, as far as possible each evidence test was designed to capture and/or verify facts about the project and situation rather than just capturing respondent viewpoint. Using multiple evidence tests in this way adds rigour to the contribution assessment.
	Additional evidence tests were specified in cases of no additionality, and/or (if applicable) to identify potential unintended adverse impacts of the Challenge.
Environmental and economic impact	Analysis was conducted to calculate the impacts of funded projects where adequate data was available. This required review of data supplied by projects to UKRI alongside data supplied directly to the evaluation team through primary research.
analysis	Each project was individually assessed, and the most robust evidence carried through to the analysis. For example, only a sub-set of environmental assessments were deemed to have sufficient detail and quality to be used (as presented) in calculating impact.
	In some cases, although the reported tonnages of material involved were considered accurate, the evaluation team opted to use conservative standard factors in calculating GHG emissions, due to limitations and uncertainty in the information supplied in environmental assessments. The economic analysis was conducted alongside the environmental analysis to ensure consistency of assumption (e.g. about the scale of activity involved and timing of impacts).
Cost Effectiveness Analysis	To understand achievements of the Challenge per pound of UKRI funding spent, a simple cost- effectiveness analysis was conducted, considering co-investment and jobs created per £1m spent by the Challenge.
Calculation of indicators	Indicators were defined in the Evaluation Framework created in Phase 1 and used to track changes in the sector as a whole, as well as to understand outcomes achieved by the portfolio of funded projects. Project indicators often included analysis of data held by UKRI alongside updated interview or proforma estimates (see Appendix 1: Project and Sector Indicators for further details). Where multiple data sources fed into an individual data point, these were reviewed and triangulated using the following processes:
	• Where data was supplied to us directly in the interview or through proforma, and there were <u>minor differences</u> to monitoring or project closure data supplied by UKRI, the interview data was considered an update to previous estimates, on the basis that it was provided more recently and directly to the evaluation team.
	• Where data was supplied to us directly in the interview or through proforma, and there were more significant differences to monitoring or project closure data supplied by UKRI, these were reviewed and discussed in more detail with UKRI; in some cases applicants were followed up with an email to confirm figure accuracy.



Figure 2 provides an overview of the various completed research tasks and how data fed into the analysis.



Figure 2. Multi-modal research approach - Primary and Secondary evidence collation and analysis.

[Primary research is in the left-hand column, secondary research is in the right-hand column, and the core impact evaluation analysis tasks (drawing on both the primary and secondary research) are listed in the central column Solid lines indicate where data has fed into individual analysis tasks.]

The work presented in this report has been undertaken in compliance with ISO20252, the International Standard for Social and Market Research. Winning Moves is registered to the Standard

Limitations

The reader should note the following limitations:

- Interview findings for successful applicants are based on feedback from representatives of 49 of the 87 projects funded by the SSPP Challenge i.e. those completing an interview with us in Phase 3. Though we achieved good coverage of funded projects, and took care to ensure the sample included representatives from all SSPP Challenge competitions and types of projects funded by the Challenge, we cannot guarantee the findings presented in this report reflect the full spectrum of project applicants and projects funded by the Challenge.
- We cannot quantify precisely what would have happened in the absence of the SSPP Challenge (the counterfactual). However, the project-level contribution assessment, which we completed for



46¹⁷ of the 87 projects funded by the Challenge, does allow us to distinguish between projects that were:

- Unlikely to have proceeded at all in the absence of the Challenge;
- Likely to have happened to some extent, but not at the same scale or timescale; or
- Likely to have happened anyway due to wider market forces.

We use this assessment throughout the report to provide an indication of additionality.

- Only a sub-set of projects completed a proforma or PCF and therefore some data, such as information on jobs, intellectual property and business and process outcomes, are not available for the population as whole. We present these data points as a conservative estimate throughout the report.
- We also present conservative estimates for environmental and economic impacts. Many of the projects funded by the Challenge involve early-stage research and innovation, meaning it is too early to robustly quantify their impacts. In other cases, projects had not collated the required data or were unwilling to share it, preventing us from producing an impact estimate. Readers should therefore interpret the environmental and economic impacts as <u>minimum impacts</u> for the Challenge.
- In estimating the environmental impacts, calculations do not account for 'quality' of recyclate from recycling facilities, only whether it is going directly into packaging or on the open market.
- Reported tonnages from increased recycling technology capacity can include plastics that in the counterfactual situation (i.e. in the absence of the Challenge) may have been recycled but outside the UK and/or to a lower grade output.
- Due to the diversity of projects and organisations funded by the SSPP Challenge, it is not possible to evaluate the Challenge against a robust counterfactual group; this limitation has been mitigated as far as possible through the use of theory-based evaluation approaches, combining multiple methods and evidence sources, including gathering evidence to understand the outcomes for unsuccessful applicants.
- Findings are based on data available up to December 2024. Funded projects have continued to progress beyond this period and further outcomes and impacts are likely to be achieved.

An evolving policy landscape and the implications for evaluating the impacts of the SSPP Challenge

Throughout the report, we consider changes in the policy landscape, where appropriate, and their potential effects on the progression and impacts of projects funded by the Challenge. A summary of changes that have occurred over the time period of funded project delivery is provided in Appendix 2. Where delays or enactment are likely to influence achievement, this is referenced in the report. We also consider future trends when discussing the potential impacts of the Challenge over the next 10 years.

¹⁷ Of the 49 interviews completed, an assessment was made for 36 projects. Five projects were excluded as direct awards and the remaining projects covered in interview were with respondents with multiple projects who only covered one project in detail during interview. Ten project-level contribution assessments were made using Phase 2 data.





IE1: To what extent, and how, did the Challenge achieve its objectives?

This chapter examines whether, how and to what extent the Challenge has achieved the six objectives outlined in the original business case. The sub-sections that follow discuss each objective in detail. The summary below provides a high-level overview of the findings.

The Challenge has made progress against all six objectives, to varying degrees. The table below provides a summary of headline findings, alongside our 'traffic light' / RAG assessment of whether and to what extent the Challenge achieved each objective.

Table 11. Summary of findings for each of the six Challenge objectives (IE1.1. to IE1.6).

[The RAG rating is based on the extent of evidence observed, where **green**=desired outcome observed and supportive evidence for additionality identified, **amber**=some evidence of desired outcome but not achieved in full and/or only some supporting evidence of additionality, **red**=outcome not observed and/or outcomes observed are not additional.]

Objective	RAG rating	Headline findings and summary
IE1.1 To what extent, and how, did the Challenge unlock a significant increase in R&I spend on new approaches to plastic packaging with improved functionality and sustainability?	Green	 From £49.8 million of committed grant funding, projects have attracted co-investment totalling £298 million to date, surpassing the original target of £149 million. While most funded projects focus on sustainability rather than functionality, a sub-set of projects target both. There is clear evidence that the Challenge unlocked investments in R&I that would not have been made in its absence, and accelerated investment in other cases. The Challenge achieved this by de-risking investment for successful applicants and boosting the confidence of external investors in the project.
IE1.2 To what extent, and how, did the Challenge deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets?	Green	 The focus of funded projects is well-aligned with the four Plastics Pact Targets, and the Challenge supported multiple projects aligned with each individual target. Though few projects will achieve impacts within the lifetime of the Pact, UKRI's decision to support near-to-commercialisation demonstrator projects has led to a clear increase in recycling capacity relative to what might have happened otherwise. The application process ensured applicants focussed on Plastics Pact targets from the outset, even where they were not aware of the Pact previously. Funding decisions made by the Challenge included assessment and scoring on the extent to which each project contributed to UK Plastic Pact Targets. Many projects would not have committed the same scale of R&I investment in projects that contribute to targets in the absence of the Challenge.



		 The Challenge facilitated a clear increase in collaboration, across the value chain, to improve the sustainability of plastic packaging. This included the following¹⁸: 24 collaborative projects between industry and academia;
		 46 collaborative projects between two or more parts of the value chain; 22 collaborative projects on which partners had not previously worked
IE1.3 To what extent. and how.		together.
did the Challenge increase UK plastic packaging value chain collaboration on improving sustainability?	Green	 Some collaborations arose through introductions made by Innovate UK, the UK Circular Plastics Network (UKCPN), Innovate UK Business Connect (previously known as the Knowledge Transfer Network) or the Natural Environment Research Council (NERC); however, the Challenge also provided the impetus for many organisations to make their own introductions to potential partners. The Challenge also helped to sustain collaboration, evidenced in interviews with unsuccessful applicants, where respondents stated that new relationships formed to apply to the Challenge broke down when they did not receive funding. Further collaborations have also been formed during project delivery and at project closure, with Innovate UK, UKCPN, Innovate CUK Business Connect (previously KTN) or NERC involved in making these connections. The connections will help secure the ongoing success of projects and further impacts beyond the lifetime of the Challenge.

¹⁸ Categories are not mutually exclusive.





IE1.4 To what extent, and how, did the Challenge increase understanding of the environmental impacts of existing and new plastic packaging to inform new and improved design, technologies, and processes?	Amber	 The Challenge encouraged environmental analyses in the application process and after project completion. For demonstrator projects, an environmental assessment was mandatory and requested in the application form. 53 projects with a value of £97.1 million undertook life-cycle analyses or other environmental assessment as part of their project. These projects have developed 18 business models, 55 designs, 5 standards and 46 processes.¹⁹ These environmental assessments contribute to increased understanding of environmental impact; however: Only eight projects from a total of 72 examined²⁰ provided GHG emission reductions in environmental assessments or from interview data, suggesting many could be taken further. The extent to which projects have shared assessments more widely is unclear. Projects aiming to produce guidance, training or data outputs are less suited to an environmental assessment but also contribute to improvements in the understanding environmental impacts. Many of these are Direct Awards, with the Challenge choosing to fund these projects to meet the wider needs of the sector (e.g. through training or data provision) and aid progression of projects funded through competitive grants.
IE1.5 To what extent, and how, did the Challenge increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes, and business models?	Green	 There is substantial evidence of activity with focus on consumer behaviour and insight: 17 projects aimed to increase understanding of behaviour on the sustainability of plastic packaging to some extent. These projects have developed 7 business models, 12 designs, 4 standards and 12 new processes informed by their learnings. And clearly disseminated their findings through 69 academic papers and 114 UK speaking slots. Most projects seeking to understand behaviour are funded through the Enabling Research or the Future Plastics Packaging Solutions Round 1 and 2 competitions. Some have achieved impacts already, with a predicted ramp up between 2025 and 2030, but many are at an earlier Technology Readiness Level (TRL) stage where it is too early to predict what their impacts might be.

²⁰ All 87 projects were not assessed as (i) some were not intended to directly generate environmental impact (e.g. knowledge/data sharing projects) and (ii) some were not interviewed and no other data on impact was available for review.





¹⁹ Please note: the number of publications, business models, designs and standards etc. reported for IE1.4 and IE1.5 cannot be summed as there is overlap whereby projects contribute to both aims.

IE1.6 To what extent, and how, did the Challenge increase the UK's international recognition for sustainable plastic packaging and increase international finance (export and investment)?	Amber	• The impact of the Challenge on the UK's reputation and international recognition is difficult to assess. International experts were often unaware of the findings from projects funded through the programme and the Challenge itself was found to be mentioned infrequently by international media outlets. However, some influence can be observed in the available evidence:
		 A handful of commercialised projects are well known by UK sector experts and some international sector experts.
		 Several sector experts and stakeholders cited examples of the Challenge influencing / being used as a blueprint for similar and related initiatives internationally, even where the international recipient beneficiaries may be unaware of the Challenge itself. In some cases, UKRI is involved in these international activities, independent of the Challenge.
		• Further dissemination of findings would help increase UK and international awareness of the Challenge and insights arising from funded projects.
		 Individual projects have received attention – and in some cases, investment - on an international stage:
		 Thirteen projects have secured inward investment totalling over £169 million and at least 17 have export licenses associated with their funded projects.
		 Nine projects have communicated findings at international speaking slots.





IE1.1: To what extent, and how, did the Challenge unlock a significant increase in Research & Innovation (R&I) spend on new approaches to plastic packaging with improved functionality and sustainability?

This section examines whether and to what extent the Challenge led to an increase in R&I spend on new approaches to plastic packaging with improved functionality and sustainability. The assessment draws on analysis of benefits, outcome and monitoring data collated by UKRI, primary research with applicants and stakeholders and secondary research on unsuccessful applicants and applicant organisations.

The balance of evidence indicates the Challenge led to a significant increase in R&I spend in the UK to improve the sustainability of plastic packaging, with a smaller number of projects also working to improve functionality. The Challenge did this by derisking project investments for successful applicants and boosting the confidence of external investors.

The importance of the Challenge was evident in feedback from successful applicant organisations (individuals involved in the investment decision). This importance was also made clear in interviews with unsuccessful applicants, many of whom were unable to pursue their project ideas to the same scale or timings without Challenge funding. The available evidence confirms the Challenge has met objective 1 and exceeded its associated target.

Objective and Target associated with IE1.1:

Objective 1: To unlock a significant overall increase in R&I spend (toward UK target of 2.4% of GDP) on new forms of plastic packaging (designs, materials and technologies) with improved 'functionality and sustainability'.

Target 1: £60m government investment matched by at least £149m of industry co-investment, with a leverage target of 1:3 for demonstrators.





Key definitions:

Improved Functionality encompasses new forms of packaging offering improved (packaging) performance, for example improved barrier properties / microbial resistance.

Improved Sustainability includes new forms of packaging offering improved sustainability over incumbent options. It also extends to innovations aiming to (a) improve the associated impact with necessary packaging; (b) eliminate packaging through introduction of reuse and refill options; (c) improve the sustainability of the plastic packaging value chain e.g. through delivering higher-value recycling or presenting an alternative end of life treatment for existing packaging.

Has there been an increase in R&I spend on new approaches to plastic packaging?

R&I spend: as of December 2024, the Challenge had committed £49.8m of funding²¹ leading to coinvestment of £298m (broken down by type in Figure 3 below). This exceeds the target of £149m of industry co-investment, set at the outset of the fund. The objective associated with increasing R&I spend was to contribute to the UK target (set in 2017) for 2.4% of Gross Domestic Product²² to be spent on R&D (approx. £65bn in 2023²³). The target has since been withdrawn, but the Challenge achievement does contribute (with total co-investment into funded projects representing 0.4% of the total £65bn target).



²¹ £41.6 million was claimed by December 2024.

²² The initial target was outlined in 2017, but was withdrawn in March 2023 to reflect the changing economic and business environment: [Withdrawn] Industrial Strategy: building a Britain fit for the future - GOV.UK

²³ 2023 was the latest available year of data at the time of the analysis.



Figure 3. Breakdown of co-investment by type.

[Note: Aligned, Pledged and Accompanying co-investment were provided by UKRI; Follow-on investment was provided by UKRI but also included as part of interviews to capture any additional investment that may have been made.]

The leverage ratio (i.e. the total co-investment achieved per pound of UKRI funding received) for the portfolio as a whole is approximately £6 of co-investment achieved per £1 awarded. As shown in Figure 4 below, this varies by competition, which reflects the following:

- The time elapsed since competitions were closed; with the exception of Demonstrators Round 1, all competitions with a ratio greater than 5 have a completion date pre-March 2023.
- The purpose of the competition; those issued funding under Direct Award were intended to support Challenge achievements and did not necessarily have the same co-investment aims. This also applies to IUK Business Connect activity (for which a ratio has not been presented).
- The Feasibility Studies for Demonstrator competition had a lower level of funds awarded compared to other competitions (£209,000) but two projects have gone on to secure a substantial sum of co-investment (£5.9m and £18.5m), driving the higher ratio.




• Demonstrator Round 1 and Round 2 projects have contributed substantially to the co-investment target, securing 73% of the reported co-investment realised for the Challenge. The individual target of a 1:3 leverage was achieved in both demonstrator competitions. The level is heavily driven by a single demonstrator project that has secured just under £135m of follow-on investment.



Figure 4. Leveraged Investment Ratio by Competition.

Investment into new approaches to plastic packaging: review of the Challenge portfolio across all competitions shows that all 87 projects had the potential to improve the sustainability of plastic packaging in the UK, whilst 13 contribute to improved functionality. Therefore, all reported investment contributes, to at least some extent, towards R&I on new forms of plastic packaging (designs, materials and technologies) with improved 'functionality and sustainability'.

Considering project type by investment shows that:

- Projects with a focus on chemical recycling represent 52% of the total £298m co-investment and those with focus on mechanical recycling represent 23%. This aligns with a high proportion of investment associated with the large-scale demonstrator projects.
- 13% of the £298m co-investment has been in projects with a focus on innovative materials.

Did the SSPP Challenge lead to more R&I investment in new approaches to plastic packaging than would have happened otherwise (beyond direct funding)?

Evidence from successful and unsuccessful applicants supports the conclusion that R&I investment is above and beyond what may have happened in its absence.





In the project-level contribution assessment, we used wider evidence from across the evaluation to examine the 46 projects covered in interviews in detail, seeking to understand if the fund supported <u>additional activity</u> to what may have happened in its absence. This project-level contribution assessment found that most projects either would not have been able to progress outside of the Challenge²⁴, or would have progressed at a reduced scale, slower timescale or both. Figure 5 shows the likely progression of successful projects had they not received funding.



Figure 5. Likely progression of funded projects had they been unsuccessful in Challenge applications.

[Analysis is based on the full project-level contribution assessment considering 14 evidence tests.]

As shown in Figure 6, 22% of the achieved co-investment (approximately £53m of £242m) is associated with the 20 projects that may not have proceeded in the absence of the Challenge.

²⁴ One of the 20 projects assessed as fully additional would have proceeded with a different project with some overlapping benefits. This was considered in the assessment, with some benefits included as fully additional and some as partially additional.







Figure 6. Breakdown of the £242m of co-investment secured by interviewed projects by whether the project was likely to have continued in the absence of the fund.

Progression status for 60 of 170 unsuccessful applicant projects was determined through secondary and primary research. Approximately half were unable to progress without Challenge funding, and consequently internal investment beyond the application to the Challenge is likely to be minimal (see Figure 7). At least 12 were only able to progress with amended scope or timescale, suggesting a smaller overall investment within the project, even where the applicant organisation committed the same funds.



Figure 7. Progression of projects unsuccessful in their application for Challenge funding.

Securing funding from the Challenge <u>de-risked investment:</u> successful applicant organisations felt Challenge funding de-risked their own investment, with 16/30 successful applicant representatives or decision makers interviewed for this evaluation reporting they would not have approved <u>any investment</u>





in their project, or any aspect of it, in the absence of Challenge funding. A further 10/30 reported they may have invested but at a smaller scale.

Challenge funding also increased external investor confidence in applicant credentials and ability to deliver proposed projects. Some successful applicants believed their proposition would have been valued lower by potential investors without the Challenge funding, whilst some unsuccessful applicants reported that investors withdrew when their project did not receive Challenge money.

"<Redacted investor name> put in a substantial amount of capital which they wouldn't have done if we didn't have other funding." (Successful project applicant)

"I really needed that grant to kick start it. Even if it had been a reduced amount, I would have been able to do [the] initial R&D which would have enabled me to go for other [funding]." (Unsuccessful applicant)

"We were hoping the SSPP application would give us the funds so we could then roll it on after that. That didn't happen. The funding from the <redacted investor/collaborator> that was indicated to be there to carry on was withdrawn." (Unsuccessful applicant)

Only four successful applicants were confident that they could have funded the project by themselves in the absence of Challenge funding, using internal R&D budgets allocated to projects of this nature. Two of the four said that it would have taken longer to complete their projects, and these may have also been smaller in scale. All four projects reported a TRL level above 4.

Alternative funding sources for project progression are not like for like: approximately two-thirds of successful applicants commenting on other funding sources (23/34), were either not aware of alternative funding sources (13/34), or believed that applying for them would have changed the direction of the project (10/24). Regarding the latter, changes might have included scale (where alternative sources offered smaller amounts of money), a lack of autonomy to work with partners of choice, and / or restricted dissemination of findings (if the project were funded by a private partner with an interest in IP, or selection of partners).

"The project would have changed quite a lot, because obviously going for European funding you have to have European partners and things like that, so it probably would have changed the project quite significantly if we'd done that." (Successful project applicant)

Seven successful project applicants would have applied elsewhere in the absence of the Challenge. Alternative funds respondents suggested they may have applied to included the Smart Grants programme, the Research & Technology Organisation (RTO) Catapult Grant scheme (also delivered by Innovate UK) and schemes open across Europe (e.g. Horizon and Eureka). There was also acknowledgement of smaller private or local funds but, in the main, they were not thought to be at large enough scale for some of the funded SSPP projects, and / or too restrictive in terms of the geographical area that innovations would need to operate in.





"Innovate UK is the most established and they allow for much larger projects which is what was needed for the project." (Successful project applicant)

Unsuccessful projects that did continue were able to do so as they found other ways to raise the funds required. Of the five interviewed, three found other external funding sources (raising funds privately or accessing other grant funding) whereas two (smaller organisations) made the decision to either self-fund or conduct works themselves as opposed to using subcontractors.

However, in all but one of the five cases, the project scope, scale or timescale was negatively impacted by this change in funding. A few applicants on unsuccessful projects reported that the Challenge awards influenced their decision not to progress, as potential competitors had been successful in gaining funding and would have an advantage working on similar projects/topics.

Summary

The Challenge has increased R&I spend above what would have been spent in its absence through (a) derisking investment for individual applicants and (b) improving their reputation with investors. Whilst it is not possible to fully assess what may have happened in the absence of the Challenge:

- Evidence from project-level process tracing (using fourteen evidence tests) suggests that progression without Challenge funding may not have been possible at all, or has resulted in reduced scale and / or slower timings.
- Primary and secondary research shows that a substantial proportion of unsuccessful applicants were unable to progress their project in the absence of funding.

The balance of evidence supports the conclusion that Objective 1 and the associated target of at least \pm 149m of industry co-investment have been met.





IE1.2 To what extent, and how, did the Challenge deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets?

This section looks at the Challenge's role in delivering R&I to support more sustainable plastic packaging that contributes to each of the four UK Plastics Pact targets. The analysis draws on UKRI's coding of projects to show contribution to each of the targets25, primary qualitative research with applicants and stakeholders, and secondary research on progress towards UK Plastics Pact targets.

Most projects contribute to at least one of the Plastics Pact targets, committing their grant funding and associated pledged co-investment to the research project. In the main, an applicant's intentions to work on topics that align with the Pact often preexisted the call for applications, either because (1) they were already aware of the targets directly; or (2) although unaware of the specific targets, the focus of their project was already aligned with the aims of the Plastics Pact i.e. the importance of improving the sustainability of plastic packaging. A substantial proportion of successful funding applicants would have implemented their projects at a smaller scale, or not at all, if they had been unsuccessful, impacting on the level of R&I achieved, with others requiring additional time to deliver projects without Challenge support.

Few of the projects funded by the Challenge will achieve impact within the lifetime of the UK Plastics Pact, which concludes in 2025. At least twelve projects that, at the time of evaluation, were commercialised or nearing commercialisation, will contribute towards Pact targets within its lifetime (discussed under IE2.2). However, we are unable at this time to quantify impacts for the funded project portfolio as a whole.

Projects funded by the SSPP Challenge, and associated follow-on investments, will continue to contribute to improvements in the UK's performance on plastics beyond the lifetime of the Pact, with eighteen projects (discussed under IE2.2) expected to realise environmental impacts between 2025 and 2030.

²⁵ UKRI report against benefits achieved by the portfolio, including contribution to Plastic Pact targets. To do this each project information is reviewed and coded for contribution. The evaluation team reviewed and verified this coding as part of the scoping stage.





Objective and Target associated with IE1.2:

Objective 2: To deliver R&I to support more sustainable plastic packaging in line with the UK Plastics Pact targets.

Target 2: Measurable progress towards achieving the UK Plastics Pact targets (as outlined in the box above)



Did Challenge funded projects align with the UK Plastics Pact Targets?

Nearly all projects funded by the Challenge were aligned with one or more of the UK Plastics Pact Targets, with coding of the 87 projects identifying projects contributing to each. Each project was scored for contribution to UK Plastic Pact Targets as part of the funding award process. Those projects that are not directly contributing to Plastic Pact Targets (5 / 87), may indirectly influence Targets through benefits associated with data provision, guidance or training outcomes. Table 12 below shows the number of projects aligned with each Target, the total value of these projects and examples of contribution.

R&I to support more sustainable plastic packaging is in line with UK Plastics Pact targets: As shown in the Table below, the value of projects aligned with each of the Plastic Pact targets is substantial. It is important to recognise that contribution to a Plastics Pact Target does not necessarily mean a project will have measurable impact towards a Target by 2025. However, it does confirm a research focus, with the potential to support future improved performance against / achievement of, the Target.

Details on progression towards each target is included in Appendix 3; evidence suggests that only Target 1 (eliminating single-use plastic) will be met in full by 2025.





Table 12. Number and value of projects contributing to each UK Plastics Pact Target.

[Where project value is the sum of grant claimed, pledged co-investment realised and confirmed accompanying co-investment. Projects can contribute to more than one target.]

Plastics Pact Target	Number of projects aligned with target	Value of projects	Examples of applicable projects			
Target 1: Eliminate problematic			Xampla – using plant-based proteins to create dissolvable and edible sachets to replace single-use plastic food and drink sachets.			
or unnecessary single-use plastic	32	£19.3m	Beauty Kitchen UK Limited – trialling a whole-systems approach to move behaviour away from using single-use plastic containers through their pre-filled and returnable packaging scheme for liquid products.			
Target 2: 100% of	61	£75.7m	Tipa Corp UK Ltd – research into the impact of compostable packaging to support the development of customer interventions and infrastructure changes needed to capture and process compostable packaging sustainably.			
plastics packaging to be reusable, recyclable or compostable			Reath Technology – the identification and standardisation of data required for packaging to be reused, feeding into the development of a digital platform which tracks the lifecycle of reusable packaging. This system uses unique IDs and tags which collect information on when the packaging was made, what it was made of, how many times it has been reused and what products it was used for.			
Target 3: 70% of plastics packaging effectively recycled or composted	57	£99.2m	Renew ELP/Mura Technology – construction of the Wilton Hydrothermal recycling demonstrator plant, which uses supercritical water to recycle hard-to-recycle plastics destined for incineration or landfill. Sylatech Limited – research and development work into microwave-assisted chemical recycling of plastic film and flexible packaging, to enable a circular economy for this problematic single use plastic.			





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Plastics Pact Target	Number of projects aligned with target	Value of projects	Examples of applicable projects
Target 4: 30% average recycled			British Plastics Federation - industry research to support the development of an online training course on how to incorporate recycled plastics into packaging, to help the supply chain create more sustainable plastic packaging solutions.
content across all plastic packaging	28	£64.3m	Recycleye Ltd – the development of an Al-driven waste- sorting technology which detects materials and objects in co-mingled waste streams at higher speeds and granularity than current technologies. This increases the recycling of less commonly collected plastics which can be processed into new recyclate.

SSPP stakeholders interviewed for this evaluation cited projects that support all four targets. However, overall the portfolio was felt to support targets to differing extents; actions to address Targets 1-3 were felt to be more common than those addressing Target 4. Examining the portfolio of projects funded, two projects specifically explored design to encompass recycled content, but many other projects sought to increase the quantity and/or quality of recyclate available for this purpose, and these projects also contribute to increasing recycled content; the number and value of these projects are reflected in the Target 4 row of the table above.

Did the SSPP Challenge lead to more R&I investment contributing to UK Plastics Pact Targets?

As described under IE1.1, the Challenge has led to greater investment in sustainable plastic packaging than would have occurred in its absence, and a substantial number of projects are unlikely to have progressed without funding. In the Phase 2 Process evaluation, the alignment of the Challenge objectives to UK Plastics Pact targets was widely considered by stakeholders and funded projects to be a shrewd decision from the SSPP Challenge Team, which guaranteed, to some extent, the immediate and ongoing relevance of the Challenge to the problems it sought to address. The Challenge has also helped to make the Pact relevant to the wider value chain:

- Approximately a third of interviewed projects were made aware of the Plastics Pact Targets through the requirement to demonstrate alignment in their application. Although most felt that the requirement to demonstrate alignment did not result in actual changes to their project idea, a couple were keen to highlight that writing the application was a learning opportunity for them, and the Plastics Pact focus helped them better design their project.
- Analysis of lead successful project applicants found only two were existing signatories of the UK Plastics Pact, showing the Challenge has stimulated focus beyond the pool of those already working towards the Pact.

The decision for the Challenge programme team to focus on the Targets when awarding funding is also reflected in interviews with unsuccessful applicants; three attributed their lack of success to their project idea not directly addressing the Targets.





Most sector experts were not close enough to the portfolio to comment on the particular contribution of the Challenge to UK Plastics Pact Targets, but it was noted that alignment of the Challenge with the Pact was a success for government.

