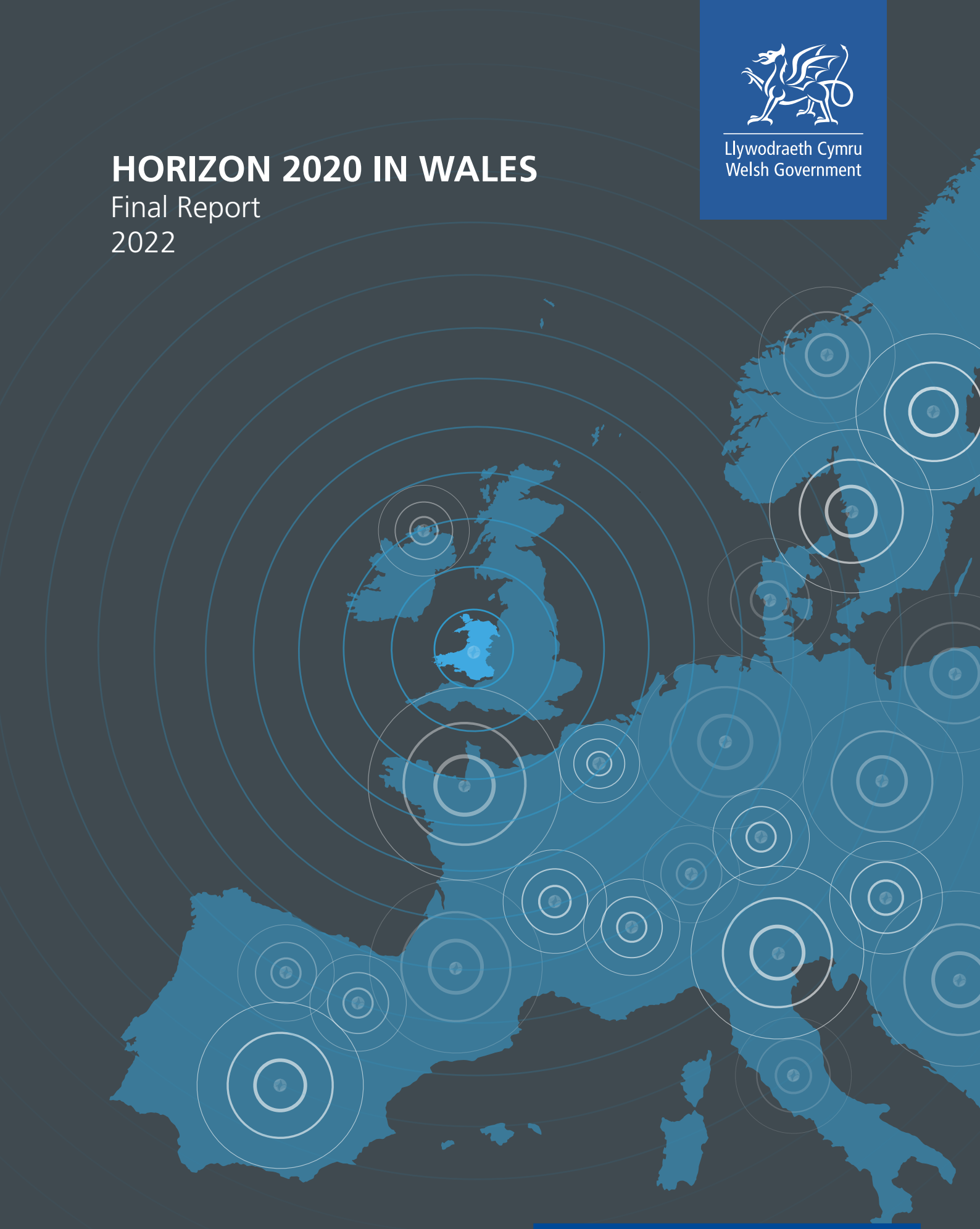
HORIZON 2020 IN WALES

Final Report

2022



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FOREWORD

Vaughan Gething MS
Minister for the Economy

I am very pleased to introduce this final report on Wales' performance in Horizon 2020. It is testimony to the efforts of universities, business, public bodies and charities who have strived and succeeded in this prestigious global programme.

The sources of Welsh success are as varied as the individuals who have participated: the ambitious researchers who break through the frontiers of human knowledge, the businesses that invest in competitive new products for global markets and the organisations of all types that collaborate across borders for the benefit of society.

The EU Framework programmes have provided an unmatched platform for collaboration and excellence for decades.

By recognising what we value in Horizon 2020, we are acutely aware of the difficulties created by the years of delay and uncertainty surrounding the UK's association to the successor programme, Horizon Europe. The Welsh Government has always advocated association to Horizon Europe. I am dismayed by the fact that this win-win outcome has been out of reach for so long after the UK has left the EU. The current situation is not sustainable. The Welsh Government continues to represent the views of Welsh researchers and innovators on this matter both in London and Brussels.

As this report highlights, Horizon 2020 is not the only EU funding that has played a role in Wales. Structural Funds have invested over half a billion pounds in research and innovation in Wales over the same period. Research in Wales is facing the challenge of transition from two major funding sources. The UK Government could still offer replacements in line with what was promised and fund the Welsh Government's regional investment plan. However, recognising that such an outcome is highly unlikely, the whole of Wales faces a challenge to compete for funding to deliver benefits for Wales, as so many have done successfully through Horizon 2020.

The Welsh Government recognises the critical role that both research and innovation have to play in delivering our programme for government. Our aspirations for a healthier, greener, fairer, more prosperous and more equal Wales can only be achieved in a setting that is innovative and transformative.

This report reflects a Wales that is outward-looking and values our ties with our European neighbours. We are a country that seeks to welcome and support the world's best researchers and companies. We also recognise that we do not have all the answers, and that bringing the world's knowledge to bear for the people of Wales is also part of the solution. Our International Strategy highlights our vision for our external relations and a new Innovation Strategy is taking shape with the help of stakeholders. It is as important as ever for the world to come together and make use of what science and innovation can offer to address our shared challenges.

CONTENTS

INTRODUCTION

Horizon 2020 was the European Union's research and innovation funding programme from 2014-2020 with a budget of nearly €80 billion. The programme continues to fund many projects even now in 2022 – a testament to the stability and long-term planning of the programmes.

The EU framework programmes have for decades brought together countries from around the world for a range of linked objectives, including:

- Advancing scientific excellence and attracting the world's best talent.
- Supporting the development, demonstration, and deployment of innovative solutions.
- Creating knowledge and innovation for the competitiveness of European industry and to address global challenges, including climate change and the Sustainable Development Goals.

In Horizon 2020 alone, Welsh partners have taken part in projects to the value of over €2 billion. Through these projects they have access to over 6,000 overseas partners. For some Welsh participants this has meant the ability to contribute to a stable programme of research with labs from different countries. Others value working with the world experts in their field, or with their supply chain on exciting new technologies. Many individual researchers and businesses seek to make breakthroughs on the back of the prestige and freedom of a generous European Research Council (ERC) or European Innovation Council (EIC) award. What is more, we can also be proud that through these programmes over 148 research fellows have chosen to locate to Wales from around the world.

There is also strength in our industrial base. A notable feature of Welsh participation in Horizon 2020 is that Wales has a higher percentage of private sector companies participating than the UK as a whole.

For over a year now, the next generation of EU research and innovation programme has arrived on the scene. Horizon Europe[1] continues the momentum of Horizon 2020, but with a larger budget and in many ways even more ambition. It involves a new approach to industrial partnerships, a fully-fledged European Innovation Council and a focus on missions such as climate adaptation and a mission on cancer. At the same time, it keeps long term continuity for the globally renowned excellent science and collaboration schemes. Some of the novelties will take some further refining in order to maximise their potential, but there is little doubt about the stature of the EU funding and the relevance of its goals to our changing world.

