

# BIOMASS BIOREFINERY NETWORK: IMPACT REPORT

Driving sustainable growth and collaboration in biorefining from 2019 to 2026



Biomass  
Biorefinery  
Network



Biotechnology and  
Biological Sciences  
Research Council



Engineering and  
Physical Sciences  
Research Council

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This evaluation was conducted by  
Rachel Dunford Consulting Ltd



On behalf of the Biomass  
Biorefinery Network

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BBNet would like to thank all current and former members of the management board and project delivery team for their support throughout the duration of the network, and our membership for their contributions to this evaluation, ensuring we could demonstrate our impact so vividly.

[www.bbnet-nibb.co.uk](http://www.bbnet-nibb.co.uk)

# 1. THE STORY OF BBNET'S IMPACT

BBNet's impact can be seen most clearly when the numbers are placed alongside the experiences of the people doing the work. The network has continued to act as a catalyst for scientific progress, collaboration and professional growth, while shaping the conditions that allow early ideas to strengthen, mature and move towards real world application.



One of the strongest observations from this analysis is that BBNet has become more than a funder or convenor. It is now a central part of how the UK biomass biorefinery community connects, learns and advances its collective ambition. The achievements captured throughout this report show a network that creates value at several levels:

- It supports the development of new tools, methods and products.
- It strengthens professional capability and confidence.
- It brings together complete value chains, linking feedstock suppliers, researchers and end users.
- At the same time, it unlocks wider environmental and economic benefit by helping projects move closer to commercial relevance.

Across the portfolio, funded project teams describe a similar pattern. BBNet funding gives them the space and resources to test early ideas, refine methods and build a body of evidence that would be difficult to achieve alone. Researchers speak about the way the network builds confidence, offers visibility of sector priorities and connects them with partners who help shape their work in constructive and practical ways. Industrial partners emphasise the importance of access to academic expertise and the value of being able to explore emerging technologies without the barriers that often constrain early engagement.

Alongside these technical and professional benefits sits something less tangible but no less important. The network has created an environment that feels inclusive, open and ambitious. Members describe a culture where people are generous with knowledge, curious about different approaches and motivated by the shared aim of accelerating the transition to a more sustainable and circular bioeconomy. This environment matters because it underpins the collaboration, creativity and problem solving that run throughout the scientific progress presented in this report.

BBNet's role as a connector is also central to its impact story. In a field where commercial and academic priorities can diverge, the network provides the neutral space where conversations can develop, expectations can be clarified and partnerships can take shape. Many of the collaborations captured in this evaluation began at BBNet events or through its small grant schemes. They represent relationships that may not have formed at all without BBNet's influence.

The impact is visible in the data that follows. Projects have moved up the Technology Readiness Level scale. Teams have demonstrated proof of concept and tested methods in realistic conditions. New products have been created, new datasets have been produced, and new tools have been developed. Funding has been leveraged at significant scale. Jobs have been created. Knowledge has grown across the community and early career researchers have been supported to take important steps forward.

These developments show that BBNet is helping to build a stronger and more future-ready bioeconomy:

- It supports the technical progress that moves the field forward.
- It strengthens the capability of the people working within it.
- It creates the partnerships needed for long term commercial success.

Above all, it provides the structure and environment in which ambitious ideas can grow into meaningful and lasting impact.

This report now explores these contributions in detail, beginning with the activities that form BBNet's core inputs and the outputs that have resulted from them.

**Professor Neil Bruce**, Network Director

## 2. EXECUTIVE SUMMARY

**The Biomass Biorefinery Network's (BBNet's) mission was to help move the UK towards a more sustainable and circular bioeconomy. It brings together academic researchers, industry partners and innovators who are working to turn biomass and organic waste into viable alternatives to fossil-based products. By 2025, BBNet's role as a connector, funder and community of practice has proved to be central to how this field progresses. This report evaluates what BBNet has enabled across its funded projects, events and wider network activity since its inception in 2019.**

To understand BBNet's impact in 2025, a Theory of Change was developed with the BBNet board and team. This mapped how BBNet's inputs and activities are expected to lead to outputs, outcomes and long-term change. Two surveys were then designed and delivered; the first explored the experiences of funding recipients, representing 43 BBNet funded projects, while the other focused on event attendees and the wider membership, and was completed by 127 people. The evaluation also drew on qualitative feedback and two in-depth case studies that illustrate how BBNet support plays out in practice.

Across its portfolio, BBNet has enabled tangible scientific and technical progress. Projects have tested early ideas, refined bioprocesses and embedded more sustainable practice in their work. Many teams report that they have moved up the Technology Readiness Scale, with most now able to evidence proof of concept and a smaller group ready to test technologies at scale in realistic conditions. BBNet-funded work has already led to new research tools and methods, new datasets and databases, and new products and processes. These advances lay important foundations for future innovation, spin-out activity and commercial application.

The evaluation shows that BBNet's impact is not limited to individual projects. It has also shaped the experience and capability of its members. Funding recipients consistently described BBNet as a network that opens doors, deepens knowledge and strengthens the direction of their work. Every respondent in this group reported that BBNet helped them build relationships, attend events, develop new ideas and improve their professional knowledge. 97% said that they had discovered funding opportunities through the network and had been able to support others.

Event attendees reported similarly positive experiences. Nearly everyone who joined BBNet to expand their professional network felt that they had done so, and most said they had gained access to insight and learning that would have been hard to find elsewhere. Many described how BBNet helped them spark new collaborations, strengthen links with industry and develop new projects or initiatives. Members did not simply attend events, they used what they learned to progress their work, build confidence and broaden their understanding of the sector.

Survey respondents explained that in their experiences prior to BBNet, collaboration between academia and industry could be difficult. Differences in pace, incentives, language and culture can make it hard to establish partnerships that endure. In this context, the number and strength of collaborations emerging through BBNet are noteworthy, and underpins BBSRC's aim to forge and support interdisciplinary collaborations where excellent bioscience has a fundamental role<sup>1</sup>. Members repeatedly said they would not have met the right partners without the network, particularly industrial contacts who are rarely visible at traditional academic conferences. Small grant schemes, proof of concept (POC) funding and business interaction vouchers (BIVs) were often described as decisive in converting early conversations into active projects.

BBNet has also played a strong role in knowledge creation and capacity building. Almost every respondent said that their involvement had strengthened their understanding of their own area of specialism and improved shared understanding across the community.

Support for early career researchers was particularly notable: members reported that BBNet helped them develop technical skills such as lifecycle assessment, as well as professional skills in communication, networking and collaboration across sectors. For many, this has influenced not only their research but also their confidence and future aspirations.

The economic and wider societal impacts emerging from BBNet activity are already significant. Follow-on funding linked to BBNet projects and events exceeds £12.5 million. This additional investment spans research grants, fellowships, studentships, capital awards and industrial partnerships. BBNet-funded projects have also created new roles across the research and innovation pipeline, showing that investment has supported both scientific progress and the people delivering it.

Projects also report contributions to wider real-world challenges. Many have influenced environmental sustainability, waste reduction and resource efficiency, and there is clear evidence of contribution to net zero aims. Some projects are beginning to influence human health and food security, often through indirect benefits such as improved material safety or more reliable waste treatment processes. Other work is building foundational knowledge that will underpin later applications. The pattern points to steady progress towards a bioeconomy that is more robust, more innovative and better aligned with national priorities for sustainability.

Overall, BBNet has become a central part of how the UK biomass biorefinery community connects, learns and advances.

It is not simply a funding mechanism or a programme of events. It has created a cohesive, motivated and capable community where expertise is shared, collaborations are built and emerging ideas can be tested, refined and moved forward. It has strengthened the foundations for sustainable biomanufacturing and encouraged people to push their work further than they might otherwise have done.

<sup>1</sup> <https://www.ukri.org/who-we-are/bbsrc/who-we-are/>

# 3. INTRODUCING BBNET

## 3.1 Purpose, objectives and the bigger picture

The aim of the network is to act as a focal point to build and sustain a community of academic and industrial innovators in the biomass biorefining field, who work together to develop new and improved processes for the conversion of non-food biomass into sustainable fuels, chemicals and materials.

In line with the BBSRC's Forward Look<sup>2</sup>, BBNet bridges the gap between laboratory breakthroughs and industrial-scale application, ensuring that the UK leads the global transition from a fossil-heavy economy to one rooted in renewable biological resources.

The network objectives are to:

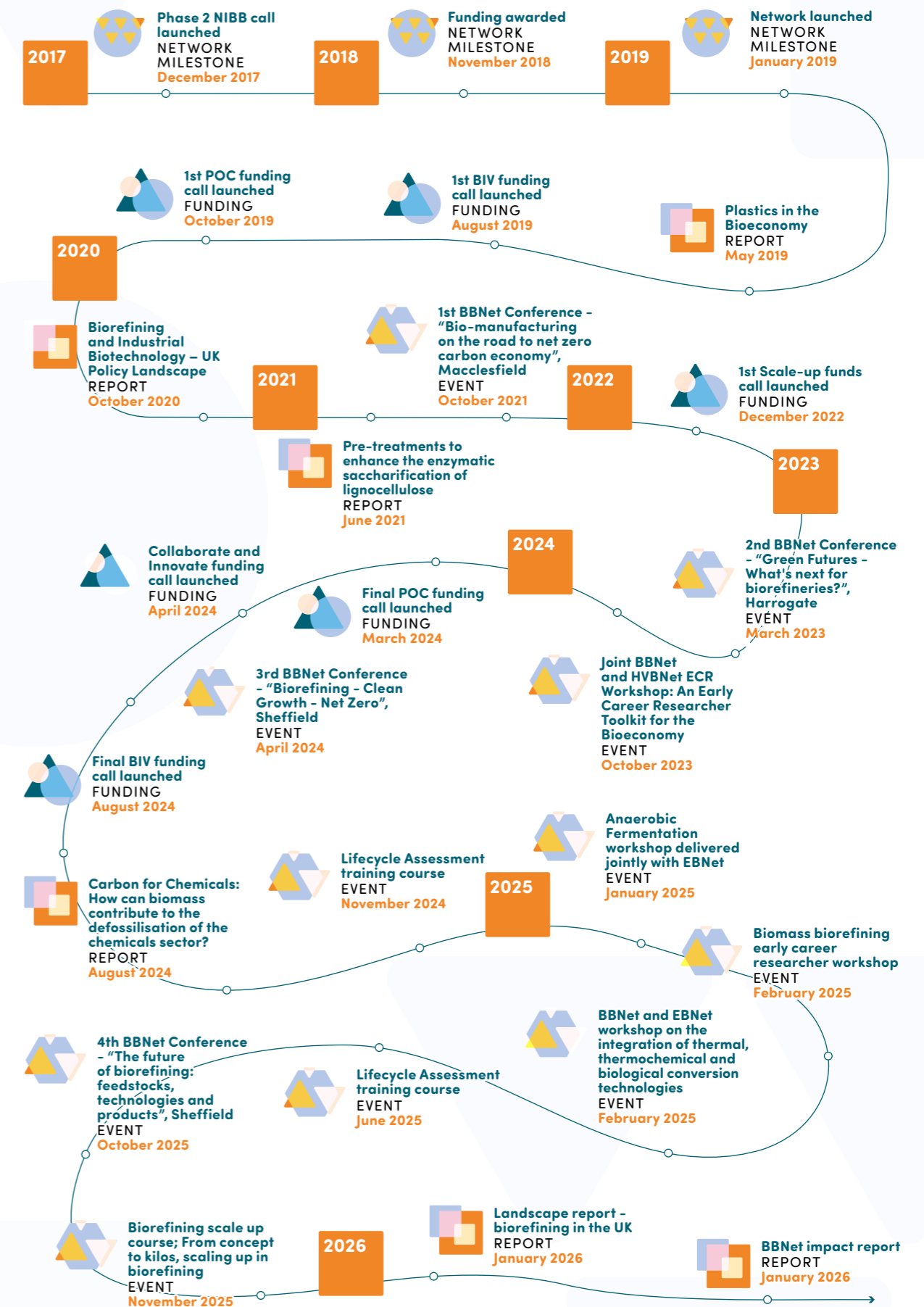
- Catalyse innovation in the biorefining and biorenewables sector by bringing together practitioners from both academia and industry to drive the sustainable bioeconomy.
- Translate advanced biological research into practical production of sustainable fuels, chemicals, and materials.
- Align stakeholders and policymakers to ensure a unified, harmonised approach to bioeconomy growth.
- Advocate for the research community to influence government policy and funding decisions.
- Identify emerging opportunities and barriers, and commission research to address them.
- Provide a central intelligence hub to guide sector policy and create supportive regulatory frameworks.