"It has been a real success in getting two government departments to come together with the same aim (Plastics Pact and Challenge Fund). In other circumstances different organisations have been funded to do the same thing without any streamlining or combining of efforts." (Sector expert)

"SSPP set-up is linked to the Plastics Pact......This strategic government joined up point of view is a very sound model." (Sector expert)

Has R&I led to measurable progress towards Plastic Pact Targets: a handful of projects will make measurable progress within the lifetime of the Pact; these are discussed in more detail under environmental impacts in Section IE2.2: . In the main, these are demonstrator projects, many of which are contributing to UK recycling capacity already and therefore likely to support Target 3 (70% of plastics packaging effectively recycled or composted).

Many projects are unlikely to contribute to measurable progress against Targets <u>within the lifetime of the</u> <u>Pact</u>, but do have future potential. Analysis of TRL level (see Table 13 below) submitted within project closure forms to UKRI shows that most report progression compared to their starting point, with average progression of two TRL levels (a two-level TRL progression was achieved by 23 of 51 projects). This is encouraging for consideration of future impacts, assuming that ideas developed here are progressed further. For some projects there are still barriers to overcome before activities can be rolled out; these include regulatory barriers (discussed further in Section IE2.5) and the need for additional funding.





Table 13. Applicant self-reported TRL progress from the outset of receiving Challenge funding to the closure of their project based on Project Closure Form data.

		Number of projects in each TRL at project close									
Starting TRL level	Count of projects	O (Project came to a dead end)	1	2	3	4	5	6	7	8	9
1	16				6	4	2	1			3
2	15			1		6	5	1	1		1
3	14	1				2	8			1	2
4	2							2			
6	3								1	1	1
7	1									1	

[Colours represent progression to commercialisation, with red representing lower TRL, orange representing intermediate TRL levels and green representing projects closer to commercialisation.]

Summary

Project-level contribution assessment shows a substantial proportion of investment associated with funded projects is either unlikely to have happened in the absence of the Challenge or would be reduced in scale.

On average, projects achieved a TRL two levels above their starting point by project closure. This has meant some projects realising impact within the lifetime of the UK Plastic Pact, but most will contribute or have potential to contribute beyond 2025.

Although many projects did report that their project ideas were already aligned with the aims of the Pact, the Challenge has resulted in more organisations focusing on Pact Targets than may otherwise have been the case, ensuring a focus specifically aligned with the Pact's aims. The objective to increase R&I with a focus on the Targets is considered met; all funded projects either directly or indirectly contribute to the aims of the Pact.





E1.3: To what extent, and how, did the Challenge increase UK plastic packaging value chain collaboration on improving sustainability?

This section considers whether, to what extent, and how the Challenge increased collaboration to improve sustainability across the UK plastic packaging value chain. It draws on benefits realisation data collated by UKRI on collaboration, alongside primary research with applicants and stakeholders.

Our findings show the Challenge led to a significant increase in collaboration across the supply chain, encouraging both new relationships and more extensive collaboration between those organisations with a pre-existing relationship. Some new collaborations were formed via introductions made by Innovate UK, UKCPN, IUK Business Connect or NERC, but the Challenge also provided the impetus for other applicants to make their own introductions to potential partners. The contribution of the Challenge to an increase in collaboration across the supply chain is corroborated by evidence from unsuccessful applicants, where we observed evidence of partnerships breaking down when they were unsuccessful in their application for Challenge funding.

Feedback from projects also demonstrates a legacy and longer lasting impact, with the Challenge helping to facilitate follow-on relationships throughout project delivery and at project close, some of which will be key to eventual commercialisation.

Objective and Target associated with IE1.3:

Objective 3: To increase UK plastic packaging supply chain collaboration on improving sustainability.

Target 3: A minimum of 10 'significant' multi-stakeholder collaborative R&D projects delivered.²⁶

Did the Challenge result in the formation of collaborations across the UK plastic packaging value chain?

49 of the 87 Challenge projects were delivered through collaborations between two or more organisations - 653 individual partnerships in total. Over half of the 87 portfolio projects are collaborations between two or more (different) parts of the value chain (see Figure 8).

In total, 32 collaborative projects meet the aforementioned definition of 'significant' i.e. comprise at least two partners, have costs greater than £250,000 and have timescales of at least 12 months. This greatly

²⁶ Where 'significant' includes projects with at least two partners, costs greater than £250k and lasting longer than 12 months.





exceeds the target set at the outset of the Challenge to deliver at least 10 multi-stakeholder collaborative R&D projects.



Figure 8. Number of funded projects with different types of collaborations.

Did the Challenge result in more UK plastic packaging supply chain collaboration on improving sustainability than would have happened in its absence?

New collaborations: interviews with successful project applicants support the conclusion that the Challenge led to an increase in collaboration. A total of 39 projects gave direct feedback on collaborations. Of these, 22 worked with new partners to deliver their project and 13 sought to form new relationships in direct response to the call for applications. Five were introduced to at least one partner within their collaborative project by Innovate UK, UKCPN, IUK Business Connect (previously known as KTN) or NERC. Feedback received from project leads during the Phase 2 Process Evaluation echoed this finding, with several project leads stating that completion of the written application necessitated engagement with departments and colleagues that they had not previously engaged with.

"I think the SSPP team should really be commended for the work that they did in connecting people up that they thought should be connected." (Successful project applicant)

Although the process of formulating an eligible project / application encouraged collaboration, being successful was key to continuing relationships. Unsuccessful applicants reported that collaborations often did not continue when Challenge funding was not awarded. Of the five unsuccessful applicant interviewees that named collaborators on their application, only one continued with all the relationships named in their application. The other four had at least one collaboration prospect end when they did not receive funding. The breakdown of these collaborations greatly impacted projects, either preventing any progress, or changing project scope e.g. one project reported they could no longer patent their product without the involvement of a proposed partner.





Existing collaborations: the Challenge also provided further opportunity for applicants to work with partners known to them. This was reported by respondents covering 20 projects. Overall, eight (of 14) projects with collaborative partnerships between industry and academia and 13 (of 23) projects with cross value chain collaboration would not have been able to proceed without Challenge funding.

Stakeholders widely recognised collaboration as an area where the Challenge had succeeded – with many citing the 'cohort approach' taken, where projects were brought together via three or four events enabling sharing of experience and an opportunity for networking. In the main, interviews with successful applicants corroborated this, as although many reported they were not introduced by the Challenge some commented that Innovate UK, UKCPN, IUK Business Connect (previously known as KTN) or NERC had introduced them to future collaborators, some of whom would be essential to testing or rolling out ideas at scale.

Long-term collaboration: there is evidence that collaborations established through delivery of Challenge projects has led to longer term collaboration. Long term collaboration examples include those where existing partners have commenced work on new projects further cementing their relationship but also examples where projects have attracted new collaborators to work with in the future. Furthermore, some successful applicants from different projects have gone on to collaborate, having become familiar with one another through both participating in the Challenge.

"The funding has created a strong footprint that has then leveraged many more funding opportunities and built many more collaborations. I think that's a really key aspect." (Successful project applicant)

Summary

The Challenge encouraged new collaborations and enabled organisations to work further with partners where they had existing relationships. In many cases collaborations were directly formed in response to the call for applications.

Future collaborations have also been encouraged, with the Challenge helping to directly facilitate relationships for projects to progress further and commercialise.

Data on whether collaborations are new is self-reported, but introductions made by the Challenge and wider evidence around formation of projects in response to the Challenge (coupled with the evidence of relationships not continuing where projects were unsuccessful in securing funding) all point to the Challenge leading to a much greater level of collaboration than would have otherwise been the case, at least in the same timeframe.

The Challenge has met its objective and associated target for a minimum of 10 significant multistakeholder R&D projects to be delivered.





IE1.4: To what extent, and how, did the Challenge increase understanding of the environmental impacts of existing and new plastic packaging to inform new and improved design, technologies and processes?

This section focuses on Challenge funded projects that increased understanding of the environmental impacts associated with existing and new forms of plastic packaging. It draws on: analysis of projects that have undertaken Life Cycle Analysis (LCA) or other forms of environmental assessment, primary research with applicants and stakeholders, and analysis of project closure forms / environmental assessment data that successful applicants supplied to UKRI.

Nearly two thirds of projects produced some form of environmental assessment, as the Challenge encouraged (and, in some cases, required) applicants to produce and submit such assessments. However, these assessments vary in their level of detail, and it is unclear to what extent projects have shared learning and data from their environmental assessments with the wider sector. Funded projects that focus on data, producing guidance and training will also contribute to the understanding of environmental impacts associated with plastic packaging.

There is supportive evidence that projects have applied newfound knowledge in new or improved designs, technologies and processes for plastic packaging.

Objective and Target associated with IE1.4:

Objective 4: To increase understanding of environmental impacts of existing and new plastic packaging to inform new and improved design, technologies, and processes.

Target 4: New knowledge from projects available to influence the development of new/improved standards for plastic packaging e.g. recyclability, biodegradability, compostability.

Key definitions:

Projects contributing to understanding of environmental impacts can be defined as any project that has undertaken some form of environmental or impact assessment (mostly Life Cycle Analysis but also things like weathering, biodegradability testing).

This chapter also considers projects that in their nature aim to increase understanding of environmental impacts and share findings as guidance or training.





Have funded projects contributed to increased understanding of environmental impacts of existing and new plastic?

Environmental assessment completion: the Challenge strongly encouraged projects to conduct life-cycle analysis, with a particular emphasis on demonstration projects doing so. Based upon those shared by UKRI or cited by interviewed project representatives, a total of 53 projects (with project value²⁷ totalling £97.1m) contributed to an improved understanding of environmental impacts by undertaking life-cycle analyses or other environmental assessment as part of their project. All projects funded through Demonstrator competitions and through Feasibility Studies for Industrial Research produced some form of project lifecycle assessment (LCA). LCAs were also produced for projects with both low and high TRL levels. Many projects that did not produce a LCA were projects for which a LCA would not be applicable; for example, projects that focus on data or research outputs and those within the Core Programme.

Environmental assessments, whilst encouraging thinking on the potential impacts of the project, are of varying degrees of quality. The environmental impact assessment presented in IE2.2 was able to assess:

- Eight projects that provided GHG impact data directly in LCAs, other environmental assessments or interview data, though only three of the eight provided quantities of plastic processed / avoided (a key metric to determine achieved GHG emission reductions).
- Nine projects that provided quantities of plastic processed / avoided, that enabled GHG emission calculations using emission factors from literature or applying average emissions factors from similar projects.

Sharing learnings: amongst projects with a LCA or other assessment, one project published two nonacademic papers and twelve projects held slots at 92 UK speaking events. One project reported an academic paper, which the evaluation team confirmed contains environmental data. The smaller number of academic papers is owing to nearly all academic publications (99%) produced by the Challenge coming from the Enabling Research competition, where for many it was not appropriate to complete an environmental assessment due to their research / early learning focus.

It is unclear to what extent LCAs and other learnings about the environmental impacts of new and existing forms of plastic packaging have been shared / disseminated. Given environmental assessments are of varying levels of detail, and some are likely to be retained internally (i.e. within project consortiums), we can conclude that knowledge is available to influence the development of new / improved standards, but at this time may not be available to the wider sector.

Wider knowledge benefits: the Challenge portfolio has contributed to increasing understanding of environmental impacts and key issues important to the sector in ways outside of direct environmental assessment. For example, funding projects that support the sector more widely through outcomes centred around:

- Data: where the project outcomes include guidance documents or open data sources;
- **Training**: where projects have aimed to upskill parts of the value chain on plastic packaging sustainability.

A few case study examples of these projects are outlined in Table 14; many of them were funded through Direct awards, on the basis that their innovations would assist the overall success of the portfolio.

²⁷ Where project value is the sum of grant claimed, pledged co-investment realised and confirmed accompanying co-investment.





Table 14. Project examples contributing to wider knowledge benefits for the value chain.

Example 1 (Direct Award): The Open 3P standard provides a common framework to help all the stakeholders involved in manufacturing, selling and recycling plastic packaging to share data with regulators and government agencies, as well as with each other. With the ultimate aim of lowering the environmental footprint of plastic packaging, its development was a highly collaborative effort between project partners Dsposal, OPRL, Open Data Manchester, RECOUP and Ecosurety ²⁸.

Example 2 (Direct Award): Ceflex's existing published design guide for flexible packaging on standards for Designing for a Circular Economy (D4ACE) is based on industry expert judgement and some commercial (secret) trials, though little real opensource data. This project delivers a series of scientific sorting and reprocessing recycling trials for flexible film packaging to inform and update the guidance and develop a data-sharing platform. Ceflex comprise the coordinating team with subcontractor input from Queen's University Belfast, UK, Ghent University, Belgium, Impact Solutions, UK, Cyclos HTP, Germany, Aimplas, Spain, Proplast, Italy²⁹.

Example 3 (Direct Award): a series of household collection and recycling trials for flexible film packaging. There are two phases: Pioneers (4 local authorities (LAs) participating) and Industrialisation (5 LAs to be included). Other LAs may contribute data from their own trials. The outputs will be published to inform development of consistent collection guidelines for all LAs in England. Defra anticipates it will require all English LAs to meet consistent collections rules by 2027. A team led by The Flexible Packaging Fund (FPF) is leading the trials and includes WRAP, Recoup, Hubbub, and Suez as sub-contractors.

Example 4 (SSPP - Feasibility Studies and Industrial Research): Reuse id funded by Innovate UK and supported by the Open Data Institute produced the first global open standard for reusable packaging³⁰. This work has led to a published whitepaper.

Example 5 (Direct Award): BPF Training Courses on how to design sustainable packaging including a course specific to the challenges of integrating recycled content into packaging, initially available at the outset of the Challenge but which has continued to be available on demand³¹.

Example 6 (IUK Business Connect (previously known as KTN) funding): the UK Circular Plastics Network work to build relationships with individuals to understand their business innovation and needs to transform the plastics system to a more sustainable one. Delivery of a programme of networking and knowledge-sharing events where the community can meet and make their own strong connections and additional support activities, such as shaping grant applications, to strengthen the innovation and collaborative partnerships within the system, accelerating ambitious ideas into real-world solutions.³²

Example 7 (SSPP Demonstrators Round 1): Renew ELP used SSPP funding to build the Wilton Hydrothermal Upgrading Demonstration Plant, which uses supercritical water to recycle post-consumer flexible, multi-layer and rigid plastics into their feedstocks. An LCA demonstrated that this process reduces climate impacts by 80% over incineration, and this LCA was published in the academic 'Journal of Polymers and the Environment'.³³ In addition, Mura Technology became the first advanced recycler to join the 'ecoinvent' Life Cycle Database, which is a database of verifiable, reliable data for analysing environmental impact.³⁴

- ³⁰ Reath | Reusable Packaging Software
- ³¹ <u>A Guide to Incorporating Recycled Plastic into Packaging Polymer Courses</u>
- 32 UKCPN | Home
- 33 Renew ELP published LCA
- ³⁴ ecoinvent Mura Technology Partner Spotlight





²⁸ PPP Phase 2 - Dsposal

²⁹ The Guidelines - CEFLEX D4ACE

Have new and improved designs, technologies and processes been informed by funded projects?

Three quarters of projects that have completed an environmental assessment have gone on to generate knowledge outcomes. This includes unique intellectual property, with three patents granted and 14 pending.³⁵ Six projects have exploited their intellectual property though IP licensing agreements³⁶ (see Figure 9). These projects have also achieved business outcomes through development of models, designs, standards and processes.



Figure 9. Outcomes achieved by projects that have produced some form of environmental assessment for their project.

To what extent do activities funded by the Challenge contribute to improved understanding of the environmental impacts of plastic packaging above what may have been achieved otherwise within the timescale?

LCAs or other environmental analyses were directly encouraged by the Challenge, both at the outset of submitting an application and retrospectively once work was completed. For demonstrator projects, an environmental assessment was compulsory and requested within the application form. Most stakeholders reflected on this focus positively, identifying it as a unique attribute of the SSPP Challenge.

"One of the things I think that sets SSPP apart, certainly from previous kinds of funding in this space, has been a desire to have people quantify [the environmental impact of the solution]." (Stakeholder)

"[The Challenge has helped fulfil this objective by] encouraging projects [to] understand their environmental impact, so encouraging people to do LCAs, to use LCA thinking, to require it of the bigger projects...." (Stakeholder)

Of the 52 projects producing environmental impact assessments, based on the project-level assessment at least 13 are unlikely to have progressed in the absence of funding and a further 14 are unlikely to have progressed to the same timeframe or scale (others were not interviewed).

³⁶ Please note: the number of business models, designs and standards etc. reported for IE1.4 and IE1.5 cannot be summed as are projects that contribute to both aims.





³⁵ Most respondents did not provide patent numbers or further details on their licensing agreements, but all answered the question in relation to their funded SSPP Challenge project.

Summary

A substantial number of funded projects shared some form of environmental assessment with UKRI or with the evaluation team directly.

It is not possible to know whether projects would have completed environmental assessments outside of the Challenge, but processes were in place to encourage this from applicants. All demonstrator projects (where assessments were compulsory) completed an assessment but the proportion completing an assessment for most other competitions is lower. This suggests at least some demonstrator projects may have made the decision to progress without an environmental assessment in the absence of the requirement to produce one.

Learnings have led to intellectual property and the development of business models, designs and processes for the individual organisations involved. Beyond production of environmental assessments, projects funded by the Challenge with a focus on data and training outcomes also contributed to wider knowledge of environmental impacts across the value chain.

Environmental assessments are valuable, but only a sub-set had sufficient detail to enable the evaluation team to quantify impacts. It is also unclear the extent to which learnings from assessments have been shared more widely. For these reasons the objective is considered to be met in part.





IE1.5: To what extent, and how, did the Challenge increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes and business models?

This section considers whether the Challenge increased understanding of consumer behaviour and how to influence this to improve the sustainability of plastic packaging. It draws on analysis of funded projects with this aim, primary research with applicants and stakeholders and analysis of project closure form data that applicants submitted to UKRI.

A sub-set of 17 Challenge funded projects contributed insights towards this aim, with successful applicants making substantial efforts to disseminate findings though academic papers and UK speaking slots, sharing findings with the wider sector. Though most projects with a focus on consumer behaviour were working at an early TRL level and had yet to generate impacts, some projects were able to provide information allowing us to estimate the environmental impacts they expect will occur between 2025 and 2030.

Stakeholders and some projects reported that finding retail partners to trial and participate in proposed research had been more difficult than anticipated, but confirmed that at least some larger well-known retailers were participating in funded projects.

There has been little legislative support to help projects to commercialise over the period of the Challenge, but sector experts expect the pEPR scheme, now due to commence in 2025, will create more and better incentives for reuse/refill models. The Challenge has supported organisations to be further along their respective journeys as policy changes are enacted.

Objective and Target associated with IE1.5:

Objective 5: To increase understanding of behaviour on the sustainability of plastic packaging to inform new and improved design, technologies, processes and business models.

Target 5: UK Plastics Pact target 70% of plastic packaging effectively recycled or composted.





Key definition:

Projects contributing to understanding behaviour on sustainability of plastics to be defined as: projects where the intention includes a focus on consumer behaviour and insights. Any project where the outcome is in part due to researching or testing things that involve consumer behaviour.

Have projects increased understanding of behaviour on the sustainability of plastic packaging?

Consumer behaviour focus: based on coding carried out by UKRI and verified by the evaluation 17 projects are contributing to this aim, dominated by projects funded through Enabling Research and the Future Plastics Packaging Solutions Round 1 and 2 competitions. Most of the projects fall under two broad categories:

- **Projects which focus on reuse and refill:** within these projects there is variety, with some focusing on testing physical refill and reuse solutions (including the introduction of biodegradable packaging as a refill solution), whilst others focus specifically on gaining a greater understanding of public receptivity to reuse and refill models.
- **Projects with a focus on the consumer disposal/discard practices for plastic packaging**: those with a disposal focus comprise those that look to better understand consumer behaviour in regard to disposing of packaging; this includes projects with a primary research component, but also track and trace systems that will provide data on packaging journeys. Some sought to test methods and messaging within communications on the best way to discard packaging and how this impacts the eventual behaviour of consumers.

All 17 projects have a learning element on consumer behaviour, whether this be on uptake of a specific product or wider behaviours on plastic packaging.

Sharing learnings: across projects looking to understand consumer behaviour, findings have been disseminated / shared through publications and over 100 speaking events (see breakdown of dissemination activity in Figure 10).



69 Academic Papers; 12 Non-Academic Papers; 114 UK Speaking Slots

Figure 10. Dissemination activity by projects with consumer behaviour focus.

Stakeholders felt that the funding had supported progression in understanding, but the complexity of informing behaviour change at scale makes it difficult to realise impact in the timeline of the Challenge. As discussed in Appendix 2: An evolving landscape, the associated UK Plastics Pact Target, is unlikely to be met. Many of the 17 projects funded by the Challenge are early TRL level³⁷ and are more likely to contribute to target achievement beyond the timescale of the UK Plastics Pact.

³⁷ Eight projects were TRL level 1-3 and six were TRL level 4-6.





"The fact that behaviour feeds into the adoption of things that could help us to live more sustainably, makes proposing a solution to those things so much more complex." (Stakeholder)

Stakeholders felt there had been a lot of interest in the outcomes of projects with a consumer behaviour focus and it was an area where UKRI itself have learnt a great deal.

"I think what was unique about SSPP was that it was very multidisciplinary. It brought a lot of siloed businesses together...That allows us to cross pollinate effectively, introduce people to other people because we're working with them. I think behavioural research is probably going on and would have happened, but we wouldn't have been aware of it, and therefore our projects and other academics and people we're working with in plastics potentially would have been less aware." (Stakeholder)

Have new and improved designs, technologies, processes and business models been informed by the Challenge?

Projects with a focus on understanding consumer behaviour have led to at least one granted patent, two pending patents and one IP licensing agreement (see Figure 11 below). Stakeholders noted that in order for some of these project outputs to become fully commercialised or commonplace, there was still work to be done in engaging big retailers to adopt changes, such as implementation of reuse and refill models which in turn will influence the behaviours and actions of the public.

"It's proven to be difficult, [with] retailers, there is a reluctance to take these things on... who's willing to stick their neck on the line for improvement and innovation?" (Stakeholder)

"There has been a real difficulty getting retailers to adopt reuse; none of them want to be the first on the market." (Stakeholder)

Business outcomes have been achieved by projects with a consumer behavioural focus; with individual projects developing business models, designs and standards (Figure 11).





Figure 11. Outcomes achieved by projects that have consumer behaviour focus.

It was possible to calculate achieved environmental impacts for three reuse and refill projects and 2025-2030 pipeline impacts for four projects (see Section 2.2). However, there is some uncertainty around data that underpins these calculations as some are based on initial application data submitted to the Challenge, and/or other assumptions. Despite some projects not being in a position to have achieved environmental impact to date, SSPP supported R&D to move the sector closer to readiness. Legislatively, as yet no strong drivers have come in to help push forward consumer behaviour initiatives³⁸, although some will be in place soon, providing further support for the roll-out of Challenge supported projects. Simpler Recycling policy will legislate mandatory film collection by March 2027 and pEPR will increase cost for obligated packaging manufacturers incentivising reuse and refill models in October 2025.

A slower progression to commercialisation for projects with consumer focus is also reflected in activity that precedes the Challenge. Reuse projects have been a focus of other NGOs for a period preceding the Challenge launch, with many run by UK Plastics Pact members, but many haven't yet got off the ground at scale, again due to a lack of legislative drivers. ^{39 40 41}

To what extent do activities funded by the Challenge inform (or have potential to inform) new and improved designs, technologies, processes and business models above what may have happened otherwise in the timescale?

Of the 17 projects funded by SSPP with consumer behaviour focus, six would not have proceeded without funding, and two would not have progressed to the same extent or within the same timescale (based on the project-level contribution assessment). The remaining sample (nine projects) was not interviewed. Projects reported that obtaining funding from other sources would be difficult, and even where successful they would not have had the unique support that the Challenge provided.

"Let's say we managed to get the money through some other Challenge. Would it have been the same? Probably not, because they were very supportive and nurturing." (Successful project representative)

"SSPP funding 'turbocharges' projects to deliver more in a far shorter timeframe." (Successful project representative)

Summary

Interviewed applicants reported that it would have been difficult to fund their projects in the absence of the challenge and all those assessed through the project-level contribution either would not have proceeded outside of the Challenge or would have done so at reduced scale or slower timings. Although

⁴¹ The UK Plastics Pact Annual Report 2021-22





³⁸ This is discussed further in Appendix 2: An evolving landscape.

³⁹ The UK Plastics Pact Annual Report 2019-20

⁴⁰ The UK Plastics Pact Annual Report 2020-21

some projects are yet to generate impact, some have laid the foundations to do so as the policy landscape becomes more favourable.

The Challenge has achieved its objective of funding projects that increase the understanding of consumer behaviour on the sustainability of plastic packaging, and these projects have informed new and improved design, technologies, processes and business models.





IE1.6 To what extent, and how, did the Challenge increase the UK's international recognition for sustainable plastic packaging and increase international finance (export and investment)?

This section explores whether the Challenge has driven positive changes in international perceptions, the UK's reputation for sustainable plastics innovation, and inward investment. It draws on primary qualitative research – with UK sector experts, international sector representatives, applicants to the Challenge and stakeholders – and results from the web scraping exercise, which examined media mentions and references to the Challenge.

The impact of the Challenge on the UK's reputation and international recognition is difficult to assess, but some impacts are evident in the available evidence.

UK and international sector experts had limited knowledge of outcomes emerging from the Challenge, apart from a few specific projects that have reached commercialisation. However, several sector experts and stakeholders observed the Challenge had been used as a blueprint to influence similar and related initiatives internationally. UKRI is involved in some of these programmes directly but engages with them outside the SSPP Challenge.

Some funded projects are expanding or have plans to expand outside of the UK. Thirteen projects have secured over £169 million of inward investment and at least 17 successful applicants have export licenses associated with their funded projects. Further work to disseminate the Challenge results have the potential to further increase recognition of the Challenge and further enhance the reputation of the UK as a whole.

Objective and Target associated with IE1.6:

Objective 6: SSPP innovation recognised internationally as a UK strength, and source of export growth and inward investment.

Target 6: An increase on the current baseline of export sales.

Has the Challenge led to an increase in the UK's international recognition?

Feedback from the six international representatives we interviewed indicates that the view of the UK plastic packaging sector is positive. However, three respondents mentioned that the fragmentation of the UK system, and lack of standardisation across England, Scotland, Wales and Northern Ireland, hinders the UKs reputation. One respondent reported a specific reputational hit following the UK's exit from the EU,





due to the deviation in regulations between the UK and rest of Europe, specifically citing the differences in the ability to incorporate recycled content in packaging⁴².

The UK is thought to excel in supporting early-stage research and development, owing to the quality of UK academic institutions. By contrast, UK-based sector experts were unsure on whether the UK was recognised internationally for its innovation, citing multiple reasons such as the inability to disaggregate reputation by country (when most companies operate globally), lower UK recycling rates compared to other countries (although the differing performance of devolved nations was highlighted) and the lag in UK regulation catching up with the rest of Europe post-EU exit.

Four international representatives felt there was an opportunity for the UK to be world leaders in plastic packaging sustainability in future, with two specifically citing chemical and mechanical recycling of plastics as an area that could develop. Two UK experts also highlighted opportunities, with one specifically citing chemical recycling; they suggested that if the UK progresses quickly enough, we may have more established capacity, enabling material to stay within the country.

Experts and stakeholders reported that to achieve international recognition and ensure UK success further support is needed. This support should take the form not just of financial funding (similar to the Challenge) but also government backing.

"I think the UK still has the potential to be a world leader in plastic circular economy but I think there's a bigger risk than ever before that we're going to let that slip. I'm kind of talking about the UK, but also UK and Europe, and we're going to let the opportunity get away from us because others will continue to push the envelope, have more ambitious policies, have more funding support, more economic support for the system itself. In the next 10 years, we could be world leaders. We could also be looking over the fence going 'we missed that opportunity and we're now just fighting to catch up'." (Sector expert)

"At the moment, where you're funding something for five years, you get it to a point where it's kicking off. Then it's like, '[we] might not invest in this going forward'. There is a lack of long-term government R&D strategy. Which is definitely a barrier to long term meaningful change. [What is needed is] exploitation past the period in which [projects are] funded by the Challenge." (Stakeholder)

Has the SSPP Challenge (and/or activities funded by the Challenge) been a driving force in positive changes in international perceptions/ the UK's reputation, export growth and/or inward investment?

The influence of the Challenge on UK reputation for sustainable plastic packaging: The influence of the Challenge on international perception of UK within the plastic packaging sector is difficult to evidence directly. Most international representatives and sector experts did not have enough familiarity with the portfolio to be able to comment on the international reach of funded projects.

⁴²UK Trade associations highlighted the need for change in UK legislation on recycled content in 2020: <u>Industry launches new</u> guidelines on including recycled content in packaging | The Food & Drink Federation





Experts gave examples of UK organisations thought to have international reputation that received Challenge funding, but their links to the Challenge were not always known by respondents. For example, the ReNew ELP Mura technology Hydro-PRT recycling plant in Wilton, Teesside, was referenced by two international plastics experts. A UK sector expert was aware of the FlexCollect project (which received direct award funding from the Challenge) and the Ceflex project, naming them as examples where the UK through investment in solutions for flexible packaging was advancing beyond international counterparts. The respondent caveated that the success of these projects depends on further research into the best solution for the treatment of flexibles once collected.