At the time of writing, UK applicants may apply to Horizon Europe and will be assessed as if belonging to an associated country. Only at the time of grant agreement must a decision be taken on whether to fund the participation through the UK's guarantee or not. If the UK associates, Welsh applicants will be treated much as though they were from a member state. If the UK decides not to associate, the UK's budget will be allocated to alternatives, including, as stated in the UK R&D Roadmap, participation in European schemes open to third countries.

This report will review the Horizon 2020 programme in Wales, with a view to better understanding the current situation and the trends for the future.

1 Horizon Europe | European Commission (europa.eu)

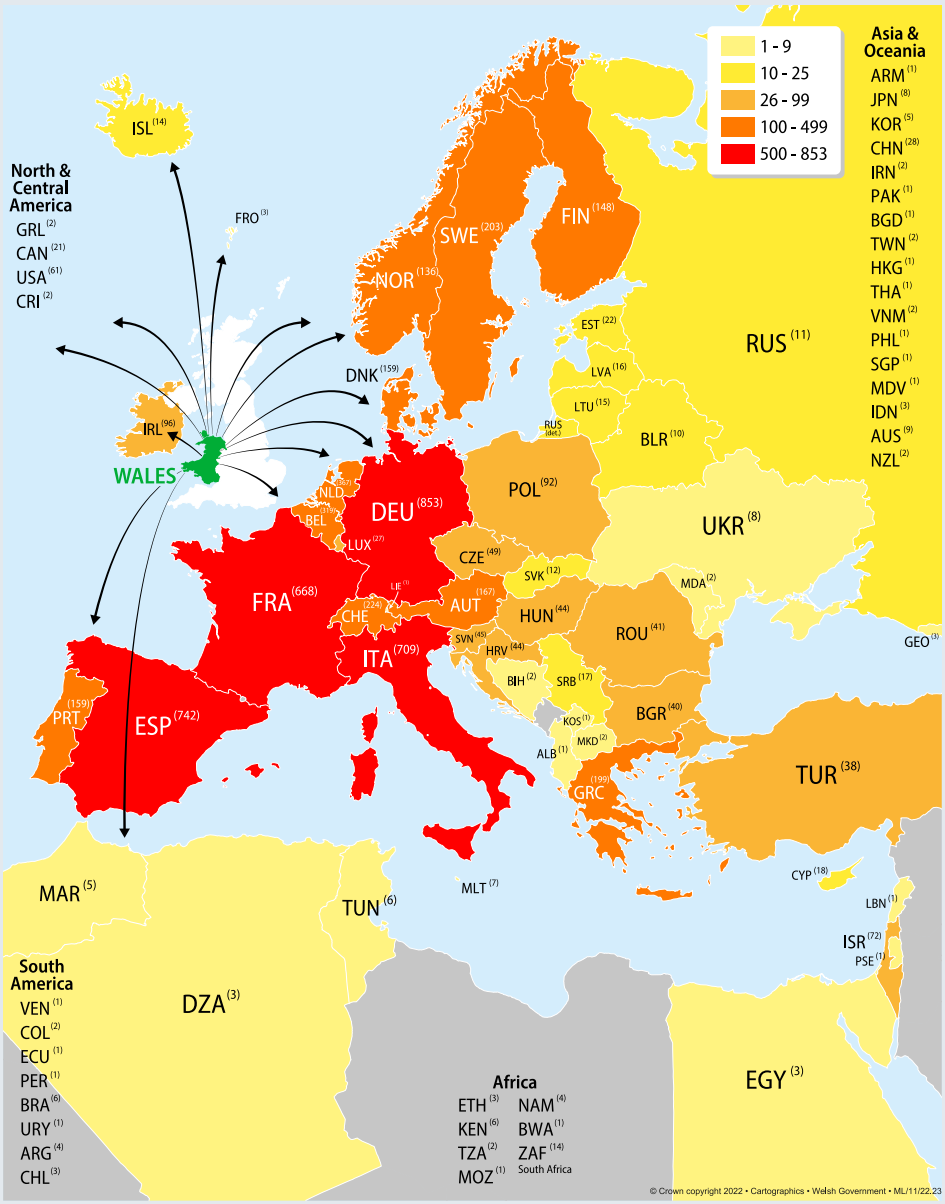
OVERALL PERFORMANCE

Through this report, we can see that there are internationally-recognised strengths in Wales. The prestigious European Research Council accounts for a sizable proportion of our projects. We know from Elsevier reports that despite the size of our research base, our universities display excellence, have an international nature and excel with reference to the UN's Sustainable Development Goals[2]. These findings clearly resonate with Wales' participation in Horizon 2020.

Not only has the programme fulfilled a benchmarking role, testing our companies and researchers among the best in the world, but it has also opened the door to a scale of collaboration that is only possible with large multilateral programmes.

Under Horizon 2020, organisations across Wales, primarily in academia and industry, have participated in 392 projects. Many projects involved more than one Welsh partner, meaning that the total number of participations in these projects was 433 participations. Often these multiple participations are due to university-business or university-government relationships that are built up over time and ensure that research is relevant and that the findings can be used in a practical manner for the people of Wales.

The participation of private companies increased by over a half compared to the previous programme, putting Wales ahead of the UK as a whole regarding the proportion of industrial participation.



2 www.elsevier.com/__data/assets/pdf_file/0018/1205514/wales-research-performance-with-uk-and-global-comparatorsASSOURCE.pdf

Welsh organisations have been involved in projects with over **6,000** partners from around the world.

Welsh organisations took part in projects to the value of over **€2.5**billion.

Attracting **148** of the best researchers to Wales, including **75** Sêr Cymru COFUND programme.

Welsh businesses account for around **a third** of all the Welsh participation

Welsh success in challenging circumstances

The level of funding secured via the EC Framework Programme continues to grow from one programme to the next. Despite the clear impact of Brexit, Welsh organisations secured EU funding of over **€150 million** under H2020, exceeding levels achieved in the predecessor FP7 programme.

This figure does not include the amounts awarded to organisations that are active in Wales but are headquartered elsewhere.

Combined with previous programmes, Wales has secured over **€400m** of funding via EU's flagship research and innovation programmes to date.