<sup>2</sup> <https://www.ukri.org/publications/bbsrc-forward-look/>

## 3.2 History

BBNet: Timeline of the network.



### 3.3 What does BBNet do?

The Biomass Biorefinery Network, or BBNet, supports research that takes organic waste and biomass and uses it in the manufacture of bio-based products, contributing to a sustainable, circular bioeconomy that reduces global reliance on fossil fuels. It does this in several distinct ways:

- Facilitating a membership-based network or community of practice which brings together researchers and businesses to develop innovative bio-based fuels, chemicals and materials.
- Funding research in the form of proof of concept studies, feasibility studies (in the form of business interaction vouchers (BIVs)), scale-up activities and consortium-building activities.
- Running events including its flagship annual conference, subject-specific workshops and training opportunities - open to members and beyond.
- Producing reports to progress thinking and shape policy, and;
- Facilitating knowledge sharing within and beyond the network.



### 3.4 What support have we provided?

#### BBNet activities overview:

**1250 members**

Bringing together researchers and businesses in an innovative community of practice, to develop bio-based fuels, chemicals and materials

The membership comprises **300 industry members (24%)**, **800 academic members (64%)** and **150 policy-makers and other members (12%)**



**£1.2m funding awarded in collaborative research projects**

Funding research that supports innovative new research ideas, develops new collaborations and drives economic impact (**49 awards in total**)



**15 events delivered**

Running events including its flagship annual conferences, subject-specific workshops and training opportunities

**384 unique individuals** have attended BBNet's events, where **~100 people** have spoken on stage, and **~130 posters** have been presented

Published **five policy reports** to progress thinking and shape policy, and promote knowledge sharing within the network and beyond

BBNet delivered **five collaborative workshops** with other networks to develop the skills and competencies of early career researchers across the sector



## 4. METHODOLOGY: WHAT HAVE WE DONE TO MEASURE OUR IMPACT?

As BBSRC funding for the network approached its natural end, BBNet undertook a robust evaluation of its impact in 2025. To support this, BBNet commissioned an independent analysis of the change created through their grant awarding and events activities. This report sets out the findings of that work, which has taken place throughout 2025.

Any thorough analysis of impact begins with the establishment of a Theory of Change. This tool sets out the change an organisation aims to create and the pathway that links its activities to its intended outcomes. It provides the foundation for any robust impact measurement project by clarifying what should be measured, why it matters and how each element of the work contributes to meaningful change.

BBNet's Theory of Change is included in Appendix 1. This describes the progression from the inputs BBNet delivers through to the immediate outputs and the short-, medium- and long-term outcomes that summarise the change BBNet aims to create.

BBNet members were surveyed to explore their experiences in relation to the Theory of Change. Two surveys were created to gather insights into BBNet's different activities:

- **127 event attendees** responded to the survey designed to assess the impact of our events
- **43 funded project recipients** responded to the survey designed to assess the impact of our grant funding

Both surveys asked the same set of questions, with an additional set of unique questions asked of the funding recipients on the outcomes of their funded project.

Analysis is presented accordingly, and the number of respondents to each question will therefore vary, and not every respondent completed every question asked of them.

Of those who answered this question, surveys were completed by:

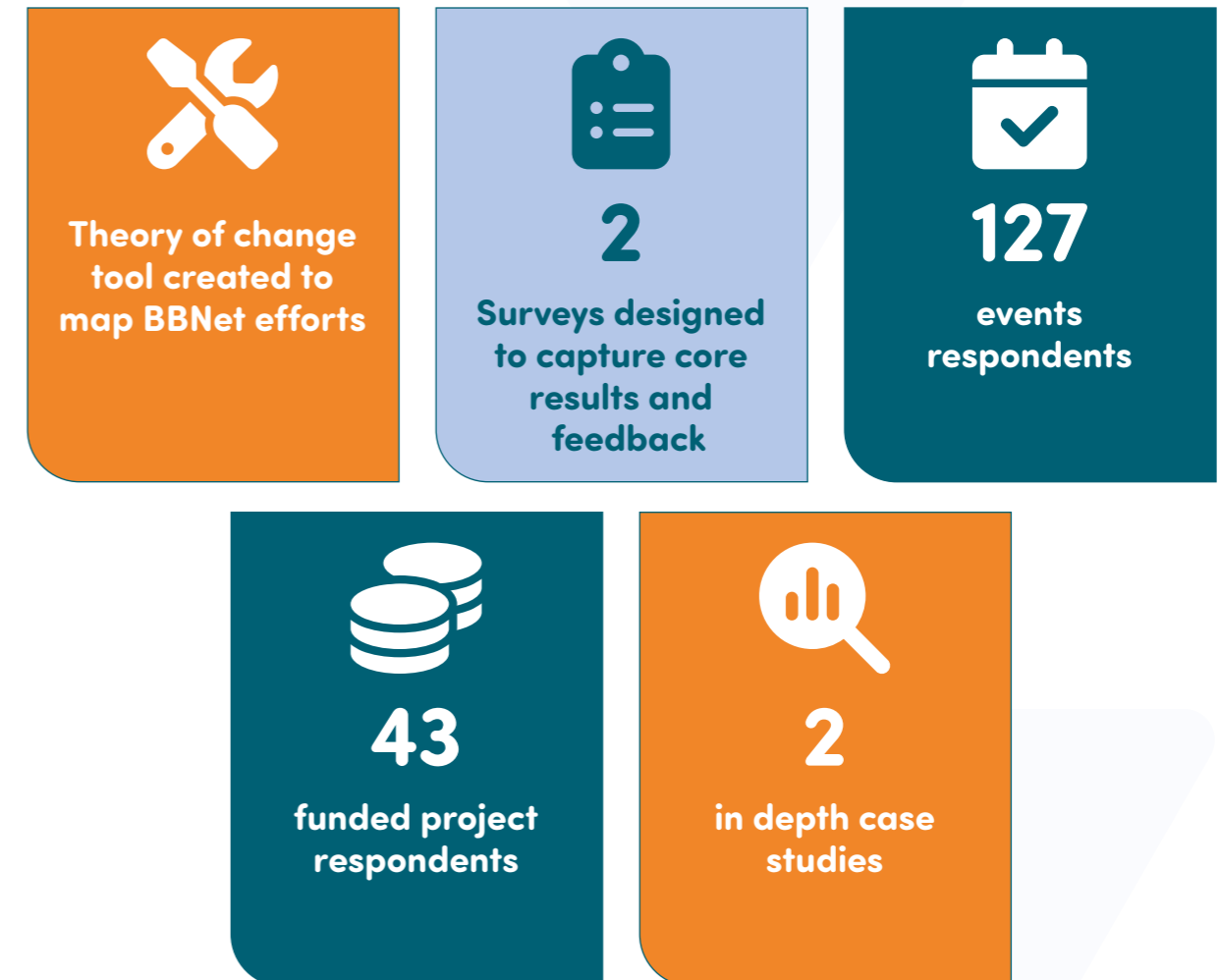
- **31 industry members**
- **124 academic members**
- **2 policy makers or employees of a government department**
- **1 employee of a NGO or thinktank**
- **1 employee of a charity, social enterprise or society**

**64 respondents** (40% of all survey respondents) said that they identify as an Early Career Researcher.

Finally, two funded projects have been included as illustrative case studies – providing compelling examples of BBNet's impact in action.

What follows is an analysis of the resulting data.

### In brief:



# 5. RESULTS: BBNET'S IMPACT AND OUTCOMES

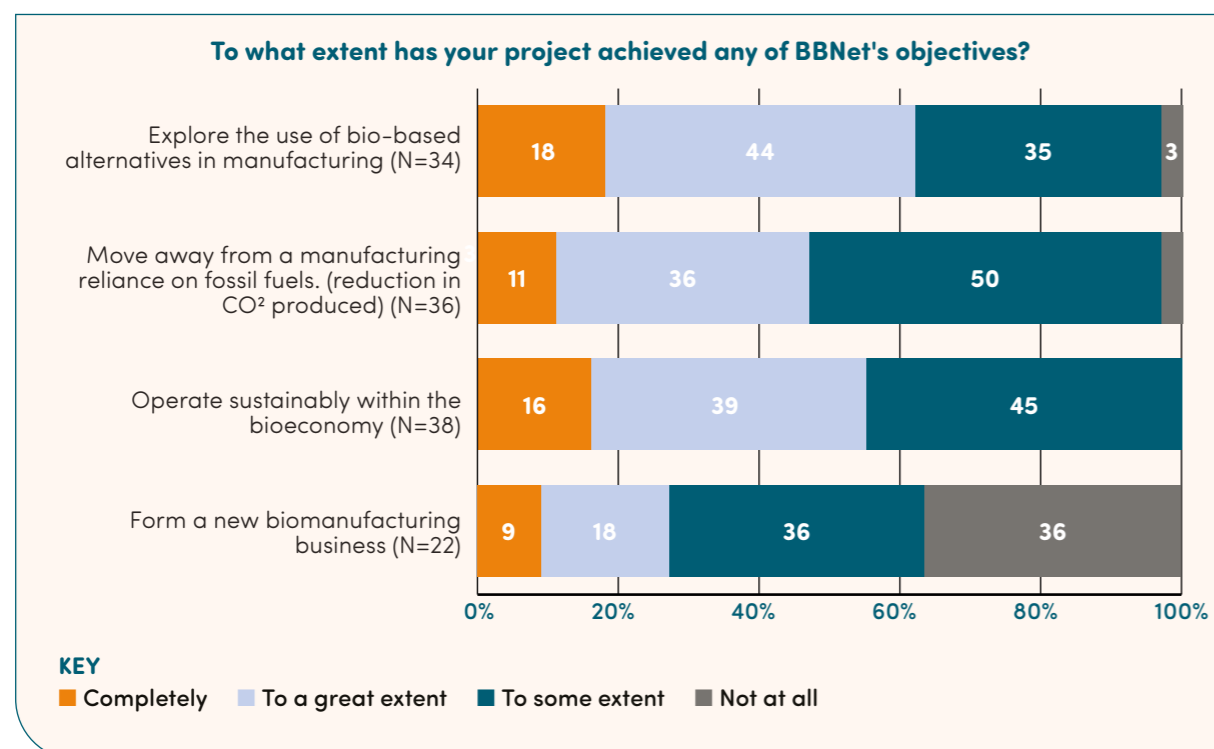
The data that follow are taken from the responses to the survey for funding project recipients conducted for the purposes of this impact evaluation.

The survey explored their experiences of being part of the network and asked them to reflect on the impact that their funding and membership had on their knowledge, career and research. Representatives from 43 projects completed the survey; the following results reflect their views rather than those of the full suite of projects supported by BBNet.

## 5.1 How BBNet funding advanced UK biorefining

- BBNet funding supported meaningful technical progression, with most projects demonstrating proof of concept and many moving through higher Technology Readiness Levels.
- Early commercial potential is emerging, including the formation of new businesses, clearer routes to market and groundwork for future spin-outs.
- Progress towards a sustainable bioeconomy is clear and multi-dimensional, with projects advancing bio-based alternatives, reducing reliance on fossil fuels and embedding sustainable operating practices.
- BBNet's value lies in more than funding alone, enabling access to industrially relevant materials, facilities, expertise and interdisciplinary collaboration that accelerated learning.

### 5.1.1 Advancements across the portfolio



### Exploring bio-based alternatives

BBNet projects are pushing the bioeconomy forward in practical and ambitious ways. Across the portfolio, teams are using their funding to test new ideas, refine processes and embed more sustainable practices in their work. A clear area of momentum is the exploration of bio-based alternatives:

- **35%** of teams are making early advances,
- **44%** are moving forward at a more advanced pace, and
- **18%** have fully achieved this objective.