Stakeholders held mixed views on the success of the Challenge under this objective. Those that felt the Challenge hadn't necessarily been a driving force in changing international perception also believed the Challenge should not be assessed by this objective, as many companies that engaged with the Challenge are not considered big players outside of the UK and would find it more difficult to achieve international standing. Those that did feel the Challenge had contributed to the UK's reputation cited specific projects with expansion plans internationally, but also some enabling research projects that have gone to make international links.

Funded projects themselves provided mixed views on whether the Challenge had raised the profile of UK plastic innovation internationally; around two thirds of those interviewed were of the opinion it had. In the main these comprised representatives from projects that have had direct approach or interest from an international organisation, but also those who thought their solution applied globally. Those that did not believe the Challenge had raised the UK's profile again were often drawing on their own project and reflecting on their progress making international connections or commercialising outside the UK.

"There has been interest from other countries wanting to see results. The evidence gap exists globally. Some of the data is valid across many different countries." (Successful project representative)

The influence of the Challenge on export growth and inward investment: At the time of evaluation reporting, 13 Challenge projects have received inward investment totalling nearly £169m, with approximately 80% of this secured by demonstrator projects. Of the 57 projects that completed a Project Closure Form or online proforma, 17 reported they had export licenses in place for innovations developed through the Challenge. Data from the Public Register of Accredited Reprocessors and Exporters of Packaging Waste (Sector level indicator 29) shows that the Challenge represents 15% of the total number of organisations with licenses (17 of 112 organisations) within the plastic packaging sector. One example of licensing fees generated from international interest is the project led by Impact Recycling, partnering with Syklo Oy to enable use of their BOSS technology in a 50,000 tpa recycling plant for Finland.⁴³

Amongst projects providing data, export sales to date are relatively small, totalling just under £24k per annum. However, this was only possible to quantify for those submitting a PCF providing data on revenue and the proportion of this from exports. Four projects comprise the total of £24,000. A further 18 projects

⁴³ Syklo Oy has decided to proceed with the construction of Finland's largest plastic recycling plant in phases - Syklo





gave a proportion of revenue from exports⁴⁴ but without an overall revenue figure to apply the proportion to; £24,000 is therefore likely an underestimate of export sales achieved.

Sharing learnings from the Challenge: dissemination was mentioned by several sector experts as something they hoped the Challenge would do more of post-closure, both within the UK and internationally.

"There is a great benefit in dissemination, particularly in light of the global treaty. I would say 'don't stop in March, focus on maximising investment by disseminating [the findings] properly. Make this relevant to businesses and investors'. How much this is UKRI versus business funded responsibility I don't know; SSPP is UK taxpayer initiative in the UK run by UKRI and therefore not seen as international." (UK Sector Expert)

For 42 projects where data was captured, nine had at least one international speaking slot on their project innovation. Several project organisations are known to be expanding internationally, including Notpla, which has conducted work with the WRAP in Chile⁴⁵ to trial and test consumer attitudes and market appetite for a compostable sachet and pipet. Outside of the Challenge, UK reputation has been enhanced through UKRI funding being provided directly to work through international Plastics Pacts, the Global Sustainable Plastics Program, the Global Business Innovation Programme (GBIP) and The International Circular Plastics Flagship Projects Competition. Although these are not funded through the Challenge, one sector expert remarked that international efforts are emulating the SSPP Challenge formula, whereby grant competitions run simultaneously to Plastics Pacts. Additionally, some efforts have been directly designed to maximise impacts of the Challenge; in 2023, for example, Innovate UK funded and organised a Global Expert Mission to India showcasing innovations developed through the Challenge⁴⁶.

Media analysis undertaken in the evaluation reviewed 134 articles and found 23% had 'international content', defined as (i) written by an international source (ii) explicitly citing international impact or (iii) using language targeting an international audience. Coverage in international media was limited, with only three articles identified, two from the Alliance to End Plastic Waste and one from PlastEurope, a business information platform for the European Plastics Industry.

Understanding of whether project dissemination reached international audiences was also developed through high level media searches on social media, google results and organisational websites. 71 unique projects were assessed and, for 13 projects, clear evidence of international reach was found. This commonly involved presentations at international conferences / exhibitions (such as GRIPS), articles posted by international organisations (such as Plastics Europe) or extensive social media posts on the projects which are anticipated to have gained international traction (mostly for larger organisations).



⁴⁴ Some projects reporting a proportion of sales from exports in Project Closure Forms did not report that they have an export license. It was not possible to verify/check this information further within the timeframe of the project.

⁴⁵ Notpla | Chile | WRAP

⁴⁶ Sustainable Plastic Packaging in India 2023 - Innovate UK Business Connect

Where there was no evidence of international dissemination interview feedback suggests that this could be due to commercial sensitivity, where projects are ongoing / IP has not yet been confirmed. Three projects had only announced that they had secured funding for their project, perhaps indicating that the project is not yet complete.

Summary

The extent to which the Challenge has a bearing on the UK's reputation for sustainable plastic packaging is difficult to evidence at present, although there are signs of contribution.

International sector expert awareness of the full Challenge portfolio is low, but there is awareness of larger commercialised projects.

It was only possible to speak with six international representatives, and their opinions may not be reflective of the wider international audience. However, low awareness is also supported by media analysis that found limited mention of the Challenge in international sources.

There are examples of inward investment in Challenge projects, which shows that individual innovations are being recognised on an international platform, though the extent of influence this has on the UK reputation overall is unclear.

Evidence of inward and international follow-on investment indicates the Challenge has met its objective in part; however, further and continued investment is likely to be required for the UK to enhance its international reputation for sustainable plastics innovation.





IE2: Did the Challenge result in additional effects in alignment with the Objectives of the programme?

This chapter considers impacts of the Challenge beyond those covered by the six objectives in the original business case. The sub-sections that follow discuss evaluation questions IE2.1 to IE2.5 in detail.

Though it is too early for us to quantify the impacts of the Challenge in full, some projects have delivered environmental and economic impacts already, and others are well-placed to do so in the next five years, contributing to a more sustainable value chain for plastic packaging in both the UK and beyond.

The table below summarises each of the sub-questions we considered under IE2, and our high-level findings for each:

Research Question	Summary
IE2.1 Step Change toward sustainable value chain	 The Challenge has supported a diverse range of R&I activity with the potential to contribute to a step change towards a more sustainable value chain. The greatest contribution to date has been to collection, sorting and reprocessing of plastic waste due to increased capacity from demonstrator projects. There are still some barriers within the UK, with some areas of interest to the UK Plastics Pact more difficult to achieve change in than others. pEPR is expected to incentivise reuse and refill models, and Simpler Recycling policy will facilitate further roll-out of flexible collection and processing. The Challenge has funded some innovative design-based projects but to reach critical mass they would need to be more widely adopted.
IE2.2 Environmental impacts	 Based on data available to the evaluation team, at least 32.2 ktonnes CO₂e GHG emissions reductions has been achieved, related to 18.2 ktonnes of virgin fossilbased plastic being avoided and 21.5 ktonnes of plastic packaging being recycled. Of the 32.2 ktonnes CO₂e GHG emissions, 37% have been achieved by projects that would not have progressed outside the Challenge and 61% are from those that (according to the project level contribution assessment) have run at a larger scale, higher specification or a quicker timescale due to Challenge funds. Many projects will generate impact beyond closure of the Challenge and beyond the lifetime the UK Plastics Pact. Calculations of pipeline impact indicate that by 2030, 1.6 million tonnes CO₂e GHG emissions reductions could be realised; this is associated with avoiding the production of 228.2 ktonnes of virgin fossil-based plastics and the recycling of 608.6 ktonnes of plastic packaging.
IE2.3 'Smart' sustainable packaging	 The Challenge was open to applications for 'smart' innovations, covering packaging that provides additional functionality or reacts to changes in its environment. Few applications of this innovation type were received, but the funded Challenge portfolio includes projects that make use of technological advancements such as sorting technologies and digital tracing.

Table 15. Summary of findings for Evaluation Questions IE2.





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Research Question	Summary
IE2.4 Clean growth	 Funded projects have demonstrated over £27.5m in revenue growth, of which nearly all would not have been realised in the absence of Challenge funding. Most impact is realised from demonstrator projects that have reached commercialisation. Without the fund, progression of activity may have been carried out internationally; for example, some project representatives said that plants may have been built outside of the UK. Similarly, where there was an existing solution to processing waste material, this would often involve overseas options, such as exporting material to international recycling plants. The Challenge has therefore supported clean growth for the UK through preventing the loss of innovation opportunity to other countries Revenue gains therefore represent clean growth for the UK even where projects may have progressed an alternative option. Further revenue gains are predicted for the 2025-2030 period.
IE2.5 Barriers and Facilitators	 Most barriers and facilitators cited by respondents were external to the Challenge and primarily involved legislative changes. Legislation was both a facilitator and barrier to progress. The HM Treasury's Plastic Packaging tax was a facilitator, but delays to enactment of other policy, such as pEPR, was a barrier making it more difficult for the value chain to make decisions on adoption and investment.





IE2.1: To what extent, and how, is the Challenge on target to contribute to a step change towards a more sustainable value chain (e.g. through thought leadership, trailblazing, reaching critical mass)?

This section considers whether projects and investments influenced by the Challenge might contribute to a step change towards to a more sustainable value chain for plastic packaging. It draws on findings from interviews with UK sector experts, review of the project portfolio, secondary research on the sector as a whole and results from the web-scraping exercise.

The Challenge funded innovative projects that will contribute to overcoming longstanding barriers to plastic packaging sustainability. The system's complexity makes it difficult to demonstrate a real step-change in the UK within the period; for example, UK recycling capacity has been impacted by several facility closures, and the pEPR scheme for packaging was delayed from 2023 to 2025. The Challenge increased UK recycling capacity through funds allocated to additional recycling facilities. Many projects yet to realise their impacts offer learnings that move the UK further along its journey towards a more sustainable value chain and stand to achieve further impacts if these are widely disseminated.

Has the Challenge overcome barriers to sustainable plastic packaging?

One way of exploring the progression and step-change towards a more sustainable value chain is to look at the barriers preventing progress at the outset of the Challenge. WRAP's Plastics Pact Roadmap set out barriers to achieving Plastics Pact targets under the themes of (i) collection, sorting and reprocessing, (ii) design and manufacturing, and (iii) consumer purchasing. For many barriers, a UK step-change is not yet evident in order to assess the extent of contribution by the Challenge, although Challenge innovation may enable step-change in the future. The Challenge has helped secure additional UK recycling capacity, through funding large-scale demonstrator projects with the aim of adding capacity. A summary of the Challenge's contribution to key barriers is outlined in Table 16 and in more detail in the sections that follow.





Table 16. Challenge contribution to overcoming key plastic packaging sustainability barriers.

Overarching theme	Barrier	Step change observed/Level of contribution by the Challenge portfolio	Summary of SSPP contribution		
Collection, sorting and reprocessing of plastic	Increasing UK collection, sorting and recycling capacity for a wider range of plastic packaging materials and formats (e.g. plastic film) to increase availability of required quality recycled materials.	Step-change observed High contribution	The Challenge has ensured greater capacity than may otherwise have been the case in a climate where other facilities have seen closures due to financial difficulties. As discussed in more detail in Section IE2.2., the combined UK capacity of six Challenge funded facilities (where data was provided for evaluation) is roughly 102,000 tonnes per annum, with nine projects sharing roll-out plans for plants with a combined capacity of approximately 442,000 tonnes per annum.		
waste			the lack of collection, sorting and treatment options for flexible packaging, with a focus on multiple parts of the lifecycle from design through to collections, sorting and treatment.		
	Increasing the quality of recycled materials	No step-change observed	Evidence suggests the UK may have experienced an increase in contamination for the period.		
	through reduction of contamination.	Moderate contribution	The Challenge has funded projects that may help to reduce contamination in the future, through introducing novel technologies to improve sorting.		
	Reducing the costs of (a) more sustainable packaging options (b) end-of-use collection, sorting and treatment pathways. This includes addressing high reprocessing costs, lack of collection, sorting and treatment options and negative environmental impacts arising from the use of flexible packaging.	No step-change observed Low contribution	Financial difficulties caused several recycling and reprocessing plant closures, and media coverage indicates costs are still an issue for the sector. The Challenge has funded activity that aims to reduce costs compared to incumbent solutions. However, little evidence was supplied by projects to evidence contribution to a reduction in costs at this time, apart from a small sub-set of projects that have started to realise cost savings for their own organisation. These solutions are not yet rolled out more widely, but could secure the longevity of organisations funded by the Challenge.		





Overarching theme	Barrier	Step change observed/Level of contribution by the Challenge portfolio	Summary of SSPP contribution		
	Developing collection, sorting and treatment solutions for "compostable" packaging.	No step-change observed Low contribution	Evidence suggests barriers associated with compostable packaging are yet to be solved, with work over the period of the Challenge focusing on ensuring compostable packaging is adequately defined and working towards a greater understanding of potential recycling pathways. The Challenge has supported research into compostable packaging and its journey, but has not funded any projects that provide collection, sorting or treatment solutions at scale.		
Design and manufacturing of packaging	Switching to more sustainable packaging materials without adverse environmental consequences or increased negative environmental or human impacts associated with the product e.g. increased food waste or less efficacious pharmaceuticals. This includes supporting a move to mono-material packaging without adverse effects.	Small-scale step- changes observed Moderate contribution	Several companies have looked to design more sustainable packaging over the Challenge period, but this has usually been focused on a specific product or brand rather than contributing to a UK wide step-change. Revised Ceflex D4ACE guidelines on 'Designing for a Circular Economy' will be available to all Ceflex members (including major packaging producers and major brand owners), but further work would need to be carried out (on extent of adoption and changes that have been made) to evidence a step- change. Challenge funded projects have supported development of packaging through development of novel polymers (including bio-based polymers) with reduced negative environmental impact. In most cases these development or are as per the nationwide trend rolled out for specific products.		





Overarching theme	Barrier	Step change observed/Level of contribution by the Challenge portfolio	Summary of SSPP contribution
	Increasing the use of recycled content in packaging without adversely affecting functionality; particularly plastic films, PP rigids, and food-contact packaging.	Step-change observed Moderate contribution	Four projects had a focus on integration of recycled content, including one aiming to produce food grade recycled PET, another providing a design platform to make integration of recycled content easier and two with a research focus providing data and information for packaging producers. Most contribution to recycled content integration by the Challenge is through funding recycling capacity that will
	Changing citizens' purchasing, recycling, and reuse/refill attitudes, behaviours, and knowledge to properly support and engage with more sustainable plastic packaging solutions.	Small-scale step- changes observed Moderate contribution	increase recycled content availability. There has been a small step-change in citizen recycling behaviour according to consumer surveys that track the number of households recycling and their recognition of on-pack labels. Funded projects are contributing by increasing the knowledge base; gaining greater understanding of consumer behaviour to inform future initiatives.
Consumer Purchasing	Increasing the availability and suitability of reuse/refill packaging options.	Small-scale step- changes observed Moderate contribution	Reusable and refillable packaging use has increased for niche items such as, carrier bags, bottles and coffee cups but there has yet to be a UK step change. Impending Extended Producer Responsibility policy does have potential to further incentivise reuse models. The Challenge has funded research and testing of reuse and refill options; although these are unlikely to have made a difference to UK-levels to date, they are in a good position to progress and commercialise further in future.

Collection, sorting and reprocessing of plastic waste

Increasing UK collection, sorting and recycling capacity for a wider range of plastic packaging materials and formats (e.g. plastic film) to increase availability of required quality recycled materials.

The WRAP Plastics Market Situation report estimates almost 730 kt UK plastic packaging recycling capacity in 2021. Of this capacity, 540 kt is for rigid plastic packaging and 190 kt for flexible plastic packaging, with the flexible plants being predominantly for commercial and industrial rather than





household waste.⁴⁷ The report authors estimate around a further 260 kt of planned recycling capacity in the next five years - 145 kt for rigid plastic and 115 kt for film.

Two SSPP funded projects are widely recognised as significant infrastructure developments. In 2023, Berry Global opened a new recycling facility for household PP (mostly pots, tubs and trays). Its CleanStream technology is designed to produce recyclate for food contact applications, suitable for processing ~40% of all sorted PP waste in the UK, with partnerships to access 40 ktonnes of UK kerbside PP waste.⁴⁸ Impact Recycling also made the press when announcing a 25 ktonnes pa recycling plant for post-consumer flexible plastic, due to open near Durham in 2024, with support from SSPP and Nestle.⁴⁹ Also of note, in 2022 Jayplas doubled its LDPE and PP film recycling capacity in Loughborough to 50 ktonnes pa⁵⁰ and, in 2023, opened a 20 ktonnes pa HDPE and PP wash plant near Grimsby.⁵¹ The company plans to open a 150 ktonnes pa plant in Swansea for both rigid and flexible plastics.⁵²

There were no commercial scale chemical recycling plants in the UK when the Plastics Market Situation report was published in 2023. In fact, in 2022, Recycling Technologies announced its Swindon plant had entered administration after failing to find additional investment.⁵³ However, Mura's subsidiary ReNew ELP planned to open a chemical recycling plant for flexible plastics in Teesside in 2024 with 20 ktonnes pa output, funded by the SSPP Challenge. Although the opening has not yet been announced,⁵⁴ it is expected to be operational in 2025.

The openings do not necessarily represent an increase in capacity for the UK. UK plastics recycling facilities continue to face financial difficulties:

- In 2024, Viridor closed its Avonmouth 80 ktonnes pa plastic recycling plant, co-located with an EfW facility, only two years after opening, citing "challenging market conditions" linked to delayed legislative drivers.⁵⁵ Viridor polymers division posted losses of £29 million in 2022/23 and £13 million the year before.⁵⁶
- Yes Recycling went into administration in 2023 owing £9 million, just months after opening a 15 ktonnes pa soft plastics recycling plant in Fife.⁵⁷
- Chemical recycler Recycling Technologies also went into administration in 2024 with debts of more than £20 million.⁵⁸

⁵⁵ <u>Viridor to close recycling plant in Avonmouth</u>

⁵⁸ <u>Yes Recycling creditors 'owed £9m' as sale collapses</u>





⁴⁷ <u>Plastics Market Situation Report 2022</u>

⁴⁸ <u>CleanStream® - The Future for Contact-Sensitive Mechanically Recycled Plastic</u>

⁴⁹ Nestle gives £7m loan to Impact Recycling for Newcastle flexible plastics site

⁵⁰ Jayplas film plant 'closes UK recycling loop'

⁵¹ Jayplas set to open HDPE & PP washing plant in Grimsby

⁵² <u>New facility to double Wales' plastic reprocessing capacity</u>

⁵³ <u>Recycling Technologies enters administration</u>

⁵⁴ ReNew ELP, coming soon in 2025

⁵⁶ <u>Viridor posts £29m loss for polymers division</u>

⁵⁷ <u>Yes Recycling creditors 'owed £9m' as sale collapses</u>
Most sector experts were aware of these closures and therefore found it difficult to comment on capacity changes overall.

"[Capacity is a] difficult one as there have been a number of facilities going bust despite new ones being built. There is still a remaining challenge on end markets for the reused products." (Sector expert)

The extent of adequate collection, sorting and treatment options for film specifically can be examined through waste data on plastic packaging separated at source. This gives a reflection of what is placed on market. A 2017 UK waste composition meta-analysis estimated that plastic packaging constituted 5% of all local authority collected household waste.⁵⁹ Roughly 60% was dense plastic packaging and roughly 50% of this was separated for recycling at point of collection. The other 40% of plastic packaging was plastic film, but only around 3% of this was separated for recycling at point of collection. The actual quantity recycled will be less due to losses in the sorting and recycling processes. This analysis hasn't been reproduced since, but largescale studies are underway to collect new data.⁶⁰



Dense plastic - separated for recycling at point of collection

- Dense plastic not separated for recycling at point of collection
- Films separated for recycling at point of collection
- Films not separated for recycling at point of collection

Figure 12. Treatment of plastic waste



⁵⁹ National Household Waste Composition 2017

⁶⁰ Defra commissions Resource Futures to provide national waste composition

The Challenge has contributed funds to two projects with a focus on film recycling - FlexCollect,⁶¹ which is trialling communications, collection, sorting and treatment options for flexibles and Ceflex, which is investigating how flexible packaging can be best designed to be sorted and recycled.⁶²

There was agreement from most sector experts interviewed for the evaluation that the UK still could achieve better recycling rates, particularly in England, where performance is often behind devolved nations. Upcoming regulations, including Extended Producer Responsibly and Simpler Recycling, may positively influence this. The Deposit Return scheme was also cited, but with potential positive or negative consequences depending on what the impact is of taking this waste stream out of system.

Reflecting on the current situation regarding film collection and reprocessing, both the FlexCollect and Ceflex projects were cited by UK sector experts as having potential to drive forward change in the collection, sorting and treatment of flexible plastics. FlexCollect is believed to be providing valuable insights into flexibles collections, but there was some uncertainty if this will be achieved by the 2027 deadline for Simpler Recycling (previously termed 'Consistency in recycling') in terms of having the correct infrastructure behind it.

"Inconsistency in services......The lack of collections for plastic film and flexibles is the key reason why we're not going to hit two out of the four [Plastics Pact] targets. Consistent collections were [due to be] implemented in 2024 and we're three years behind schedule in terms of the policy implementation and DRS as well, which we know will help to drive up recycling rates for beverages." (Sector expert)

"If another 3-4 hundred thousand tonnes comes into the reprocessing market, where is it going to go to? The market is changing all the time. We've seen [since 2022] a lot of companies start to express an interest in flexibles because it's becoming a serious issue. (Sector expert)

Increasing the quality of recycled materials through reduction of contamination.

Contamination was examined as part of the sector-level indicator analysis for this evaluation but was an assumption-based calculation, as data was not available for all nations. With this caveat in mind, there has been an increase in contamination levels between 2018 and 2023.

The Challenge has funded projects aimed at reducing contamination, including those that focus on improving existing technologies for sorting:

- Recycleye GRIP-R AI driven sorting technology. 63
- Greyparrot (GP) and Blue Green Vision (BGV) collaboration hybrid waste recognition and monitoring system to complement and enhance NIR sorting machines. ⁶⁴



⁶¹ Household collections – Flexible Plastic Fund

⁶² CEFLEX awarded UK Research and Innovation funding for flexible packaging design testing programme - CEFLEX

⁶³ <u>Recycleye wins share of £3.2m to fund plastic recycling innovation - Recycleye</u>

⁶⁴ Greyparrot's AI/NIR Waste Recognition System receives UKRI funding

Implementing technologies in more UK plants has potential to influence contamination levels in the longer term. Not all projects of this type were covered in interviews, but those that were are not yet fully operational in the UK and are yet to realise impact.

Sector experts had limited views on contamination, but one did raise concerns with recent innovations on bioplastics and the contamination of plastic feedstock with biobased plastic, that won't be as stable as PE, PP and polyolefin.

Reducing the costs of (a) more sustainable packaging options (b) end-of-use collection, sorting and treatment pathways. This includes addressing high reprocessing costs, lack of collection, sorting and treatment options and the negative environmental impacts in the use of flexible packaging.

Reported prices for recycled plastics on the secondary materials markets have varied significantly, as shown in Figure 13 below. For example, since 2021, clear PET prices have fluctuated from around £150 to over £600 per tonne. Recent media coverage reports that the prices of recycled materials have fallen in Europe because of low demand, cheaper virgin material prices and wider economic uncertainty.⁶⁵ These market conditions make reducing the costs of sustainable packaging options - collection, sorting and treatment - more important.

A handful of interviewed successful applicants reported that their innovations will reduce costs for their organisations; this includes reduced sorting costs associated with improved technology for sorting, but also improved ability to deal with mixed material within the recycling process themselves. These technologies, although enabling the funded organisations to reduce costs, are not more widely rolled out.

Projects supported by the Challenge have looked to develop alternative solutions whilst keeping costs low compared to incumbent solutions. For example, the use of alternative cleaner processes to chemical solvents aim to reduce costs, as do some projects employing AI technology to facilitate better sorting. Data supplied by projects to date does not, however, evidence a reduction in cost.



⁶⁵ European Plastic Recyclers report 'severe pressure'





Figure 13. Recovered plastic prices (£/tonne).²

Developing collection, sorting and treatment solutions for "compostable" packaging.

Across the period 2018 to 2020, there has been limited change in market share of plastic packaging that is compostable, fluctuating between 0.4% and 0.6%. Beyond this, period data was not available to enable quantification. In WRAP's 2022 Roadmap to 2025⁶⁶, an aim by the end of 2023 was to understand pathways for composting packaging via food waste collection services, but no published guidance was identified other than guidelines on what constitutes 'compostable' packaging.⁶⁷

The Challenge has few projects that solely address solutions for compostable packaging; however, funding was awarded through ISCF Smart Sustainable Plastic Packaging: Business-led R&D competition to carry out research on the environmental and economic impacts of compostable packaging.⁶⁸ This likely contributes to filling knowledge gaps that are preventing progression on compostable packaging.

Sector experts reported several ongoing barriers to "compostable" packaging. Presently compostable packaging is often sent with food waste to Anaerobic Digestion but is sorted and separated from food waste for incineration.

"[Compostable plastics] should have a place, but it needs to be thought through..... use them for a very specific product where they can be collected with that product.... If I have my burger wrapped in compostable packaging then I should be able to take that burger and that packaging and put them in the same [bin], but it doesn't behave like food, does it, and so when you go to the anaerobic digester, what you see is all the food going through and all the corn starch bags in another pile, ready to go for incineration." (Sector expert)

Design and manufacturing of packaging

Switching to more sustainable packaging materials without adverse environmental consequences of the packaging, or increased negative environmental or human impacts associated with the product; for example, increased food waste or less efficacious pharmaceuticals. This includes supporting a move to mono-material packaging without adverse effects.

Challenge-funded projects contributing to this aim predominantly looked at the use of novel polymers, including bio-based options. Their application across the portfolio is diverse, including proposed alternatives for incumbent flexible and rigid plastic packaging. Examples are provided in Table 17.



⁶⁶ <u>A Roadmap to 2025: The UK Plastics Pact | WRAP</u>

⁶⁷ WRAP Considerations for Compostable Plastic Packaging - Feb 2020

⁶⁸ Capturing and Processing Compostable Packaging - Behaviour Change Interventions and Infrastructure Considerations

Table 17. Example projects with focus on more sustainable packaging materials without adverse environmental consequences.

Example 1 PlantSea-Pack^{69, 70} (SSPP Future Plastic Packaging Solutions Round 2): PlantSea-Pack is a packaging solution that replaces single-use plastic sachets and bottles providing an alternative to Polyvinyl alcohol.

Example 2 (SSPP Future Plastic Packaging Solutions Round 2)⁷¹: MarinaTex is developing a sustainable, marine-based, coating for paper and paperboard food packaging that can be used across multiple industries, including airline, hospitality and retail.

Example 3 Xampla LTD (SSPP Future Plastic Packaging Solutions Round 2)⁷²: working on the development of consumable plastic packaging.

Example 4 HiBarFilm2 (ISCF Smart Sustainable Plastic Packaging: Business-led R&D)^{73,74}: developing a mono-material alternative to flexible films for food contact applications.

The revised Ceflex D4ACE guidelines on 'Designing for a Circular Economy' (cited as an example in IE1.4) will also contribute to this aim. The guidance will be available to all Ceflex members, including major packaging producers and major brand owners. Further work would need to be carried out to understand the extent of adoption and changes that have been made in response to these guidelines to evidence step-change.

Sector experts believed that some niche / product-specific innovations do exist, but they are often not delivered at scale. Barriers still remain for smaller businesses that do not have the resources for R&D into their own solutions. Funding that is on offer often comes with tight turnaround times, making application difficult for smaller businesses with fewer resources to dedicate to an application without sufficient notice.

Funding can also be restricted to specific sector definitions, for example those classified as 'Advanced Manufacturing'. A couple of experts felt this has delayed progression in the food and drink industry, which was not until recently classified as 'Advanced Manufacturing'. There has also been a lack of confidence due to waiting on the outcomes of policy, in particular the Packaging and Packaging Waste Directive, Extended Producer Responsibility and the Deposit Return Scheme.

⁷⁴ UKRI HiBarFilm2 - High barrier monomaterial flexible films for food contact applications





⁶⁹ Turning the Tide on Plastic Together | PlantSea Ltd

⁷⁰ £3.2 million for innovation in plastics reduction – UKRI

⁷¹ MarinaTex

⁷² Xampla: Natural materials to change the world

⁷³ HiBarFilm – High barrier monomaterial flexible films for food contact applications

"I think producers want to feel that they can innovate with confidence, if you like. And the materials that they come up with will be collected for recycling, they will be allowed to incorporate recycling content into those materials etc. So, I think that it all kind of fits together in that way." (Sector expert)

Two areas where sector experts reported a concentration of efforts are: (1) the elimination of single use plastics (an original Plastics Pact Target that was written into legislation later); and (2) introduction of mono-material in place of multi-material, with a view to making plastic packaging easier to recycle at end-of-life. Experts interviewed for this evaluation reported that there is no universally accepted solution to this at present, and further R&D is required.

