

International collaborations create chemistry

Science is a collaborative, international endeavour and provides the most benefits to society when researchers from different backgrounds, be that country, sector or discipline, come together. Scientists based in the UK and European Union (EU) are keen to continue collaborating to ensure their work meets the global challenges we face, even after the UK leaves the EU. The EU's research and innovation Framework Programmes are an important, and internationally recognised, way in which they achieve this, as well as broader international collaborations. EU Member States and the European Parliament are currently agreeing the shape of the next EU Framework Programme, Horizon Europe. The right programme design will maintain the programme's reputation for and track-record of facilitating excellent science and enabling the broad collaborations associated with it.

By developing member case studies and analysing the effects of international collaboration on the science published in our journals, we set out to understand more fully the benefits that international collaboration in general, and participation in EU programmes in particular, bring to chemistry.

Recommendations

Horizon Europe should continue to support excellence and international collaboration to benefit Europe's science and innovation base and its citizens.

The UK should associate to Horizon Europe to preserve and enhance these international collaborations, since they bring many reciprocal benefits to both the UK and the European Union.

To support this, the UK government needs to put in place an agile, welcoming mobility framework for science that enables the easy movement of scientists and their families.

Key findings

Our research found that EU research and innovation Framework Programmes bring a wide range of unique benefits to the UK that cannot be replicated within a single country or through bilateral agreements. The UK's participation is also important to many projects, benefitting the EU.

The programmes operate on a **scale that is unique globally**, spanning different disciplines, countries and sectors

Their prestige and the collaborations they facilitate are associated with **higher impact science** for the UK and for the EU

They enable businesses to **grow, create jobs and invest** in the UK

They enable science and research to **inform and shape policy** locally and globally

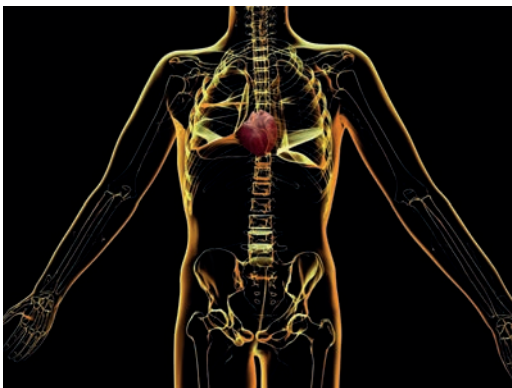
They facilitate the **easy movement of researchers** that is essential to science as a global endeavour

They **complement national research programmes**, broadening the kinds of research we can do in the UK and widening our access to expertise and equipment

Operating on a unique scale globally

The collaborations that the EU Framework Programmes enable are on a completely different scale to what individual countries or bilateral agreements can achieve, acting across borders, disciplines and sectors.

This is vital in the context of tackling global challenges where we can only achieve progress by bringing together the best people, facilities and equipment in the world.



Virtual human, CompBioMed



Inside the LEAK cloud chamber, Eurochamp-2020

"I may be happy playing in the English Premier League but really, I want to be part of the UEFA Champion's League. We need to be able to work alongside the best."

Professor Peter Coveney, CompBioMed

CompBioMed is developing computational methods to speed up the discovery and design of new drugs, and ultimately combine patient data and modelling to determine the best treatment for patients quickly.

"It is vitally important to have the UK groups participate."

Professor Hartmut Herrmann, EUROCHAMP-2020 project

EUROCHAMP-2020 is a Europe-wide network seeking to improve our understanding of air quality and its impacts on human health. The network includes two chambers in the UK.

International collaborations are associated with more impactful science

The reputation and standing of some streams of EU funding act as an international badge of quality.

EU researchers see the UK as a valued scientific partner, both in terms of expertise and leadership. The research community feel that continued collaboration between the UK and the EU is vital for the ability of science to progress and contribute to the grand challenges we face.