These projects are developing new materials, improving methods and laying the foundations for bio-based options that could replace traditional manufacturing inputs.

### Moving away from fossil fuels

There is also significant movement away from fossil fuel reliance:

- **50%** of projects are contributing to this shift, supported by work on cleaner processes and alternative feedstocks.
- A further **36%** report substantial progress, and
- **11%** have already achieved this aim completely.

These projects point towards emerging low carbon pathways and show how BBNet funding is helping accelerate more sustainable forms of production.

### Operating sustainably

Sustainable practice is equally prominent. Many teams are strengthening the way they operate, with:

- **45%** embedding more sustainable approaches to some extent, and
- **39%** doing so more extensively.
- Another **16%** report that sustainability is now fully integrated into their work.

Together, these changes support a more responsible and resilient bioeconomy.

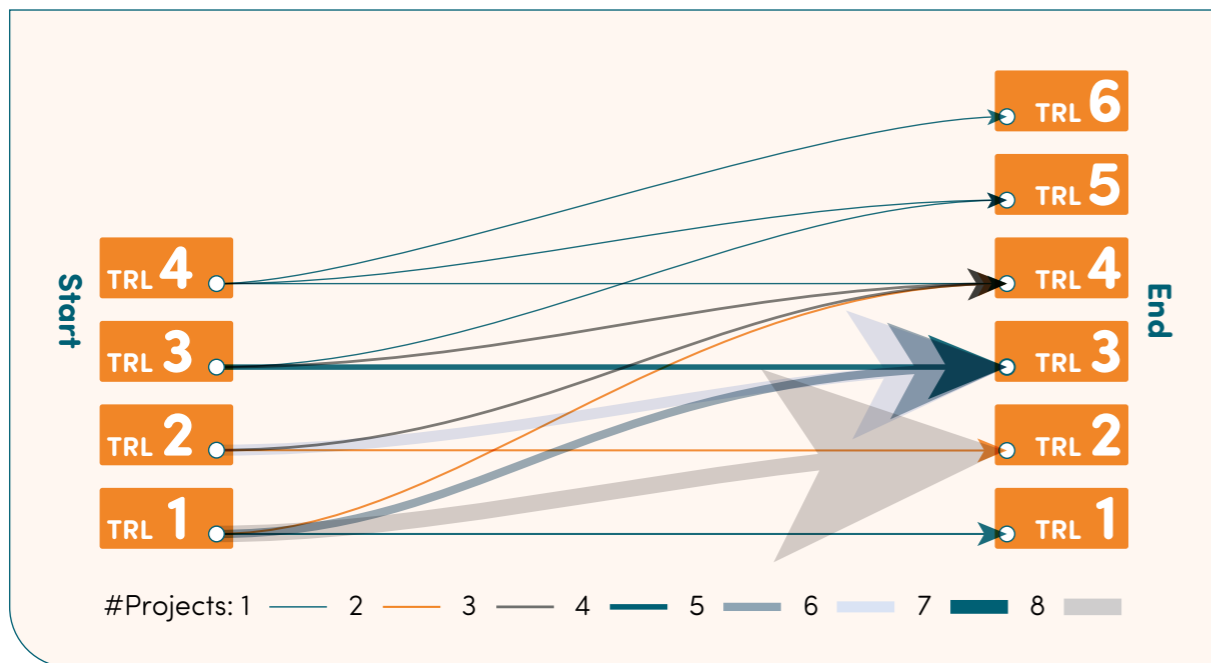
### Forming new businesses

Creating a new biomanufacturing business naturally takes longer, but early signs of commercial potential are beginning to emerge:

- **36%** of teams said they have achieved this to some extent,
- **18%** of projects said they had achieved this to a great extent,
- while **9%** of projects said they had completed this objective.

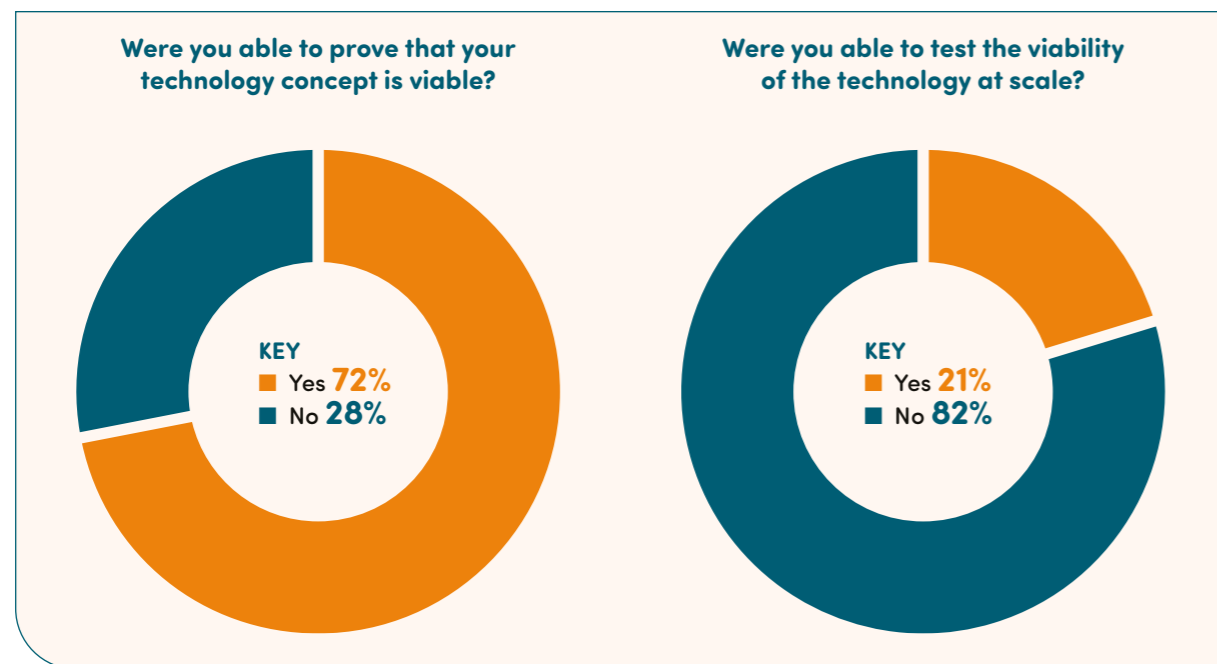
Others are laying essential scientific and technical foundations that will underpin future spin outs and commercial ventures. This evidence shows a community moving purposefully towards a more sustainable and circular bioeconomy, with BBNet funding acting as a catalyst that helps teams convert ideas into action and build the conditions for long term impact.

### 5.1.2 Moving from concept to product



Progress is also visible in the movement of projects through their Technology Readiness Levels (TRLs). When funding began, most projects sat at the earliest stages, reflecting the exploratory and innovative nature of the work. 18 teams started at TRL 1, 11 at TRL 2 and eight at TRL 3, with very few beyond that point.

The landscape now looks markedly different. Projects have advanced into higher readiness stages, with many demonstrating proof of concept or early-stage validation. Ten teams now sit at TRL 2, 15 at TRL 3 and nine at TRL 4. Three projects have progressed to TRL 5. This progression shows a clear upward trajectory. Early concepts have been tested, refined and strengthened, and many teams are now operating at a level where their work can be validated under more realistic conditions or prepared for future scale. BBNet funding has boosted this development and enabled researchers to take meaningful steps towards practical or commercial application.



Most projects have been able to demonstrate proof of concept, with 72% confirming that they have shown their technology is viable. Far fewer have tested their technology at scale, with only 21% reporting that they have reached this stage. Of the seven projects that were able to test their technology at scale, five said that it could be applied in a commercial setting. These results are commensurate with the level of funding received, as proof of concept funding supports early to mid-stage commercialisation activities that *validate* the development of concepts, to ascertain commercialisation routes. Other types of funding, such as seed funding or follow-on funding, are often sought to take viable concepts forward to commercialisation.



### 5.1.3 How BBNet enabled this progress

BBNet enabled progress across three main areas: materials and tools, people and connections, and processes and data. The following impact data was reported through qualitative responses.

#### MATERIALS AND TOOLS

- **Access to industrially relevant materials and real-world testing conditions**

BBNet played a direct role in helping teams move beyond small laboratory experiments by facilitating access to industrially relevant materials, realistic feedstocks and testing environments. Through its network and project support, BBNet enabled researchers to obtain purified cellulose, real food waste, algal biomass and other authentic materials. BBNet also supported access to larger reactors and continuous systems, which allowed teams to understand how their technologies perform under more realistic operating conditions. This exposure was vital for validating methods, revealing limitations and building confidence in scalability.

“Access to a reliable, industrially relevant feedstock: working with Lixea’s purified cellulose allowed us to move from early lab-based proof of concept to testing with real-world materials under more scalable conditions.”

- **Access to facilities, equipment, funding and skilled people**

BBNet investment unlocked access to the facilities and expertise that projects needed to progress. This included scale-up facilities, specialised instrumentation and laboratory infrastructure that would otherwise have been out of reach. BBNet funding enabled teams to recruit skilled researchers and technicians, increasing capacity and enabling rapid progress. In some cases, BBNet support contributed directly to securing a continuous rig or a studentship that will shape future work.

“Capacity building: investment in lab infrastructure and the training of staff (e.g., in fermentation techniques) provided the technical capabilities needed to carry out more advanced and reproducible experiments, which are essential for TRL 4 validation.”

#### PEOPLE AND CONNECTIONS

- **Strong academic and industry collaboration**

BBNet’s network model created the conditions for productive partnerships between academic teams and industrial organisations. These relationships offered technical direction, insight into commercial relevance and opportunities to test early ideas in real settings. Continuous feedback from partners such as Lixea and Croda was made possible because BBNet brought these groups together and supported collaboration at the right moments. By enabling researchers to connect with design teams, textile specialists and other industrial contacts, BBNet helped shape decisions, inform improvements and generate clearer future pathways.

“Strong academic and industry collaborations, including with the Royal College of Art and major industrial partners, provided technical input and opportunities for follow-on funding.”

- **Interdisciplinary expertise and cross-sector collaboration**

BBNet created a space where teams could bring together expertise from biology, chemistry, engineering, modelling and thermal processing. This cross-sector collaboration gave projects access to deeper technical insight and more robust problem-solving. BBNet facilitated the connections that allowed these interdisciplinary methods to flourish, strengthening research design and enabling more rigorous validation.

“The interdisciplinary nature of the team, bridging thermal and biological processing was key to achieve the project outcomes.”

#### PROCESSES AND DATA

- **Development and optimisation of processes, protocols and engineered systems**

Many of the improvements in process design and optimisation were possible because BBNet provided the support, space and resources needed for teams to refine their work. BBNet funded new fermentation strategies, improved protocol design, engineered microbial systems and enhanced anaerobic digestion approaches. This foundation allowed projects to build more reliable methods and test technologies under increasingly demanding or realistic conditions.

“Development and optimisation of fermentation protocols: establishing new methods for bioreactor operation, troubleshooting microbial growth, and improving product yields enabled us to demonstrate the process under conditions representative of industrial settings.”

- **Proof of concept: generating the first successful data**

For several teams, BBNet funding was the catalytic step that enabled them to generate their first successful data. This early evidence marked the transition from idea to demonstrable concept. BBNet supported projects that converted textile waste into bacterial cellulose, improved organic acid yields, generated early bio-efficacy data and tested new bioproducts or microorganisms for the first time. These results created the momentum needed for further funding, industrial engagement and early commercial exploration.

“Demonstrating proof of concept that succinic acid production can be achieved using biofilm-based fermentation as well as free-cell systems.”

- **Economic and sustainability assessments**

BBNet enabled several teams to undertake lifecycle assessments and techno-economic analyses that clarified the environmental and economic potential of their technologies. These assessments helped shape optimisation decisions and strengthened the commercial credibility of work progressing up the TRL scale. By supporting both scientific development and early feasibility assessment, BBNet helped teams understand which approaches could be viable at scale.