"Another big advancement has been the approach to elimination of plastics. Focusing the industry to find a solution to overcome the challenges. For example, polystyrene which does not recycle at scale was put on the Plastics Pact elimination list. At first industry was reluctant, saying they could not find a solution to the coffee cup, but eventually got there. 'Necessity is the mother of invention." (Sector expert)

"You've got one or two big [brands], who are making a big thing about moving to mono material.....that is a good thing from a recycling perspective, because one material is much easier to deal with than laminates. The challenge for certain packaging formats [is to make them] with the same properties as the current laminate or multi-material......It's not easy. Some of them have been researching and trying for two, three, four years.... What no one wants is substandard packaging that results in more food waste. (Sector expert)

Sector experts often had limited knowledge of the complete portfolio of SSPP Challenge funded projects but Notpla⁷⁵, who received Challenge funding to focus on seaweed-based packaging solutions, were named as making contribution to this area.

Increasing the use of recycled content in packaging without adversely affecting functionality; particularly plastic films, PP rigids, and food-contact packaging.

The Challenge funded four projects that focus on overcoming the integration of recycled content:

- Blow Moulding Technologies Ltd were successful in their application for funds to design software helping manufacturers to integrate more recycled content or biobased polymers into plastic bottles.
- Veolia's collaboration with Unilever, Charpak Ltd and HSSMI funding the UK's first dual PET (Poly Ethylene Terephthalate) bottle and tray recycling facility, making 'bottle to bottle' or 'tray to tray' recycling possible.⁷⁶



⁷⁵ Notpla Home Page

⁷⁶ <u>A huge step forward in plastic packaging recycling | Veolia UK</u>

- The University of Liverpool's research project (now led by University of Manchester) which looked to create a better understanding of the properties of HDPE PCR, how to enhance the recycled product (so it performs as well as virgin HDPE) and how to overcome barriers to the use of PCR in the supply chain.
- The University of Manchester's 'One-Bin' project. This included (a) the development of an open database identifying the most valuable method of recycling for each material stream, and (b) interventions to reduce plastic waste based on this. The project sought to overall improve the physical qualities of materials at higher post-consumer recycled content.

There are several projects that will increase UK recycling capacity or capability. This in turn will increase the availability of recycled polymer for packaging manufacturers. In the wider landscape, the Plastic Packaging Tax has been a key driver in increasing recycled content within plastic packaging and progress has been observed since the outset of the Challenge. As outlined in the Section IE1.2, there has been an observed increase in recycled content from 9% in 2018 to 24% in 2022.

Sector experts felt there are still some prominent barriers preventing integration of recycled content from reaching its full potential. Many producers target an international market, including countries without recycled content legislation, and therefore find it more cost effective to carry on with existing packaging than making changes that only impact a small proportion of their market. This, in combination with the cheaper price of virgin plastic (even considering tax) is hindering widescale adoption of a higher proportion of recycled content. A number of experts (and a couple of project representatives) cited the deviation of UK regulations from the rest of the Europe following EU exit - the EU has legislation that allows recycled content in food contact packaging, but the UK has yet to implement an equivalent solution.

"The main issue is the divergence of UK and European legislation. There is the single use plastic directive in Europe, which is driving a lot of the changes, especially in design incorporating recycled content, in banning particular plastics etc.; this is diverging quite a bit now from the UK-based legislation. Legislation on certain issues, such as food contact, are significantly different to what is happening in Europe, and this causes problems for anyone in the design and development world." (Sector expert)

Consumer Purchasing

Changing citizens purchasing, recycling and reuse / refill attitudes, behaviours, and knowledge to properly support and engage with more sustainable plastic packaging solutions.

The most recent Recycling Tracker published by WRAP (2022) shows that recycling is commonplace in the UK, with nine in ten respondents reporting they regularly recycle. Over time, there has been reduced contamination of plastic; for example, the proportion of citizens that put specific flexibles (such as film lids and carrier bags) in the recycling (when these are not accepted) reduces from between 21%-27% in 2021 to between 16% and 20% in 2022. Recognition of key labelling to indicate recyclability has also





increased, with 80% recognising the Recycle Swoosh in 2022 (compared to 46% in 2013) and 66% recognising On-Pack Recycling Labels (OPRL) in 2022 (compared to 41% in 2013).⁷⁷

As discussed under IE1.5, the Challenge supported projects that looked to better understand consumer behaviour on the sustainability of plastic packaging. This included projects that specifically looked at understanding current attitudes and looking at the outcomes of specific messaging and communication methods; for example, the RECOUP Recycling led Kent 'Live Lab' project.⁷⁸ There are also projects that have looked at different mechanisms for tracking or tracing packaging. These projects provide data on the journey of discarded plastic packaging, which can inform better solutions for influencing consumer behaviour. One such example is the Perpetual Plastic for Food to Go project led by Loughborough University.⁷⁹

Most sector experts felt there had been a noticeable shift in attitudes to sustainability over the past five years, with more consumers wanting to 'do the right thing'. The biggest barrier was felt to be ensuring that the average consumer knows what the 'right thing' is, sharing enough information to increase understanding, whilst keeping this concise and clear. Some experts reported that studies they have carried out show that consumers tend to have less confidence in how efficient recycling is when they do engage; particularly for plastics, where there has been mainstream news focus on problems associated with plastic waste and its disposal. Where disseminated, better understanding developed through the Challenge-funded projects should help address these barriers, through testing effective messaging and communication mechanisms.

"One of the things that was always very difficult is that people want to understand more about what's happening, but they don't want to have too much information.....It's about us as householders, citizens, etc. taking some responsibility for the material that we are disposing of and it not being seen as 'once we've finished with it and we put it in the bin, someone else deals with it, it's not our responsibility'." (Sector expert)

Increasing the availability and suitability of reuse/refill packaging options.

A recent consumer survey showed that over 50% of consumers reported a lack of reuse options or brands (where they shop) as a key barrier to reducing their use of single-use plastic.⁸⁰ There are signs that reusable packaging is starting to become more common, especially for specific items; the aforementioned consumer survey showed that 81% use reusable shopping bags (likely encouraged by the UK single-use carrier back charge enacted in 2021⁸¹), 65% use reusable water bottles and 41% use reusable coffee cups. Self-reported uptake of items in reusable packaging is lower for groceries (15%) and beauty products (13%).

⁸¹ Carrier bag charges: retailers' responsibilities - GOV.UK





⁷⁷ Recycling Tracker Report November 22.pdf

⁷⁸ KENT UNDERSTANDING PLASTICS 'LIVE LAB' UP PROJECT

⁷⁹ Loughborough awarded £1m to research alternatives to single-use plastic packaging | News and events | Loughborough University

⁸⁰ CTS Consumer Survey Report 2024; based on 2,037 UK respondents participating in March 2024.

The Challenge funded projects that tested reuse and refill models or the introduction of new products to their range:

- Ocean Bottle Ltd created reusable bottles made from ocean-bound, recyclable Bisphenol A (BPA)free plastic, and with challenge funding aimed to design and test the first ever customer loyalty platform that incentives refills, using guaranteed plastics collection.^{82,83}
- Abel & Cole (through their Club Zero range) have launched the UK's first refillable polypropylene plastic milk bottle.⁸⁴

On balance there has been a step-change in generating the research and innovation required for change, with some projects realising impact. As discussed under IE1.5, the policy for Extended Producer Responsibility due to come into force late 2025 is likely to incentivise action in this space further. The Challenge has put funding organisations in a position to 'hit the ground running'. Most experts felt there has been an increase in availability of reuse and refill options, which is promising, but thought the UK to be at the start of the journey.

"I think reuse is getting there. There's so much more work to do on reuse, but we have made some progress in the last five years from it being really niche into something that's being more accepted." (Sector expert)

A few projects were named by sector experts as contributing to supporting sustainable changes in consumer purchasing. This included the SSPP funded GoUnpackaged trials⁸⁵ testing a number of refill options in-store and for home delivery. Others included including brand specific refill options now available to consumers and ongoing work by OPRL to help ensure that labelling on plastic packaging on how to dispose it at end of life is clearer for consumers.

Have projects communicated findings across the value chain?

As shown in Figure 14, over 100 papers have been published and nearly 200 UK speaking slots attended. Most academic papers (all but one) and non-academic papers (13 of 20) have been produced by the Enabling Research competition and by projects that have at least some focus on understanding consumer behaviour (69 academic papers and 10 non-academic papers). Most dissemination through published papers is achieved by twelve projects.



⁸² The World's Most Needed Reusable Water Bottle » Ocean Bottle

⁸³ Funding for consumer plastic packaging innovation – UKRI

⁸⁴ UKCPN: News & insights - UK's first refillable plastic milk bottle wins top award

⁸⁵ The UK Refill Coalition Launches First In-store Trial at Aldi to Reduce Single-Use Plastic Waste | GoUnpackaged Reuse Consultancy



69 Academic Papers; 12 Non-Academic Papers; 114 UK Speaking Slots

Figure 14. Academic papers, non-academic papers and UK speaking slots achieved by Challenge funded projects.

Most interviewed projects had plans for dissemination of findings (27 of 33), but the audience for dissemination does vary for this group, with five projects only planning to share results with potential clients and collaborators, and / or partial results in the long term. Planned mechanisms for disseminating include speaking slots, publication on websites and social media. Some specifically mentioned the GRIPS Conference, and the encouragement they had from the Challenge to participate.

"The events and the activities allowed us to.... get our results in front of people who would be interested in it, which isn't something normally a funding scheme directly does. So, I think that added a lot of value." (Project representative)

Where projects gained new collaborators or received further funding, it was common for this to have encouraged project teams to disseminate project findings more widely.

Those without dissemination plans often reported that this was to protect their IP or maintain competitiveness. For projects not covered in interviews, the accessibility of disseminated information was explored through media searches. This found evidence of dissemination (above and beyond project announcement) for just over a third of projects (13 of 37). While the remaining projects may have held speaking slots or disseminated elsewhere, public information on these projects could not be found with ease.

Sector experts were often not familiar with the Challenge portfolio. Even where they were, they did not feel that there had been ample dissemination of findings. To ensure future contribution to this objective, sector experts believe continued dissemination of findings from the Challenge will be important. Two sector experts were also keen to highlight that for best practice findings to become commonplace, there needs to be solutions that smaller organisation or those with limited R&D budget can adopt with little investment.

"There were so many projects that were funded and I lost track of what's happened to them all. The one thing that I think is a bit of a mess with the SSPP funding is the dissemination..... although [they say] 'you must have a dissemination plan' (and this is the same [for all] government grant funding), the reality is the dissemination starts when the funding stops. There is a massive, missed opportunity with the follow-up, not just in the next six months but a year or two years later." (Sector expert)

The Challenge was found to have good coverage in media and generally in a positive tone; however, linked to the above findings on dissemination, there was more focus on its announcement than individual





project findings or learnings. Media coverage was examined through targeted web searches (primarily of trade news articles and articles published via successful project applicants and stakeholder organisations) combined with web scraping of national news and social media outlets.

Table 18 below provides a count of all articles, categorised under eight themes. These themes were identified through reviewing all article titles and opening paragraphs, and summarising article content. A total of 368 articles were identified through searches and webscraping. The overwhelming majority of articles (335/368) carried a positive tone. Emphasis in these articles was very much on informing the reader, about SSPP funding and funded projects and / or the benefits of specific activities such as recycling / reuse / refill. Of the 368 articles reviewed, only six were categorised as negative. These articles discussed concerns regarding a specific issue or policy and focused less on the Challenge, its projects and its achievements.

	National News	Social media	Stakeholder organisations	Trade News	Total
Events and conferences	-	55	3	7	65
Fund announcement	-	51	21	33	105
Marketing	-	27	4	6	37
Partnerships and collaborations	1	12	3	7	23
Project Specific and Fund announcement	-	1	1	3	5
Project Specific announcement	2	45	16	30	93
Research findings	1	15	5	16	37
Other	-	3	-	-	3
TOTAL	4	209	53	102	368

Table 18. Breakdown of articles by theme

Summary

The Challenge has funded projects that have contributed to <u>some</u> step changes that overcome known barriers to sustainable plastic packaging.





- The Challenge directly funded over 100ktpa of UK recycling capacity. Given recent fluctuations in capacity, arising from the financial difficulties faced by the sector, this is an important contribution.
- Sustainable packaging design barriers still exist. Smaller organisations find it difficult to make the required investment. For some larger multi-nationals that produce products for the international market, varying regulations can pose a barrier to making change. However, there have been efforts in this area by Challenge funded projects, including the direct award to Ceflex to revise guidelines on 'Designing for a Circular Economy'.
- Several projects focus on consumer behaviours, particularly within the Enabling Research competition, but it is likely that a further policy push is required to enable UK-wide change.

There has been significant effort by some projects to disseminate findings, but this is not across the entirety of the portfolio and those outside of the Challenge are often unaware of the full spectrum of funded work and its learnings.





IE2.2: To what extent, and how, can the projects supported by the Challenge be expected to bring about a reduction in the environmental impact associated with plastic packaging, and over what time frame? i.e. beyond the UK Plastics Pact Targets.

This section explores the environmental impacts arising from funded projects, focussing on their impact on GHG emissions, production of fossil-based plastic packaging and increasing recyclability and recycling of plastic packaging. Environmental impacts have been calculated using primary interview data, application data and LCA data where available. The findings are also discussed in the context of the state of play of the plastics value chain defined in the sector indicators.

Overall, the evidence indicates that the Challenge is already having a positive environmental impact which, under supportive external conditions, will increase as more projects become established or embedded in the plastics packaging value chain.

Calculating Environmental Impacts

Inherent to the SSPP Challenge was the expectation that all projects would at some point contribute to improvements in the sustainability of plastic packaging production, use and management at end of use. In the evaluation, we sought to determine the scale of environmental impact at three levels: achieved, pipeline and potential.

- Achieved impacts were those that could be determined as having been achieved by end of 2024, on an individual project basis.
- **Pipeline impacts** covered cumulative predicted impacts between 2025 and 2030 inclusive i.e. a maximum period of six years, again for individual projects.
- **Potential impacts** beyond 2030 (on a per year basis) were identified for each project where evidence was made available, with this data used to produce an aggregated potential value, taking account of the sector level indicators.





Achieved and pipeline impacts

Based on calculations that could be carried out, 32.2 ktonnes CO_2e GHG emissions reductions has been achieved to date, arising from 18.2 ktonnes of virgin fossil-based plastic being avoided and 21.5 ktonnes of plastic packaging being recycled. Of these, 37% of emissions reductions have been achieved by projects that would not have progressed outside the Challenge, whilst 61% are achieved from those that were able to run at larger scale, higher specification or at a quicker timescale due to Challenge funds.

As outlined in Section IE1.2, most projects have not achieved impact within the lifetime of the Plastics Pact. By 2030, calculations of pipeline impact indicate that 1.6 million tonnes CO_2e GHG emissions reductions could be realised, associated with avoiding the production of 228.2 ktonnes of virgin fossil-based plastics and the recycling of 608.6 ktonnes of plastic packaging.

The Challenge directly funded six plants that will increase UK capacity by 102 ktpa. The Challenge has also enabled 160 ktonnes of international capacity through projects replicating UK projects elsewhere and one project has licensed its technology for use in a 50 ktonnes capacity plant in Finland.

Table 19 below summarises calculations for four key environmental impact areas agreed between the evaluation team and UKRI. In line with the overarching aims of the SSPP Challenge, key environmental impact metrics were determined as:

- The avoidance of virgin fossil-based plastics production (for packaging or other markets).
- Increased recycling of plastic packaging to reduce waste to landfill and incineration with the associated resulting reductions in GHG emissions.

As summarised in Table 19, even conservative calculations indicate that the SSPP Challenge overall has already contributed to positive environmental impacts. The results presented are likely to be an underestimate of impact as they are based on cases where sufficient data was available to enable calculations to be carried out. Some form of calculation of achieved and/or pipeline environmental impact was carried out for 22 projects. An indication of potential impact beyond 2030 was determined for an additional nine projects. The impacts presented include the achievements of six directly funded recycling facilities that will increase UK recycling capacity by 102,350 tonnes per annum.

It should be noted that the development of new facilities and products involves use of resources such as water and chemicals that may have other environmental and social impacts not accounted for in calculations of carbon impacts.





Table 19. Environmental impact summary

Impact Metric	Definition	Units	Achieved to date	Pipeline (2025- 2030)	No. of projects achieved	No. of projects pipeline
Climate Change:						
GHG emissions reduction	Covers all net greenhouse gas emissions reductions either from Life Cycle Analyses or calculated	tonnes-CO ₂ e	32,169	1,602,720	12	18
Reduction in plastic packaging and resource use:						
Virgin fossil-based plastic packaging avoided ⁸⁶ Of which, avoided through:	Reduced use of virgin fossil-based polymers in plastic packaging	tonnes	18,174	228,248	7	14
 Increased recycling 	Increased recyclate (recycled material outputs) placed on market specifically destined for input into plastic packaging (i.e. as packaging recycled content)	tonnes	18,114	198,145	2	4
Reuse/refill	Reuse/refill models and product innovation that avoids the use of single use plastics	tonnes	13	13,849	3	4
Alternative materials	Increased use of alternative materials with lower environmental impact POM	tonnes	47	16,253	2	6

⁸⁶ Assumed to be a 1 to 1 displacement effect.

Impact Metric	Definition	Units	Achieved to date	Pipeline (2025- 2030)	No. of projects achieved	No. of projects pipeline
• Better design	Better design of packaging decreasing the quantity of fossil- based plastic production	tonnes	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Other virgin fossil- based plastics avoided (non- packaging)	Reduced use of virgin fossil-based polymers through recyclate placed on the open market, not specifically for plastic packaging. This counts the outputs of recycling processes that are placed on the open market for other uses than packaging (e.g. textiles, automotive) that are also looking for recycled polymer content but may also end up in plastic packaging	tonnes	1,248	126,988	1	3
Other avoided resource use	Resource use improvements through better design and control of recycling facilities involving sustainable management of input processing materials, e.g. chemicals, solvents, water, energy	tonnes/kWh//m³	Insufficient data ⁸⁷	Insufficient data	Insufficient data	Insufficient data
Increased resource use:						
Water	Water used in production of packaging or recycling facilities	tonnes	60,170	701,117	3	6
Chemicals	Chemicals use in the production of packaging or recycling facilities	tonnes	5,000	30,00088	1	1

⁸⁷ A number of data/sensing technology related projects focussed on improving the efficiency of existing recycling facilities that was assumed to have a subsequent efficiency gain in the use of other feedstocks for processing the plastic packaging inputs. However, quantified data could not be provided in interviews due to their early TRL stage or project representatives not participating in interviews.

⁸⁸ One project gave data required for quantification for this metric.

Impact Metric	Definition	Units	Achieved to date	Pipeline (2025- 2030)	No. of projects achieved	No. of projects pipeline
Waste:						
Additional plastic packaging recycled Achieved through:	Plastic packaging now recycled that would previously have been landfilled/incinerated.	tonnes	21,511	608,564	7	10
 Increased mechanical recycling 	Plastic packaging now mechanically recycled that would previously have been landfilled/incinerated	tonnes	21,415	457,224 ⁸⁹	4	7
 Increased chemical recycling 	Plastic packaging now chemically recycled that would previously have been landfilled/incinerated	tonnes	50	150,200	1	2
 Increased organic recycling 	Plastic packaging now organically recycled that would previously have been landfilled/incinerated	tonnes	46	1,140	2	1
Waste reduction Achieved through:	Net reduction in waste across the system	tonnes	20	16,193	4	5
• Byproduct use	Waste avoidance through use of byproducts from other industries (e.g. seaweed waste from seaweed food production) ⁹⁰	tonnes	Could not be calculated	Could not be calculated	Could not be calculated	Could not be calculated

⁸⁹ This includes 50,000 being reprocessed in Finland using the demonstrator technology.

⁹⁰ There are indications in project application data that some projects may be using seaweed waste from the food industry but as such projects did not engage in interviews, data was not available to quantify values.

Impact Metric	Definition	Units	Achieved to date	Pipeline (2025- 2030)	No. of projects achieved	No. of projects pipeline
 Increased recyclability 	Materials placed on market increasing recyclability of plastic packaging ⁹¹	tonnes	-	2,343		1
• Reuse	Waste avoidance through reuse of packaging and refill models	tonnes	20	13,849	4	4
Waste production:						
Waste production	Waste produced during the production of innovative materials or running of new recycling processes ⁹²	tonnes	4,022	32,351	2	6
Other environmental impacts:						
Additional land/ aquaculture requirements	Space required specifically for bio-based packaging production	hectares	0.6	759	1	4
Land area	Land area used for bio-based packaging production	hectares	-	741		3
Aquaculture area	Aquaculture area used for bio- based packaging production	hectares	0.6	18	1	1

⁹¹ To take account of projects where they're changing layers in multilayer packaging so the plastic can now be recycled - they will potentially still be fossil-based but increases recyclability avoiding landfill/ incineration.

⁹² Individual waste streams are not presented as they are unique to each project.

Interpretation of impact data: The quality of data available to inform calculations was highly variable. On this basis, calculations were categorised as either:

- Green (indicating high levels of confidence due to the quality of interview data obtained).
- Amber (moderate levels of confidence where a nominal number of assumptions had to be made).
- Red (low levels of confidence due to significant assumptions having to be made due to lack of interview data).

UK impact: For the achieved and pipeline calculations, three sets of calculations were assessed as green, 16 as amber and three as red. In all cases where calculations were carried out, the most conservative values were used.

Three projects accounted for the majority of the achieved impacts; all were demonstrator projects (one category green and two amber), with two focussed on increasing recycling technology capacity in the UK and one focused on behaviour change to improve mechanical recycling rates.

Four demonstrator projects did not have achieved values for any of the metrics as they are currently not operational. Four other projects did not have pipeline values for any of the main indicators due to the expected timescales for impacts being determined as likely to arise from 2030 onwards. Three projects accounted for 96% of the calculated GHG reductions achieved. One demonstrator project accounted for 99% of the amount of plastic packaging avoided and 84% of the quantity of plastic packaging recycled to date.

For the pipeline impacts, three demonstrator projects account for approximately 86% of the pipeline calculated GHG emission reduction value, 86% of the plastic packaging avoided and 94% of the plastic packaging recycled impact metric values. These projects have such a significant contribution due to the scale of the project and its readiness level. They are also major contributors to the longer-term potential impact of the overall Challenge. Regarding confidence in the calculation of impact of these projects, for two of the projects sufficient data was made available through interview and, as such, there is a high level of confidence in these calculations. For the third project, limited time was given for interview and not all questions could be asked, such that achieved impacts could not be calculated and operational impacts (water use etc.) were determined based on data in the application/LCA.

An evaluation of the environmental impact of each project could not be made at this stage due to the diversity, scale, stage of readiness level for adoption in practice and future plans, and differing levels of evidence made available through interviews. Furthermore, 15 of the 87 funded projects were associated with follow-on funded projects; these were not calculated separately to the analysis of their subsequent follow-on project in order to avoid double counting. However, for these projects, where impact calculations could be made, an apportionment factor determined by UKRI was applied to take account of the value of the preceding research.

Not all projects calculated as generating achieved impacts went on to have pipeline impacts or potential impacts, as evidence suggested low levels of confidence in further activity being undertaken. Similarly, projects having pipeline impacts may not have had achieved impacts and may not have impact for the full six-year pipeline impact period. Pipeline impact values were determined on the evidence derived from post completion forms or interviews (where available), regarding when the project would start having impact and for how long impact would be maintained.





Furthermore, although plastic feedstock for one of the projects was destined to be recycled in Europe, onshoring recycling in the UK is assumed to have opened additional capacity that has been backfilled in Europe. Similarly, the feedstock for one of the chemical recycling projects was reported by the project as being material that was already being mechanically 'downcycled' into lower quality products. The environmental metrics and calculations do not take account of 'quality' of recyclate from recycling facilities, other than if they are reported as going directly into packaging or on the open market, as long as it is recycled.

Although these projects, as standalone, have been calculated as having positive environmental impacts, the changing landscape of recycling operations in the UK and Europe may result in such impacts not being observed as additional to the environmental performance of the plastics packaging value chain overall, particularly for mechanical recycling facilities. This is on the basis that a number of plastics recycling facilities have ceased operating over the last few years, as UK plastics recycling facilities continue to face financial difficulties (discussed in section IE2.1). This has been experienced by one of the demonstrator projects funded under the SSPP challenge, delaying development of the project. Furthermore, two chemical recycling demonstrator projects stopped prematurely due to companies entering administration, or market conditions leading to key partners pulling out, at a time of high debate around the performance and environmental benefits of chemical recycling technologies.⁹³

However, subject to market conditions, currently closed existing facilities may become operational by 2030; as such, the SSPP funded projects would count as providing additional impact beyond that timeframe. It is noted that Sector Indicator 96 outlines that there was a reduction of 44,000 tonnes in UK domestic recycling between 2022 and 2023, whilst export for recycling increased by 33,000 tonnes; this reflects the volatility in capacity for recycling in the UK, affected by a wide range of external factors. The 2023 updated BPF Recycling Roadmap²⁰ noted the need to change its 2030 and 2035 forecasts for plastics recycling due to 'delays and changes to critical milestones', meaning high levels of uncertainty for the industry and challenging economic conditions.

As expected, analysis of impacts by TRL level, waste hierarchy, plastics packaging lifecycle stage and competition was consistent in indicating that projects at high TRL level, addressing reprocessing capacity and at large scale demonstrator stage, dominated the achieved and pipeline environmental impact outcomes. Summaries are provided in Table 20 and Table 21.

When determining the environmental impact, all projects contribute to the GHG emissions metric, and an individual project could contribute to more than one of the other impact metrics. For example, a mechanical recycling-based demonstrator project not only contributes to the additional plastic packaging waste recycled indicator (due to using plastic packaging as an input material), but to the virgin fossil-based plastic packaging avoided metric (due to its output material – recyclate - being use as a feedstock for production of plastic packaging or other products). It is to be noted that it is not a 1:1 conversion of input to output quantities as no facility is 100% efficient.

⁹³ <u>Plastic pyrolysis threatens Paris Agreement climate change goals, warns Zero Waste Europe</u>





Table 20. Environmental impact summary by TRL, waste hierarchy and plastic packaging life cycle⁹⁴

Category	GHG emissions reduction		Fossil-base (a	Fossil-based plastic avoided (all routes)		plastic packaging recycled	Net system waste reduction	
	Tonnes-	CO₂e		Tonnes		Tonnes	Tonnes	
	Achieved	Pipeline	Achieved	Pipeline	Achieved	Pipeline	Achieved	Pipeline
Overall	32,169	1,602,720	19,422	355,236	21,511	608,564	20	16,193
TRL level:								
Not defined	36%	0%	0%	0%	9%	0%	0%	0%
1-3	0%	0%	0%	0%	0%	0%	0%	0%
4-6	18%	6%	7%	9%	7%	3%	52%	15%
7-9	46%	94%	93%	91%	84%	97%	48%	85%
Waste hierarchy:								
Prevention & reduction	0%	3%	0%	4%	0%	2%	0%	14%
Refill and reuse	0%	5%	0%	4%	0%	0%	100%	86%
Mechanical recycling	98%	51%	100%	63%	100%	73%	0%	0%
Chemical recycling	1%	41%	0%	29%	0%	25%	0%	0%
Organic recycling	0%	0%	0%	0%	0%	0%	0%	0%
Not defined	0%	0%	0%	0%	0%	0%	0%	0%
Plastic packaging life cycle:								
Design and manufacturing of packaging	1%	4%	0%	5%	0%	2%	16%	15%
Consumer purchases	0%	5%	0%	4%	0%	0%	84%	85%
Discarded by consumers	36%	0%	0%	0%	9%	0%	0%	0%
Collected by local authorities	2%	1%	1%	1%	1%	1%	0%	0%
Sorting and bulking	0%	0%	0%	0%	0%	0%	0%	0%

⁹⁴ The Technical Annexe includes more information on project classifications, including the waste hierarchy used which was adapted and adopted by UKRI for the Challenge.