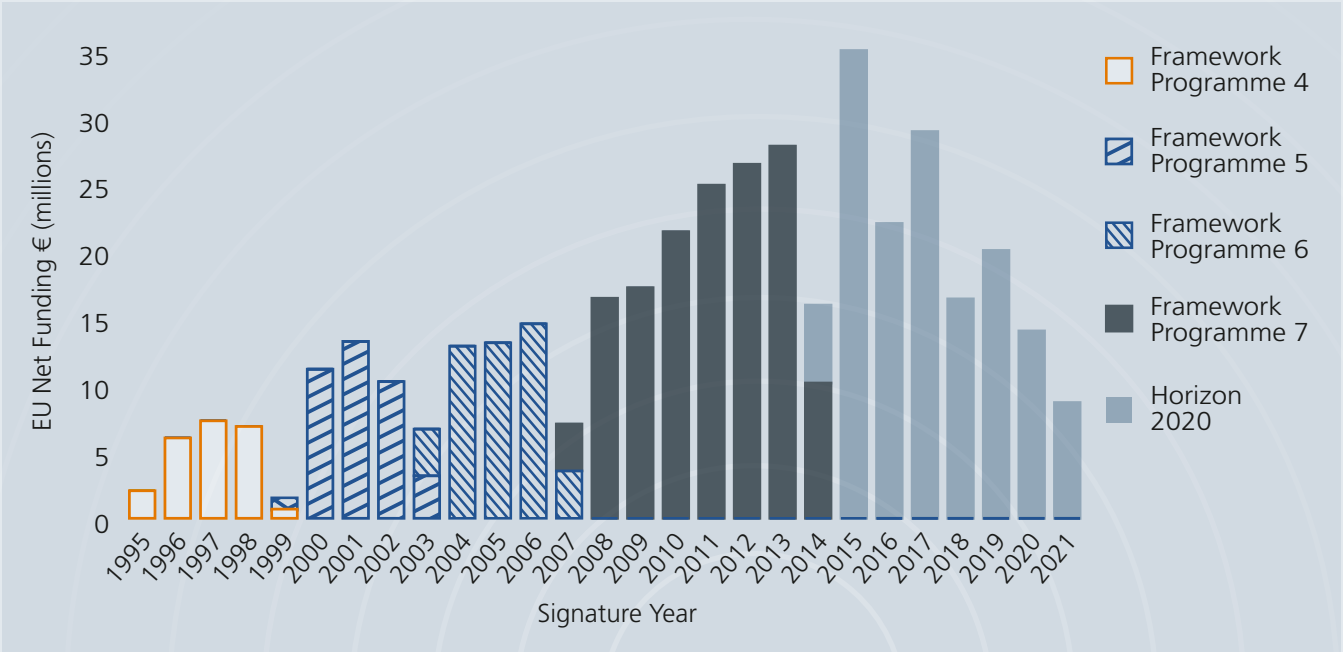


FIGURE 1 Net EU Funding by Programme and Signature Year

High Demand

The continued pull of the EC Framework Programme is evident in the volume of proposals submitted to Horizon 2020. Despite operating under the uncertainty of Brexit for much of the programme, Welsh proposals under H2020 grew by over a third to 2,775, requesting around €1.7bn. In the preceding programme, organisations based in Wales submitted around 2,000 proposals requesting under €1bn. This increase in demand was not unique to Wales or the UK.

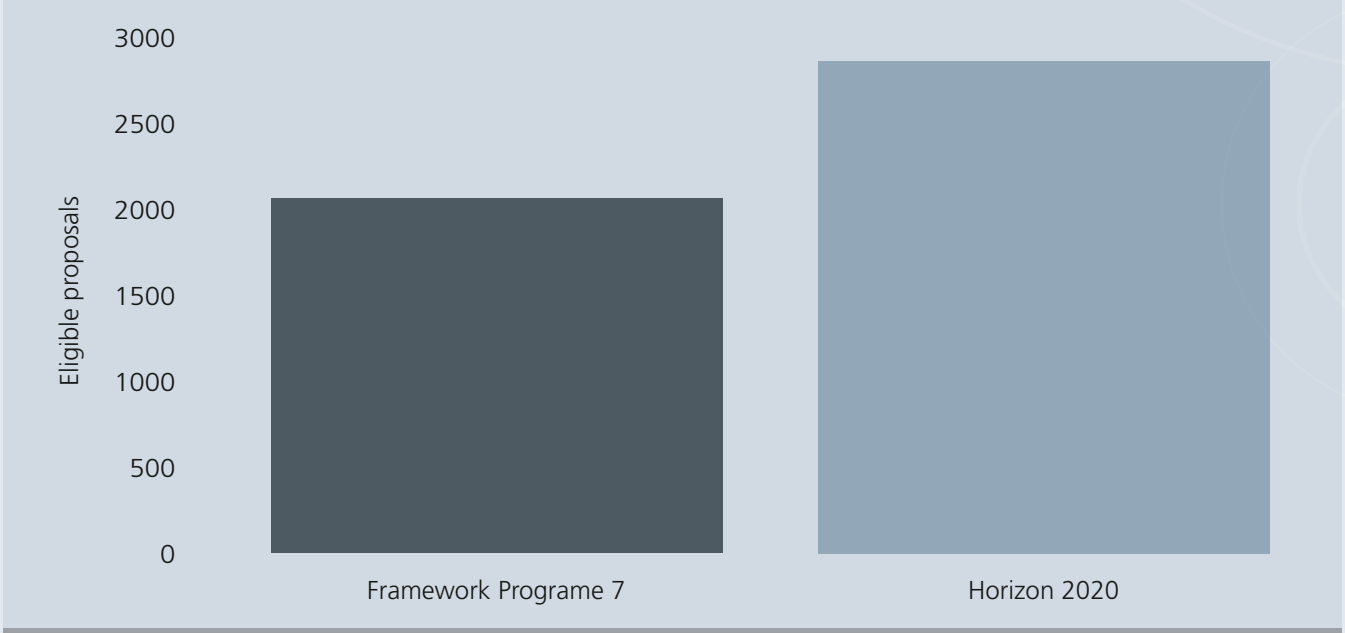


FIGURE 2 Welsh eligible proposals by programme

Unmet Demand

The increased volume of proposals made Horizon 2020 a **more competitive** programme than its predecessor despite the increased level of funding.

The high momentum and demand of the programme ran through to the very last calls: the **European Green Deal** call in 2021 attracted 1550 proposals from over 140 countries across the globe. Although a high proportion of the proposals received high scores, the budget only stretched to 73 projects. In this call Wales achieved significant success, winning 5% of the UK funding, in line with our population share and above our historic levels of research funding. Bangor University is collaborating on forest restoration, Blue Lobster IT is working on a digital twin of the ocean and Steam Bio Ltd is advising on bio-based energy in Africa.

Overall, **success rates** in Horizon 2020 (12%) were well below the FP7 rate (19%). At 13%, the Welsh Horizon 2020 success rate was higher than the average for the programme. Nevertheless, there were still many projects that passed the quality threshold but were not funded.

Our analysis in March 2020 suggested that the unmet high-quality demand in Wales exceeded €500m.

Generalisations on success rates can be misleading. Many individuals and organisations had very **high success rates**, including 100% success for those with a winning combination of excellence, impact and implementation. While there has been criticism of established collaboration patterns, for those in networks that consistently produce winning bids, the high success rate provides a steady source of funding for their work.

Success rates also vary greatly by theme and call, particularly where the numbers of applications are small. 'Research Infrastructures' and 'Advanced Materials' had success rates for Wales of around 40%. Food, and Energy and Environment combined had a high volume of applications from Wales yet one in every five applications was funded. It is of note that in many cases, the development of a proposal was in itself a positive step in the progression of a research idea: building a consortium and articulating a plan in the context of policy objectives.

UK Context

Welsh funding **relative to the UK** varied greatly by theme. In biotechnology for example, Wales attracted 10% of the UK funding. Advanced manufacturing received 5% and other major areas such as food/marine/agriculture, the environment and some fellowship calls were also high. In other parts, such as Euratom, Wales did not have any projects.

Overall, Wales received 2% of the amount of funding invested in UK organisations and 2.5% of the number of UK participations. In relation to the UK as a whole, it appears that Wales continues to perform largely in proportion to its underlying capacity: expenditure on Research and Development in Wales as a percentage of the UK remained around 2% in 2021.

For the university sector, a comparison with the recent UK Research Excellence Framework results shows that while there is a high correlation between Horizon 2020 funding and the number of researchers receiving 3* and 4* ratings, there is still considerable variation on a per researcher basis. Overall in the UK, universities with internationally-regarded specialisms topped the table per researcher – namely the London School of Hygiene and Tropical Medicine and Imperial College. The largest universities also performed well on a per researcher basis – Cambridge, Oxford, UCL. The three highest placed Welsh universities in terms of funding per head were very closely ranked, at 53 – Bangor University, 56 – Aberystwyth University and 58 – Cardiff University. When drawing any conclusions, it should be noted that REF data is the result of decisions made by individual institutions and the REF methodology, and that the Horizon 2020 data does not include UK funding that universities may be targeting.

FIGURE 3 Size and efficiency: REF vs income per person

Brexit and EU context

The UK's share of Horizon 2020 funding dropped from 16% in 2015 to 8% in 2020.