“Access to lifecycle and techno-economic assessment tools allowed us to evaluate the sustainability and commercial viability of the process at an early stage.”

- **Identification of limitations and clearer future direction**

Even where projects did not progress up the TRL scale, BBNet enabled valuable learning. Through its support and collaborative structure, BBNet helped teams identify biological, technical or operational constraints that need to be addressed next. These insights prevented unproductive development paths and clarified what needs to happen in the next phase of work.

“No change in TLR but challenges and possible contributing factors to lack of initial success are better understood, enabling consideration and investigation of effects of possible solutions.”

### 5.1.4 BBNet members' reflections on their journeys towards commercialisation

BBNet members' experiences reveal that early commercialisation is a long, staged process where progress depends on building the right evidence, partnerships and technical foundations. Across the projects, BBNet funding often acted as the first enabling step. It allowed teams to generate the data needed for commercial conversations, refine early processes and begin shaping intellectual property. In some cases, it also brought together complete value chains, linking feedstock suppliers, technical specialists and end users in ways that strengthened the commercial relevance of the work.

A recurring pattern is that early commercialisation requires iteration. Several projects identified technical challenges that need to be overcome before scale-up is viable, such as strengthening microbial consortia, managing viscosity or metal content in recycled fibres, or adapting protocols to achieve consistent product quality. These insights helped teams define the next stage of development. They clarified what still needs to be solved and provided a clearer route forward.

The examples also show how early proof of concept work can unlock new opportunities. Some teams moved directly into further funding applications, explored licensing or spin-out routes or laid the foundations for new research centres. Others described how small technical breakthroughs led to new collaborations or positioned their work for the next phase of research and development. Taken together, these journeys illustrate that BBNet support helped teams move from idea to early commercial potential. It accelerated the generation of key technical data, connected projects to real market contexts and created the momentum needed to pursue larger scale validation. Even where commercialisation is still some way off, the groundwork laid through BBNet has made that path clearer, more credible and more achievable.

*“The BBNet proof of concept funding was instrumental in laying the groundwork for our commercialisation journey. It enabled us to generate key technical data, refine our processes, and build early IP-relevant outcomes – all of which are essential for translating research into market-ready solutions.”*

*“We are now actively engaging with the University of Hull's commercialisation team to explore IP protection, licensing opportunities, and spinout potential. The project also helped us define a clear route to market by connecting the entire value chain – from biomass feedstock (Lixea) to product formulation and application (Croda). This integrated approach has not only increased the commercial relevance of our technology but also fostered valuable relationships with industry stakeholders.”*

*“In parallel, the work has catalysed the creation of the IITM-Hull Biorefinery Centre, opening up international collaboration and funding opportunities that will support commercial scale-up and market validation.”*

*“Overall, this project has significantly accelerated our ability to move toward commercial impact, and we are now in a strong position to pursue both follow-on R&D funding and strategic partnerships.”*



### 5.1.5 What advancements has BBNet enabled?

BBNet funding has enabled a range of scientific and technical advancements, including new tools, datasets and products.

In numbers... the advancements:

**The £1.2m in funding awarded by BBNet has...**



Leveraged more than **£6 million** in further funding, with a further **£40m** indirectly attributed

Aided development of...

**21** new research tools or methods

Created or retained **49** new jobs

**14** new or improved datasets or databases

Enabled **32** projects to move up in their technology readiness level

**6** new pieces of software, technical products or processes developed

Enabled articles of high quality in **48** publications, including **11** journals

**5** spin-out companies have been launched as a result of BBNet funded projects and event

Research cited in **24** publications, including in **7** journals

#### i. Turned waste into valuable new products

- Examples have included: textile waste converted into bacterial cellulose for new fibres; recycled paper strengthened with bacterial cellulose which showed a 57% improvement; gypsum recycling demonstrated; keratin waste converted into peptides and amino acid; and new methods for improving biogas yield using simpler measurements.

#### ii. Developed new or improved bioprocesses

- Examples have included: more stable fermentation and anaerobic digestion processes; improved microbial tolerance through biofilm systems; efficient enzymatic conversion of seaweed derived monomers; and effective static fermentation strategies for bacterial cellulose.

#### iii. Discovered promising bio-based chemicals and materials

- Examples have included: a new method for converting carbon dioxide into long chain carboxylic acids; a bio-mineral catalyst with promising selectivity; yeast-based systems producing methacrylic acid; low energy extraction of fragrance ingredients; enzyme-based terpene ester production; and cultivating magneto-tactic bacteria on waste streams.

#### iv. Moved technologies closer to industrial application

- Examples have included: new equipment and PhD funding enabling scale-up; integration of feedstocks into industrial partner processes; insights into limitations that guide optimisation; and protocols embedded for future scale-up work.

#### v. Deepened scientific understanding and enabling future innovation

- Examples have included: full transcriptomics and proteomics datasets; new understanding of anaerobic fungi behaviour; mechanical property data for seaweed fibres; and clarity on ineffective co cultivation strategies.

## How three BBNet funded projects worked to tackle real-world challenges

### Dr. Mauro Adriel Rinaldi

**Lecturer, The University of Hull - Converting forestry and agricultural waste into something valuable**

Dr Rinaldi's project developed a microbial system that can turn forestry and agricultural waste into useful cell mass and high value chemicals. This creates an alternative to petrochemical feedstocks and supports cleaner manufacturing.

By using non-food biomass, it also avoids competing with agriculture. The team explained that the platform could, in future, be adapted to produce microbial proteins or compounds used in health-related products.

Although still at an early stage, the work lays foundations for more sustainable supply chains across several sectors.



### Dr. Alexandra Lanot

**Enterprise Fellow, The University of York - Using biotechnology to support textile circularity**

Dr. Lanot's projects aimed to provide a biobased alternative for re-purposing textiles waste, reducing waste to landfill and providing more sustainable materials for clothes production.

Alongside their lab work, they ran webinars, school presentations and took part in major sustainability events. These led to collaborations with a fashion SME and a sustainable start-up. Feedback from participants showed that attitudes towards biotechnology shifted, with some saying they would adopt these approaches if commercial scale options were available.

Their work has helped raise awareness of how biotechnology can support more sustainable recycling processes towards circular materials.



### Dr. Jolanda van Munster

**Royal Society University Research Fellow, Scotland's Rural College (SRUC) - Improving how food waste is turned into renewable energy**

Dr. van Munster's project determined how we can use microbes to improve anaerobic digestion of waste from food production. This allows agricultural waste such as rice straw to be converted into biogas, providing an alternative for burning rice straw in the open fields and reducing the production of greenhouse gas and pollutants this causes.

The team found small benefits of combining fungi with anaerobic digester microbes at laboratory scale, and gained experience with scaling up to augmentation to experimental anaerobic digestors.

Their findings support further optimisation of anaerobic digesters to convert waste to renewable energy, strengthening local energy resilience and reducing reliance on fossil fuels.



## 5.2 Building a thriving community

### 5.2.1 How members benefited from being part of BBNet

Membership of BBNet delivered consistently strong outcomes for both funded project holders and event attendees.



**Funding recipients** described a network that opened doors, expanded their connections and strengthened the quality and direction of their work. Every respondent reported that their involvement helped them build relationships, attend events, develop new ideas and deepen their professional knowledge. 97% said they discovered new funding opportunities through BBNet and were able to support others within the community. This reflects a network where knowledge sharing and collaboration are part of everyday practice.



**Event attendees** told a very similar story. Nearly everyone who joined to broaden their professional network said they achieved this, and most felt they gained access to events, insight and learning they would not have encountered elsewhere. Many described how BBNet helped them spark new collaborations, strengthen links with industry and develop new projects or initiatives. A large proportion also said that being part of BBNet helped them learn about or apply for relevant funding opportunities. These patterns show that members did not simply attend events or passively consume information. They built relationships, exchanged ideas and used what they learned to progress their work.

Overall, the responses show that BBNet is delivering what members come for and more. People leave events with new contacts and renewed motivation. They return to their work with clearer direction, stronger partnerships and a deeper understanding of the field. The consistency of these experiences across both groups demonstrates the distinctive value of the network and the breadth of support it provides.

### 5.2.2 The value of being part of BBNet

#### • i. A community where ideas accelerate

Across the qualitative reflections, one of the strongest insights was the sense of community that BBNet created. People spoke about the openness, diversity and energy of the network, often in warm and enthusiastic terms. BBNet was described as

*“... a great network with driven, inspiring people.”*

and

*“... a very broad church in terms of expertise.”*

It brought together individuals who might not otherwise meet, and created a space where ideas developed quickly, confidence grew and collaboration felt both natural and productive.

#### • ii. Collaboration as a springboard for progress

Collaboration emerged as a defining feature of BBNet's impact. Academic teams, industrial partners and early career researchers all reflected on the way the network helped them build relationships at the right moments.

People valued the clarity and momentum these partnerships created. One participant commented that BBNet

*“... provides far more than funding. It creates the environment, connections, and shared understanding needed to make collaborations between academia and industry work.”*

These interactions helped ideas move from possibility to action. Several project teams reflected on the practical difference this made, with one explaining that BBNet

“... turned conversations into real projects, allowing you to move from ideas to demonstrable outcomes.”

and another describing the network as

“... a catalyst for technical progress, industrial engagement, and strategic growth.”

The earlier evidence of TRL progression aligns closely with these reflections, showing how relationships enabled through BBNet directly contributed to the scientific and technological progress captured across this evaluation.

• **iii. A place to learn, grow and gain visibility**

BBNet also became an important place to learn.

Many members highlighted how the network deepened their understanding of the bioeconomy and provided visibility of developments across the sector that would have been difficult to access alone.

Events were described as energising and generous with knowledge. One attendee remarked that BBNet felt like

“... a hive of activity and expertise.”

While another explained they were able

“... to learn more in a few hours than would be possible independently in many months.”

Early career researchers found this particularly valuable. People reflected on how BBNet supported their growth, broadened their thinking and allowed them to see their work within a wider system.

One participant described it as

“... a fantastic network that can boost your career through learning, collaboration, networking and personal development.”

For many, BBNet influenced not only their research but their confidence and aspirations within the field.

• **iv. A supportive, inclusive and motivating environment**

The culture of the network was highlighted just as strongly as the technical benefits. People consistently described BBNet as friendly, encouraging and inclusive. Several comments captured this atmosphere clearly, referring to

“... a well-defined, welcoming and inclusive environment.”

and a

“... friendly, helpful, welcoming network of like-minded people.”

Others spoke about

“... lovely, intelligent people working to advance the bioeconomy.”

emphasising the collective motivation that runs through the community.

This environment helped people feel comfortable to share early ideas, ask questions and seek and find support. It strengthened the personal relationships that underpin effective collaboration and created the conditions for open dialogue about both challenges and opportunities.

• **v. Shared themes, different emphases**

While the themes were consistent across the community, different groups emphasised different aspects.

Those leading funded projects spoke most strongly about progress. They highlighted how BBNet enabled them to:

- test early-stage ideas,
- secure support and
- work with industrial partners at the right moments.

Several reflected on how the network made it possible to undertake proof of concept work that “... is difficult to fund” elsewhere.

Event attendees placed more emphasis on the wider value of exposure, insight and confidence building. Many described how BBNet helped them:

- expand their networks,
- learn from others and
- stay informed about developments across the bioeconomy.

For these members, the network fostered new ways of thinking and broadened their sense of possibility.



### 5.2.3 A network that enables ambitious progress

These reflections show that BBNet is not simply a funding mechanism or a convenor of events.

It has created a cohesive, motivated and capable community where expertise is shared, collaborations are built, and emerging ideas can be tested, refined and moved forward. Whether through learning, partnership or professional development, BBNet has enabled progress that feels both meaningful and lasting. It has strengthened the foundations of the UK bioeconomy and inspired people to push their work further than they might have done alone.



“Great chance to meet people from a huge range of backgrounds that are all trying to address similar problems.”



“Helps you see where your work fits in the bioeconomy.”