Reprocessing	61%	90%	99%	91%	90%	97%	0%	0%
Additionality assessment (%)								
Full additionality	37%	31%	0%	25%	9%	21%	52%	0%
Partial additionality	61%	63%	99%	69%	90%	76%	35%	100%
Not assessed	2%	6%	1%	6%	1%	4%	13%	0%

Table 21. Environmental impact summary by SSPP competition

Category	GHG emissions reduction		Fossil-based plastic avoided (all routes)		Additional plastic packaging recycled		Net system waste reduction	
	Tonne	s-CO ₂ e	Toni	nes	Tonnes		Tonnes	
	Achieved	Pipeline	Achieved	Pipeline	Achieved	Pipeline	Achieved	Pipeline
Overall	32,169	1,602,720	19,422	355,236	21,511	608,564	20	16,193
Competition:								
521 - SSPP - Feasibility Studies for Demonstrators (FS4D)	0%	0%	0%	0%	0%	0%	0%	0%
530 - SSPP- Feasibility Studies and Industrial Research (FS&IR)	0%	0%	0%	0%	0%	0%	0%	0%
817 - ISCF Smart Sustainable Plastic Packaging Demonstrators - Eol	0%	0%	0%	0%	0%	0%	0%	0%
763 - ISCF Future Plastic Packaging Solutions	53%	0%	6%	2%	15%	0%	52%	0%
1480 - ISCF SSPP Collecting flexible plastic packaging waste at home	0%	0%	0%	0%	0%	0%	0%	0%
SSPP - Enabling Research (ER)	0%	0%	0%	0%	0%	0%	0%	0%
522 - SSPP - Demonstrators Round 1 (D1)	0%	41%	0%	29%	0%	25%	0%	0%
900 - ISCF Smart Sustainable Plastic Packaging: Demonstrators Round 2 Full Stage	44%	45%	93%	55%	84%	70%	0%	0%
934 - ISCF Smart Sustainable Plastic Packaging: Business-led R&D	1%	3%	0%	3%	0%	2%	0%	0%

1285 - SSPP Future Plastic Packaging Solutions Round 2	0%	11%	0%	10%	0%	3%	35%	100%
Direct Award	2%	1%	1%	1%	1%	1%	13%	0%
IUK Business Connect (previously known as KTN) Activity	0%	0%	0%	0%	0%	0%	0%	0%

International presence: the Challenge has also enabled 160 ktonnes of international capacity through projects replicating UK projects elsewhere and one project has licensed its technology for use in a 50 ktonne capacity plant in Finland.

Potential impacts

The potential longer-term combined UK capacity of five mechanical and four chemical recycling projects funded by SSPP (where calculations could be carried out) is 445 ktonnes. If they all come to fruition at the intended scale in 2030, this will contribute significantly towards the level of capacity required in the UK to process plastic packaging. As outlined in the WRAP Plastics Market Situation Report, 730 ktonnes of recycling capacity for plastic packaging was operational in 2022. Assuming this capacity remains fully utilised in 2030 the additional capacity needed to reach a best-case desired scenario recycling throughput would be 789 ktonnes.

Assuming all the aforementioned projects come to fruition at the intended scale by 2030, they could be generating £44.5 million/year revenue and contributing 1.4 million tonnes CO₂e GHG emission reductions each year in the UK (based on today's GHG emission factors) through (a) avoiding plastics going to incineration/landfill and (b) output recyclate or chemicals displacing the production of virgin fossil-based plastic.

On displacing virgin fossil-based polymer, the five mechanical recycling projects have the potential to make available 251 ktonnes of polymer recyclate each year in the UK. The three chemical recycling facilities have the potential to produce 89 ktonnes of basic chemicals suitable for conversion into polymers for packaging.

Assuming average recycled content of plastic packaging POM would be 30% by 2030, driven by regulatory requirements, recyclate demand has been estimated as being approximately 754 ktonnes in 2030. The eight large-scale recycling facilities funded by SSPP could therefore make a significant contribution to meeting domestic recyclate demand, although demand may continue to outstrip supply.

Indications of potential impacts were estimated for 30 SSPP-funded projects, although all funded projects have the potential to realise impact over the next 10 years (subject to advances in TRL, additional funding and/or changes in market conditions).

However, some supported projects are potentially targeting the same market or are focusing on a precursor stage of the plastics lifecycle e.g. collection of plastic packaging going to a recycling facility that also requires changes in consumer practices. Therefore, to avoid double counting and recognising volatility in market conditions, potential impacts cannot be treated as a straight sum of the indicative values determined on an individual project basis.

The scale of potential environmental impacts has been investigated in relation to scenarios of the market context of UK plastic packaging in 2030 and 2035 and changes to UK and European policy and regulatory context underway or planned as outlined in Appendix 2.

Three scenarios (worst case, business as usual and desired) describing the market context for plastic packaging have been estimated, calling upon two reports: the WRAP 2022 Plastics Market Situation report²¹ and the BPF Recycling Roadmap report²². Further details on each of these scenarios are provided in Appendix 4.

Estimates based on the BPFs worst case scenario (in which only marginal improvements in capture of materials are made over the next 10 years, whilst plastic waste continues to grow in the UK), indicate that by 2030, 34% of plastic packaging POM in the UK may be recycled domestically, with continued





reliance on export for recycling, whilst overall recycling is 57%. By 2035, overall recycling could be 70% with 45% recycled domestically under this scenario.

Under the BPF desired scenario, domestic recycling rates could be of the order of 46% (2030) and 68% (2035), with overall recycling rates of 60% and 80% respectively.

The SSPP Challenge is contributing to achieving the desired scenario in the following ways:

- **Supporting policy**: Challenge-funded projects support the required policy and regulatory changes and have the potential to contribute to many of the desired conditions of the BPF Recycling Roadmap.
- **Supporting sorting and recycling technologies:** the Challenge included funding for the innovation and commercialisation of 13 recycling technologies (with three earlier-stage funded projects) and four projects focussed on innovations in sorting technologies (with two precursor funded projects).
- **Improving communication and ensuring consistency of collections:** three early-stage research projects have been funded under SSPP, addressing improving recycling practices of consumers .
- Increased collection infrastructure: six further projects were funded to design collection containers for flexible plastic packaging that could be used by local authorities, and a Direct Award was granted to a project investigating flexible packaging routes for local authorities.

Potential impacts: Recycling and recyclate

Regarding sector indicators on the amounts of plastic packaging exported for recycling, the amount being recycled domestically and the total amount of plastic packaging being recycled (Indicators <u>95</u> to <u>97</u>), five mechanical and four chemical reprocessing technology projects funded by SSPP were estimated as having the potential to make a significant contribution to increasing UK capacity and reducing reliance on exporting of plastic packaging waste. This is through recycling at least 789 ktonnes/year of plastic packaging, in addition to the existing plastic packaging recycling capacity in the UK of 730 ktonnes.⁹⁵

Regarding sector indicators for the amount of plastic packaging the sector is responsible for POM and the average percentage of recycled content for plastic packaging on the market (Indicators <u>78</u> and <u>84</u>), recyclate demand has been estimated as being of the order of 754 ktonnes in 2030 for the 2,838 ktonnes of plastic packaging POM (excluding compostable packaging). The five funded mechanical recycling facilities, if fully operational by 2030, have been estimated as placing 251 ktonnes of polymer recyclate on the market. The three funded chemical recycling facilities could be producing 89 ktonnes of basic chemicals suitable for conversion into polymers for packaging, such that combined there is the potential for the UK to create a resilient, self-reliant home plastics value chain that meets regulatory demands (where economic market conditions are supportive). However, more capacity would be required to meet the 2035 regulatory requirement of 50% recycled content.

A key condition for high utilisation of the UK generated recyclate and long-term viability of the projects relates to market signals. Current signals indicate low demand for recyclate across Europe due to low prices of virgin plastic.⁹⁶ As can be seen from Figure 15 based on PET, price volatility is currently high and



⁹⁵ Plastics Market Situation Report 2022

⁹⁶ European plastic recycling industry growth threatened by shrinking market



virgin polymer prices are relatively low. High operational costs of facilities in the UK, attributed to electricity usage, has been cited as a major issue for operators in the UK.⁹⁷

Potential impacts: Reuse and refill

In addition to increasing UK recycling capacity and making recyclate available to incorporate as recycled content in plastic packaging, a key instrument that has the potential to reduce the use of virgin fossilbased plastic is the development and uptake of reusable packaging and refill systems. As outlined in Appendix 2: An evolving landscape, the European PPWD sets reuse and refill targets, initially targeted at beverages, takeaway food, and transport packaging (pallets etc.). Furthermore, as mentioned in section IE1.5, reuse and refill models have been trialled for many years with high-profile Plastics Pact members, as reported in WRAP Plastics Pact annual reports since 2019.⁹⁹ ¹⁰⁰ ¹⁰¹ However, there has been little evidence of national scale roll out.

Despite this position, the SSPP Challenge funded 18 diverse projects (plus four precursor projects) aimed at understanding and encouraging reuse and refill solutions. The focus of these projects included: the provision of refillable beauty, personal care and cleansing products and associated reusable containers; reusable food and beverage takeaway containers and systems; centralised cleansing systems; design of reusable packaging for food use; embedding trackable technologies and systems into reusable containers to manage the logistics of reuse, to behaviour change interventions to encourage adoption of reuse and refill. Representatives from nine of these projects participated interviews, of which five focussed on the

¹⁰¹ UK Plastics Pact Annual Report 2021-22





Figure 15. Market prices for rPET food-grade, rPET non-food-grade, and PET food-grade from October 2016 to February 2022 (McGeough, 2021, Tudball, 2022)⁹⁸

⁹⁷ Plastics Market Situation Report 2022

⁹⁸ Why pledges alone will not get plastics recycled: Comparing recyclate production and anticipated demand

⁹⁹ UK Plastics Pact Annual Report 2019-20

¹⁰⁰ UK Plastics Pact Annual Report 2020-21

provision of refillable pod/sachet-based products and associated reusable containers, and could provide some data. Estimates of the potential amount of virgin plastic packaging avoided per year were attempted for these projects (all amber levels of confidence in the quality of data). The five projects all aimed to displace high volumes of lightweight single use plastic. They all involved the creation of new reusable packaging, manufactured from more durable and reusable materials that were heavier (thicker plastics, glass or aluminium). LCAs can indicate that single use plastic packaging has a lower environmental impact when based on production and recycling information only.¹⁰² Where refillable packaging involves decentralised or centralised collection and cleaning before distribution for reuse (e.g. cosmetics, food and beverage containers), calculations of the environmental impacts of such reuse and refill systems can demonstrate a worse impact than using single use lightweight packaging in the short term. In these systems, the environmental benefits are heavily reliant on the refillable container material choice, number of times the reusable packaging is actually returned and reused, transport requirements for returning reusable packaging and cleansing requirements.¹⁰³ The greater the number of returns and reuse cycles the greater the level of reduction of environmental impact, although the environmental impact will plateau as transportation and cleaning are required for every cycle. Without information on the number of reuse cycles of each refillable container placed on the market (and associated transport and cleansing requirement data), calculations could not be carried out with an appropriate level of confidence for reporting. This is due to the complex nature of reuse and refill systems. In models where reusable containers are not returned for cleansing but are serviced at home through the provision of refill products, overall environmental impacts could be lower, as demonstrated in a reported example of a refillable shampoo bottle¹⁰⁴, although the impacts of supply of the refill need to be taken into account.

Overall, the potential environmental impacts of a refill or reuse model would need to be determined on a case-by-case basis and require substantial levels of data not currently made available for the projects funded through the SSPP Challenge. However, there is evidence on websites that some projects have created viable products that are being distributed and in use, with interview data for two projects indicating plans for refills (3m and 15m respectively) to be distributed annually from 2030. On the number of specially designed reusable containers in circulation, interview data for four projects indicates that at least 1.5m reusable containers would be in circulation each year from these projects.

Potential impacts: Innovative materials

Calculations of potential environmental impact were carried out for nine projects (plus associated precursor projects) focussed on developing innovative materials that aimed to improve the recyclability or compostability of packaging. Of these projects, representatives of six were interviewed, although only three interviews provided data that enabled an estimate of potential levels of more recyclable materials being placed on the market. We have low levels of confidence in the calculations carried out for the non-interviewed projects as the calculations were based on application data or assumptions developed through information available on the companies' websites. Together, the nine projects were estimated as placing 42 ktonnes/ year of more recyclable or compostable material on the market each year from 2030 onwards, avoiding the production of non-recyclable fossil-based single use plastic packaging and reducing GHG emissions by 230 ktonnes CO₂e each year. Of the nine projects, five were focussed on biobased solutions to increasing biodegradability of packaging, that could contribute to sector indicator <u>80</u>. Although there was limited data available for these five projects (only one was interviewed and all are

¹⁰⁴ The Truth About Reusable Packaging





¹⁰² Spectra Packaging Life Cycle Analysis

¹⁰³ <u>Reusable vs Single Use Packaging: A review of environmental benefits</u>

currently at TRL 4-6 stage¹⁰⁵), they were assessed as having the potential to place nearly 2.4 ktonnes of packaging / year on the market. This would account for <0.1% of the packaging POM in 2030 (sector indicator 78) and could generate revenues of around £6.1 million/year with associated GHG reductions of 13.4 ktonnes CO₂e/year. Three of the other projects focussed on producing more recyclable fossil-based plastic packaging for food contact applications contributing to sector indicators 96 and 97. There is a higher level of confidence in the calculations for these projects, as all were interviewed. They were estimated as placing 33.6 ktonnes of more recyclable fossil-based food contact plastic packaging on the market with the potential to generate revenues of £44 million/year associated with GHJG emission reductions of 182 ktonnesCO₂e /year. It is to be noted that two of these projects are currently at TRL 4-6 stage.

Overall, there is a high level of uncertainty on the potential environmental impact of the projects focussed on the development of innovative materials, due to (a) the projects currently being predominantly at TRL 4-6 stage and (b) a lack of data provided by projects. However, the development of biobased packaging solutions is a rapidly growing area and recognised as having significant environmental benefits, although energy and water consumption in the production of biopolymers is seen as a concern (as summarised in Figure 16).

CO ₂ -eq Emissions (kg/kg)	Energy Consumption (MJ/kg)	Water Consumption (L/kg)	Degradation Time (Years)	Source/Renewability	Ref.
2.15-3.0	109.2-115.2	5.9	>100	Non-renewable (petroleum)	[92,93,94]
1.75–2.3	73	59	>100	Non-renewable (petroleum)	[92,93,95]
1.8	46	15–23	0.5–2	Renewable	[94,96,97]
0.49	78–88	268	1.5-3.5	Renewable	[98,99,100]
16.1	31.6	460	0.2-0.5	Renewable	[101,102]
1.8–3.7	33–72	10	0.4-0.5	Renewable	[103,104,105]
1.64	31.0	250	0.1-0.2	Renewable	[106,107]
	CO ₂ -eq Emissions (kg/kg) 2.15-3.0 1.75-2.3 1.8 0.49 16.1 1.8-3.7 1.64	CO2-eq Emissions (kg/kg) Energy Consumption (MJ/kg) 2.15-3.0 109.2-115.2 1.75-2.3 73 1.8 46 0.49 78-88 16.1 31.6 1.8-3.7 33-72 1.64 31.0	CO2-eq Emissions (kg/kg) Energy Consumption (MJ/kg) Water Consumption (L/kg) 2.15-3.0 109.2-115.2 5.9 1.75-2.3 73 59 1.8 46 15-23 0.49 78-88 268 16.1 31.6 460 1.8-3.7 33-72 10 1.64 31.0 250	$\begin{array}{ c c c c c c } \hline CO_2-eq \ Emissions \\ (kg/kg) & Energy \ Consumption \\ (MJ/kg) & (U/kg) & Degradation \ Time \\ (Years) \\ \hline \\ 2.15-3.0 & 109.2-115.2 & 5.9 & >100 \\ \hline \\ 1.75-2.3 & 73 & 59 & >100 \\ \hline \\ 1.75-2.3 & 73 & 59 & >100 \\ \hline \\ 1.8 & 46 & 15-23 & 0.5-2 \\ \hline \\ 0.49 & 78-88 & 268 & 1.5-3.5 \\ \hline \\ 0.49 & 78-88 & 268 & 1.5-3.5 \\ \hline \\ 1.61 & 31.6 & 460 & 0.2-0.5 \\ \hline \\ 1.8-3.7 & 33-72 & 10 & 0.4-0.5 \\ \hline \\ 1.64 & 31.0 & 250 & 0.1-0.2 \\ \hline \end{array}$	$\begin{array}{ c c c c c }\hline CO_2-eq \ Emissions \\ (kg/kg) & Energy \ Consumption \\ (MJ/kg) & Water \ Consumption \\ (L/kg) & Degradation \ Time \\ (Years) & Source/Renewability \\ \hline \end{array}$

Figure 16. Comparison of bio-based and conventional packaging materials¹⁰⁶.

As outlined in the 'Innovations in Food Packaging: From Bio-Based Materials to Smart Packaging Systems' paper¹⁰⁷, scaling the production and use of bio-based materials is still seen as challenging due to high cost, mechanical and barrier properties and functionality, lack of harmonised regulations, standards and certification systems and lack of advanced recycling and composting infrastructure.

Summary

The Challenge has achieved at least 32,000 tonnes of GHG avoided emissions to date, with an additional 1,600,000 tonnes expected by 2030.

¹⁰⁷ Innovations in Food Packaging: From Bio-Based Materials to Smart Packaging Systems





¹⁰⁵ Four of the projects were classed as red in terms of level of confidence in the values.

¹⁰⁶ <u>Innovations in Food Packaging: From Bio-Based Materials to Smart Packaging Systems</u>

Environmental impacts presented are likely to be an underestimate of impact as they are based on cases where sufficient data was available to enable calculations to be carried out; some form of calculation of achieved and/or pipeline environmental impact was carried out for 22 projects.

The Challenge has directly funded UK recycling capacity contributing 102ktpa capacity. The potential longer-term combined UK capacity of five mechanical and four chemical recycling projects funded by the SSPP Challenge (where calculations could be carried out) is 445 ktonnes. However, most plans are reliant on the individual applicants securing funding, for which there are no definite/committed sources to date.





IE2.3 To what extent, and how, has the Challenge facilitated the innovation of "smart" sustainable plastic packaging? What are the expected benefits of this?

This section describes innovations for "smart" sustainable plastic packaging. Findings draw on analysis of project focus and stakeholder interviews. The Challenge remained open to receiving applications for 'smart' innovations throughout the competition; however, few applications were made that fall into this category. Those that were include functions such as heat resistance and antimicrobial properties. In addition to these projects, the Challenge has supported several projects that make use of other technological advances, such as sensors or computer-aided sorting technology.

Key definitions:

The definition of "**smart**" is defined in terms of active and intelligent packaging.

Active packaging is defined as: packaging that provides one additional function, in addition to its primary purpose of containment and protection. For example, moisture absorption or oxygen control through desiccants.

Intelligent packaging is defined as: packaging that senses a change in the environment and communicates or signals this information to an interested party in a two-step process. Functions include counterfeit protection, supply chain management control, food safety and marketing applications. Examples include ripeness indicators, time or temperature indicators, NFC labels.

The Challenge was open to applications that proposed 'smart' solutions to sustainable plastic packaging and lined up support for these from the Centre for Process Innovation (CPI). The nature of applications received to the Challenge had few that proposed innovations with 'smart' solutions, with fewer still that were successful in securing funding. This likely reflects the highly complex nature of 'smart' projects and the potentially long timescales for delivery. A few funded projects are delivering 'smart' innovations; one example of active packaging is KluraLabs (formerly known as Codikoat¹⁰⁸) which integrates antimicrobial properties into food packaging.

Most projects have looked to overcome other, fundamental problems to enable progression against UK Plastics Pact targets, before 'smart' technology can be considered. Whilst not fitting the definition of 'smart', there are many projects perceived as showing technological advancements, with some boasting first-in-the-world innovation. These projects have:

- Utilised existing digitally-enabled technologies to support circularity of plastics. For example, some of the tracking and tracing projects discussed in IE1.5 and IE2.1.
- Embedded high quality data to enable more effective management of plastics at end of use.

¹⁰⁸ Codipac - a hygienic, reusable packaging solution designed to replace disposable plastics in grocery supplies.





• Developed and/or integrated sorting technology in recycling facilities, to determine between different types of polymers.

Summary

The Challenge was open to applications for 'smart' solutions to sustainable plastic packaging but few were received.

The portfolio of funded projects, although not necessarily making use of 'smart' solutions, have aimed to address the more immediate needs of the sector to enable progression towards UK Plastic Pact targets.

Further work may be required to establish the need for and potential role of smart solutions in driving further improvements in the sustainability of plastic packaging, as some of the more fundamental issues and barriers are addressed.





IE2.4: To what extent, and how, has the Challenge benefited the UK plastic packaging and related business sectors and contributed to clean growth? Was the timing or scale of projects improved because of the Challenge intervention?

This section explores the Challenge's contribution to UK plastic packaging and related business sectors. Findings draw on revenue figures supplied by project representatives in primary interviews, PCFs submitted to UKRI and online proforma data submitted by successful applicants as part of the evaluation.

Funded projects have demonstrated revenue growth (greater than £27.5 million) nearly all of which would not have been achieved, at least in the same timescale, in the absence of Challenge funding. Further revenue gains are predicted for the 2025-2030 period, with substantial contribution from projects that would have been achieved at slower timescale (and possibly outside the UK) in the absence of the Challenge. Most impact is realised from demonstrator projects that have reached commercialisation. Evidence suggests that at least two-thirds of pipeline revenue represents UK growth. Without the fund, activity that may have progressed would likely have occurred outside the UK. Where there was an incumbent solution, it also involved overseas options, so UK activity was not displaced.

Key definition:

Clean Growth can be defined as Growth supporting development, manufacture and use of low carbon technologies, systems and services (as defined by ISCF), and economic growth that does not compromise resources or contribute to greenhouse gas emissions i.e. lower carbon intensity of growth.

The Challenge supported projects that have realised economic impacts from the investment in more sustainable technologies. The economic impacts of projects associated with the portfolio are shown in Table 22 below. Overall, at least £27.5m of revenue has been achieved to date, with a total of £392m of revenue expected to be raised by 2030.

Most of the achieved revenue to date is partially attributable to the Challenge; revenue expectations for the period 2025-2030 show just over three quarters partially attributable to the challenge and 5% fully attributable. Predicted pipeline revenue mainly arises from two projects, one with partial attribution and one with unknown attribution; these have not raised any revenue yet, but are expecting to raise (between them) more than £150m of revenue up to 2030.

As with the environmental impacts, recycling, either mechanical or chemical, accounts for most of the revenue raised, both achieved and pipeline. However, about 22% of revenue in the pipeline is accounted for by projects focussing on either displacing fossil fuel-based plastics or replacing them with plastics that are recyclable.

With regards to reuse and refill projects, revenue was found to be smaller, especially considering their environmental impact. On a couple of occasions, the new system was achieving similar levels of revenue





to the model it displaced. This reflects earlier commentary under IE1.5 where many of these projects are at lower TRL level.

As expected, projects with the highest TRL (7-9), as well as projects from competitions funding demonstrators, are accounting for the majority of achieved revenue. However, a non-negligible proportion of pipeline revenue is expected from mid-TRL projects 4-6 (~20% of pipeline revenue), as well as projects from the business-led R&D competition (~17%).

Approximately 70% of the pipeline revenue is accounted for by two demonstrator projects. In both cases, the projects would have progressed without the Challenge, albeit at a smaller scale and / or over a different timescale. These projects have indicated that the Challenge convinced them to build the plant in the UK, rather than outside the UK (which had been their original plan), or that materials recycled in their plant would have been recycled outside the UK. This provides compelling evidence the Challenge has contributed to clean growth in the UK.

The Challenge has also resulted in the creation of jobs and the upskilling of individuals working within funded organisations. Further individuals have also been upskilled through BPF courses funded through direct awards (see Figure 17 below).



263 jobs created

239 individuals trained or upskilled within organisations receiving funding through grants

539 individuals trained or upskilled through BPF courses directly funded by the Challenge

Figure 17. Jobs created an individuals trained and upskilled.

Of the 263 jobs created, 13 have been created by projects unlikely to have progressed without funding. 223.5 were created by projects that would have progressed over a slower time period and / or to a smaller scale; evidence also suggests these jobs may have been created outside of the UK in the absence of funding. All remaining jobs (26.5) were created by projects that were not interviewed.

Of the 239 individuals trained, 35 were for projects that were unlikely to proceed without funding and 150 from those where project scale / timings would have changed. One project has created the most jobs (80%) and is responsible for a quarter of trained individuals. This project reported they would have progressed to the same scale but may have taken longer while they secured alternative funding; there is also possibility that job creation would be outside of the UK if the Challenge had not funded the project.

	Achieved - Revenue	Pipeline- Revenue
Total (£)	27,501,357	392,970,748
Additionality assessment (%):		

Table 22. Economic impacts.





Achieved by projects that are unlikely to have progressed without Challenge funding	0.6%	5.3%
Achieved by projects that are likely to have progressed but at slower timings or reduced scale	95.1%	78.8%
Competition (%):		
522 - SSPP - Demonstrators Round 1 (D1)	0.0%	31.3%
ISCF Smart Sustainable Plastic Packaging: Demonstrators Round 2 Full Stage	94.9%	44.9%
ISCF Future Plastic Packaging Solutions	0.6%	0.2%
SSPP Future Plastic Packaging Solutions Round 2	0.2%	4.7%
ISCF Smart Sustainable Plastic Packaging: Business-led R&D	0.0%	17.1%
1480 ISCF SSPP Collecting flexible plastic packaging waste at home	0.0%	0.0%
530 - SSPP- Feasibility Studies and Industrial Research (FS&IR)	0.0%	0.0%
521 - SSPP - Feasibility Studies for Demonstrators (FS4D)	4.3%	1.8%
SSPP - Enabling Research (ER)	0.0%	0.0%
IUK Business Connect (previously known as KTN) Activity	0.0%	0.0%
Direct Award	0.0%	0.0%
Waste hierarchy (%)		
Prevention and reduction	4.3%	21.5%
Refill and reuse	0.6%	0.7%
Chemical recycling	0.0%	31.3%
Mechanical recycling	95.0%	46.4%
Organic recycling	0.0%	0.0%
None	0.0%	0.0%
Plastic packaging lifecycle (%)		
Design and manufacturing of packaging	5.0%	22.4%
Consumer purchases	0.0%	0.5%
Discarded by consumers	0.0%	0.0%
Collected by local authorities	0.0%	0.0%
Sorting and bulking	0.0%	0.0%
Reprocessing	94.9%	77.0%
None	0.0%	0.0%
TRL (%)		
TRL 1-3	0.0%	0.0%
TRL 4-6	5.1%	20.0%





TRL 7-9	94.9%	80.0%	

Summary

Funded projects have secured $\pounds 27.5m$ of revenue to date, with a total of $\pounds 392m$ of revenue expected to be generated by 2030. A substantial proportion of this revenue is associated with projects that in the absence of funding may have progressed but at reduced scale and / or a slower time scale.

Most revenue growth was achieved from larger scale demonstrator projects that are near to commercialisation. For many projects, it was too early to provide accurate revenue forecasts and it is therefore likely that reported impacts are an underestimate of what will be achieved by the Challenge as a whole. Further and ongoing monitoring of the growth and performance of organisations and activities supported by the Challenge would be required to understand the full impacts of the Challenge and contribution to clean growth in the UK.





IE2.5 Were there any unexpected barriers or facilitators to desired impact?

This section draws on evidence from primary interviews with applicants and stakeholders to consider whether any <u>unexpected</u> barriers or facilitators were encountered to the impacts identified in the Theory of Change.

Unexpected barriers included external influences outside of the control of the Challenge. The Covid-19 pandemic was cited as impacting early delivery. Sector experts felt delays in Simpler Recycling and Extended Producer Responsibility slowed down value chain decisions to adopt innovation, where they want to ensure compliance.

Legislation that had come into force, such as the plastic packaging tax, was cited as a facilitator. Other facilitators cited by stakeholders and sector experts (albeit expected) included continued media coverage of the negative impacts of plastic packaging, maintaining focus on key issues and the decision by the Challenge to focus on collaboration and networking.

Barriers

Unexpected barriers to the Challenge achieving its desired impact cited by stakeholders and sector experts were all external and outside the control of the Challenge.

Sector experts felt that the divergence in UK and EU policy since EU exit had hindered innovations around including recycled content in food grade packaging. The European Commission updated regulations in 2022,^{109, 110} setting out clear rules to ensure that recycled plastic can be safely used in food packaging in the EU; an equivalent regulation / approval process has not yet been enacted in the UK. The Challenge has funded innovation that will enable food-grade recycled content once approval processes are in place. Similarly, the required regulation to enable recycled content in pharmaceutical use was cited as a barrier to commercialisation and closing the loop on blister packaging.

Covid-19 was mentioned as an unexpected barrier by project team stakeholders, impacting on the timescales in which they were able to get project activities up and running. This was mirrored in the Phase 2 evaluation (conducted in 2022), where Covid-19 was the most commonly cited and most detrimental barrier, leading to delays in project set-up and delivery, and the suspension of all face-to-face and practical research and engagement, including laboratory-based and consumer-facing (i.e., ethnographic) research.

"Doing a project on reuse was a bit tricky during covid when people were concerned about contamination and not reusing things." (Successful applicant)

¹¹⁰ Plastic Recycling - European Commission





¹⁰⁹ Commission adopts new rules to enhance safety of recycled plastics used in contact of food - European Commission
As outlined in Appendix 2 (setting out the Evolving Policy Landscape), there have been some policy delays. For example, Extended Producer Responsibility was initially due to be enacted in 2023, but delayed to late 2025. The Consistency in Recycling policy (later replaced by Simpler Recycling) is running to a delayed timetable of at least two years later than initially announced¹¹¹. Sector experts felt delays had stalled progress across the sector; whilst awaiting decisions, it has been difficult for some to commit to innovations without knowing if they would fit into upcoming policy changes.