This correlates with a reduction in applications rather than success rates, suggesting the reduction was due to barriers to entry, whether from the UK or collaborative partners. Anecdotal evidence suggested that where there were long-standing relationships, EU colleagues still appreciated the expertise of their Welsh partners and were keen to continue working together.

However, due to a perception of risk, political sensitivity and uncertainty around the UK's status, some people found it more difficult to enter new relationships or rekindle old ones.

It is likely that, were it not for Brexit, the UK would have applied for and won considerably more EU funding than it did in the years following the Brexit referendum, as stated previously by the Royal Society. For Wales this may have meant a reduction in funding of some €38m.

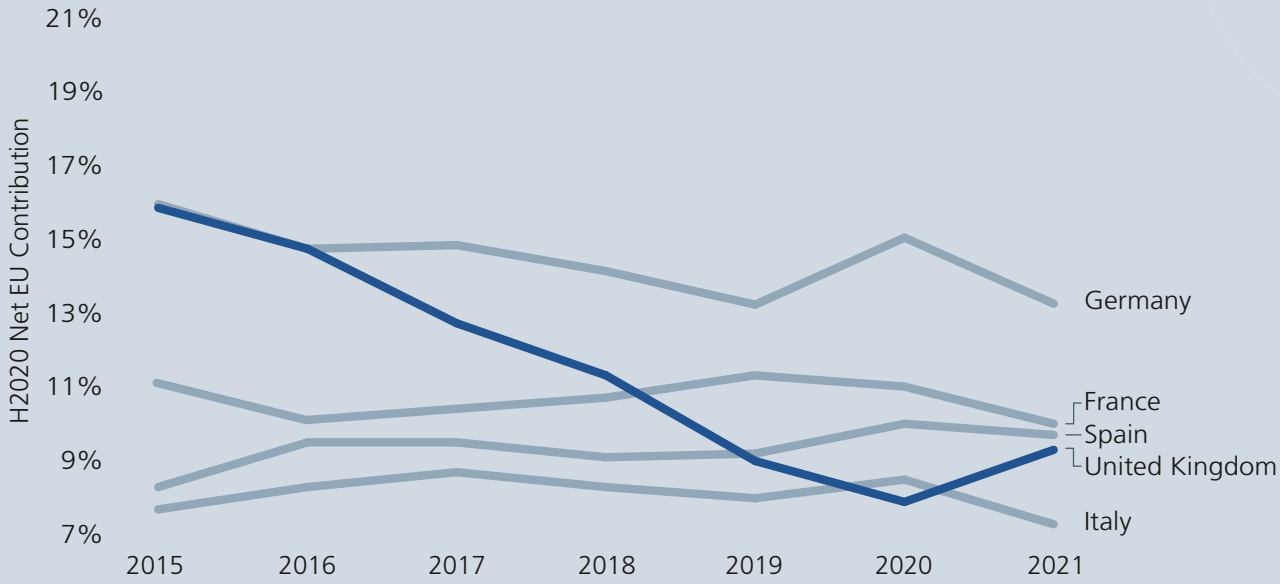


FIGURE 4 % Share of H2020 Net EU Contribution secured, France, Germany, Italy, Spain and UK

Our conversations with participants suggest that there was a rebound for some organisations in the first year of Horizon Europe as they submitted more applications in expectation of association. The continuing delays to association and the currently insufficient UK funding guarantee may well slow or reverse this trend in 2022.

The effects of the referendum complicate comparison with EU regions, along with the headquarters effect that registers funding to the legal address of organisations rather than where the research takes place (particularly in France).

Per head of population, Wales received funding levels greater than Normandy and Northern Ireland, similar to Brittany and Schleswig Holstein, but considerably below others such as the Basque Country and Estonia. Per head, the West of Inner London received 28 times more funding than Wales. Even taking into account the effect of the referendum, Wales still has far to go before featuring among the top performing regions in Horizon Europe.

Range of Participants

Welsh **universities represent two thirds** of the Welsh Horizon 2020 funding, which mirrors the picture for the rest of the UK but differs noticeably from other countries in Europe. This is illustrative of the relative strength of universities in the UK and that of the research and technology organisations in the EU, such as CNRS in France, Fraunhofer in Germany, and Tecnalia in the Basque Country. Likewise, relatively few of the largest private sector participants are headquartered in the UK. Of the top 100 companies in Horizon 2020, 8 were from the UK. It is notable that two of these were tidal energy companies, Orbital Marine Power and Nova Innovation, which are active in Wales. In comparison, 19 of the top 100 university recipients of Horizon 2020 funding were from the UK, with Cardiff University coming in at 129.

A significant aim of the EU for Horizon 2020 was to increase industrial participation in the programme. This appears to have had an impact considering that the number of applications from **Welsh industry doubled** from FP7 to Horizon 2020 (from 416 to 897).

Wales differs notably from the UK in that **Welsh private sector funding** accounts for over a quarter of all Welsh funding secured. This represents a considerably greater share than the equivalent figure for the UK (19%) and is close to the figure for Horizon 2020 as a whole (28%).

This is perhaps a reflection of the way in which Welsh businesses form part of supply chains and research and innovation networks. Despite lacking the large industrial research headquarters and unicorns, Wales has a wealth of innovative businesses that are striving to work with their purchasers and suppliers, experts and standard-setting organisations in order to develop new products and markets. It should be noted that the industrial figures are likely to be underestimated for Wales as funding is registered to the headquarters address, not to the location where the research and innovation actually takes place. For example, the figures do not include the numerous successes of TWI in Port Talbot.