“BBNet is full of lovely intelligent people working to advance the bioeconomy.”



“Key to keeping up to date with advancements and challenges in the field.”



“Much needed, strongly recommended.”



“A great place to learn about industry needs and talk about science.”

## 5.3 Facilitating collaboration

### 5.3.1 Why collaboration between industry and academia is challenging

Respondents to the funded project survey reported a clear and consistent set of barriers that make collaboration between industry and academia difficult to establish and sustain.

The most prominent challenge was the fundamental difference in pace, priorities and incentives. Industry partners often need rapid and targeted results, while academic work follows slower research cycles shaped by publication pressures, staff availability and grant timelines.

As one person summarised it;

“... industry needs results as soon as possible while academia is comfortable with slow pace.”

Differences in what each side considers success create further strain. Companies often look for commercial impact, while academics seek to deepen research and publish findings. These distinctions are sometimes intensified by communication gaps and the cultural distance between sectors. Respondents described situations where goals were misaligned, assumptions went unspoken and information was interpreted differently on each side.

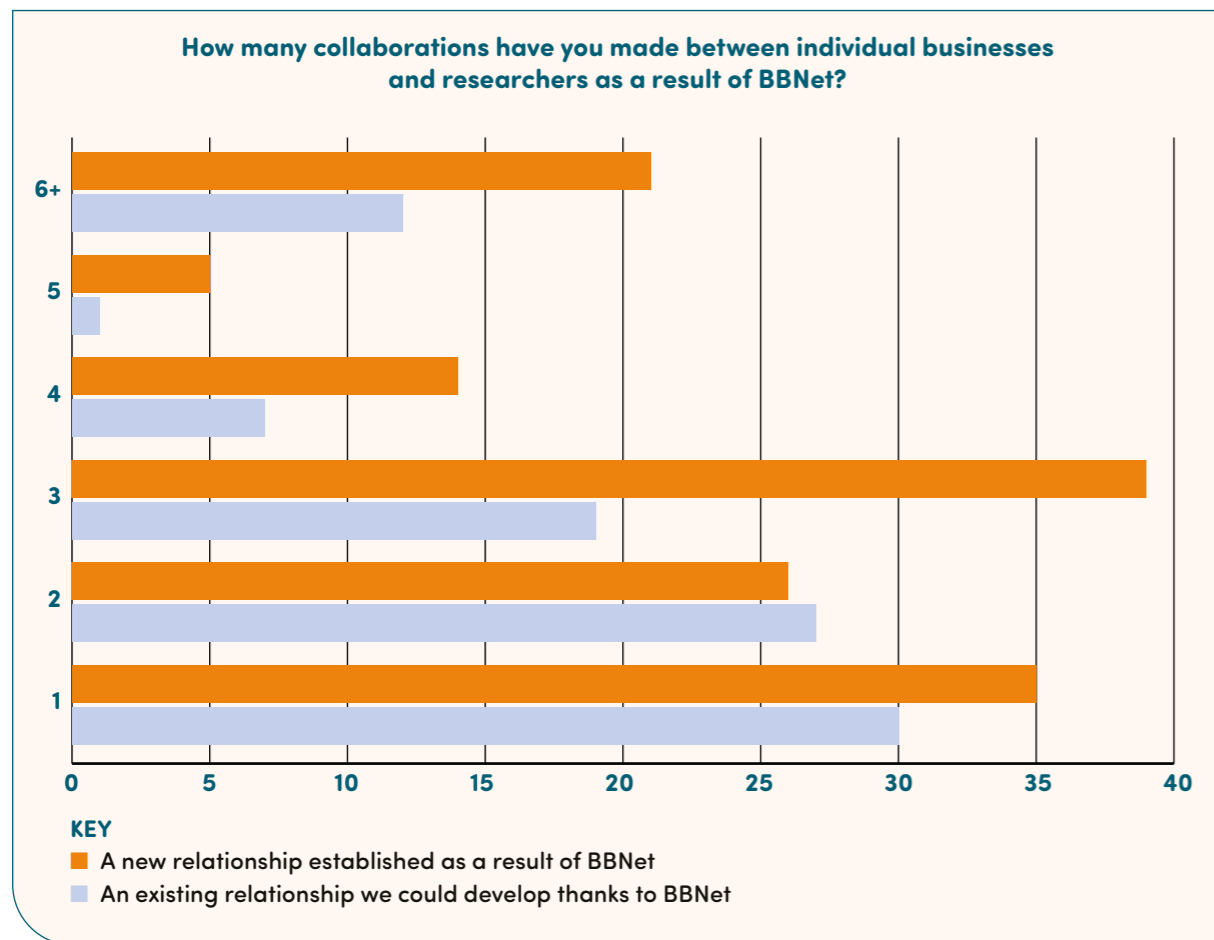
Practical constraints add further complications. Limited funding and short-term grants make it difficult to sustain momentum once initial projects end. Intellectual property, data ownership and differing attitudes to confidentiality also create tension, particularly where priorities or risk appetite diverge. Several respondents noted the challenge of simply finding the right person inside a company to speak to, with one commenting that without networks like BBNet,

“... it is not easy to get in contact with the right person in industries.”

Partnerships are also vulnerable to staff turnover, shifting commercial priorities and the loss of key champions. Other barriers include limited access to scale-up facilities, heavy workloads, administrative delays and a lack of sustained forums where relationships can be strengthened over time. Taken together, these factors show that collaboration is complicated – not just because of one issue, but rather because of the combined effect of timescales, resources, incentives and communication that rarely align neatly.

Against this backdrop, it is significant that BBNet members reported that, thanks to BBNet’s support, they had been able to establish or maintain a considerable number of collaborations through their involvement: event attendees reported **179 collaborations**, and funding recipients reported **49 collaborations**.





### 5.3.2 How BBNet increased the likelihood of collaboration

Across both event attendees and funded project holders, there was strong agreement that many of these collaborations would not have formed without BBNet. People repeatedly reflected that they would not have met the right partners elsewhere, especially industry contacts who are not always visible or accessible at traditional academic conferences.

One person stated simply,

“I would not have met these persons if it were not for BBNet.”

Another said that

“... the scientific events organised by BBNet have been a great platform for developing collaborations with researchers working in related fields.”

Members emphasised that BBNet did not only introduce people – it created the right conditions for conversations to deepen. People described how in-person meetings, topic focused workshops and two-day events made it possible to explore ideas in ways that email exchanges or isolated encounters could not. Others noted that, while collaborations might eventually have emerged through other NIBBs or large conferences, they would almost certainly have taken longer or been harder to initiate.

“Maybe [the relationship might have happened], but it would have taken much longer.”

The reflections from funded project holders strengthened this further. They explained that the network provided both the relationships and the practical tools that allowed collaborations to progress. Early-stage funding, proof of concept awards and business interaction vouchers were described as being pivotal to this.

One respondent explained that,

“... the 2 BIVs that I got from BBNet have helped me to deepen research collaborations with two existing companies and four new organisations.”

Others highlighted that BBNet created an environment where academic and industrial partners could engage on equal terms, helping to build trust and momentum. Even those who felt a collaboration might theoretically have formed elsewhere often added that it would have been slower, more uncertain or less likely without BBNet.

**The evidence paints a clear picture of BBNet as both the catalyst and the enabler of constructive relationships. It brought the right people together and provided the circumstances in which collaborations could be explored, tested and sustained.**



### 5.3.3 How BBNet created the conditions for successful collaboration

Across both groups, respondents described successful collaboration as something grounded in clarity, trust and mutual benefit. They emphasised the importance of open discussion at the outset, particularly around expectations, priorities and timings.

Many reflected that collaborations work best when both sectors understand each other's realities and constraints. Academics spoke about the importance of recognising commercial pressures, and industry partners valued the exploratory nature of academic research.

One participant captured this simply, saying that success depends on

“... a shared vision and mutual honesty.”

Another stressed the importance of

“... good open discussions before the project starts to have everyone's expectations clear.”

Funded project holders went further, describing how BBNet helped to create the environment where these principles could take hold.

One participant reflected that collaboration

“... is a bit like learning a new language, and BBNet served as an excellent interpreter and teacher.”

Another emphasised the practical role of early funding, saying that proof of concept support

“... was not just symbolic, it was catalytic,”

because without it, conversations often ended with

“what is the point of us talking about this?!”

Respondents also highlighted the importance of complementary expertise, sustained communication and a willingness to adapt. They noted that all these elements were supported by BBNet's ability to bring together like minded partners who shared an interest in advancing sustainable biotechnologies.



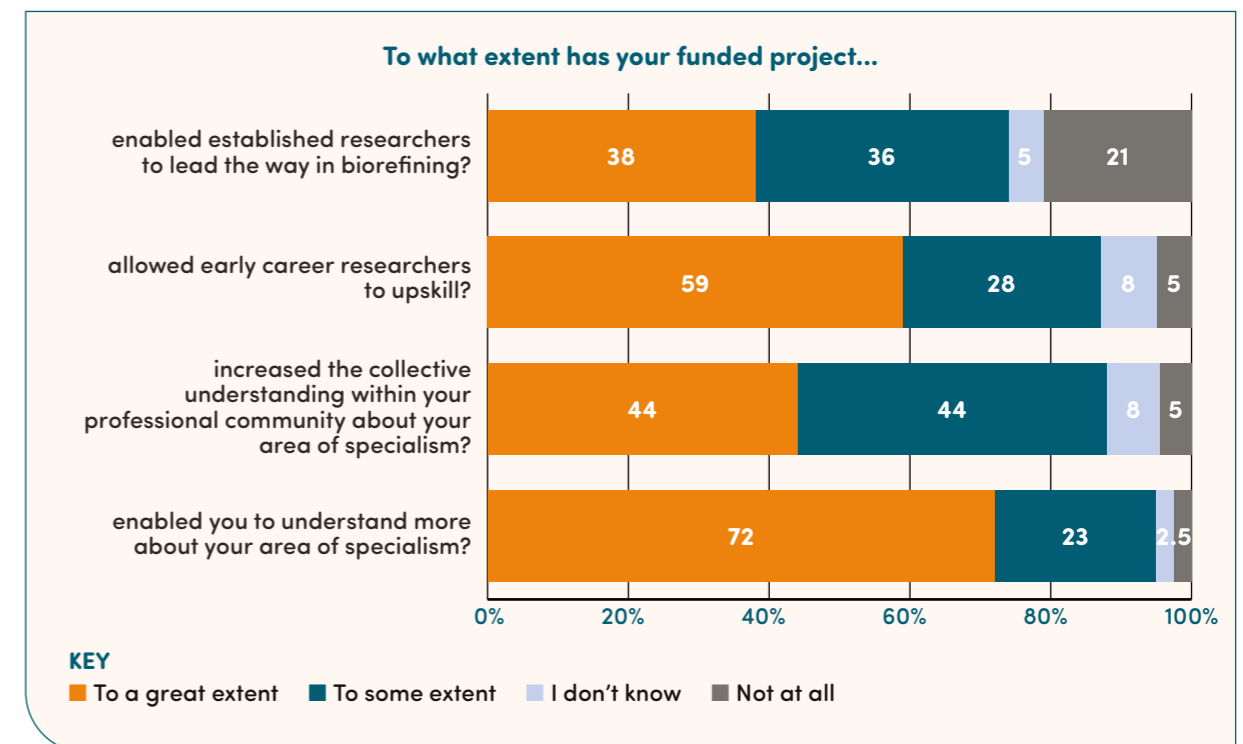
### 5.4 Deepening knowledge and capacity building

Funding project recipients were asked to consider the extent to which BBNet had impacted their area of specialism. Among the academics in this sample, almost every respondent felt that BBNet had helped them deepen their understanding of their own specialism, with 92% (n = 24) agreeing either “to a great extent” or “to some extent”. Only two respondents said BBNet had not contributed to this or that they were unsure. This pattern reflects a strong perceived benefit in helping academics strengthen and refresh their expertise.

A similar picture emerged when the same group of academic respondents was asked about BBNet's influence on collective understanding within the wider professional community. 80% (n = 21) respondents reported a positive effect, while only a very small number felt unable to identify a contribution. This suggests that BBNet also played a meaningful role in helping the community build a shared knowledge base.