"There was a hope in the plastics industry that producer responsibility would have come in; by now there would have been a fund for some national messaging on recycling." (Successful project representative)

"I think it all comes down to profit and also lack of legislation because if there was legislation to say, you've got to do these things, then they would do them." (Stakeholder)

Facilitators

Stakeholders cited several (albeit usually expected) drivers that have facilitated desired impacts:

- The running of the Challenge in a way that supported networking, bringing people together with the same focus and interests. As discussed under IEQ1.3, future collaboration beyond the Challenge has been cited as a benefit of participating in the Challenge, with some relationships facilitated directly by the Innovate UK, IUK Business Connect (previously known as KTN), CPN or NERC.
- Ongoing mentions in the media of the negative impacts of plastic packaging. Although some sector experts mentioned this as a barrier to designing more sustainable packaging, as it sometimes results in less-than-optimal solutions, such as switching to materials with a higher carbon footprint, it was also thought to be a benefit to Challenge projects, helping to ensure sustained interest in their R&D.
- Enactment of legislation; for example, HM Treasury's plastic packaging tax, and EU waste packaging regulations which those operating within Europe have needed to comply with.
- A couple of sector experts felt the UK Plastics Pact itself was likely to have facilitated impact.

"The networking opportunities that a programme of this nature provides; this programme can invite the cohort to interact with each other." (Stakeholder)

"[Plastic is] in the news every day, in one form or another, in industry and trade news and in the national news ramping up the pressure on everyone from government to retailers to the plastic packaging industry to focus on sustainability and circularity, because they can't not." (Stakeholder)

¹¹¹ Policy delays have been worsened by unclear guidance, report claims





Summary

Covid-19 was cited as an earlier barrier to progression of projects, but more recently projects have been affected by delays in UK policy enactment (e.g. EPR and Simpler Recycling). These delays slow down adoption and investment decisions across the value chain.

Most projects were able to progress and achieve much of what they set out to within their project; the more significant effect of the barriers encountered is the delay this has caused to realising their potential benefits.

Facilitators to desired impact also included UK policy, in the form of the plastic packaging tax. Work conducted by UKRI to bring individuals together, media pressure and alignment with the Pact were also cited as facilitating impact.





IE3: Were there any unintended adverse impacts from the activities of the Challenge that conflicted with the Aims of the programme?

This chapter explores any unintended adverse impacts from the Challenge that conflicts with its aims. It draws on evidence from primary interviews with applicants and reflections from the analysis of environmental impacts associated with projects.

Successful applicants did not report any adverse impacts arising from their participation in the Challenge. A handful of projects will deliver some negative environmental impacts, but these are unlikely to outweigh the positive impacts of these projects or of the funded portfolio overall.

Unintended consequences for applicants

There was little evidence of funded organisations diverting resources to the SSPP project at the expense of other activities/projects. Where receipt of funding has any knock-on effects, this was usually positive, improving other activity or plans for future activity. Specifically, interviewed successful projects did not report any evidence of:

- Adverse impacts on quality or extent of learning because of the way the Challenge was run.
- Slow-down in other activities relevant to SSPP Challenge objectives i.e. because timescales and requirements led projects to prioritise SSPP Challenge over other activities that were outside of the Challenge.
- SSPP funding leading to the exclusion from other opportunities.

There was evidence from two unsuccessful projects that they did not progress their projects / specific product development on the basis that competition from funded projects would be too great. This was also cited as a potential consequence by stakeholders.

"[There is] impact on unsuccessful projects who were doing the same things as successful projects, but now can't as the successful project beat them to it. But in the absence of SSPP either both would not have made it, or they would have had to compete." (Stakeholder)

Unintended negative environmental impacts

As reported in Section 2.1, there are some negative environmental impacts associated with a small number of projects. This includes six projects that will produce waste and five projects that have land or aquaculture requirements; these impacts are shown in Table 23 below.

The funded projects aim to deliver environmental improvements but, as with all activities, there will also be some resources required and therefore negative environmental impacts. The balance of environmental costs and benefits is often a subjective one; for example, it is difficult to directly compare waste





production to land-use change. However, the 'virgin fossil-based plastic packaging avoided' figures are an order of magnitude greater than the 'waste production' figures below, suggesting (on a pure tonnage basis alone) a net gain of quantifiable benefits for material resources.

Table 23	. Negative	environmental	impact.
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Impact Metric	Definition	Units	Achieved to date	Pipeline (2025- 2030)	no. of project s achieve d	no. of projects pipeline
Increased resource use:						
Water	Water used in production of packaging or recycling facilities	tonnes	60,170	701,117	3	6
Chemicals	Chemicals use in the production of packaging or recycling facilities	tonnes	5,000	30,000 ¹¹²	1	1
Waste production:						
Waste production	Waste produced during the production of innovative materials or running of new recycling processes ¹¹³	tonnes	4,022	32,351	2	6
Other environmental impacts:						
Additional land/ aquaculture requirements	Space required specifically for bio-based packaging production	hectares	0.6	759	1	4

¹¹³ Individual waste streams are not presented as they are unique to each project.





¹¹² One project gave data required for quantification for this metric.

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Land area	Land area used for bio- based packaging production	hectares	-	741		3
Aquaculture area	Aquaculture area used for bio-based packaging production	hectares	0.6	18	1	1

Stakeholders felt that some projects may have some adverse impacts that are challenging or impossible to measure using quantitative methods; for example, measuring the impacts of seaweed harvesting and drying on local ecosystems. Such impacts were classified as out of scope, as such considerations often require qualitative methods and long-term observation to fully understand the implications.

"You can't transition from a system that's highly optimised - like grocery retail around single use packaging - to something that's reusable or refillable without there being a need to build significant infrastructure in the first instance and that has that has a negative impact. There's also a pain period from an environmental perspective where some things are going to have to travel for hundreds of miles to get cleaned and brought back before a wash centre gets built 30 miles away; that kind of thing." (Stakeholder)

"The plastics sector is a huge financial sector so any changes made to it will result in some sort of backlash. Even bioplastics have their own problems in terms of chemicals, we need to make sure alternatives are not going to bring lots of new problems, but overall, the Challenge is wholly positive." (Stakeholder)

Summary

Successful applicants did not identify any adverse impacts for their organisation associated with participation in the Challenge. It is possible that applicants were less inclined to provide feedback that may reflect poorly on the Challenge or their projects; however, interview questions on this topic were, as far as possible, phrased in a way that sought to gather facts rather than asking respondents to reflect on negative aspects of the Challenge.

A small number of projects may have negative environmental impacts, but, based on the available evidence, the benefits are thought to outweigh these.





IE4: To what extent is the challenge on target to offer good value for money?

This chapter considers the value for money of the Challenge. It draws on evidence from primary interviews with stakeholders, analysis of investment and other data collated by UKRI, and revenue and jobs data provided by projects during interview.

Though it is too early to assess the full impacts of the SSPP Challenge, the Challenge has already delivered good value for money by exceeding its targets in securing and leveraging substantial R&I investment. This includes co-investment pledged (and realised) by funded projects, further funds raised by projects to cover costs that were not eligible under the fund, and investment secured in project technologies to take ideas to market.

Considering the entire claimed spend of the Challenge as of December 2024 (£41.6m) solely against the R&I investment leveraged in the sub-set of projects we determined through interview would not have progressed at all in its absence, the Challenge realises £68.45m of investment and additional R&I spend (£1.64 for each £1 spent). This suggests that, even in the unlikely scenario that all other activity and investments made by other funded projects would have gone ahead anyway, the Challenge delivers value for money. Particularly given the potential of these investments to deliver significant environmental and economic impacts for the UK.

IE4.1: How do the benefits of the programme compare to the costs?

As reflected in Section IE1.2, the Challenge derisked investment to the right level to make progression of projects attractive. The results of the Cost Effectiveness Analysis are outlined in the table below and are based on what has been achieved from £41.6m of claimed Challenge funds as of December 2024. Overall, Challenge funded projects have led to the creation 263 jobs. SSPP Challenge funds have leveraged £354.1m of further funding (£298m of co-investment including all forms of co-investment, as reported under IE1.1, and a further £56.1m in additional funds raised). This includes:

- Pledged co-investment of £73.1m, returning £1.76 of R&D investment per £1 spent. Pledged coinvestments are funds committed to Challenge funded projects by successful applicant organisations and their investors as a condition of funding. Pledged co-investment was assessed separately in the value for money assessment, from other forms of co-investment, to distinguish between investments participants were required to make, and further investments beyond what was required by the Challenge. As reported under IE1.1, total co-investment, including all forms of co-investment (pledged, accompanying, and follow-on investment) amounted to £298m.
- £281m pounds of investment and further funds raised, returning £6.75 of further funds per £1 spent. This includes aligned, accompanying and follow-on co-investment (totalling £224.9m), as tracked by UKRI, as well as any other investment that has been facilitated by the SSPP Challenge (totalling £56.1m), as reported by beneficiaries either in their project closure form or in the survey. For the purposes of the Cost Effectiveness Analysis, funds raised includes investment





outside the UK and investment into related projects which has not been included in the total coinvestment figure reported under IE1.1.

Table 24. Cost Effectiveness Analysis Results

	Pledged co- investment committed (£)	Funds raised (£)	Jobs created (FTE)
Total	73,123,913	281,029,434	263
Per £ spent by the Challenge	1.76	6.75	-

As shown in Table 25, a substantial proportion of the pledged co-investment and funds raised were achieved through large scale demonstrators and consequently with focus on mechanical and chemical recycling at higher TRL levels.

Table 25. Cost Effectiveness Analysis Results – per type of project

Competition	Pledged co- investment (£ per £ spent)	Further investment / funds raised (£ per £ spent)	Jobs created (FTE Total)
522 - SSPP - Demonstrators Round 1 (D1)	4.62	30.17	210
ISCF Smart Sustainable Plastic Packaging: Demonstrators Round 2 Full Stage	2.66	3.91	10
ISCF Future Plastic Packaging Solutions	0.66	4.31	10
SSPP Future Plastic Packaging Solutions Round 2	0.46	1.15	15
ISCF Smart Sustainable Plastic Packaging: Business-led R&D	0.66	5.04	14
1480 ISCF SSPP Collecting flexible plastic packaging waste at home	-	0.31	-
530 - SSPP- Feasibility Studies and Industrial Research (FS&IR)	1.60	3.50	4
521 - SSPP - Feasibility Studies for Demonstrators (FS4D)	0.40	118.90	-
SSPP - Enabling Research (ER)	0.22	1.51	-
IUK Business Connect (previously known as KTN) Activity	-	-	-
Direct Award	2.04	0.09	-





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Waste hierarchy	Pledged co- investment (£ per £ spent)	Further investment / funds raised (£ per £ spent)	Jobs created (FTE total)
Prevention and reduction	0.78	7.05	11
Refill and reuse	1.51	1.28	15
Chemical recycling	3.89	26.02	214
Mechanical recycling	1.83	5.18	18
Organic recycling	0.31	1.57	2
None	0.21	-	3
Plastic packaging lifecycle	Pledged co- investment (£ per £ spent)	Further investment / funds raised (£ per £ spent)	Jobs created (FTE total)
Design and manufacturing of packaging	0.55	3.9	17
Consumer purchases	1.97	1.72	13
Discarded by consumers	0.29	2.21	3
Collected by local authorities	2.50	0.09	-
Sorting and bulking	0.38	8.98	4
Reprocessing	2.73	10.85	226
None	0.18	-	-
TRL	Pledged co- investment (£ per £ spent)	Further investment / funds raised (£ per £ spent)	Jobs created (FTE total)
TRL 1-3	0.26	1.32	5
TRL 4-6	0.44	7.90	28
TRL 7-9	2.94	8.81	230

Considering total spend by the Challenge against just the sub-set of interviewed projects that were unlikely to have progressed without funding, the Challenge still achieves \pounds 68.5m of co-investment and further funds raised, equating to \pounds 1.64 per \pounds 1 of Challenge investment. Also including those that reported in interview they have progressed to greater scale or more quickly with funding, per \pounds 1 spent by the Challenge, \pounds 6.83 of co-investment and further funds have been raised overall.

All stakeholders agreed the Challenge has delivered good value for money, citing the leveraged investment and its role in accelerating change, enabling projects to achieve outcomes more quickly than they would have done without the support.





"I think it's been a great use of money and the ROI is much more than we thought.... it's the most rewarding Challenge that I've worked on for Innovate UK." (Stakeholder)

"We have hopefully started on a path, and I really hope it isn't the end of it. I think that the thematic funding thing is critical when you're funding innovation. I would hope a lot of the projects would back that up and say that SSPP has come through and not just provided the funding but provided a whole range of support to help maximise the potential for success for them." (Stakeholder)

"I think we've accelerated the transition as well. I think some of this stuff would have happened eventually, but it would have taken a lot longer to get there." (Stakeholder)

A unique element of the Challenge was the allocation of a substantial proportion of funding to late-stage demonstrator projects. This was perceived as a risky decision at inception, as a large proportion of the fund was allocated to fewer projects. Two demonstrator projects were unable to proceed, evidencing the risk associated with this decision; however, stakeholders believed that funding demonstrators was a good decision overall, helping the Challenge to realise larger impacts more quickly than it may have otherwise.

"[Smaller] projects tend to be smaller spends relative to the size of the company. So they're not exposed to the company risk, and they're going from TRL3 to TRL5 and that's successful then. But then you can argue, is ultimate success taking it to [TRL]5? Or is it that they actually get implemented to make a difference?" (Stakeholder)

Demonstrators represent a substantial proportion of impact that can be quantified at this time. These projects also represent a substantial proportion of realised R&I, and jobs. Despite the size of the investment made by these organisations themselves, those interviewed reported they are at least up and running more quickly than would have been the case in the absence of Challenge funding.

Summary

Per £1 spent by the Challenge, £1.76 of pledged co-investment has been realised and a further £6.75 of further investment / funds raised, equating to \$8.51 in total per £1 spent. The Challenge allocated a substantial proportion of funds to late-stage demonstrators, and although there has been risk associated with this (two were unable to proceed), those that have proceeded realise a high proportion of the benefits reported for the Challenge to date.

Overall, we conclude the Challenge represents good value for money, particularly when considered alongside the extent of environmental benefits arising as a result of activities funded by the Challenge and considering only a subset of these could be quantified at this time.





Theory of Change Review

This chapter examines whether the Challenge achieved its intended outcomes and impacts as set out within the Theory of Change. It draws on findings from all work elements and analysis presented in this report.

The balance of evidence indicates the Challenge worked as intended, with many of the anticipated outcomes being achieved and the Challenge influencing these as expected. For some impacts, it remains too early to tell, as their achievement will be beyond the lifetime of the Challenge and the UK Plastics Pact.

Table 26 provides an overview of the main intended outcomes and impacts of the Challenge specified in the ToC and tested as part of the evaluation, along with the underlying assumptions and our overarching conclusions, based on the evidence available to date. The RAG rating indicates the extent to which each has been achieved. In summary:

- The available evidence suggests the Challenge functioned largely as intended, stimulating additional R&I and collaboration to improve the sustainability of plastic packaging, in line with the targets of the UK Pact. This has included projects that aim to:
 - **Understand the environmental impacts of plastic packaging**: these businesses achieved outcomes, although learnings are not necessarily being shared more widely.
 - Understand the influence of consumer behaviour on the sustainability of plastic packaging.
- It is too early to tell what the full impacts of the Challenge will be, but many of the intended impacts are starting to be realised, with some achieving environmental gains (such as GHG emission reductions) and economic gains (such as revenue returns).
- The key assumptions underpinning the ToC are largely supported by the Theory of Change, with two exceptions. These two exceptions relate to:
 - Achieving international recognition, where there is early evidence of international investment stimulated by the Challenge, but limited evidence to date of a significant shift in the UK's reputation internationally.
 - Knowledge sharing and dissemination, where although efforts have been observed there is evidence findings have not always reached the wider sector. Some dissemination is also associated with a smaller pool of projects, with others expressing a desire to protect their IP.





Table 26. Overview of outcomes and impacts.

Key outcomes and impacts	Overarching conclusion	Key outcomes and impacts	Overarching conclusion
Increased investment in R&I to improve sustainability of plastic packaging	Achieved (see IE1.1)	A step change towards a more sustainable value chain for plastic packaging	Progress made but there has been greater achievement in specific areas. (see IE2.1)
More sustainable plastic packaging in line with the UK Plastics Pact targets	Achieved (see IE1.2)	A reduction in the environmental impact associated with plastic packaging	Too early to quantify benefits in full – but some reductions achieved already with further reductions in the pipeline (see IE2.2)
Collaboration and Networking	Achieved (see IE 1.3)	Economic benefits and contribution to clean growth	Too early to quantify benefits in full, but some evidence already of commercialised projects generating revenue and creating jobs. (see IE2.4)
Increased understanding of environmental impacts of existing and new plastic packaging	Achieved to some extent. Individual projects with assessments have achieved intellectual and business outcomes (e.g. IP, business models etc.) but understanding is not necessarily disseminated more widely. Assessments were also of varying quality in terms of enabling project quantification. (see IE1.4)	Increased international recognition and international finance (export and investment)	Achieved to some extent. The UK is not yet considered a leader in consumer smart sustainable plastic packaging. However, at least some individual Challenge funded projects have secured inward investment and export sales. (see IE1.6)





Increased understanding of consumer behaviour on the sustainability of plastic packaging	Achieved (see IE1.5)	-	-	
Assumptions		Overarching o	conclusion	
Announcement of the SSPP Challenge, and amount of funding on offer, sends a strong signal to the market (supply chains, value chains and investors) that the sustainability of plastics packaging for consumer products is a serious societal issue to be addressed, supporting and reinforcing pre-existing signals (e.g. the UK Plastics Pact).		Evidence collected to date supports this assumption.		
The SSPP Challenge is sufficiently attractive to individual subgroups of the relevant supply and value chains to encourage a diverse range of high-quality applications necessary to allow for a balanced portfolio of funded projects.		Evidence suggests that the Challenge has worked as intended, with applicants from across the value chain and with diverse focus of applications.		
Highlighting specific issues / problems in need of solutions (in calls for applications, promotional webinars etc.) encourages academics and actors in the plastic supply and value chains to pursue and/or prioritise efforts to address these issues/problems.		Evidence confirms that the SSPP Challenge both highlighted and encouraged applications in areas highlighted through the Challenge.		
The funding on offer is sufficient to de-risk investment, reducing the outlay required by applicants to progress innovative ideas and projects to an acceptable level given the risks and uncertainty involved.		Evidence supports the assumption that the SSPP Challenge has been sufficient to de-risk investment at the project level.		
Programme Management and activities delivered by the Cor and connect relevant actors a and value chains to collaborat otherwise.	governance by UKRI and re Programme bring together nd experts across the supply te where they may not have	Evidence shows collaboration across the supply chain, with evidence that some of these collaborations will continue beyond the lifetime of the Challenge.		
Support is provided to projects funded throughout delivery, to overcome barriers to the success of the project and/or maximise return on investment.		Where projects were open to or required support, evidence suggests that this was provided to them. There is a cohort of projects that did not feel they needed support and therefore were able to carry on with delivery without the need for intervention or advice.		





Projects funded by the Challenge are successful and progress sufficiently for the intended immediate outcomes and impacts to be realised.	Evidence suggests the Challenge has made good progress in this area, with many outcomes and impacts evidenced as achieved from <u>at least some</u> projects. There are still some desired outcomes and impacts that have not yet come to fruition but for most the balance of evidence suggests that these may be achieved beyond the lifetime of the Challenge. There are some for which the available evidence is insufficient to draw firm conclusions.
Outcomes and impacts from the SSPP Challenge enable the UK to build a reputation as a leader in consumer smart sustainable plastic packaging.	Evidence from international experts to date suggests that the UK is not yet considered a leader in consumer smart sustainable plastic packaging. Many did feel there was opportunity for the UK to build such a reputation through further investment and innovation going forward. At least some individual projects funded by the SSPP Challenge have gained traction internationally, achieving inward investment and securing export sales.
Knowledge sharing and dissemination (through the SSPP Challenge and the individual projects) supports ongoing innovation and further raises awareness among wider stakeholders and interest in plastic packaging value chain sustainability.	Evidence suggests that dissemination efforts have been observed but may not yet be reaching the wider audience of stakeholders and organisations less involved in the Challenge. The evaluation team recommend that there is a synthesis of learning from individual projects, both to facilitate any future assessment of longer-term impact and to ensure that that the Challenge achieves its potential in terms of impact.

The outcomes, impacts and assumptions of the ToC are considered in further detail in Appendix 4, including a brief discussion of the evidence underpinning our overall conclusion in each case.





Summary

In summary:

- The Challenge has made good progress against all six of its objectives, achieving most of the intended immediate outcomes as set out in the Theory of Change.
- This includes collaborative partnerships, learning outcomes such as business models and processes and efforts to disseminate findings (see Figure 18. Overview of Outcomes achieved below).



Figure 18. Overview of outcomes achieved.





- Some funded projects have already resulted in environmental and economic impact, with more in the pipeline for 2025-2030, as shown below in Table 27. This is likely to be an underestimate, as it is based on a sub-set of projects that were able to provide sufficient data.
- Funding demonstrators has helped the Challenge to realise environmental impact more quickly than would otherwise have been the case, with demonstrators representing a substantial proportion of impact that can be quantified at this time. This has increased the UK's capacity for plastic recycling, compared to what would have happened otherwise.
- Across all projects where an assessment was possible, the evaluation observed a high proportion of additional activity. Just under half of successful applicants considered in the project-level contribution assessment (20 out of 46) were unlikely to have progressed at all in the absence of the Challenge.
- The available evidence suggests the Challenge has delivered good value for money and there are opportunities to further increase its impact as the Challenge draws to a close and in the years that follow.

no. of no. of Achieved to Pipeline (2025projects projects Impact Metric Units date 2030) achieved pipeline Climate change: tonnes-1,602,720 **GHG** emissions reduction 32,169 17 18 CO₂e **Economic and Growth impacts:** £ 298,018,341 NA 81 NA Co-investment¹¹⁴ £ 27,501,357 392,970,748 10 17 Revenue FTE 263 N/A 25 N/A Jobs created People upskilled / trained FTE 239 N/A 65 N/A directly by projects People upskilled / trained FTE 539 N/A 1 N/A through Challenge funded BPF courses

Table 27. Overview of Quantified Impact.

¹¹⁴ Projects were not asked in interview to estimate investment beyond (i) what has been realised and (ii) investment where there were definite plans / commitment. Similarly, UKRI do not request investment beyond definite commitment in project monitoring processes. A single figure is therefore presented for co-investment rather than a breakdown between achieved and pipeline.





Glossary

Table 28. Glossary of terms

Terminology	Definition
Additionality	The extent to which an activity (and its associated outcomes and impacts) would have taken place at all, on a larger scale, earlier, or within a specific area or target group in the absence of the intervention (i.e. the SSPP Challenge).
Activities	The work undertaken by the SSPP Challenge, for example, awarding grants.
Active packaging	Packaging that provides one additional function, in addition to its primary purpose of containment and protection. For example, moisture absorption or oxygen control through desiccants.
Assessment	The activity undertaken by selected individuals (assessors) on all applications to the SSPP Challenge to determine the merits of each application against set criteria (assessment guide), typically resulting in an assessment score, which may be used to help rank the applications in order of merit.
Assumptions	Necessary conditions for expected changes from an intervention to be realised.
Benefit	The quantifiable and measurable change arising from an intervention that is perceived to be a positive outcome by its stakeholders.
Benefits realisation	The practice of monitoring whether the expected benefits from outputs are achieved.
Benefits realisation data	Data collated by UKRI on outputs and outcomes achieved by SSPP-funded projects.
Causality	Causality is a direct or indirect relationship by which a programme or policy (a cause) contributes to the production of an intended or unintended change in a system.
Co-investment (pledged)	Investment (in terms of eligible costs) a grant recipient declares it, and collaborators, plan to make on R&D activity part-funded through an ISCF Challenge programme, in line with ISCF business cases/project plans. Declaration of this pledge is made by signing the Grant Offer Letter (GOL).





Co-investment (Accompanying)	The extra public (but non-UKRI) and non-public investments in ISCF-funded R&I activity over and above those which are considered eligible costs as part of the grant subsidy. This may include further costs outlined in the business cases / project plans for that activity, made in order to achieve the agreed output or outcome, but which are not part of the grant subsidy. The accompanying co-investments may be seen as: (1) Accompanying Public Co-investment - from other public funded sources e.g. another government department (note: these are highly likely to count as state-aid - but it is assumed that it is the grant recipient's responsibility to manage state aid/subsidy regime implications). (2) Accompanying Private Co-investment - from private sources e.g. the grant recipients, banks, venture capitalist, angel investors etc (note: these do not include co-investment 3rd sector organisations (not-for-profit)). (3) Accompanying TSO Co-Investment - from 3rd sector organisations (TSO).
Co-investment (Aligned)	The investment in a technology/research area thematically aligned to, and evidently prompted by, ISCF-funded R&D activity(ies), e.g. as a result of increased confidence in the area created by the policy focus and ISCF Challenge an organisation starts a second related research project with no grant from the ISCF. As with Accompanying Co-investment this may be further broken down into Aligned Public, Private or TSO Co-investment.
Co-investment (Follow-on)	Investment to take to market, or exploit, outcomes from ISCF-funded R&D activity. Often involves combining with other intellectual property or technology to achieve commercial product. As with Accompanying Co-investment this may be further broken down into Follow-on Public, Private or TSO Co-investment.
Competition	Competitions in the SSPP Challenge include: 521 - SSPP - Feasibility Studies for Demonstrators (FS4D) 530 - SSPP - Feasibility Studies and Industrial Research (FS&IR) ISCF Future Plastic Packaging Solutions 522 - SSPP - Demonstrators Round 1 (D1) ISCF Smart Sustainable Plastic Packaging: Demonstrators Round 2 Full Stage SSPP - Enabling Research (ER) ISCF Smart Sustainable Plastic Packaging: Business-led R&D SSPP Future Plastic Packaging Solutions Round 2 1480 - ISCF SSPP Collecting flexible plastic packaging waste at home



Contribution Analysis	An approach for assessing causal questions and inferring causality in real-life programme evaluations. It offers a step-by-step approach designed to help managers, researchers, and policymakers arrive at conclusions about the contribution their programme has made (or is currently making) to particular outcomes. The essential value of contribution analysis is that it offers an approach designed to reduce uncertainty about the contribution the intervention is making to the observed results through an increased understanding of why the observed results have occurred (or not occurred) and the roles played by the intervention and other internal and external factors (including consideration of COVID-19, UK policy changes and the cost of living crisis).
Challenge-level contribution assessment	A structured approach to contribution analysis, assessing the difference made by the Challenge through a series of evidence tests, using process tracing principles. Contribution assessments using structured evidence tests are useful in situations where designing an experiment to test/prove causation is impractical and the intervention is just one of many potential influences on outcomes and impacts in a complex system.
Chemical recycling	Chemical recycling is the broad term used to describe a range of emerging technologies in the waste management industry which allow plastics to be recycled, that are difficult or uneconomic to recycle mechanically. By turning plastic waste back into base chemicals and chemical feedstocks, chemical recycling processes have the potential to dramatically improve recycling rates and divert plastic waste from landfill or incineration. ¹¹⁵ Chemical recycling includes recycling via any of the following four processes: Depolymerisation, Pyrolysis, Gasification and Hydrothermal Treatment. ¹¹⁶
Clean growth	Clean growth, as defined for the purpose of the ISCF, is growth supporting development, manufacture and use of low carbon technologies, systems and services. The SSPP Challenge evaluation adopted a broader definition, however, to include economic growth that does not compromise resources or contribute to greenhouse gas emissions.
Core Programme	The Core Programme includes projects but no competitions. These projects have been/will be funded by SSPP through direct funding. Core Programme funding is awarded where only one organisation is in a position to deliver a piece of work which is considered essential to the overall delivery of the programme, or used to commission projects that the Challenge needs to deliver in order to meet its objectives.



¹¹⁵ Chemical Recycling 101

¹¹⁶ <u>Chemical Recycling: A Beginner's Guide</u>

Counterfactual	What would have happened in the absence of an intervention. Where the report refers to self-reported counterfactuals – these are statements from beneficiaries (usually obtained through post-intervention surveys) regarding what would have happened or what they would have done otherwise, in the absence of the intervention. Winning Moves also consulted unsuccessful applicants as a proxy to consider what might have happened in the absence of the Challenge to the projects taken forward by successful applicants.					
Demonstrator	A near market technology addressing real issues by testing different solutions in real-life conditions.					
Evaluation	A systematic assessment of the design, implementation and outcomes of an intervention. It involves understanding how an intervention is being, or has been, implemented and what effects it has, for whom and why. It identifies what can be improved and estimates its overall impacts and cost-effectiveness. The SSPP Challenge evaluation included a baseline (Phase 1 evaluation), an interim evaluation (Phase 2 evaluation) and the current Phase 3 evaluation delivered by Winning Moves and Resource Futures between April 2023 and March 2025.					
Exploitation Plan	Exploitation plans set out how Smart Sustainable Plastics Packaging Challenge funded projects will use their results in developing, creating and marketing or improving a product, process, or service, or shaping a policy that could have a positive impact on the public's quality of life.					
Gross Domestic Product (GDP)	GDP measures the total value of all of the goods made, and services provided, during a specific period of time.					
Indicators	Metrics used by Winning Moves to evaluate the outcomes and impacts of the SSPP Challenge, reflecting conditions before, during and after the Challenge. Phase 1 of the evaluation produced an initial set of project-level and sector-level indicators for the evaluation; Winning Moves refined them with UKRI in phases 2 and 3 to produce a final set of indicators.					
Impact	An impact is the longer-term benefit or effect from an outcome or intermediate benefit, or the aggregate result of multiple benefits.					
Industrial Strategy Challenge Fund (ISCF)	The Industrial Strategy Challenge Fund (ISCF) was created to support research and development projects under the four themes of the former government's Industrial Strategy: clean growth, the ageing society, the future of mobility and artificial intelligence & the data economy. UKRI is responsible for implementing the ISCF, which is now referred to as the UK Research and Innovation (UKRI) Challenge Fund.					
Inputs	The resources required for the intervention to deliver activities.					