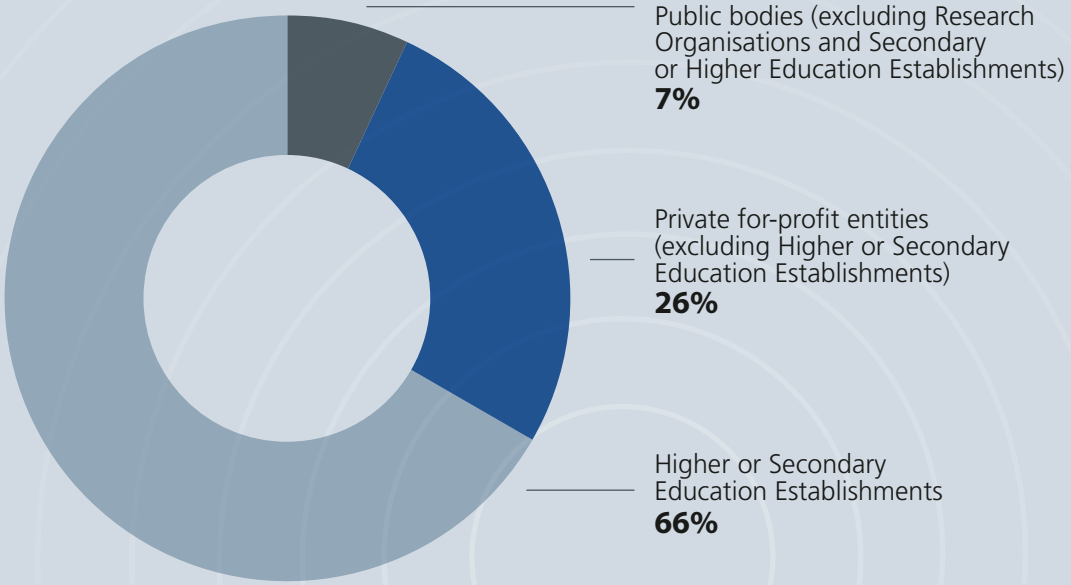


FIGURE 5A H2020 funding secured by organisation type – WALES

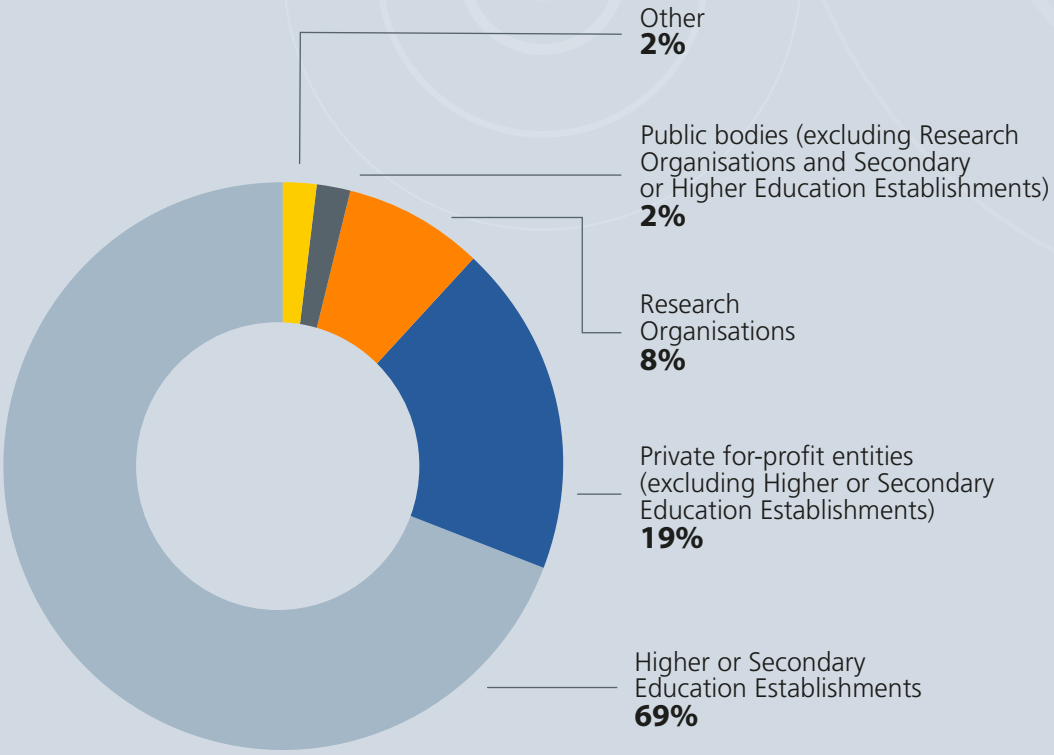


FIGURE 5B H2020 funding secured by organisation type – UNITED KINGDOM

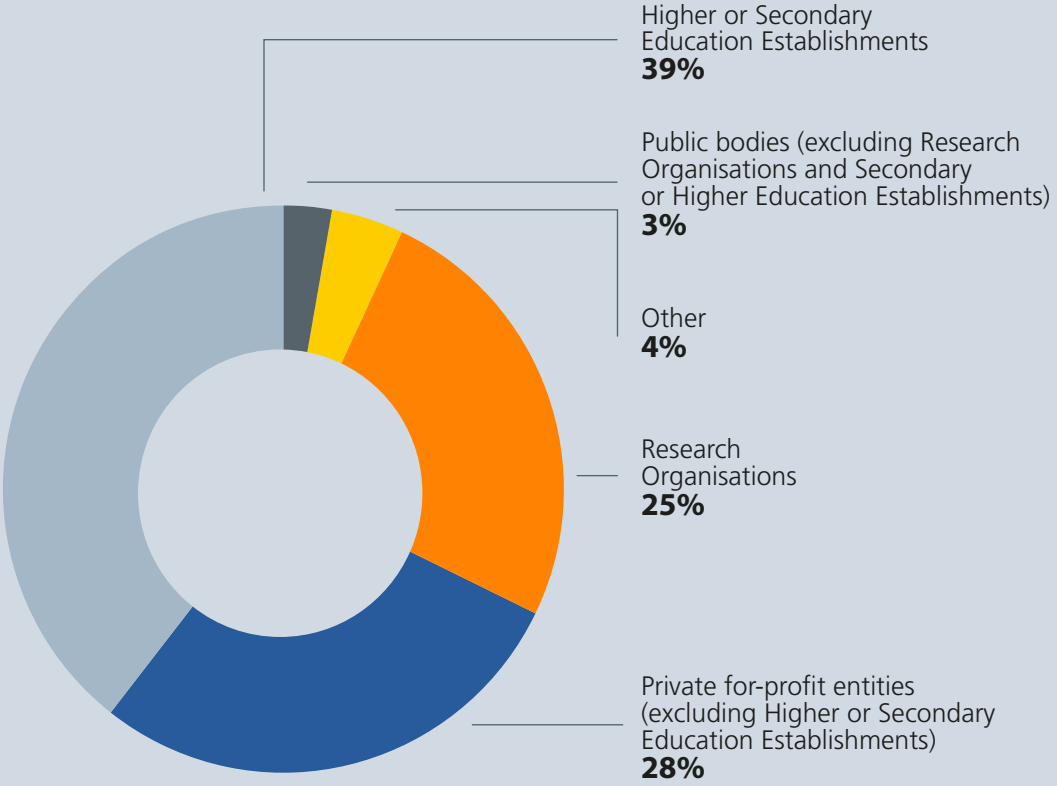


FIGURE 5C H2020 funding secured by organisation type – PROGRAMME

PERFORMANCE BY PILLAR

Excellent Science

55% Over half of all Welsh funding was secured in the Excellent Science pillar, illustrating the strength of universities in Wales.

over **€31** million secured via European Research Council (ERC), to support **31** top research projects in Wales.

Of all the parts of Horizon 2020, the Excellent Science pillar brought in the most funding by far to Wales.

The **European Research Council** is one of the most prestigious and competitive awards for a scientist, and its terms are suitably generous, allowing the applicant's team to work with up to €3.5 million over several years with only one criterion – the excellence of the science. Two ERC grantees won Nobel prizes in 2021, bringing the total up to nine ERC grantees who have won Nobel Prizes since the ERC launch in 2007. Others were already Nobel Prize laureates when they won their ERC grants. The availability of the ERC is part of the competitive offer of Europe in a global context.

As we have seen, the Welsh research base may be relatively small, but it is world class and in Horizon 2020 it succeeded in receiving **31 ERC awards** to a value of over €31m.

Throughout Horizon 2020, a full ERC Advanced Grant remained out of reach by a narrow margin, though the University of Wales Trinity St David contributed to an Advanced Grant project investigating the submerged landscape of Doggerland. It is a substantial achievement therefore that one of the first Horizon Europe grants for Wales was an **ERC Advanced** grant.

€3M HORIZON EUROPE FUNDING FOR SWANSEA UNIVERSITY CLIMATE RESEARCH

QUERCUS, a project led by researchers at **Swansea University**, has been awarded **€3 million Horizon Europe** funding through the European Research Council. In partnership with the University of Oxford they will be able to date wooden buildings and objects more accurately, by analysing the chemistry of ancient oak trees, to reconstruct the climate of north-west Europe including the UK over the last 4500 years. Professor Neil Loader of Swansea University's Department of Geography will work with the University of Oxford's School of Archaeology and an interdisciplinary team of experts including representatives of indigenous groups from across Europe, Aotearoa/New Zealand, and the USA.

The ERC proposal was supported with a grant for training from SCoRE Cymru.

The Marie Skłodowska Curie Actions (MSCA) are particularly treasured by Welsh researchers, and indeed many businesses, who appreciate the doctoral programmes, staff exchanges and fellowships. These projects often form close bonds between organisations over a number of years and result in globally desirable skills, including industrial experience. Wales has a mutually beneficial relationship with the UK and EU research area, providing fulfilling and relevant stages in researchers' careers.