The strongest result related to BBNet successfully providing support for early career researchers. 92% (n = 24) academics in the funded project survey said BBNet had enabled early career researchers to upskill, with the majority agreeing that this had happened “to a great extent”. Only 2 respondents felt unable to report a contribution. This indicates that BBNet's activities were particularly effective in helping early career researchers develop the skills and confidence needed to progress.

**Overall, the results show that BBNet strengthened individual expertise, expanded shared understanding across the sector and created valuable opportunities for early career researchers to build their capability.**



The funded projects generated a wide range of new knowledge, from methodological advances to novel applications. The following examples give a flavour of the breadth of what BBNet helped to unlock.

### Turning waste wood into greener chemicals

One project developed new ways to convert waste wood into sustainable chemicals used in products such as fragrances, medicines and cosmetics. The team showed how clean, wood-based material could successfully feed microbes to produce these chemicals, while also creating better tools for growing the microbes safely and efficiently at industrial scale.

**PI: Dr. Mauro Adriel Rinaldi,**  
University of Hull

### Discovering how carpet beetles digest keratin

Researchers uncovered new insight into the digestive enzymes produced by carpet beetles, helping to explain how these insects break down keratin. This knowledge could inform future biotechnology applications that rely on degrading tough, protein-rich materials.

**PI: Dr. Federico Sabbadin,**  
University of York

### Improving biogas production and monitoring

The project found that certain microbes with strong biogas-producing potential could survive well in anaerobic digesters handling varied wastes. The team also developed a quick and inexpensive method to detect how much of the microbe was present, helping operators maintain healthy and efficient digesters.

**PI: Dr. Caroline Orr,**  
Teesside University

### Creating a more sustainable way to recycle textiles

Through proof of concept funding and further BBNet support, one project demonstrated that dyed polycotton textiles can be converted into bacterial cellulose at scale. This work validated a promising approach for textile-to-textile recycling and helped strengthen collaborations with major industry partners exploring circular systems for the fashion sector.

**PI: Prof. Neil Bruce,**  
University of York

### Developing a simpler way to predict biogas from food waste

Another team created a practical new method to understand and predict how food waste converts into biogas. By using only basic measurements alongside computer modelling, they produced an easy-to-use tool that can help improve the efficiency of small-scale biogas systems used in homes and communities.

**PI: Dr. Gina Javanbakht,**  
University of Huddersfield

Event attendees told us that engagement with BBNet rarely changed their core research specialism, but consistently broadened perspectives, strengthened skills, and increased awareness of real-world application, interdisciplinarity, and future research opportunities.

- **BBNet rarely changed core research specialisms, but frequently enriched and broadened them.**

Many academics reported that their main research focus was already established before engaging with BBNet, but that the network strengthened, enriched or broadened their work.

*“It has not influenced my research specialism, but it has enriched it.”*

- **Engagement increased awareness of real world application, scale up, and industry relevance.**

Attendees described gaining insight into industrial challenges and applied use cases, influencing how they think about their research.

*“My engagement with BBNet has notably shaped my research specialism by exposing me to industry-relevant challenges and applied research opportunities.”*

- **Training and workshops shaped skills, confidence, and future research capability.**

Practical training, particularly around LCA, scale-up, and methods, was repeatedly highlighted as valuable for future funding and publications.

*“I attended the LCA workshop which enabled me to understand the basic concepts and steps to do LCA on my research projects.”*

- **BBNet supported more interdisciplinary and integrated thinking.**

Engagement encouraged researchers to bridge disciplines and take more integrated approaches.

*“It has been beneficial to combine bioprocessing/biotechnology with my thermochemical processing background.”*

- **Exposure to peers and sector developments helped refine direction rather than redefine it.**

Discussions, presentations and networking surfaced new ideas, applications, or perspectives that helped sharpen future research directions.

*“It helped in putting my research in perspective and receive feedback that strengthened it.”*

- **For early career researchers, BBNet played a formative role in confidence and career development.**

Several responses show BBNet influencing confidence, awareness of opportunities, and sense of belonging in the field.

*“Now I feel confident there are lot of opportunities in this field.”*

### 5.4.1 To what extent does BBNet engagement influence an academic's chosen specialism?



Most respondents said that while BBNet did not fundamentally change their chosen research specialism – it added breadth, context and direction to their work.

Many described how their involvement broadened their understanding of the wider biorefining landscape, exposed them to industry needs, and gave them new applied perspectives. Several said it helped them see how their work fits within sector priorities, with one noting that engagement with BBNet

*“... broadened my perspective as a materials scientist to a significant extent,”*

while another said it

*“... helped me to see more applications of biorefinery in scaling up and industrial application.”*

Respondents also highlighted the value of BBNet's training, workshops and events in strengthening their skills and refining aspects of their approach, particularly through learning about lifecycle assessment, scale-up and cross disciplinary methods.

Others described how meeting researchers and companies with complementary expertise encouraged them to explore new directions or consider applied questions they had not previously engaged with.

A smaller number said their research agenda remained unchanged, usually because it had been determined before joining BBNet or because their engagement with the network was still recent.

**Overall, the responses show that BBNet enriched existing research specialisms by expanding researchers' knowledge, strengthening methodological skills and connecting them with the wider opportunities and challenges shaping the field.**

### 5.4.2 To what extent does BBNet engagement influence the direction of industry-members' companies?



Most industry respondents said that BBNet had not significantly changed the overall direction of their company. Several noted that their strategic priorities were already well-established, particularly in more mature sectors. One respondent observed that their company is

*“always trying to innovate”*

regardless of external networks, while another commented that farming is a mature industry and their engagement was driven more by personal interest than by strategic need.

Even so, respondents described valuable benefits that sat around, rather than within, influencing their business direction. Many said that BBNet helped them stay informed about new research, understand emerging trends and gain insight into developments that they would not have had capacity to track internally. One respondent noted that information on policy and university research had been

*“invaluable.”*

Others said it provided useful exposure to different industries and approaches.

A smaller group reported a more direct influence; early-stage companies, in particular, said that BBNet had shaped their development by facilitating collaborations and enabling business interaction through their funded voucher scheme.

One respondent explained that BBNet

*“had an important influence on the company's direction.”*

by helping them establish academic partnerships to support new work.

**Overall, while BBNet did not typically shift core industrial strategy, it provided a valuable mechanism for insight, relationship-building and early engagement with academic expertise.**

### 5.4.3 Does membership of BBNet enable its members to develop new skills?



More than half of the respondents said they developed stronger networking skills through BBNet. They felt more comfortable approaching new contacts, starting conversations and building relationships across academia and industry. Several described real personal growth, including one who said the supportive environment helped them become

*“... better at networking and social interaction”*

and another who felt they now network in a

*“... targeted and strategic way.”*

Communication skills came through just as strongly. Respondents said they became more confident presenting their work, speaking to mixed audiences and explaining technical ideas clearly. Lifecycle assessment was the most frequently mentioned technical skill, with more than ten respondents saying they gained new understanding or confidence in this area.

Others said BBNet helped them work more effectively with partners, in topics ranging from

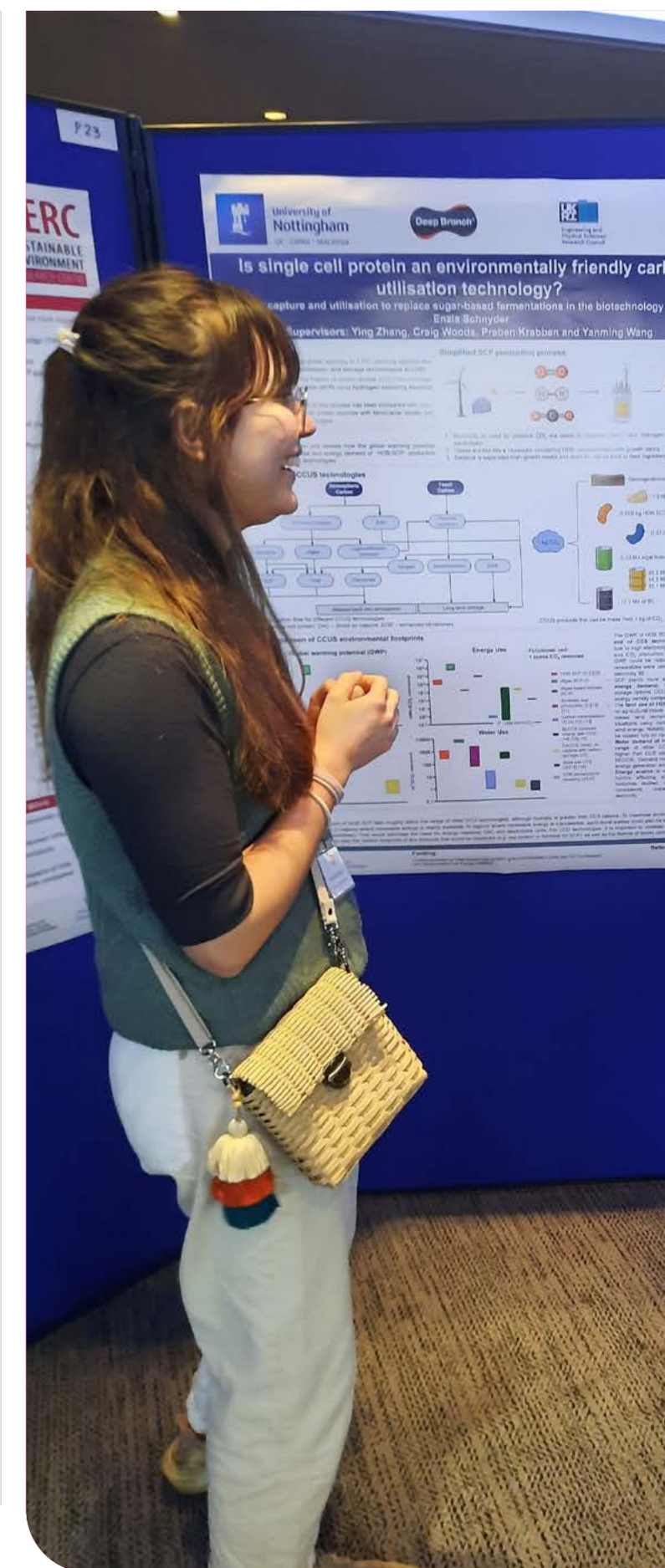
*“... how to build project consortia,”*

to

*“... how to talk to stakeholders and get what you need.”*

A small group said they did not develop new skills, usually because they had attended only one event or had limited engagement.