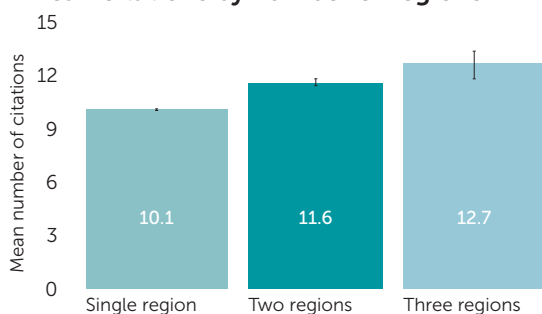


Cold water Ascidiaceae, PharmaSea

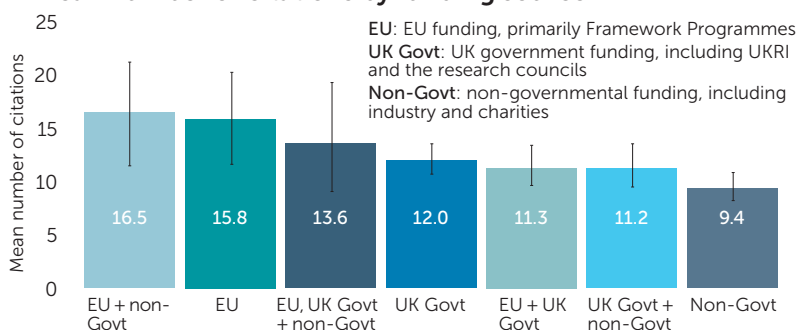
International collaborations, such as those EU Framework Programmes can facilitate, are associated with higher impact publications.

Highly international collaborations produce, on average, higher impact publications.

Mean citations by number of regions



Mean number of citations by funding source



EU: EU funding, primarily Framework Programmes
UK Govt: UK government funding, including UKRI and the research councils
Non-Govt: non-governmental funding, including industry and charities

The vertical error bars are based on the standard deviation and the number of publications in each region or funding category.

Papers co-authored by researchers based in different countries or regions have a higher number of mean citations than those with authors from a single country or region.¹ Furthermore, when UK, European Economic Area (EEA) and authors from the rest of the world come together to collaborate, their publications have a higher mean number of citations than papers with just UK and EEA authors.

Research funded by EU programmes has a high average impact: significantly higher than research papers funded by UK Government funding sources.

For the papers that were authored by researchers in the UK in our journals, we found that EU funded research received a higher number of mean citations than research funded by the UK government alone.

¹ It is important to note that while number of citations is a widely used measure of research impact, it only represents one aspect of impact and its value as a metric is the subject of ongoing debate in the scientific community.

One fifth of all projects in Horizon 2020 were led by UK scientists from 2015–16

CORDIS, cordis.europa.eu

“Since the Brexit vote I’ve been asked to be part of more EU science advisory boards and committees than ever before and, while they are afraid that we might lose the ability to have UK partners in H2020 and its successor, they still want the UK to provide expertise on advisory boards.”

Professor Marcel Jaspars, PharmaSea

PharmaSea is an international collaboration led from the University of Aberdeen that is advancing treatments for conditions such as Alzheimer’s disease and epilepsy and informing global policy on marine biodiversity.

Creating growth, jobs and investment in the UK

From programmes designed to support small and medium enterprises (SMEs) to prestigious competitive grants, EU funding supports UK businesses to grow and flourish in global markets and can help leverage further investment in local communities from industry.

The SME instrument helps companies set up pilot facilities, understand their market, build their visibility and brand, access international networks and customers, access mentoring from experienced entrepreneurs and leverage further investments.

Winning prestigious, competitive EU grants can enable universities to leverage further investment from industry. It can also be a factor in large companies choosing to locate near a university, bringing jobs and prosperity to the local economy.



The team at Smart Separations Ltd

“The SME phase 2 [grant] is a game changer for us [...] Our company would not exist today without it.”

Dr Hugo Macedo,
Smart Separations Ltd

SME Instrument: Dr Hugo Macedo, a former Erasmus student, started London-based company Smart Separations Ltd, which employs 14 skilled scientists from all over the world. They have devised a cheaper, more efficient method for making reusable, recyclable microfilters with a wide variety of applications from air filtration to blood processing and antibody production.

“This technology is very applicable to both the UK market and internationally. We have spoken with companies in the UK but also some in Europe, including Belgium, Germany, and Switzerland.”

Nathan Lawrence, ANB
Sensors

SME Instrument: ANB Sensors used a Horizon 2020 SME Instrument grant to carry out a feasibility study for sensors measuring the degree of alkalinity or acidity of water, which is important for environmental testing.

96% of UK companies in the chemical and pharmaceutical sectors are SMEs

Eurostat, ec.europa.eu/eurostat

£658m of EU funding went to UK SMEs between 2007 and 2013
CORDIS, cordis.europa.eu

£81m joint public-private investment in the Materials Innovation Centre in Liverpool leveraged from winning EU funding

“The ERC has a certain prestige to it [...] Large companies such as Unilever, when they are looking to invest in an area, bear these things in mind.”