Innovate UK	Innovate UK, part of UK Research and Innovation (UKRI), is the UK's innovation agency. Their mission is to help companies to grow through their development and commercialisation of new products, processes and services, supported by an outstanding innovation ecosystem that is agile, inclusive and easy to navigate.					
Intelligent packaging	Packaging that senses a change in the environment and communicates or signals this information to an interested party in a two-step process. Functions include counterfeit protection, supply chain management control, food safety and marketing applications. Examples include ripeness indicators, time or temperature indicators, and near-field communication (NFC) labels.					
Knowledge Transfer Network (KTN) now known as Innovate UK Business Connect	Their aim is to connect innovators with new partners and new opportunities beyond their existing thinking – accelerating ambitious ideas into real-world solutions.					
Leverage ratio	The amount of investment into SSPP funded projects from sources outside of the Challenge per pound of awarded Challenge grant money.					
Mechanical recycling	Mechanical recycling involves reprocessing plastic waste through various mechanical processes. This widely adopted method is pivotal in recycling popular plastics like polyethylene (PET), high-density polyethylene (HDPE), and polypropylene (PP). The process involves collecting, sorting, shredding, washing and melting plastic before extruding it back to a plastic pellet. By sorting plastics by their material type, mechanical recycling enables us to repurpose used plastics into a variety of new applications. ¹¹⁷					
National Environment Research Council (NERC)	NERC is the UK's main agency for funding and managing research, training and knowledge exchange in environmental sciences.					
Outcomes	The result of the change derived from using the project's outputs and/or capabilities.					
Outputs	What is produced from activities delivered by the Challenge for example, products, services or other deliverables.					

¹¹⁷ <u>Chemical Recycling: A Beginner's Guide</u>



Programme Logic	A programme logic model sets out the resources and activities that comprise the programme, and the changes that are expected to result from them.					
Project Closure Form (PCF)	Upon their completion, SSPP-funded projects were required to submit a Project Closure Form, in which they answer questions related to their project's performance and related outputs, outcomes and impacts.					
'Smart' sustainable plastic packaging	Smart sustainable plastic packaging encompasses both 'Active packaging' and Intelligent packaging' (defined separately in this table).					
Technology Readiness Level (TRL)	Technology Readiness Levels (TRLs) are a type of measurement system, ranging from 1 to 9, used to assess the maturity level of a particular technology.					
Theory-based evaluation	Evaluation approaches that consider the available evidence with reference to a Theory of Change to draw conclusions about impact, including experimental evidence (where available) and non-experimental evidence.					
Theory of Change	Outlines how an intervention and its activities are intended to bring about outcomes and eventual impacts.					
UK Circular Plastics Network (UKCPN)	UK Circular Plastics Network is an activity supported by Innovate UK and UKRI aiming to engage innovators, scientists and changemakers to move towards a more circular economy for plastics.					
UK Plastics Pact	The Plastics Pact Agreement was established in 2018 and is a voluntary agreement focusing on the impact of consumer plastic packaging placed on the UK market. There are four targets Pact members work towards with an aim of achieving these targets by 2025:					
	• Eliminate problematic or unnecessary single-use packaging through redesign, innovation or alternative (reuse) delivery model;					
	• 100% of plastics packaging to be reuseable, recyclable or compostable;					
	• 70% of plastics packaging effectively recycled or composted;					
	• 30% average recycled content across all plastic packaging.					





Appendix 1: Project and Sector Indicators

Indicator Number	Description					
Project level indicator No.	Description					
Ind.1	Value of project-level investment in R&D - pledged co-investment (committed)					
Ind.2	Value of project-level investment in R&D - pledged co-investment (realised)					
Ind.3	Value of project-level investment in R&D - accompanying co-investment					
Ind.4	Value of project-level investment in R&D - aligned co-investment					
Ind.5	% of co-investment relative to the £149 million target					
Ind.6	Value of projects focused on increasing the recyclability, reusability or compostability of plastic packaging					
Ind.7	Value of projects focused on achieving a recycling /composting rate of 70%					
Ind.8	Value of projects focused on the elimination of problematic and unnecessary single-use plastic items					
Ind.9	Value of projects focused increasing the recycled content of plastic packaging					
Ind.10	Value of projects focused on understanding the environmental impacts of plastic packaging					
Ind.11	Value of projects focused on increasing the understanding of consumer behaviour associated with using more sustainable plastic packaging					
Ind.12	Value of projects that have made use of 'smart' technology to improve sustainability of plastic packaging					
Ind.13	Amount of inward investment received at project-level					
Ind.14	% of project-level investment in R&D relative to 2.4% of GDP target					
Ind. 102	Total project-level export sales					
Ind.18	Whether or not the fund is oversubscribed					

Table 29. Project and Sector Indicator descriptions.





Ind.19	Number of companies with export licences for SSPP-funded products and services					
Ind.20	Number of SSPP-funded collaborative projects between industry and academia					
Ind.21	Number of SSPP-funded collaborative projects between two or more parts of the value chain					
Ind.22	Number of SSPP collaborative projects between organisations that had not previously worked together					
Ind.23	Number of new jobs in the plastic packaging value chain due to SSPP-funded projects					
Ind.24	Number of people trained or upskilled stemming from SSPP-funded projects					
Ind.39	Number of projects focused on increasing the recyclability, reusability or compostability of plastic packaging					
Ind.40	Number of projects focused on achieving a recycling/composting rate of 70%					
Ind.41	Number of projects focused on the elimination of problematic and unnecessary single-use plastic items					
Ind.42	Number of projects focused increasing the recycled content of plastic packaging					
Ind.43	Number of projects focused on understanding the environmental impacts of plastic packaging					
Ind.44	Number of projects focused on increasing the understanding of consumer behaviour associated with using more sustainable plastic packaging					
Ind.45	Number of projects that have made use of 'smart' technology to improve sustainability of plastic packaging					
Ind.47	Number of academic papers published					
Ind. 103 (replacing Ind. 48-57 dropped from the evaluation)	Number of non-academic papers published					
Ind.58	Number of patents in the process of being granted					
Ind.59	Number of patents granted					
Ind.60	Number of signed IP licence agreements					
Ind.61	Number of UK events where beneficiaries held a speaking slot					





Ind.62	Number of international events where SSPP beneficiaries held a speaking slot					
Ind.63	Number of international awards won					
Ind.64	Amount of plastic packaging beneficiaries are responsible for POM					
Ind.65	Market share of SSPP-funded packaging that is recyclable					
Ind.66	Market share of SSPP-funded packaging that is compostable					
Ind.67	Market share of SSPP-funded packaging that is reusable					
Ind.68	Tonnes of 'problematic and unnecessary' single-use plastic packaging removed from market (e.g. substituting with less damaging material) due to SSPP funding					
Ind.69	Tonnes of single-use plastic packaging not categorised as 'problematic and unnecessary' POM by SSPP-funded projects					
Ind.70	Market share of single-use plastic packaging not categorised as 'problematic and unnecessary' POM by SSPP-funded projects					
Ind.71	Average % of recycled content for SSPP-funded plastic packaging					
Ind.72	Number of new / improved business models that have been informed by SSPP- funded projects					
Ind.73	Number of new / improved designs that have been informed by SSPP-funded projects					
Ind.74	Number of new / improved standards that have been informed by SSPP-funded					
	projects					
Ind.75	projects Number of new / improved processes that have been informed by SSPP-funded projects					
Ind.75 Sector-level indicator No.	projects Number of new / improved processes that have been informed by SSPP-funded projects Description					
Ind.75 Sector-level indicator No. Ind.25	projects Number of new / improved processes that have been informed by SSPP-funded projects Description Value of sector-level investment in R&D					
Ind.75 Sector-level indicator No. Ind.25 Ind.26	projects Number of new / improved processes that have been informed by SSPP-funded projects Description Value of sector-level investment in R&D Amount of inward investment received at sector-level					
Ind.75 Sector-level indicator No. Ind.25 Ind.26 Ind.27	projects Number of new / improved processes that have been informed by SSPP-funded projects Description Value of sector-level investment in R&D Amount of inward investment received at sector-level % of sector-level investment in R&D relative to 2.4% of GDP target					
Ind.75 Sector-level indicator No. Ind.25 Ind.26 Ind.27 Ind.29	projects Number of new / improved processes that have been informed by SSPP-funded projects Description Value of sector-level investment in R&D Amount of inward investment received at sector-level % of sector-level investment in R&D relative to 2.4% of GDP target Number of companies with export licences across the sector					





Ind.31	National news outlets - article tone					
Ind.32	National news outlets - article theme					
Ind.33	Trade news outlets - proportion of outlets that published articles					
Ind.34	Trade news outlets - article tone					
Ind.35	Trade news outlets - article theme					
Ind.36	Number of jobs in the plastic packaging value chain					
Ind.78	Amount of plastic packaging the sector is responsible for POM					
Ind.79	Market share of plastic packaging that is recyclable					
Ind.80	Market share of plastic packaging that is compostable					
Ind.81	Market share of plastic packaging that is reusable					
Ind.82	Tonnes of 'problematic and unnecessary' single-use plastic packaging on market					
Ind.83	Market share of 'problematic and unnecessary' single-use plastic packaging					
Ind.84	Average % of recycled content for plastic packaging on the market					
Ind.85	Imports of plastic packaging					
Ind.86	Exports of plastic packaging					
Ind.87	Quantity of plastic packaging collected					
Ind.88	% of plastic packaging collected					
Ind.89	Quantity of plastic packaging sorted					
Ind.90	% of plastic packaging sorted					
Ind.91	Quantity of plastic packaging landfilled					
Ind.92	% of plastic packaging landfilled					





Ind.93	Quantity of plastic packaging incinerated
Ind.94	% of plastic packaging incinerated
Ind.95	Amount of plastic packaging exported for recycling
Ind.96	Amount of plastic packaging being recycled domestically
Ind.97	Amount of plastic packaging being recycled (total)
Ind.98	Plastic packaging recycling rate
Ind.99	Contamination levels of plastics entering Materials Recovery Facilities (MRFs)
Ind.100	Output quality of plastics from Materials Recovery Facilities (MRFs)





Appendix 2: An evolving landscape

UKRI launched the SSPP Challenge in a relatively busy period of national policy development for resources and waste.

The Resources and Waste Strategy for England^[1] (December 2018) and the 25 Year Environment Plan (January 2018) set out the Governments ambitions, targets and key activities. The aims of SSPP and the projects it funded were designed to address many of the challenges in meeting Plastics Pact targets and challenges faced in the UK plastics sector in general - reducing carbon impacts of production and waste, increasing the range of plastic packaging collected and reprocessed especially plastic films, and increasing recycled content including food contact.

Market conditions have been challenging for companies trying to address these challenges at scale in the UK, as shown by several plant closures and companies going into administration. Since the outset of the Challenge, though some of the planned legislation has come into force directly affecting the UK plastic packaging landscape, delays in other policies have impacted the industry. The implication of these delays is that the market lacked the strong drivers that were expected to stimulate changes in supply and demand, financial viability, and value-chain alignment.

Recent announcements are providing more clarity, and early movers will already be planning for the changes, with policy changes now expected to come into effect in the next two years.

The following summary outlines key policy changes and their observed or anticipated impacts on the market, providing context for the discussion of the outcomes and impacts of the SSPP Challenge that follows.

What might UK policy changes and wider influences mean for the SSPP Challenge funded projects?

The HM Treasury's plastic packaging tax and PPWD are drivers for achievement of the UK Plastic Pact target to increase the average recycled content within packaging to 30%. This may act as an additional facilitator for projects with a focus on this aim. Similarly, single-use plastic bans support the Pact's target to eliminate all single use unnecessary and problematic plastics.

Delays to enactment of the Simpler Recycling policy and pEPR reforms may slow down decisions by the value chain to invest in innovative technology, services and products, with key decision makers waiting until they fully understand their legislative responsibilities. This may slow down decisions to adopt innovations from the Challenge.

Any deviation in policy between the UK and Europe can make decisions more complex for the value chain, especially for organisations that have operations outside the UK. In practice, this can mean policy outside the UK influences packaging sold within the UK. Equally, some UK policy may have a smaller impact if the UK market is a small proportion of an organisation's overall revenue.

UK Policy Changes

Governments across the UK have introduced market restrictions in specific product areas.

Single-use plastic bans have been implemented in England (in two stages, 2020 and 2023), Wales (in 2023 and due in 2026), Scotland (in 2022), and Northern Ireland (date TBC). The legislation varies by





nation, but common items are single-use plastic drinks stirrers, balloon sticks, cutlery, Expanded / Extruded Polystyrene food and drink containers, plates, bowls, straws, cotton buds and wet wipes. ¹¹⁸ ¹¹⁹

In 2021, changes in England increased the single-use carrier bag charge from 5p to 10p and extended it to all retailers.¹²⁰ The Welsh Government will ban the bags (with a few exceptions) by Spring 2026.¹²¹ The Welsh Government has also banned oxo-degradable plastics (effective in 2026),¹²² but is the only UK nation to do so. Defra and BEIS published a call for evidence on standards for biobased and biodegradable plastics, but this was not progressed.¹²³

HM Treasury's plastics packaging tax came into force in April 2022, aiming to deliver on the Government's commitment to stimulate demand for recycled plastic by introducing a tax on plastic packaging with less than 30% recycled content. The 2023/24 data reports 46% of plastic packaging met the threshold of containing 30% recycled plastic.¹²⁴ The Government recently confirmed that chemical recycling could be accounted for in tax calculations for recycled content via a mass balance approach.¹²⁵ This will create considerable tax benefits for chemical recycling as the tax is set at over £200 per tonne, and potentially signals increased Government acceptance of the technology.

The government has yet to implement a **deposit return scheme (DRS) for drinks containers**, with the planned start date moved from 2023 to October 2027. The Scottish DRS plans for an earlier launch collapsed in October 2024 due to conflicts with the Internal Market Act,¹²⁶ with Biffa taking legal action against the Scottish Government as a result for £200 million in lost investment costs.¹²⁷ In November 2024, the Welsh Government announced its split from the Defra DRS scheme, timeline and management organisation, signalling an interest in maintaining existing high recycling performance, reuse and the inclusion of glass.¹²⁸ All schemes will capture PET drinks bottles and are expected to reduce litter whilst producing a higher volume of homogeneous waste material for recycling. The 2021 UK impact assessment estimated the net cost to business as £347m per annum.¹²⁹

Packaging EPR (pEPR) reforms were similarly delayed from a 2023 start, now scheduled for October 2025. The legislation will increase the total cost producers contribute to waste collection and recycling by roughly 4.5 times, from roughly £600 million (the total PRN market in 2023, half of which was for plastic

¹²⁹ Introducing a Deposit Return Scheme on beverage





¹¹⁸ Single-use plastics bans and restrictions

¹¹⁹ <u>UK-wide ban on wet wipes containing plastic to be put into law.</u>

¹²⁰ <u>10p plastic bag charge to come into force on 21 May</u>

¹²¹ <u>The Environmental Protection (Single-use Plastic Products) (Wales) Act 2023</u>

¹²² <u>The Environmental Protection (Single-use</u>

¹²³ <u>Standards for bio-based, biodegradable, and compostable plastics</u>

¹²⁴ Note that a further 12% was exempt from the legislation and so the level of recycled content is unknown <u>Plastic Packaging Tax</u> (<u>PPT</u>) statistics commentary

¹²⁵ <u>HMRC approve chemical recycling in Plastic Packaging Tax</u>

¹²⁶ Deposit Return

¹²⁷ Waste firm sues for £200m over collapsed deposit return scheme

¹²⁸ <u>A Deposit Return Scheme that delivers for Wales</u>

packaging¹³⁰) to an expected £2.7 billion per year under pEPR.¹³¹ The pEPR fees will initially vary by material with plastic as the second most expensive per tonne, roughly double the price of glass or paper/card.¹³² Eventually the fees will be eco-modulated based on the resale value and recyclability of the material.

Material industry bodies have highlighted the plastics packaging tax, DRS and pEPR will influence packaging material and consumer format choices based on cost, particularly in relation to DRS, e.g. that it could push consumers to shift from buying multipacks of drinks (24-pack of aluminium cans having 24x the deposit) to fewer large PET bottles (4x the deposit).¹³³

The simpler recycling policy aims to make waste collections in England more consistent. It mandates dry recycling collections (including plastics) from businesses and non-domestic properties by 31st March 2025 and from all households by 31st March 2026, with the inclusion of plastic film packaging and plastic bags by March 2027. This will increase the amount of plastic packaging separated at source and sent for recycling. Mandatory plastic recycling collections will include:¹³⁴

- Plastic bottles made of PET, PP and HDPE
- Pots, tubs and trays made of PET, PP and PE
- PE and PP plastic tubes larger than 50mm x 50mm
- Cartons for food, drink and other liquids
- Plastic film packaging and plastic bags made of mono-PE, mono-PP and mixed polyolefins PE and PP, including those metallised through vacuum or vapour deposition.

Sector experts expect further legislative changes. The Government has signalled that the **UK Emissions Trading Scheme (ETS) scope** will be expanded to include Energy from Waste (EfW), subject to consultation.¹³⁵ This is expected to have significant impact for fossil-based plastics, driving improved source-separation and reprocessing.¹³⁶ Chemical recycling of plastics is planned to remain exempt.¹³⁷

UK environmental legislation has diverged from the EU since the UK withdrawal from the EU (Brexit) came into effect in 2020. The most relevant EU requirements are described below for revisions to the Packaging and Packaging Waste Directive (2022), the Single Use Plastics Directive (2019), recycled plastics for food contact (2022), guidance on biobased and biodegradable plastics (2022), and a financial levy on non-recycled plastic packaging waste (2021).

The Packaging and Packaging Waste Directive (PPWD) revisions require all packaging to be designed for recycling by 2030 and recycled at scale by 2035. They specify a minimum recycled content in plastic packaging ranging by packaging type from 10%-35% by 2030 and rising to 50%-65% by 2040 (with some

¹³⁷ Energy Advice Hub: UK ETC expansion: what this means for the waste sector





¹³⁰ 2023 PRN Expenditure – Biggest Boost to Recycling Funding Since System Began

¹³¹ Food and drink sector sounds alarm over EPR costs

¹³² <u>Gov.uk: Extended producer responsibility for packaging: illustrative base fees</u>

¹³³ Alupro: Deposit Return Scheme

¹³⁴ Gov.uk: Extended producer responsibility for packaging: illustrative base fees

¹³⁵ Gov.uk: UK Emissions Trading Scheme scope expansion: waste consultation

¹³⁶ <u>Circular: The big changes ahead for the UK Emissions Trading Scheme</u>

exceptions), and per capita packaging waste reduction targets of 5% by 2030, 10% by 2035 and 15% by 2040.¹³⁸ They also introduce a ban on overpackaging, a mandatory DRS for plastic and metal beverage containers, and requiring very lightweight plastic carrier bags to be industrially compostable plus a per capita reduction target. The PPWD sets reuse and refill targets including beverages, takeaway food, and transport packaging (pallets etc.), with lower targets (5%-20% reusable packaging) set for 2030 and much higher targets (15%-90%) for 2040, with a requirement to set up refill systems. The plastic packaging recycling targets are set at 50% for 2025 and 55% for 2030.

The single-use plastic bans legislation in the UK and devolved administrations largely aligns with the products banned under the EU Single Use Plastics Directive. Some differences exist, and the EU Directive introduces requirements for other products which have not been replicated in UK legislation, such as collection rate and recycled content targets for plastic bottles, extended producer responsibility, product marking, separate waste collection and awareness raising.

Wider influences on UK Policy

New EU regulation aims to ensure the chemical and microbiological safety of recycled plastic intended for food contact.¹³⁹ In this context of food contact, it sets out rules for manufacturing with recycled plastic content and requires recycling processes to be authorised by the European Food Safety Authority ('EFSA') and with chemical composition below the maximum safe levels published by the EFSA.

The EU also provided guidance on biobased and biodegradable plastics including standards, labelling, and sustainable sourcing of biomass, tying together legislative instruments relevant for these polymers and signposting to standards bodies.¹⁴⁰

Direct financial incentives are already in place with the EU COVID-19 recovery plan introducing a levy on Member States based on the quantity of non-recycled plastic waste.¹⁴¹ This raised \notin 7.2 billion in 2023 (4% of the EU's total revenue) but with a shortfall of a further \notin 1.1 billion due to issues in implementation.¹⁴²

Whilst UK environmental legislation has diverged from the EU since Brexit, EU legislation still influences the UK market. For example, the EU Single-Use Plastic Directive requires caps on beverage containers to be tethered to the base and, whilst not a legal requirement in the UK, many beverage containers in the UK now have a tethered cap. This is due to global supply chains serving multiple countries and the inefficiency of producing 'untethered' products just for the UK market. UK companies seeking to export their products to EU markets will, of course, also have to comply with EU regulations.

The UK Government is also participating in development of the **UN global treaty** for a legally binding agreement on plastic pollution. Negotiations failed to produce an agreement in the fifth Intergovernmental Negotiating Committee in December 2024 and are expected to reconvene in 2025.



¹³⁸ European Commission: Regulation of the European Parliament and of the Council report

¹³⁹ Food.ec.Europa.eu: Plastic Recycling

¹⁴⁰ Environment Europa: Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions

¹⁴¹ CMS Law: Plastics and packaging laws in the European Union

¹⁴² ECA Europe: Special report 16/2024: EU revenue based on non-recycled plastic packaging waste: A challenging start hindered by data that is not sufficiently comparable or reliable.

Potential policies cover reducing virgin plastic production, hazardous chemicals, single-use plastics, and reuse.

Looking forward

The British Plastics Federation published its second Recycling Roadmap in 2024 which forecasts a doubling of UK mechanical recycling between 2022 and 2030, whilst exports shrink by around a third, and chemical recycling only becomes a significant treatment method between 2030 and 2035.¹⁴³ Plastics Europe published its roadmap in 2023, focussing on decarbonisation through circularity, low-carbon energy, carbon capture and storage, biobased plastics and recycling.¹⁴⁴ It estimates €235 billion in additional investments and operational costs is needed for the sector to reach Net Zero by 2050.¹⁴⁵ However, the plastics recycling market in Europe is experiencing similar challenges to those seen in the UK. Growth in European recycling capacity slowed in 2022, with the plastics recyclers industry body citing low demand for recyclate due to low prices for virgin plastic.¹⁴⁶

The merits of chemical recycling are still debated, and Zero Waste Europe has published several critical reports including carbon impacts¹⁴⁷ and market readiness.¹⁴⁸

The global market for biobased plastics totalled 1.8Mt in 2022, roughly 0.5% of the plastics production market.¹⁴⁹ Large players are interested in the UK market, with Brazilian company Braskem presenting at the Innovate UK Global Research & Innovation in Plastics Sustainability (GRIPS) conference in 2024 and operating a largescale production plant of 260,000 tonnes per annum in Brazil.¹⁵⁰

There has been a renewed focus on the carbon impacts of plastics leading up to COP29 and the UN Plastics Treaty negotiations. Research by CleanHub reports that plastics account for around 3% of global GHG emissions, far more than aviation or shipping.¹⁵¹ The emissions are mostly from plastics production (60%), distribution (29%) and disposal (11%). A study by Berkley Lab produced a higher estimate for plastics at 5% of global GHG emissions, almost four times higher than aviation.¹⁵²

The relationship between plastics and food waste continues to develop. Recent research by the WWF suggests food waste contributes 10% of global GHG emissions.¹⁵³ However, not all food plastic packaging is seen as necessary and Waste Resources Action Programme (WRAP) and Policy Connect are calling for

¹⁵³ WWF: Driven to waste global food loss on farms





¹⁴³ BPF Recycling Roadmap

¹⁴⁴ <u>Plastics Europe: The Plastics Transition</u>

¹⁴⁵ LetsRecycle: Plastics Europe launch "Plastics Transition" roadmap for EU

¹⁴⁶ Plastic Recyclers European plastic recycling industry growth threatened by shrinking market

¹⁴⁷ Zero Waste Europe: Climate impact of pyrolysis of waste plastic packaging in comparison with reuse and mechanical recycling report

¹⁴⁸ Zero Waste Europe: Fifty years - chemical recycling's fading promise reports

¹⁴⁹ European Plastics: Bioplastics market development update 2024

¹⁵⁰ Braskem expands its biopolymer production by 30% following an investment of US\$ 87 million

¹⁵¹ <u>Circular online: Plastic contributed more emissions than aviation industry report</u>

¹⁵² Berkeley Lab: Climate Impact of Primary Plastic Pollution

the UK government to ban packaging (of all materials) on fruit and vegetables, starting with a list of 21 food products.¹⁵⁴

There has been a high volume of refill and reuse trials, including Tesco, Loop, M&S, Procter and Gamble, Unilever, Waitrose, Morrisons, Asda, Aldi, and McDonalds in the Plastics Pact members alone.¹⁵⁵ ¹⁵⁶ ¹⁵⁷ However, national-scale roll-out of reuse and refill schemes is yet to be seen, and in 2024 UK-based company Dizzie announced the closure of its pioneering online grocer 'prefill' and return business.¹⁵⁸

Restrictions on plastic waste exports are being discussed by Government following exposés on mismanagement of waste from the UK. MPs on the Environment, Food and Rural Affairs Committee called for a ban on all plastic waste exports in 2022,^{159 160} and the previous UK Government's 2019 manifesto committed to banning exports to non-OECD countries¹⁶¹ which was due for consultation in 2024.¹⁶²

¹⁶² <u>UK Parliament: Written questions, answers and statements - Plastics: Waste</u>





¹⁵⁴ WRAP: Removing Packaging Uncut Fresh Produce report

¹⁵⁵ WRAP UK Plastics Pact Annual Report 2019-20

¹⁵⁶ WRAP UK Plastics Pact Annual Report 2020-21

¹⁵⁷ WRAP UK Plastics Pact Annual Report 2021-22

¹⁵⁸ Packnode: Dizzie's Closure: Challenges, Lessons and the Future of Reusable Packaging

¹⁵⁹ <u>UK House of Commons Committees: The price of plastic</u>

¹⁶⁰ UK Parliament Committees: Environment, food and rural affairs - MPs call for ban on all plastic waste exports

¹⁶¹ UK Parliament Committees: Environment, food and rural affairs - MPs call for ban on all plastic waste exports - EU strategy for plastics.

Appendix 3: UK Plastic Pact Target Progression

This appendix provides current understanding on the likely achievement of UK Plastic Pact targets by 2025.

Plastic Packaging Placed on Market

The WRAP Plastics Market Situation report 2022 reveals the total amount of plastic packaging placed on the market in the UK fell by 3% between 2019 and 2021, driven by a fall in HDPE and PET.¹ It also reports a 122% increase in PE, half of which was PE film "demonstrating a movement towards lightweight packaging". In 2021, all UK local authorities collected plastic bottles, 83% plastic pots, tubs, and trays, and 16% collected at least one type of plastic film, but only 5% collected all films.

The plastic packaging recycling rate, shown in Figure 19, fluctuated since 2019 leading to a rate of 65% recycling in 2023. As a comparison, Defra reports the UK recycling rate across all packaging materials was 65% in 2023, with the highest performing materials being metal (72%), paper/card (73%) and glass (68%).¹⁶³ The plastic packaging recycling rate of 65% compares favourably to the targets of 50% for 2025 and 55% for 2030 in the EU Packaging and Packaging Waste Directive, which the UK regulations are designed to implement.¹⁶⁴ ¹⁶⁵ This is against a background of limited improvements in the wider recycling and waste streams. For example, England failed to meet the municipal waste recycling target of 50% in 2020 and is unlikely to meet the target of 55% in 2025¹⁶⁶. The current municipal waste recycling rate is 42% in 2022, having barely increased in over a decade from 41% in 2010¹⁶⁷.



Figure 19. Plastic packaging recycling rate (sector-level indicator 98, calculated from data in the National Packaging Waste Database)



¹⁶³ Gov.uk: UK statistics on waste: packaging waste

¹⁶⁴ Note: The UK regulations set annual targets for obligated businesses which have been set higher than the national targets of the EU Packaging Waste Directive.