**Overall, the responses show that BBNet helped people build both the professional and technical skills they need to work confidently in a field that links academia and industry.**

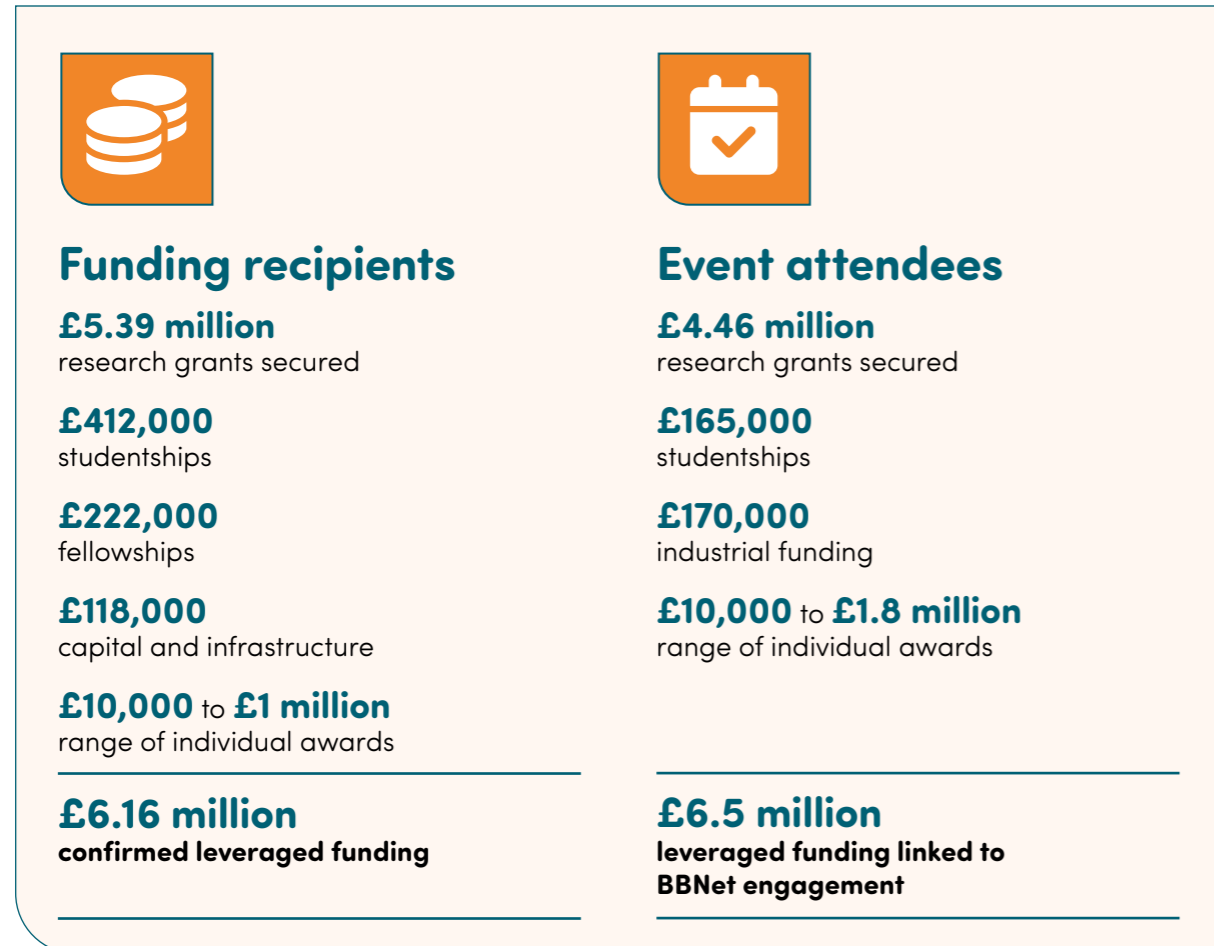


## 5.5 Delivering economic and wider societal impact

### 5.5.1 Leveraging funding

BBNet membership has catalysed significant further investment across both funded projects and wider network engagement.

The combined value of follow-on funding **exceeds £12.5 million**.

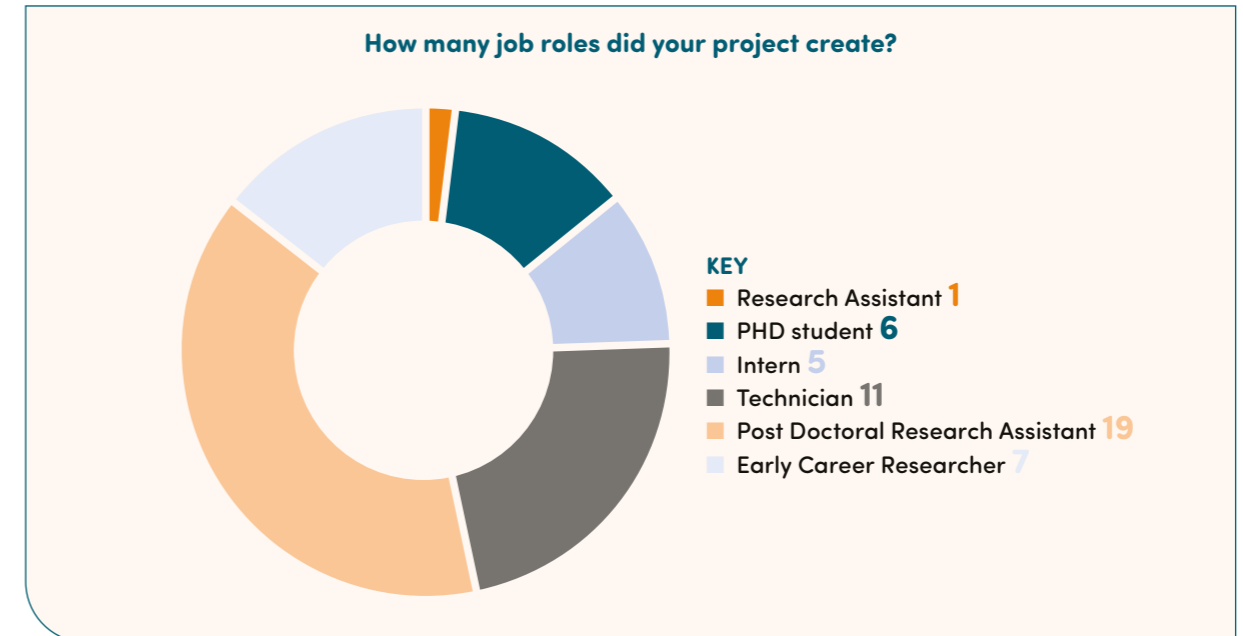


Most of the funding came through research grants, which accounted for more than £5 million, with further funding secured through studentships, fellowships and capital investment. Individual awards ranged in value from £10,000 to £1 million, showing that BBNet helped projects progress at many different scales.

Significantly, event attendees who were not directly funded through BBNet also reported substantial leveraged value. More than £6.5 million of additional funding was linked to collaborations, ideas or opportunities that emerged through BBNet events. This included more than £4 million in research grants, almost £2 million in fellowships and further investment through industrial partnerships and studentships.

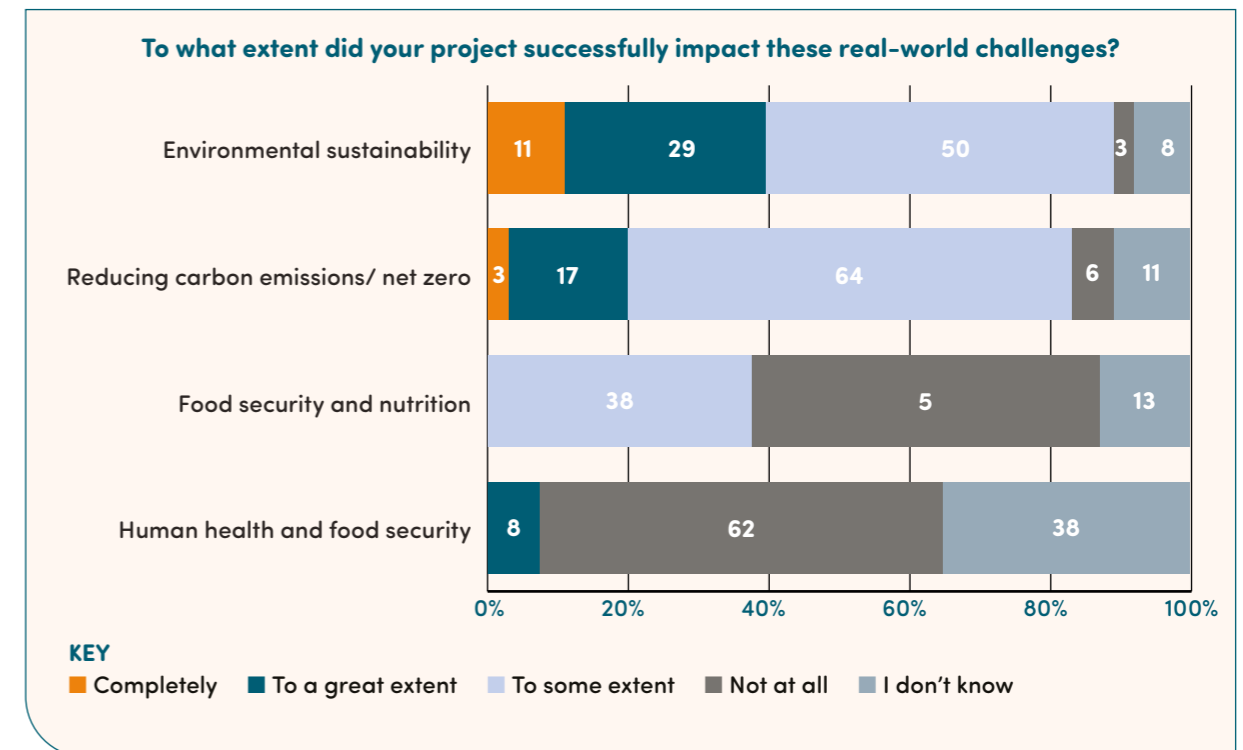
**Overall, the funding data shows that BBNet activity supported a wide range of follow-on funding successes across the community.**

### 5.5.2 Job creation



BBNet funded projects created new roles across the research and innovation pipeline, though no detail was provided about the lifespan of these new roles. The largest group was post-doctoral research assistants, with 19 positions created. This was followed by 11 technician roles, 7 early career researchers, 6 PhD students, 5 interns and 1 research assistant. Together, these roles show how BBNet investment supported both scientific progress and the people delivering it.

### 5.5.3 Solving real-world challenges



Beyond the direct economic benefits evidenced elsewhere in this report, many projects also contributed to wider real-world challenges that influence long-term economic resilience. The responses show that BBNet-funded projects are already generating value in areas that support future markets, reduce environmental risk and strengthen the conditions for sustainable growth.

### Environmental sustainability

Environmental sustainability emerged as the strongest area of contribution. More than two thirds of respondents reported that their project had positively influenced their attempts to influence this issue, reflecting the clear environmental intent built into many BBNet-funded programmes. Work that reduces waste, improves resource efficiency or creates lower-impact alternatives is laying foundations for future economic advantage, particularly in sectors where regulation and market demand are shifting towards cleaner technologies.

### Reducing carbon emissions/net zero

Progress on reducing carbon emissions or supporting net zero aims was similarly visible. Many projects reported at least some influence, with a smaller group stating that their work had contributed significantly or completely to this. These early steps are important, because technologies that support decarbonisation often underpin new commercial opportunities and help future-proof supply chains.

### Human health and food security

A number of projects also reported positive contributions to human health and food security, though fewer described these as primary areas of focus. In several cases, respondents explained that, while their work was not directly designed to address these challenges, it offered indirect benefits such as improved material safety, enhanced quality of bioproducts or more reliable waste treatment processes.

### Other focuses

As expected for early-stage research, some projects did not aim to influence these wider challenges at all. Their focus was on generating technical evidence or building foundational knowledge that could support longer-term innovation or commercial development. These findings highlight the diversity of BBNet-funded work, spanning both exploratory science and early applied impact.

**More broadly, the pattern suggests that BBNet-supported innovation is contributing to a stronger, more resilient bioeconomy. The environmental and net zero benefits captured here not only align with national priorities but also support the economic case for continued investment in sustainable biotechnology, where environmental performance and commercial opportunity are increasingly intertwined.**



## 6. THE FUTURE: WHERE NEXT?

**It is evident that BBNet has built an impactful network of deep and lasting connections that will no doubt continue to prosper and develop for many years to come.**

**H**owever, the data presented in this report demonstrates that the activities that generated the greatest impact are the events and grant funded projects, made possible only by the funding received from BBSRC to support and manage the network. Events, including conferences, workshops and training, have yielded a 19 fold return on investment (£19 of research funding leveraged for every £1 of costs associated with running events), with grant funded projects yielding a 400% return (£5 of leveraged research funding per £1 of BBNet funding received). Furthermore, it is noteworthy that business interaction voucher (BIV) funding offers the larger return on investment as this type of funding yielded a 600% return on investment through leveraged funding, compared to that of proof of concept (POC) funding which sits at 135%.

This report clearly demonstrates and celebrates the lasting impact the network has had on its members and within the wider community. By bridging the gap between laboratory breakthroughs and industrial-scale application, the network has successfully fostered a cohesive, motivated community where over 1,250 members from academia, industry, and policy could collaborate with a shared purpose.