The Marie Skłodowska Curie Actions (MSCA) scheme attracted **148** of the best researchers to Wales during the programme through its fellowship programme alone. This included **75** through the wider Sêr Cymru COFUND scheme and others took part in PhD and exchange programmes.

Of those who applied directly to MSCA, seven in ten of those who applied to come to Wales were of sufficient quality to receive grants but could not come due to lack of EU funding. This highlights the attractiveness of the Welsh research base to high quality early career international researchers.

It is not a surprise that those who do come to Wales are extremely productive. An Elsevier review of the Welsh research landscape stated that "As a small research nation, Wales has also benefited greatly from research mobility and exchange with other EU countries. Welsh researchers are highly mobile, and the Welsh researcher base is the most mobile among all UK nations. Mobile researchers migrating to and from the EU show the highest productivity and Field-Weighted Citation Impact for all groups. A decline in researcher mobility associated with Brexit will clearly pose risks for Wales' future research performance".

SIRCIW/SÊR CYMRU CASE STUDY

The Sêr Cymru project was a landmark in Welsh participation in Horizon 2020. In one application, it brought over €9 million into Wales. Alongside this funding, the European Regional Development Fund (ERDF) financed a number of additional posts where these aligned with Welsh smart specialisation.

Underlying both funds was the recognition that Wales had excellence but small scale, so by growing areas of specialism there would be the opportunity to bid for more competitive funding and grow the research base, in a way that was relevant for the wider economy and societal challenges. The fund also benefited from significant amounts of university funding.

The project was an early example of how regional investment and excellent science can have overlapping areas of activity, despite their different objectives.

Horizon 2020's doctoral networks and staff exchanges are highly valued. They have built close-knit relationships between teams of researchers across the world and between university and business.

CHARLES OWEN LTD OF WREXHAM DOCTORAL NETWORK

For over 100 years, Charles Owen has manufactured world-leading riding helmets in Britain. With a mission to make products 'for a safer world', the company made use of an ERDF SMART grant for equipment and then took part in a training network for advanced designs in safety. The company hosted three students for between two weeks and 3 years. The company co-wrote 5 published papers on helmet and concussion research. These papers have been used as evidence in the committees in charge of the relevant international standards. One of the papers is actively changing a methodology for measuring rotational acceleration. The project has improved the understanding of head impact injury. It has been designing new helmet standard test methods that recognise the influence of rotation and may save lives.

The Infrastructure part of the programme is relatively small but fulfils an important role. It integrates and opens up national research facilities, as well as developing e-infrastructures that offer research services to users from different countries.

Examples from Wales include Aberystwyth University's involvement in EPPN2020. A consortium led by the Institut National de la Recherche Agronomique, France, provided European public and private scientific sectors with access to a wide range of state-of-the-art plant phenotyping facilities, techniques and methods.

More recently, Professor Ronan Lyons, Clinical Professor of Public Health, Population Data Science at Swansea University and Co-Director, Secure Anonymised Information Linkage (SAIL) Databank, is taking part in 'Population Health Research Infrastructure' (PHIRI) – an international research team of over 41 partners from over 31 countries coordinating efforts to generate the best COVID-19 population health knowledge. The Swansea team, supported by SAIL Databank, focuses on measuring the impact of COVID-19 on vulnerable populations and also evaluates the effectiveness of counter-measures.

SAIL has shared its expertise and data with other Horizon 2020 projects tackling global societal challenges in Health. SAIL Databank was the lead organisation for Wales in EUROlinkCAT, establishing a linked European Cohort of Children with Congenital Anomalies. Also, building on the knowledge and methodologies developed in EUROLinkCAT, and the earlier EUROmediCAT, researchers from Swansea University and SAIL Databank are playing a key role in a €28m pan-European study to improve the safety of medicines given to mums-to-be and breastfeeding mothers, via the EU-funded ConcePTION project[3] under the Innovative Medicines Initiative.

3 More information about ConcePTION – University helping to improve medicine safety in early motherhood – Swansea University

Industrial Leadership

74 unique Welsh businesses from across Wales participated in R&I projects under H2020.

€15.6m funding secured with SCoRE Cymru support (from £759k grant investment).

The Industrial Leadership part of the programme aimed to speed up development of the technologies and innovations that underpin the business of the future, and help innovative European SMEs to grow into world-leading companies.

This part of the programme supported the development of a range of technologies. The following chart shows Welsh organisations' participation.

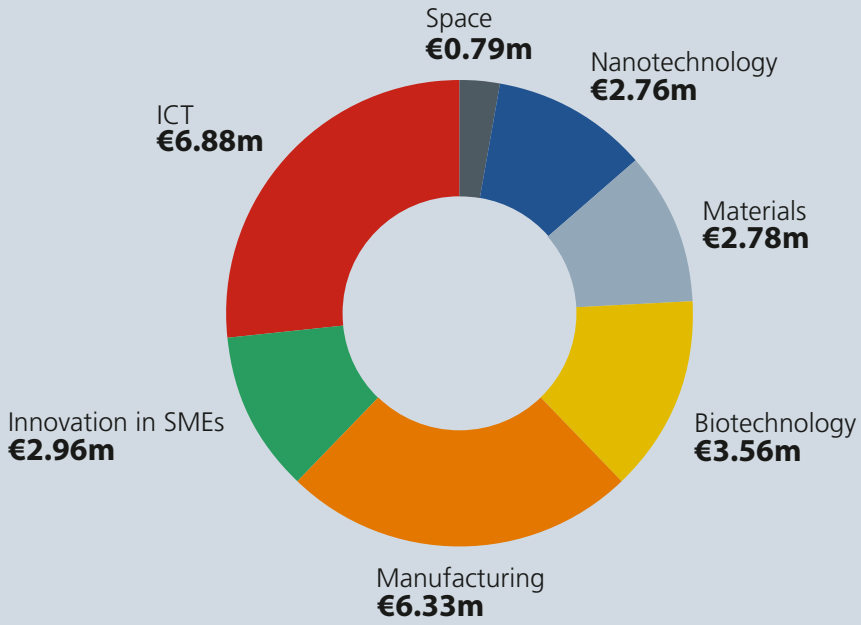


FIGURE 6 Welsh H2020 funding for industrial leadership € (millions)

In absolute terms, **ICT** was an area of strength for Welsh businesses, however it was also a large part of the programme. In relative terms, Wales had specialisms in biotechnology, nanotechnology, materials and manufacturing.

A cluster of companies in Bridgend stands out, with Control2k at the centre of a successful network that has put Wales on the map for the **Digital Innovation Hubs**.

Photonics and semiconductors are clearly visible through the work of the leading companies MicroSemi, Pegasus Chemicals and Qioptiq.

In the **biotechnology** field, the VAMOS project was the largest for Wales. It brought in over €3.5m supporting a Welsh company, Fiberight Ltd, and Aberystwyth University. This is an illustration of university-business interaction within Wales that is of global relevance and draws on expertise beyond our borders.

The Horizon 2020 programme piloted the **European Innovation Council Accelerator** (SME Instrument). This aims to bridge the gap from demonstration to commercialisation for innovative SMEs.

TRAMETO: EIC ACCELERATOR

Trameto are developing a patent protected portfolio of Energy Management Integrated Circuits (EMICs) named OptiJoule (also branded as "HarvestAll"). These devices permit applications to harvest all types of ambient energy, enable the design and development of next generation autonomous micro energy sources (AMES) and allow the creation of novel applications for the Internet of Things.

Products will be exported to global customers with whom Trameto have built strong relationships through strategic and aggressive business development activities with the support of Horizon 2020, Innovate UK, and private seed-funded projects. Trameto were supported with Welsh Government SCoRE grants for travel, proposal development and legal advice for their grant development.