¹⁶⁵ Environment Europa: Packaging Waste

¹⁶⁶ Gov.uk: Progress report on recycling and recovery targets for England 2020 corporate report

¹⁶⁷ Department for Environment, Food and Rural Affairs - Resources and Waste Strategy Monitoring Progress

Other market changes are apparent in the progress reports of the UK Plastics Pact whose members represent a large section of the market controlling 85% of plastic packaging sold through UK supermarkets and over 75% of all consumer plastic packaging.¹⁶⁸

Assessment of Plastic Pact Targets

- Target 1: Eliminate problematic or unnecessary single-use plastic: the Plastics Pact target to eliminate 100% of problematic plastics is very nearly met (99.6%), strongly supported by the single-use plastic legislation which banned most of the items covered by the Pact's target. The ambition has since been raised, adding six more packaging items to this target.
- Target 2: 100% of plastics packaging to be reusable, recyclable or compostable: Based on WRAP Plastics Pact reports, as at the end of 2022 the recyclability of plastic packaging (sector-level indicator 79) has only increased 5% since 2019, now at 69%, and 70% reusable or recyclable, well below the target of 100% for 2025.
- Target 3: 70% of plastics packaging effectively recycled or composted: Plastic packaging recycling is currently 65%, as described above, still below the Pact target of 70%.
- Target 4: 30% average recycled content across all plastic packaging: The reported recycled content in plastic packaging (sector-level indicator 84) is up significantly from 9% in 2018 to 24% at end of 2022 but with progress yet to go towards the 30% target for 2025.

¹⁶⁹ WRAP UK Plastics Pact Annual Report 2022-23





¹⁶⁸ WRAP: Retailers and Brands

Appendix 4: Market Context Estimations

As discussed in Section IE2.2, three scenarios of the market context for plastic packaging have been estimated, drawing upon two reports: the WRAP 2022 Plastics Market Situation report²¹ and the BPF Recycling Roadmap repor²². The market context estimations for 2030 and 2035 are summarised below. Table 30

Table 30. Indicative market context 2030 and 2035

ktonnes/year	2030			2035		
Plastic packaging	Worst	BAU	Desired	Worst	BAU	Desired
Plastic packaging POM	2,838			2920		
Plastic packaging (rigid)	1,990			1,958		
Plastic packaging (flexibles)	848			962		
Recycled in UK	1003	1,328	1,519	1,355	1,768	2,334
Mechanical recycling	940	1,245	1,227	1,240	1,601	1,716
Chemical recycling ¹⁷⁰	50	68	100	100	146	400
Export for recycling	643	527	409	732	516	352
Composting/AD ¹⁷¹	12	15	192	15	20	218
Reuse ¹⁷²	0	96	409	0	258	564

To achieve a desired scenario, BPF put forward the need for:

- 1. Funds from the HM Treasury's plastic packaging tax to be invested in recycling infrastructure.
- 2. Support for innovation and commercialisation of sorting and recycling technologies.
- 3. Clear, concise communication to residents and businesses.



¹⁷⁰ Assumed all in the UK and included in recycled in UK figure.

¹⁷¹ Assumed composted in UK and included in recycled in UK figures.

¹⁷² Assumed to be related to transit packaging and not consumer plastic packaging.

- 4. Consistent collections across all Local Authorities.
- 5. Increased collection infrastructure of plastics in addition to kerbside.
- 6. Reforms to legislation including the PRN system, food contact regulations, plastic packaging tax (mass balance approach), verification and traceability of recycled content, quality standards, design guidance and increased use of recyclate into packaging.

The policy and regulatory changes outlined in Appendix 2 are addressing points 1 and 6. The longer-term implications of these changes is that more and more plastic packaging POM will have recycled content, creating demand for high quality recyclate from recycling facilities, thus encouraging collection and reprocessing, where the economics make sense for plastic packaging producers.

Assuming policy and regulatory changes come into force by 2030, an estimate of key sector indicators has been carried out for 2030 and 2035, summarised in Table 31 under a BPF BAU and desired scenarios.

Sector indicator	Description	2023	2030	2035
78	Amount of plastic packaging the sector is responsible for POM ktonnes	2,641	2,838	2,920
80	Market share of plastic packaging that is compostable %	0.05%	0.6%/ 11.4%	0.6%/ 9.4%
81	Market share of plastic packaging that is reusable %	0.34% [data from 2022]	2%/10%	6%/ 13%
84	Average % of recycled content for plastic packaging on the market %	24% [data from 2022]	30%	50%
88	% of plastic packaging collected	69%	70%	75%
95	Amount of plastic packaging exported for recycling ktonnes	611	527/ 409	516/ 352

Table 31. Indicative sector indicators 2030 and 2035




Sector indicator	Description	2023	2030	2035
96	Amount of plastic packaging being recycled domestically ktonnes ¹⁷³	575	1,328/ 1,519	1,768/ 2,334
97	Amount of plastic packaging being recycled (total)	1,186	1,855/ 1,928	2,284/ 2,686

¹⁷³ 2030 and 2035 figures include plastic packaging that is composted & chemically recycled assuming all chemical recycling is in the UK.





Appendix 5: Theory of Change Review

Achievement of outcomes

Intended outcomes of the Challenge are outlined and discussed under four key areas below in Table 32 below.

Table 32. Intended Outcomes of the Challenge

Outcomes	Discussion	Related evaluation question
 Collaboration and Networking Active connections established between organisations across different parts of the plastic packaging supply and value chains. Collaborative networks created within the plastic packaging supply and value chains. Projects operating across whole of value chain. Network sustained and used for collaborative ventures. 	As discussed under IEQ1.3, the Challenge has both facilitated new collaborations and given project team representatives / organisations the opportunity to work further with those they had relationships with. These collaborations are across the value chain and evidence from projects suggests that many of them are continuing beyond the lifetime of the Challenge.	IE1.3
 Innovation and project achievements Enhanced knowledge base empowers designers and supply chain actors to make sustainable decisions throughout the plastic packaging process. Standards development activities result in the creation of a Publicly Available Specification (PAS). Innovations in materials, processes or technologies that reduce environmental impact of plastic packaging developed and/or tested. Product design innovations to increase recyclability, reusability or compostability of plastic packaging developed and/or tested. Innovations that reduce use of single-use packaging items are developed and/or tested. Innovations in materials, processes or technologies that reduce environmental impact 	The Challenge has supported innovation, with some projects demonstrating world-first technology. The Challenge itself encouraged increased R&I to improve the plastic packaging value chain, discussed in detail under IE1.1. Funded projects have resulted in the development of at least 11 standards, with six patents granted and a further 18 pending. Several projects reported that they had created business models and developed new processes and designs, many of which were associated with projects that would either not have progressed or may have done so but at a slower time scale or smaller scale without Challenge funding. Three of the four Plastics Pact targets are unlikely to be achieved by 2025, but there are projects with innovation and associated environmental impact that will contribute to their aims. Much of this impact will be beyond the lifetime of the Pact. It is expected that between 2025 and 2030, projects will recycle over 620,000 tonnes of plastic packaging, contributing to Target 3 (70% of plastics packaging effectively recycled or composted). Reuse/refill models and product innovation that avoids the use of single use plastics are predicted to be over 13,000 tonnes between 2025 and 2030, in alignment with Target 2 (100% of plastics packaging to be reusable, recyclable or compostable).	IE1.1, IE1.4, IE1.5

Outcomes	Discussion	Related evaluation question
 of plastic packaging are demonstrated. Product design innovations to increase recyclability or compostability of plastic packaging are demonstrated. Innovations that reduce use of single-use plastic packaging items are demonstrated. A measurable impact on Plastics Pact targets is delivered. UK response to UN Treaty on Plastic Pollution. Private investment in SSPP R&D in the UK is unlocked. Standards improved or developed that draw on new understanding. Intellectual property secured in UK companies. Improved business models are trialled that draw on improved understanding. New information is gained around consumer engagement with plastic packaging and sustainable processing of plastic packaging. Objective aligned with innovation outcomes: Objective 1: Increased investment in R&I to improve sustainability of plastic packaging value chain. 	As discussed under IE1.1, Objective 1 - to increase investment in R&I to improve sustainability of plastic packaging value chain - has been achieved, with many projects citing that without Challenge funding the investment made by their own organisations or by external investors would not have been made. Or if it had, it would have been of lower value. This evidences unlocking of UK private investment. The outcome of new information has been achieved through projects funded on consumer behaviour covered, some with specific focus on communications and messaging. The UK response to the UN Treaty on Plastic Pollution is currently underway and has not been covered under the evaluation.	
 Dissemination Awareness of SSPP Challenge among wider stakeholders is raised. Results of SSPP are communicated widely. 	Dissemination activities were encouraged by the Challenge, at networking events and conferences such as the GRIPS conference. Evidence from UK sector expert representatives supports the assessment of raised awareness of the Challenge among wider stakeholders. Many academic papers have been published (at least 84 based on evidence provided), with non-academic papers also produced (at least 20), and nearly 200 UK speaking slots have been secured to share project findings. Most academic papers (all but one) and non-academic papers (13 of 20) have been produced by the Enabling Research competition and by	IE1.6, IE2.1



Outcomes	Discussion	Related evaluation question
	 projects that focus on consumer behaviour (69 academic papers and 10 non-academic papers). This suggests further dissemination could take place on the results as projects close. Most UK sector experts were either not familiar enough with the portfolio funded by the Challenge to comment on its achievements or, despite knowing about some initially funded projects, were unsure where they had ended up. The exception to this is the larger commercialised projects, many of which have had mainstream media coverage. It is also important to highlight that there will always be a cohort of projects that wish to protect their IP and therefore do not wish to share findings or results in a public forum; there is a higher publication rate amongst the Enabling Research competition projects, which more commonly include academic institutions. There is still likely room for dissemination on project areas of interest and research without revealing IP that enables a wider audience to appreciate the 	
Measurement Impacts of projects, competitions and Challenge are understood and measured against a robust baseline. 	The Challenge intended for the impact of individual projects to be measured against a robust baseline to inform an assessment of the impact by competition and for the Challenge overall. The Environmental and Economic Impact Evaluation has shown quantification of impacts from a sub-set of projects was possible. Request for impact data showed that not all projects are measuring against a baseline and were unable to provide information to enable quantification of impact. The calculations presented within this report are therefore likely to be an underestimate of the full impact of the Challenge. This did include projects where it is too early to quantify impact, and for which there may be future impacts, as well as those that are not intended to generate environmental and economic impacts but instead have knowledge, learning and data outcomes. Evidence from stakeholders and projects to conduct LCAs.	IE2.2, IE2.4, IE4.1





Achievement of impacts

The Theory of Change sets out impacts and extended impacts included in detail and discussed in Table 33 below.

Table 33. Intended Impacts of the Challenge

Impacts	Discussion	Related evaluation question
 Impacts: Acceleration of R&D towards active commissioning of new / improved technologies, processes, business models, behaviours. Materials, designs, technology and business models developed to improve plastic packaging supply and value chain sustainability are tested. The potential to improve plastic packaging supply and value chain sustainability is demonstrated. Progress is made towards enhanced resource efficiency through reduced environmental impact. Regulation and standards for food grade PP are improved. Wider stakeholder awareness of SSPP findings is increased. Objective 2: New and/or improved more environmentally friendly plastic packaging materials, designs and technologies are developed that align with UK Plastics Pact 	Objectives 2 and 3 align with impacts set out in the ToC for the programme. As outlined under IE1.2 and discussed above in relation to achievement of outcomes, evidence demonstrates an increase in collaboration across the plastic packaging value chain. Similarly, there is alignment of projects with Plastic Packaging targets, as covered under IE2.3. However, the impact of these innovations is more likely to be realised beyond the time frame of the Pact. Projects funded through the Challenge have demonstrated concepts that will improve plastic packaging supply and value chain sustainability, with some at a stage where environmental impacts have been realised or will be realised within the next five years. One project has developed a means of recycling domestically recovered household waste polypropylene (PP) back into food- grade packaging. However, there is still a requirement for the regulation and standards for food grade PP to be implemented within the UK. As discussed under outcomes, the Challenge has provided support to projects to disseminate findings at events. Wider UK	IE1.1, IE1.2, IE1.4, IE1.5
 Objective 3: Plastic packaging value chain collaboration is increased. 	sector expert interviews suggest that although awareness of the fund is high, awareness of the nature and scope of individual projects and their associated learnings is lower.	
 Extended Impacts: A step change towards a more sustainable plastic packaging supply and value chains is achieved. Environmental gains from Programme continue to be realised in subsequent years. 	Extended impacts are those that are predicted over a longer timescale and therefore there is no expectation that these will be achieved to date. Evidence suggests that although there has been a step change towards a more sustainable plastic packaging and value chain, there remains several barriers to achieving this.	IE1.6, IE2.1, IE2.3, IE4.1





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Impacts	Discussion	Related evaluation question
 Clean growth of plastic packaging sector is enhanced. UK plastic packaging policy & legislation is informed by SSPP R&I. Enduring connections made between disparate elements of value chain. Wider stakeholder interest in plastic packaging value chain sustainability increased. Objective aligned with extended impacts: Objective 6: UK's international standing as a global leader in plastic innovation increases. 	Environmental gains are expected, with a saving of over 1.6 million tonnes of GHG emissions through SSPP funded projects anticipated between 2025 and 2030, with associated clean growth of the packaging sector. There is limited evidence collated under this evaluation to suggest that UK policy and legislation has been informed by the Challenge, but innovations tested through the Challenge will help upcoming existing policy to be delivered. Wider stakeholder interest in plastic packaging value chain sustainability should be monitored as the Challenge comes to a close and further dissemination work is carried out; current findings suggest that there is limited knowledge of the findings of the portfolio as a whole. Objective six is discussed in detail under IE1.6; evidence suggests that although there is a potential for the UK to be recognised as a global leader in plastic innovation, it has not yet achieved this reputation.	





Theory of Change Assumptions

Underlying assumptions on how the Challenge would achieve its outcomes and impacts are outlined in Table 34 below, reflecting on whether and to what extent the Challenge operated as intended. Evidence here draws on Phase 3 evaluation activity, but also the Phase 2 process evaluation that covered some of the early elements of the Challenge, such as its announcement more extensively. A RAG rating has been included. where green means evidence supports the assumption, and amber indicates that although there is some supportive evidence, not enough has been observed to fully support the assumption at this time. A red rating would imply that no supporting evidence was found for that assumption, but none were rated as red in this evaluation.

Table 34. SSPP Challenge Theory of Change Assumptions

Assumptions underpinning the ToC	Evidence review and summary of progress	RAG rating
 Announcement of the SSPP Challenge, and the amount of funding on offer, sends a strong signal to the market (supply chains, value chains and investors) that the sustainability of plastics packaging for consumer products is a serious societal issue to be addressed, supporting and reinforcing pre-existing signals (e.g. the UK Plastics Pact). SSPP Challenge priorities are sufficiently aligned with, and build on, existing priorities and commitments; UKRI announce and promote the SSPP Challenge effectively. Those in a position to respond to the Challenge are made aware of SSPP; The Challenge evolves and is responsive to changes and challenges in the wider landscape; Funding eligibility criteria and timing etc. make SSPP a good fit in practice as well as principle. 	Alignment with existing priorities and commitments The Phase 2 evaluation concluded the SSPP Challenge team took a conscious and deliberate decision to align the Challenge objectives to Plastics Pact targets – these were developed collaboratively with businesses, UK Government and non-governmental organisations. Alignment with the UK Plastics Pact ensures similar alignment with Pacts in Europe and India. These findings were further evidenced in the Phase 3 evaluation, with reports of other countries, based on the UK success, using similar models to the SSPP funding (although mostly of smaller scale in terms of funds available) to underpin their own Plastics Pacts. Funded projects continue to recognise the importance of re-use, recycling, removal of problematic plastics and development of new packaging design. Funding eligibility criteria and timing etc. made SSPP a good fit (in practice as well as principle) for many projects, with many reporting in interview that where they were aware of other funding opportunities, SSPP was the best fit for their idea and had they applied elsewhere this may have changed project scale, timing or focus. Effectiveness of challenge promotion It is clear from review of project applications and successful project outputs that the SSPP Challenge has received a variety of applications across the competitions, and areas of interest detailed within the Theory of Change. In Phase 2, while many stakeholders agreed that using existing networks proved to be a highly effective mechanism for attracting applicants, some Challenge	Green: Evidence collected to date supports this assumption.
	Staff and project leads felt that it had led to the 'same old' organisations applying. Interview evidence from Phase 2 and Phase 3 confirms many application submissions were received from organisations with pre-existing relationships with UKRI and SSPP; however, there is evidence of new organisations participating, including new start-ups and small companies.	

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	Responsiveness to changes and challenges	
	 The original business case for the Challenge was responsive to the platform established via Blue Planet 2 and was submitted at time of heightened societal and governmental interest. Thereafter, the Challenge responded to ongoing changes: The SSPP Challenge was adaptive to the COVID-19 pandemic granting extensions where required and were flexible, whilst still holding projects to account. The Core Programme aimed to address barriers to project successes; for example, helping to facilitate supply chain collaboration, and providing training to the sector on design. An active decision was also made to focus on large-scale demonstrators in a bid to deliver measurable and significant impacts against Plastics Pact targets by 2025. The risk taken with allocation of a larger proportion of funding to demonstrator projects (where one failed innovation could result in no impact generation from a substantial proportion of investment) has paid off, with these projects representing much of the quantifiable impacts reported at this time (88% of pipeline GHG emissions predicted for 2025-2030 are due to be achieved from demonstrator projects). 	
 SSPP Challenge is sufficiently attractive to individual subgroups of the relevant supply and value chains to encourage a diverse range of high-quality applications necessary to allow for a balanced portfolio of funded projects: Awareness of SSPP Challenge is sufficiently high across the entire supply and value chain; SSPP is sufficiently attractive to individual subgroups of the supply and value chain to attract a diverse range of applications; Those in a position to respond to the Challenge: Have, or are able to formulate, ideas and projects that are eligible for funding; 	Qualitative evidence from stakeholders and applicants in Phase 2 showed that Innovate UK Business Connect (previously KTN) and UKCPN played an important role in raising awareness of the SSPP Challenge throughout the supply chain. Phase 3 evaluation interviews with UK sector experts showed that although not always aware of the individual portfolio of projects, awareness of the Challenge itself is high, with some referencing its initial announcement and call for applications as a key part of this knowledge. The Challenge involves universities (scientific and research communities), investment from private sector (including plastics producers, waste management and collection, recycling facilities, and retailers) and the inclusion of research with consumers, demonstrating its reach across the supply and value chain.	Green: Evidence suggests that the Challenge has worked as intended, with applicants from across the value chain and with diverse focus of applications.
	however, Phase 2 did find some evidence that smaller organisations found the	

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 Have sufficient time and skills to write applications of sufficiently high quality to be considered for funding. 	 application process more difficult and those less engaged with UKRI were less likely to receive funding. Successful applications contribute to each of the four Plastics Pact targets in line with the focus of the Challenge and across the plastic packaging lifecycle, with projects looking to innovate around design, disposal, collection, and reprocessing and sorting. 	
 Highlighting specific issues/problems in need of solutions (in calls for applications, promotional webinars etc.), encourages academics and actors in the plastic supply and value chains to pursue and/or prioritise efforts to address these issues/problems. Activities to promote the SSPP Challenge raise awareness and reach those in a position to address specific issues/problems; Those in a position to respond to specific issues/problems formulate or tailor their ideas/proposed projects to address particular issues; A sufficient number of applications of sufficient quality are put forward to address the issues highlighted. 	Qualitative evidence from stakeholders and applicants in Phase 2 showed that launch events struck an appropriate balance between administrative necessity and subject matter discussion, with the latter including presentations and discussions relating to key issues of concern. Wider use of UKCPN and Innovate UK Business Connect (previously) KTN helped facilitate engagement from across the supply chain. In Phase 2 and Phase 3, there are some examples from interviews of individuals formulating project ideas in response to specific issues and problems highlighted by the Challenge. Many projects' ideas did pre-exist from individual organisation research projects, a drive to meet individual organisation needs, or stemmed from previously funded projects, such as the Plastic Research and Innovation Fund. However, the Challenge often stimulated further development of these ideas, with tailoring to application requirements. The Challenge committed £49.8 million of the £55.6 million allocated to grant funding. Review of SSPP's portfolio balancing in the Phase 2 evaluation identified several projects that scored above the fundable threshold of 70 but did not receive funding, which illustrates that the Challenge received a	Green: Evidence confirms that the SSPP Challenge both highlighted and encouraged applications in these areas.
 The funding on offer is sufficient to de-risk investment, reducing the outlay required by applicants to progress innovative ideas and projects to an acceptable level given the risks and uncertainty involved. Project ideas exist that are promising, but deemed too risky to progress in the absence of grant funding; The availability of funding prompts people to consider or reconsider projects that they would have dismissed otherwise; 	Just over half of successful projects covered by interviews (where a decision maker was available to comment, or the lead applicant was confident to answer) reported that they would not have been able to secure internal investment for their projects in the absence of Challenge funding due to the level of risk or uncertainty. A further third would have approved some budget, but the value would have been lower or the timescale slower.	Green: Evidence supports the assumption that the SSPP Challenge has been sufficient to de- risk investment at the project level.

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 The SSPP Challenge prompts acceleration or earlier scaling-up of projects that might not be prioritised otherwise; The extent to which the SSPP Challenge de-risks the investment is sufficient to secure internal approval to proceed / for R&D investors to match fund the investment. 	 This corroborates Phase 2 findings, where just over half reported that they would be unlikely to progress in the absence of the Challenge. The Challenge effectively 'de-risked' the activities through funding: Academic institutions to research and pursue experimental and 'proof of concept' activities that would otherwise be too financially and resource intensive. Smaller organisations, and those working on lower TRL projects to progress where they would not have been able to invest the required level of funds due to the perceived risk of doing so. The Challenge also helped by instilling confidence in private investors, enabling organisations to secure additional investment they needed by 	
	effectively 'endorsing' the decision to research.	Casar Fuidence
Programme Management and governance by UKRI and activities delivered by the Core Programme bring together and connect	The SSPP Challenge has successfully established collaborative partnerships. A third of projects reported in interview that at least one partnership or	shows collaboration
relevant actors and experts across the supply and value chains to	collaboration was formed for their funded project specifically and did not	across the supply
collaborate where they may not have otherwise:	exist prior to the Challenge. Where relationships were pre-existing, the	chain, with evidence
 Actors in the relevant supply and value chains are willing 	Challenge provided opportunity for further collaboration. 24 projects included	that some of these
and open to collaboration;	both industry and academic partners and 46 are between two or more parts of	collaborations will
 New collaborations (between people and/or projects) are 	the value chain. Some projects also reported in interview that further	Lifetime of the
maintained following the completion of projects and the end of the Challenge;	work on their projects beyond the lifetime of the Challenge.	Challenge.
Projects selected for funding allow proposed	In Phase 2, several wider stakeholders referred to 'legacy' and the role that	
collaborations and the forming of new networks to	SSPP has played in developing longstanding partnerships between segments	
progress OR these collaborations progress outside of the SSPP Challenge;	of the supply chain that had never previously worked together.	
UKRI recommendations to assist in knowledge exchange	The Challenge provided opportunity for knowledge exchange through its	
across the supply and value chains are practical and	delivery including nosting events, such as GRIPS.	
aligned with the needs of stakeholders;		
Actors across the value chain communicate effectively so collaborative networks endure across disparate elements		
of the chain.		

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 Support is provided to projects funded throughout delivery, to overcome barriers to the success of the project and/or maximise return on investment. This support helps to address skills and knowledge gaps and tackle barriers to market, resulting in better (e.g. quicker, larger scale) outcomes than would have occurred if funded by an alternative source: Through the SSPP Challenge, beneficiaries are able to access the skills and advice to deliver their projects successfully; Beneficiaries are willing to accept help and support. 	 There are instances of support from the Challenge programme team, Monitoring Service Providers, UKCPN, IUK Business Connect (previously KTN) and NERC providing support to funded projects. In the main, most reported support at the outset of project delivery, where feedback on applications shaped eventual delivery. However, some projects also cited the following: Provision of support to projects to help them keep to timetable e.g. through regular check-ins and setting milestones; Acting as a 'critical friend' that helped challenge thinking and hypotheses throughout the process; Facilitating introductions to potential partners throughout the process and also, when projects were close to completion, to enable work to continue. 	Green: Where projects were open to or required support, evidence suggests that this was provided to them. There is a cohort of projects that did not feel they needed support and therefore were able to carry on with delivery without the need for intervention or advice.
 Projects funded by the Challenge are successful and progress sufficiently for the intended immediate outcomes and impacts to be realised: Investable propositions emerge from projects funded by the SSPP Challenge to stimulate further investment in R&I to improve plastic packaging sustainable packaging in the value chain; New standards and methods emerge for simulating and measuring environmental impacts of full life cycle of plastic packaging; New learning is generated and disseminated to inform best practice and advance knowledge in terms of exploring innovation, design, demonstration, and development. 	Evidence shows that funded projects are successful and have progressed sufficiently for immediate impacts to be realised. As discussed under 'Achievement of Outcomes' above, there is evidence of the Challenge facilitating the desired collaboration outcomes and evidence individual projects are achieving their innovation goals. The desired measurement outcome - that all projects measure their impact against a baseline - has been evidenced for some but not all projects. Those without measurement systems in place include some projects for which it is too early or not applicable, but there was a subset of projects for which data would be expected but was not available (or not shared with the team to enable an assessment). Related to measurement of impacts, new standards and methods have been produced by projects, although these are not necessarily associated with measuring the environmental impacts of the full life cycle of plastic packaging as detailed in the ToC assumption. There are a handful of desired impacts that it is not possible to comment on at this stage. These include the UK response to the UN Treaty on Plastic Pollution, which was ongoing at the time of conducting analysis for this	Green: The Challenge has made good progress in this area, with many outcomes and impacts evidenced as achieved from <u>at</u> <u>least some</u> projects. There are still some desired outcomes and impacts that have not yet come to fruition, but for most the balance of evidence suggests that these may be achieved beyond the lifetime of the Challenge. There are some for which there is not enough

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	report. Similarly, project work has focused on solution for food grade PP, but this has not yet led to change in regulation and standards at this stage.	evidence to make a conclusion.
 Outcomes and impacts from the SSPP Challenge enable the UK to build a reputation as a leader in consumer smart sustainable plastic packaging: Effective leadership, programme and stakeholder management contributes to policy developments as well as the UK's global standing in plastics innovations; Outcomes and impacts from the SSPP Challenge are relevant to tackling global consumer plastics packaging issues; Relevant audiences outside the UK recognise the increasing progress being made in the UK above and beyond that of other nations in terms of: 	 Evidence on international standing suggests that there is opportunity for the UK to take on this role but is not yet seen as leading. Many international sector experts had limited knowledge of the Challenge itself, though a few were aware of larger commercialised projects. There have been some promising UK influences internationally including: Application of a similar funding-based approach to supporting international Plastics Pacts, although not formally referenced, sector experts felt that the success of the Challenge have secured (cumulatively) around £176 million of inward investment, all of which either would not have progressed or would have progressed at smaller scale and / or slower timescale in the absence of the Challenge. Export sales that could be quantified are currently small (£24,000), but a number of projects reported this impact without providing enough information to allow the total to be quantified. Additionally, we know that licensing fees have been agreed for at least one project with an international party which has been accounted for in revenue figures presented in IE2.4. 	Amber: Evidence from international experts to date suggests that the UK is not yet considered a leader in consumer smart sustainable plastic packaging. Many did feel there was opportunity going forward. At least some individual Challenge funded projects have made traction internationally, achieving inward investment and securing export sales.
 Knowledge sharing and dissemination (through the SSPP Challenge and the individual projects) supports ongoing innovation and further raises awareness among wider stakeholders and interest in plastic packaging value chain sustainability. This is achieved through: Sufficient and accurate monitoring activities so that lessons can be learnt to inform future challenges; Projects funded through the Enabling Research Programme (and individual projects funded through the CR&D programme where they chose to do so) disseminating findings to relevant external parties e.g. 	Dissemination of project findings has taken place through publications and UK speaking slots. There could be further work carried out to help outputs reach a wider audience as projects complete and findings are available. As anticipated, most publications (academic and non-academic) have been produced by the Enabling Research programme, which comprises academic partners. There is less expectation on those funded through the Collaborative Research and Development programme to share findings, but where they are willing to do so, this could help to further amplify the impact the Challenge has. Wider sector experts were often unaware on of the final findings of funded projects	Amber: Dissemination efforts have been observed. To support ongoing innovation The evaluation team recommend that there is a synthesis of learning from individual projects,

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 wider stakeholders, policy makers, general public and these parties engage with seminars, trade fairs, conferences, talks, site visit opportunities, data, case studies and reports generated through the SSPP Challenge; Actors in the supply chain and value chain look to draw on existing collaborations and knowledge gained through the SSPP Challenge to further progress research and development for consumer plastic packaging allowing environmental gains from the Challenge to be realised in subsequent years. 	experts suggested that there was a need for more 'on the shelf' solutions that smaller businesses and those without their own R&D capabilities could adopt to enable adoption of best practice.	future assessment of longer-term impact and to ensure that that the Challenge achieves its potential in terms of impact.