The foundations laid through BBNet-funded projects have not only advanced individual technologies up the readiness scale but have also secured over £12.5 million in follow-on investment, significantly advancing progress in the manufacturing of sustainable fuels, chemicals, and materials of the future.

There is an appetite from the BBSRC to continue interdisciplinary support for the biomass biorefining sector, however at the time of publication no follow on funding or initiatives are planned.

*“It is not simply a funding mechanism or a programme of events. It has created a cohesive, motivated and capable community where expertise is shared, collaborations are built and emerging ideas can be tested, refined and moved forward. It has strengthened the foundations for sustainable biomanufacturing and encouraged people to push their work further than they might otherwise have done.”*



# 7. ILLUSTRATING BBNET'S IMPACT: CASE STUDIES IN ACTION

## CASE STUDY 1: Mauro Rinaldi – using microbes to create sustainable chemicals

### What Mauro is working on

Mauro Rinaldi (University of Hull) is developing a cleaner way to manufacture terpenoids, the chemicals found in fragrances, detergents, cosmetics and pharmaceuticals. These ingredients are usually made from petrochemicals or through extraction processes that are expensive, carbon-intensive or environmentally damaging. Mauro's goal is to engineer microbes that can produce these chemicals more sustainably, avoiding harmful production routes altogether.

### Where he was before the BBNet funding

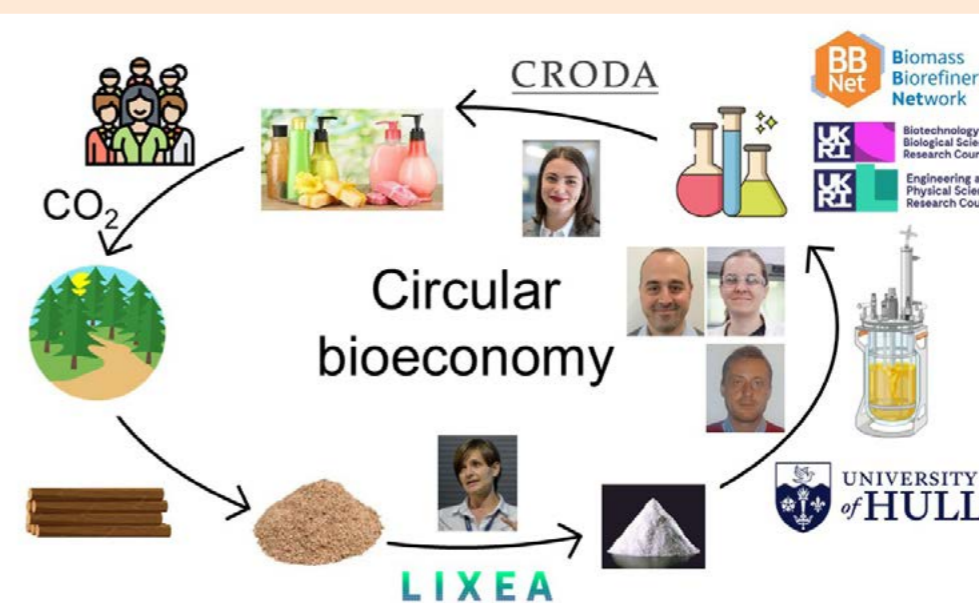
Mauro had early proof of concept results for one terpenoid but lacked the resources to test the method on other chemicals. He did not have the bioreactor, consumables or materials needed to scale the work, nor did he have any industrial partners to help guide its commercial relevance. Progression beyond academic concept stage was not possible with existing support.



“BBNet funding allowed us to set up fermentation and saccharification from scratch at Hull and to train new people in those skills. That capability simply wouldn't exist in my lab without this project.”

### What the BBNet project enabled

BBNet funding allowed Mauro to move from an early-stage idea (TRL 1–2) to a credible multi-chemical demonstration (TRL 3–4). It funded essential equipment, including a bioreactor, and provided access to high-cost genetic materials. The project also supported the hiring and training of a research technician, increasing laboratory capacity and momentum across the group. Crucially, BBNet's network enabled direct engagement with Croda and Lixia, giving Mauro informed industrial conversations that would have been challenging to initiate independently.



“What BBNet really did was connect the dots: Lixea's forestry residues, our microbes, and Croda's products. Suddenly we weren't just doing an experiment in a lab, we were building a real supply chain from waste biomass to high-value ingredients.”

### Impact on his research, collaborations and career

The project strengthened Mauro's research direction and clarified which industry partners are best aligned with the technology. Ongoing discussions with Croda are now exploring how the method could be integrated into their industrial strains. The work has also positioned Mauro strongly for future funding. He is preparing a BBSRC New Investigator application, progressing through the UK ICURE commercialisation programme and exploring protectability and potential spin-out routes. The BBNet project has helped him build a strong, evidence-based research portfolio early in his lectureship.

### Environmental significance

Microbial production offers a way to avoid fossil-based manufacturing and damaging extraction practices. This approach could significantly reduce emissions, ease pressure on agricultural land, remove pollutants associated with chemical processing and eliminate unsustainable sourcing practices such as harvesting shark-derived squalene. It represents a meaningful step towards cleaner, more responsible chemical manufacturing.

### What happens next

Mauro is now deepening the scientific understanding of the microbial system, exploring commercial readiness through ICURE, and seeking new funding to adapt the process to industrial strains. The project has laid the scientific, collaborative and commercial foundations needed to bring this sustainable technology closer to real-world application.

## CASE STUDY 2:

### Parimala Shivaprasad – turning waste flowers into sustainable chemicals



#### What Parimala is working on

Parimala Shivaprasad (University of Nottingham) is exploring whether chemicals used in personal care and homecare products can be produced more sustainably by converting surplus flowers into valuable ingredients. Many of these chemicals currently rely on petrochemical sources. Surplus petals offer a simpler, lower-impact feedstock because they contain useful natural compounds and require far less processing than woody biomass.

#### Where she was before the BBNet funding

Parimala had an early reactor concept capable of converting biomass into chemicals but lacked the UK feedstock, industrial partnerships and proof of concept needed to test the idea commercially. She also needed evidence strong enough to build future funding bids and partnerships. The BBNet call aligned all of these requirements for the first time.

#### What the BBNet project enabled

The funding allowed Parimala to demonstrate both technical and economic feasibility. Her team produced fragrance ingredients and bio-based polymers from surplus flowers, supported by techno-economic analysis that showed clear commercial promise. BBNet also connected her with Bridge Farm for flower supply and with Unilever as an end-user partner, giving her a complete supply chain from feedstock to formulation testing. Flexible funding supported both laboratory research and economic modelling. Through BBNet events and small-grant schemes, she expanded collaborations with Croda and partners in the UK and India.

“The funding allowed me to test the lab scale protocol on UK specific feedstock for the first time and establish links with horticulture businesses like Bridge Farm. The outcomes of the project have enabled me to secure further research funding and develop my research group as a new PI.”



#### Impact on her research, partnerships and career

The project rapidly increased Parimala’s visibility in the field, establishing her as a recognised specialist in waste-flower valorisation. It also unlocked major opportunities. A meeting with Unilever at a BBNet conference has grown into a partnership now being developed into a potential multi-million-pound Prosperity Partnership. She has since taken on a leadership role within the Supergen Bioenergy Hub and secured a DSIT fellowship, contributing to national horizon scanning of climate and energy technologies.

“If just 10% of the UK’s flower waste were processed, it will generate £100 million worth of fragrance ingredients and reduce 30% CO2 emissions compared to commercial production processes.”



#### Environmental significance

Early lifecycle assessment shows clear benefits. Around 80% of the emissions associated with natural fragrance oils come from cultivation. Because surplus flowers have already been grown, using them as feedstock avoids these emissions entirely. Initial estimates suggest this approach could reduce greenhouse gas emissions by around 30%, alongside savings from more energy-efficient processing.

#### What happens next

Parimala is now preparing the Prosperity Partnership bid, which would support a five-year programme to move from laboratory results towards real consumer products. She is also strengthening international collaboration and contributing to national policy work. The BBNet project has placed her on a clear pathway towards commercial adoption and wider system influence.

## APPENDIX 1: BBNET'S THEORY OF CHANGE

Support research that takes organic waste and biomass and uses it in the manufacture of bio-based products, contributing to a sustainable, circular bioeconomy that reduces global reliance on fossil fuels.					
Objective	Inputs	Outputs	Short-term outcomes	Medium-term outcomes	Long-term outcomes
	<ul style="list-style-type: none"> <li>Network based membership/ community of practice bringing together researchers and businesses to develop innovative bio-based fuels, chemicals, and materials</li> <li>Funding research in the form of:                             <ul style="list-style-type: none"> <li>proof of concept studies</li> <li>feasibility studies (BWs)</li> <li>scale-up activities</li> <li>consortium building initiatives</li> </ul> </li> <li>Events                             <ul style="list-style-type: none"> <li>Annual conferences</li> <li>Subject-specific workshops</li> <li>Training opportunities</li> </ul> </li> <li>Reports to progress thinking and shape policy</li> <li>Knowledge sharing within and beyond the network</li> </ul>	<ul style="list-style-type: none"> <li>Grow the network/community with increased membership from industry and academia</li> <li>High levels of attendance and breadth/quality of speakers and posters presented at our events</li> <li>Successful collaborative research projects enabled</li> <li>Further grant funding catalysed – triggered by successful projects and events funded by BBNet</li> <li>Funding leveraged with match funding from industry</li> <li>Journals/articles of high quality (and associated reach) published</li> <li>New technologies (products and processes) developed</li> <li>New spin-out companies created</li> <li>Contributed to consultations on new policies or regulation/framework changes</li> <li>Invited to speak on other stages/conferences</li> <li>New or improved datasets and databases created</li> <li>New intellectual property registered</li> <li>Jobs created or retained</li> <li>New pieces of software or technical products developed</li> <li>Projects moved up in their technology readiness level</li> </ul>	<ul style="list-style-type: none"> <li>Increased numbers of successful collaborations between individual businesses and academic researchers.</li> <li>Individual researchers undertaking high quality, cutting-edge research to understand more about their specialist areas.</li> <li>More technologies being tested by the collaborative partnerships – proving initial concepts.</li> <li>New knowledge generated with potential applications across multiple sectors such as agriculture, materials and chemical production, biopharmaceuticals, waste processing and recycling</li> <li>More businesses explore the use of bio-based alternatives in manufacturing.</li> <li>More opportunities available for early career researchers to upskill in the form of funding and support.</li> <li>Improved awareness of the barriers that affect businesses in industrial biotechnology.</li> <li>Improved awareness of the potential for industrial biotechnology within the community and beyond</li> <li>Increased international interest in the work of the BBNet community.</li> </ul>	<ul style="list-style-type: none"> <li>Strengthened links between industry and academia allowing research to be aligned with industrially relevant problems</li> <li>Increased and improved collective knowledge base including drawing on lessons from failed projects.</li> <li>More successful trials of viable biotechnologies.</li> <li>Knowledge applied at scale to test and evidence potential commercial viability</li> <li>More businesses actively moving away from a manufacturing reliance on fossil fuels.</li> <li>More businesses influencing the sector to follow their lead to operate sustainably within the bioeconomy.</li> <li>Increased numbers of early career researchers working in the biorefining sector.</li> <li>Closer working relationships between academia, industry &amp; policy-makers to tackle identified barriers.</li> <li>Greater influence over policy that increases support for industrial biotechnology.</li> <li>Increased number of international collaborations between UK and international academic researchers.</li> </ul>	<ul style="list-style-type: none"> <li>Sustained relationships between academic research and business application</li> <li>Real world challenges can be addressed using improved collective knowledge.</li> <li>Increased numbers of products or processes applied in a commercial setting to improve societal impact.</li> <li>Reduced use of fossil fuels in manufacturing (reduction in CO2 produced)</li> <li>New biomanufacturing businesses entering the arena.</li> <li>Established researchers leading the way in biorefining.</li> <li>Fewer barriers to progress and growth relating to businesses in industrial biotechnology.</li> <li>Better-informed government regulatory decision-making to support UK economic growth.</li> <li>Increased number of international companies to develop new technologies in the UK.</li> </ul>
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