During the project Trameto safeguarded three jobs and created up-to 4 more full-time roles along with numerous contract/freelance positions. The Horizon 2020 project provided credibility and aligned perfectly with the Silicon Catalyst incubator programme.

Eureka!

The Eureka programme is an intergovernmental programme that offers funding to UK innovative SMEs in collaboration with one other country. It offers a range of opportunities, some of which are funded by the EU (Eurostars) and others which are purely intergovernmental (e.g. UK-South Korea).

In September 2021, the Compound Semiconductor Centre (CSC) received €675,000 support from Eureka Eurostars to develop new products that integrate semiconductors in order to reduce power consumption and increase performance.

The project is accelerating commercialisation of semiconductors, developing a new European source of products and the associated supply chain. SCoRE Cymru provided financial support to CSC for the application.

In the sphere of health diagnostic devices, Thermetrix has also participated. The company is developing a portable camera that integrates 3D scanning, visual and (thermal) infrared imaging modalities. Once available on the wound care market, the product has the potential to reduce public health costs significantly and to save lives.

Societal Challenges

Over €40m of EU funding to Welsh organisations to help **address major concerns** shared by citizens in Europe and elsewhere.

Over €10m (4% of all UK funding) for FOOD Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy.

Almost €17m towards projects aimed at the **energy** and **climate action and environment**

EU Framework programmes provide an internationally familiar platform on which to tackle the biggest challenges facing modern society. In this part of the programme, the role of research and innovation in addressing policy objectives is clear. From health systems to flooding risk, EU experts and policymakers have determined which challenges require research and innovation, and project consortia have devised proposals for solutions.

SMALL SYSTEMS, BIG BENEFITS

The company Econotherm in Bridgend has taken part in no less than 5 Horizon 2020 projects. The company designs and manufactures **heat pipes and heat pipe exchangers** for use in diverse areas of industrial waste heat recovery. Its leading-edge development of new heat pipe technology continues to put it at the forefront of the waste heat recovery business.

Working with Brunel University London, through the **ETEKINA** project, the company has been installing equipment to capture heat from aluminium production in Spain, a steel factory in Slovenia and, in ceramic tile production in Italy.

The project ended in 2020 and achieved its initial target to recover 40% of the waste heat in the exhaust streams, including a world first for the reuse of more than 40% of waste heat streams to heat high-pressure water used in the ceramic production process. Four years on, each facility has exceeded the 40% goal, resulting in huge-scale savings on energy, costs and emissions.

As Mark Boocock, managing director of **Econotherm**, UK, highlights: *"Rising gas prices and higher carbon costs are significantly driving the demand for waste heat recovery, worldwide."*

"Energy projects that were struggling to get signed off in the past are now flying through and we're also seeing a greater focus on environmental governance in many businesses," he adds. *"We've seen many global companies implement waste heat recovery in existing facilities whilst also mandating it in new facilities – this is a great time for projects such as ETEKINA."*

As a result of their patented, custom-built heat pipe technology, Econotherm saw strong sales and a corresponding impact on employment at their factory in Bridgend.

The Societal Challenges part of the programme was the part with the most international collaborative activity.

Elsevier reports on the Welsh research base have highlighted the importance of collaboration. Wales, as a small research nation, benefits from collaboration with international partners. The performance-based assessment of the Welsh Research Base (2021) has shown that international collaboration for Wales grew from 42% of its total research output in 2010 to 58% in 2018, with an average of 50%. Internationally collaborated publications showed a high FWCI (2.4), placing Wales in a leading position amongst all UK nations.

The benefits of collaboration are not just felt in the university sector. The private and public sectors must be front and centre of tackling the world's challenges.

Blue Lobster IT Ltd, based on Anglesey, was the company from Wales with the most Horizon 2020 participations. The EU funded ILIAD DTO project will contribute to the implementation of the EU's Green Deal and Digital Strategy. It seeks to understand the marine environment through a data-intensive, cost-effective Digital Twin of the Ocean allowing experts to develop what-if scenarios, analysing the impact of measures to prevent and adapt to climate change.

The Welsh Government and EU funded project 'The Works site', Ebbw Vale, was designed to revitalise the area and create social, environmental and economic opportunities. The site includes a District Heating Network which has seen Blaenau Gwent County Council take part in three EU funded projects with Cardiff University as a live test environment for new technologies:

- Resilient – Focussed on optimising heating network and the installation of a demand lead system, monitoring and supporting individual buildings to meet their varying heating demands.
- Pentagon – Investigating new energy conservation technologies and strategies to foster flexibility in the low-voltage and medium-voltage grid.
- Drive – Looks at further improving energy systems efficiencies.

Welsh thematic specialisation in this part of Horizon 2020 was particularly noticeable in the fields of Agrofood/Marine/Bioeconomy, and the Environment/Climate Change.

SteamBio Ltd based in Colwyn Bay, North Wales has worked with universities around Wales in order to develop SteamBioAfrica; one of only five projects selected under the topic 'Accelerating the green transition and energy access partnership with Africa'. The €11.7m project, of which €950k of the EU funding awarded to Wales, builds on the results of the earlier Horizon 2020 project SteamBio. The top scoring (15/15) SteamBioAfrica proposal runs to August 2024 and will test a workable and sustainable source of large scale, clean burning, secure and affordable energy across Southern Africa. The proposal included direct input from ERDF-funded operation Centre for Photonics Expertise (CPE), providing photovoltaics analysis which formed part of the evidence supporting the proposal.

OTHER AREAS

European Institute of Innovation and Technology (EIT)

Welsh universities have been taking part in the various Knowledge and Innovation Communities of the EIT. Aberystwyth University has been involved with the Climate KIC and the Health KIC, in particular through their expertise on nutrition and links to the ERDF-funded innovation campus and future food projects.

Cardiff Metropolitan University has used its food expertise to play a role in the Food KIC.

Minesto, a leading marine energy company operating in Holyhead, received investment from the Inno-energy KIC, as well as the SME Instrument and other Horizon 2020 and ERDF projects.

Early in 2022, the Manufacturing KIC presented its offer to Welsh companies and there has been work to take part in a proposal in the Creative and Cultural KIC.

Science With and For Society

Though a small part of the programme, this is an extremely important area that has been a source of Welsh success.

Cardiff-based social enterprise, Science Made Simple through the Horizon 2020 PERFORM project sought to spark interest by incorporating drama-based techniques into science education. Approximately 250 secondary school students, 100 teachers and 100 early-career researchers took part in the project, which tested different approaches at workshops in different countries to encourage students to pursue their studies in STEM subjects. These included improvisation theatre in France, stand-up comedy in Spain and public place performances in the UK. Science communicators helped students co-produce theatrical, comedic and entertainment pieces with their teachers and researchers.

THE HORIZON 2020/HORIZON EUROPE UNIT

The Horizon 2020 Unit maximised the uptake of Horizon 2020 opportunities. Since the Horizon 2020 programme was replaced by Horizon Europe, the Unit has been known as the Horizon Europe Unit.

A fundamental part of the Horizon Europe Unit's work has always been to provide information and advice to Welsh organisations applying for research and innovation funding from the EU. Support ranged from presentations to hundreds of participants to one-to-one conversations with SMEs, researchers and public bodies. The unit also sent out regular e-mail newsletters to over 500 recipients (some of whom forwarded it on to their extensive networks), containing events and funding opportunities and updating the community throughout Brexit.

The unit has always fed into policy debates on the programmes, but with the Brexit referendum this work became more frequent. The unit has developed relationships and expertise in order to navigate the post-Brexit referendum landscape and influence developments. It has supported Welsh ministers at a UK Cabinet Committee as well as other ministerial meetings, and has contributed directly to preparations for the UK-EU Specialised Committee for Union Programmes under the Trade and Cooperation Agreement. The unit is in frequent contact with Scottish and Northern Irish colleagues and with the relevant part of BEIS in UK Government on the preparation of alternatives to Horizon Europe. The unit is also part of the UKRI National Contact Point network and takes part in strategic meetings with UKRI.