Professor Andy Cooper,
RobOT

RobOT: Fundamental, blue-skies research at the University of Liverpool is exploring computational modelling and robotics to develop better, faster ways of discovering new materials.

Enabling science to inform and shape policy

Internationally collaborative research can inform and shape international policy at the early stages, locally and globally.

In environmental policy, scientific research can play a critical role in determining policy options to protect and enhance our environment. For nationally-specific issues such as waterways and air space, internationally collaborative research that brings together the perspectives of scientists from different nations can provide compelling evidence that action is needed and help develop specific policy options.



Scientists at the LEAK cloud chamber, Eurochamp-2020



Marcel Jaspars, PharmaSea

"60% of oceans are not covered by international laws to protect marine biodiversity. Our work showed what the commercial value might be of this deep sea biodiversity."

Professor Marcel Jaspars,
PharmaSea

"Our activity is very closely watched by environmental agencies. I am aware that there is regulation in the pipeline because at some point, if the air quality in winter gets worse, you have to do something."

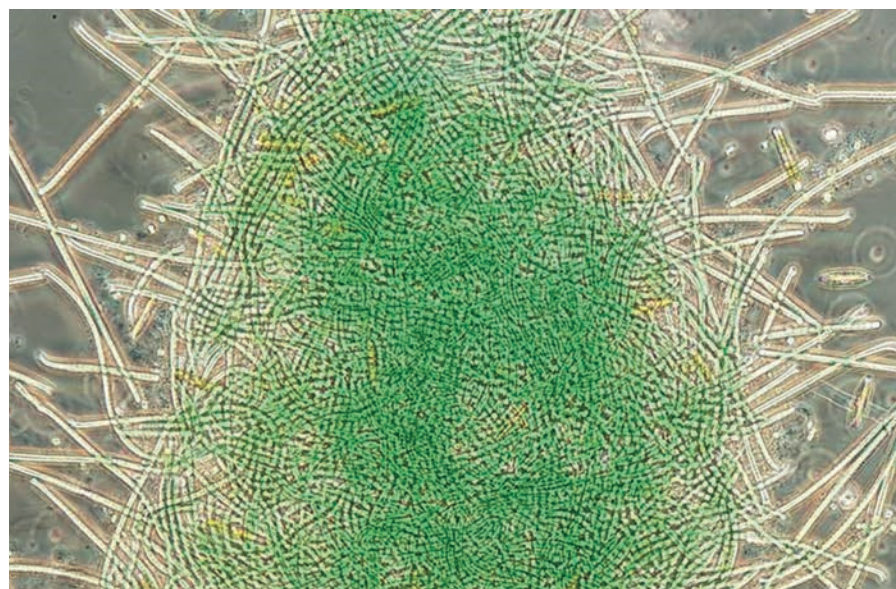
Professor Hartmut Herrmann,
EUROCHAMP-2020

EUROCHAMP-2020:

Domestic fuel burning in Germany contributes more to particulate air pollution in the course of one winter than an entire year of vehicle emissions.

"[...] our work is heavily engaged in long-term planning and communication to farmers, anaerobic digestive businesses, policymakers and regulators. It's bringing all those aspects together to make a complete solution."

Professor Carole Llewellyn,
ALG-AD Interreg



Algae in action: transforming waste to value, ALG-AD

UK science has also benefitted from funding outside the Framework Programmes, for example through the European Regional Development Fund.

This can lead to improved technological solutions and inform policy and regulation that benefits UK regions.

ALG-AD Interreg supports circular economy research into algal technologies that turn agricultural waste into food for livestock that can otherwise pollute waterways. This is a particular issue in Wales, which has a large farming sector.

Facilitating vital movement of people

Enabling easy movement of scientists and their families to support a constant, steady flow of knowledge exchange is vital for science to progress.

For some areas of research, recruiting internationally is essential because there are only a small number of people with the highly specialised scientific skills and knowledge needed. For SMEs, being able to recruit the skills they need quickly and easily is vital to their growth and success.



Econic Technologies

For early career researchers, participating in EU projects supports their development and career progression.

Funding for travel enables access to different facilities, mentoring and training, and even opportunities for supervision or project management that aren't available in their home institution. It helps them grow their networks and equips them to work as part of the global scientific community.