The unit has carried out a range of activities with a focus on success in the Horizon 2020 programme, but in doing so has also supported internationalisation more generally across science, technology and broader innovation.

Supporting Collaborative Research and innovation Endeavours (SCoRE Cymru)

The Horizon Europe Unit has run **SCoRE Cymru** consistently throughout the Horizon 2020 programme. The fund is still open to support Horizon Europe.

SCoRE Cymru is a Welsh Government grant scheme for Welsh organisations who want to collaborate internationally with a view to taking part in programmes such as Horizon Europe.

SCoRE Cymru has supported the exploration of societal challenges between different research teams, the formation of consortia for funding bids, consultancy to aid with the writing or reviewing of applications, awareness-raising events, membership of international organisations, and training.

Since its inception in 2013, SCoRE Cymru has helped to bring over €15 million to Wales from Horizon 2020. This was achieved through 358 grants of a total of £759,142 to 102 individual organisations. More than half of those funds went to Welsh SMEs.

In addition to the core grant funding activity, the unit worked with the Welsh Government's International Relations team to run seed funding with target regions. This included the following three funding competitions:

- Securing Wales' Future Relations, which supported the Welsh Government's International Strategy
- Bilateral co-operation projects between Wales and the Basque Country
- Co-operation across the Irish Sea

The unit has contributed to the development of the Regional Investment Framework for Wales and is an active partner in the emerging Agile Cymru approach to economic co-operation with international, European and UK partners which builds on that work.

Examples of successes following SCoRE Cymru financial support:

- **Trameto Ltd** made a successful bid for EU investment of €2,184,389 for their HarvestAll project under SME Phase 2. Trameto made use of SCoRE Cymru to develop their 'HarvestAll' proposal, a battery-free energy harvesting technology for the Internet of Things.

  SCoRE supported the company further, for travel to Tokyo to meet various IoT Companies to develop a further Horizon 2020 bid and for legal advice when their €2m EU funding was awarded.

- **Dr Paul Roche, Cardiff University** received SCoRE Cymru financial support for subcontracted expertise for proposal development. Their 'Our Space our Future' project was successful, receiving the maximum score of 15 (excellent in each category – Excellence, Impact and implementation) and EU funding of €1,199,908 under 'Industrial Leadership – Leadership in enabling and industrial technologies – Space'.
- **Prof Carlos Garcia de Leaniz, Swansea University** received SCoRE Cymru financial support for travel to Spain to meet with consortium partners for a preparatory H2020 meeting. The 'AMBER' proposal was successful with the applicant receiving an EU award €1,145,540.
- **IMSPEX diagnostics Ltd** received SCoRE support for subcontracted expertise for proposal development. Their proposal BreathSpec was successful in receiving an EU award of €1,447,950.
- **Prof Yacine Rezgui, Cardiff University** received SCoRE financial support for European Construction Technology Platform (ECTP) membership and travel. The membership resulted in a successful Horizon 2020 application worth €350K.

By working with Welsh universities, SCoRE Cymru has had the opportunity to help upskill over 500 researchers for competitive funding, including:

- Proposal Writing Workshops for Marie Skłodowska Curie Individual Fellowships
- Yellow Research webinars on writing a successful European Research Council (ERC) Grant proposal
- ERC interview training
- Hyperion training workshop on "How to write a competitive proposal"

This has contributed to several grant awards:

- Dr Ben Jervis, Cardiff University awarded €2 million ERC Consolidator grant
- Prof Neil Loader, Swansea University awarded €3,140,000 ERC Advanced grant
- Training has contributed to the successes for doctoral education and postdoctoral training in Wales.

The Role of Synergies

Wales has been exemplary in its recognition of the overlap between regional development policy and internationally competitive science and technology. While programmes for regional development and scientific excellence clearly have different objectives, they intersect where they create ideas for a more competitive economy and solve challenges such as industrial and energy transition.

Through the Horizon 2020 programme period (2014-20), the EU Structural Funds in Wales were guided by the principle of smart specialisation: "regional innovation strategies which set priorities in order to build competitive advantage by developing and matching R&I own strengths to business needs in order to address emerging opportunities and market developments in a coherent manner, while avoiding duplication and fragmentation of efforts".

EU Structural Funds have supported the researchers and businesses on the stairway to competitive funding as well as the clusters that can put international learning into practice at a local level (upstream and downstream interactions).

For its part, Horizon 2020 has recognised the opportunities to make use of national budgets to create impact, both through specific cofounding mechanisms such as Sêr Cymru and through seeking follow-on or demonstration projects through regional development.

As highlighted in the Welsh Government's paper "Wales: protecting research and innovation after EU exit" in 2019, and the statement on the Shared Prosperity Fund[4] there is now a substantial threat to the Welsh research base from the lack of an adequate transition from EU funding.

EU Structural Funds

The EU Structural Funds invested over £1 billion from 2014 to 2020 in Welsh Research and Innovation in a number of ways:

- European Regional Development Fund
  - Projects targeting competitive research income
  - Business-university collaborations
  - Ireland-Wales projects
  - Marine Energy
  - Infrastructure
- European Social Fund
  - Masters and Doctoral programmes
  - Apprenticeships
- Rural Development Fund

There was an explicit link between Horizon 2020 and structural funds in the investment of £165 million in 17 projects that sought to generate competitive income.

Nearly all of these projects are ongoing and have yet to report their final funding success but for example, The Cardiff University Brain Research Imaging Centre has reported competitive funding worth nearly 7 times the structural funds investment.

4 https://gov.wales/written-statement-confirmation-welsh-governments-position-uk-governments-shared-prosperity-fund

Not all of the competitive funding was European; in the field of solar photovoltaics, the SPARC II consortium succeeded in bringing UK research council funding for strategic equipment to Swansea, which is enabling vapour deposition for a new generation of semiconductor materials.

In other parts of the EU regional funding programme, universities developed strong and varied collaborations within Wales, both between universities and businesses. The BEACON bioeconomy project in Wales reported over 500 collaborations. These and others created links that benefited applications to Horizon 2020 and supported businesses to innovate, as illustrated by the EU's Joint Research Centre[5].

UK and EU investments came together in the Aberystwyth Enterprise and Innovation Campus. The Welsh Government invested £20m for the construction of a new facility alongside a £10 million contribution from the UK's Biotechnology and Biological Sciences Research Council. The Institute of Biological, Environmental and Rural Sciences in Aberystwyth University is working on innovative products with local companies on an INTERREG project on healthy oats, and they participated in the European Institute of Technology on both Health and Climate. Furthermore, they went on to win a successful number of Horizon 2020 projects, one of which involves growing biofuel crops on marginal land.

The European Regional Development Fund has also played an important role in the funding landscape for tidal stream and wave power, as well as supporting offshore floating wind indirectly. Companies that have looked to Horizon 2020 for some phases of their development (including the SME Instrument, Eurostars, Societal Challenges and EIT Inno-energy) have also taken advantage of the resources Wales has to offer in order to move closer to market.

The European Social Fund has played a role by helping to create career routes for researchers in Wales as well as funding industrially-relevant research courses that create a specialist workforce for cutting-edge research.

As we look ahead to new policies and programmes, we learn the lessons and build on the successes of decades of EU programmes. Collaboration with the EU is widely seen as a win-win scenario due to our shared outlook and challenges. Science and innovation remain vital to tackling the industrial and social issues of our time. Whatever the political challenges, we will continue to work with people and organisations in Wales to pursue their businesses, careers and research in the context of the wellbeing of future generations.

5 https://publications.jrc.ec.europa.eu/repository/handle/JRC116094