Although the effect is less pronounced for the UK and for the EU, there is evidence that across all academic subjects, women are less likely than men to collaborate internationally on research papers.² In its first three years, women led 31% of Horizon 2020 projects and made up 53% of its advisory panels.³ Engagement in the Framework Programmes with their commitments to gender equality is important. Women face pervasive barriers⁴ to progression and retention in the chemical sciences internationally, which participation in Framework Programmes may help address.

² *Gender in the Global Research Landscape*, Elsevier, 2017 (<https://www.elsevier.com/research-intelligence/campaigns/gender-17>)

³ *Key findings from the Horizon 2020 interim evaluation*, European Commission, 2017 (<https://ec.europa.eu/research/evaluations/index.cfm?pg=h2020evaluation>)

⁴ *Breaking the Barriers: women's retention and progression in the chemical sciences*, Royal Society of Chemistry, Nov 2018 (<http://www.rsc.org/campaigning-outreach/campaigning/incldiv/inclusion--diversity-resources/womens-progression/>)

One third of staff in UK university chemistry departments came from outside the UK in 2015/16

HESA student & staff records 2015/16 [hesa.ac.uk](https://www.hesa.ac.uk)

"[...] you look for people that have relevant experience in the types of tech you are doing and our employees have been working in groups inside and outside the UK on particularly strong research that just made them good candidates."

Dr Rowena Sellens, CEO, Econic Technologies

SME Instrument: Econic Technologies is an SME start-up that has commercialised an innovative catalyst technology that could have an environmental impact equivalent to taking two millions cars a year off the road.

"It's not like hiring a doctor or a lawyer; these are areas of research where there are maybe fewer than 50 people working in them. [...] for this research, it would not have been able to happen without hiring from the EU."

Professor Andy Cooper, RobOT

"I've been able to work with one of their PhD students and co-supervise them on a joint project [...] something I never thought would be possible."

Dr Sara Kyne, COST action

COST action: Dr Sara Kyne is an early career researcher at the University of Lincoln. EU funding has given her access to mentoring and experience supervising a PhD student.

Complementing national research programmes

EU Framework Programmes can fulfil a different and complementary purpose to UK funding streams, broadening the kind of research UK-based scientists can do.

In universities, EU funding can enable longer-term blue skies research or multilateral collaborations that a single nation would find challenging to coordinate. For businesses, EU funding offers unique benefits like access to international networks, markets, mentoring and training.



Computational chemistry, RobOT

23% or £55m – the amount of funding UK university chemistry departments received from the EU in 2014/15

HESA finance records 2014/15
hesa.ac.uk

“Increasingly funding is becoming challenge-led whereas the ERC is not, it is science-excellence driven.”

Professor Andy Cooper, RobOT

RobOT: Fundamental, blue-skies research at the University of Liverpool is exploring computational modelling and robotics to develop better, faster ways of discovering new materials.

“Being able to access and influence EU funding from within the UK is crucial. UK based academics in chemistry are highly effective at bringing in EU funding.”

James Douglas, AstraZeneca

NoNoMeCat: AstraZeneca is a global pharmaceutical company researching treatments for conditions such as cancer, heart and lung disease and diabetes. Through NoNoMeCat, they are providing PhD students with research experience and training in an industry setting.

Methodology

Developing member case studies

We asked our community to tell us about their experiences of EU Framework Programme funding. Based on the responses, we followed up with in-depth interviews to develop case studies with researchers and entrepreneurs from across the UK and from the EU based in universities, SMEs and large multinational businesses. All the case studies featured in this booklet were supported by Framework Programme 7 and Horizon 2020 funding, except ALG-AD Interreg, which was funded by the European Regional Development Fund. The 10 case studies are published in full at rsc.li/2PoeNCj.

Analysing our publications

We carried out an analysis of papers published across our portfolio of 44 journals to understand differences in the impact of research depending on where co-authors on a paper worked. We examined the number of citations papers published between 2012 and 2016 received within two years of publication, using data from CrossRef. Citations are a widely used measure of research impact, although there are limitations to it.

The analysis looked at collaboration between five regions, selected based on volume of papers: the UK, the rest of the EEA, the USA, China and the rest of the world, with region and country designations based on place of work, not nationality.

With over 50,000 members and a knowledge business that spans the globe, the Royal Society of Chemistry is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world.

We represent a global and interconnected network of chemical scientists with members in 100 countries, including across EU member states. Our members include those working in large multinational companies and small to medium enterprises, researchers and students in universities, teachers and regulators.

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