



THE LEARNED SOCIETY OF WALES CYMDEITHAS DDYSGEDIG CYMRU

THE NATIONAL ACADEMY — CELEBRATING SCHOLARSHIP AND SERVING THE NATION
YR ACADEMI GENEDLAETHOL — YN DATHLU YSGOLHEICTOD A GWASANAETHU'R GENEDL

Review of Science for Wales Research Strategy (2012-16)

Context and Remit: The CSA is seeking a light touch review of the current Sêr Cymru research strategy from a wide range of science/research stakeholders. The questionnaire is not intended to be a formal consultation, but rather a mid-term evaluation for the Science Advisory Council for Wales (SACW) to confirm the general direction of travel and consider any refinements given the changing research ecosystem in the UK.

Overview: The general perception from researchers in different fields of science both inside and outside Wales is that the Sêr Cymru programme has been a considerable success and a timely catalyst for growing the Welsh research base. A key driver behind this government investment was recognition of the investment gap with other UK nations, and the need to grow new scientific talent in Wales intended to build future capacity that supported the economic and national development of Wales. The first phase of the programme (Sêr Cymru I) supported: Three National Research Networks in Grand Challenge areas and Four Sêr Cymru Research Chairs. The second Phase addressing under capacity in STEMM research is in progress.

Like all large complex change projects Sêr Cymru will take several years to fully demonstrate impact. Nevertheless, it is appropriate at this juncture to pause and take stock of some of the outputs/outcome of the strategy with a view to considering any relevant adjustments to ensure successful delivery on the vision and objectives going forward.

At this stage the best form of evaluation is through the independent members of SACW, supplemented by available quantitative evidence and consultation with relevant stakeholders particularly feedback from the universities who are co-funding and employing the new staff.

The timing of the review reflects the need to be sensitive to the changing context in which science in Wales, and the UK more broadly finds itself. Relevant change drivers include:

- *Addressing historical capacity issues (Halligan and Bright 2015).*
- *Reorganisation of the U.K. Research councils (2015/16)*
- *2014 REF outcomes and changes to the format of the next REF (2014/2016)*
- *BREXIT and demise of EU funding (2016)*
- *Wales Elsevier reports (2013/2016).*
- *Establishment of the Innovation Council in Wales*
- *Cuts to HEFCW funding particularly innovation.*
- *Diamond recommendations and changing student recruitment pattern (2016)*
- *Rollout of Sêr Cymru 2 (2015/2017).*

Reaching *Science for Wales* targets: In 2011, the Welsh Government's science strategy, *Science for Wales*, set out a new bold new strategy to accelerate its efforts to create a globally competitive science and technology base that supported the economic and national development of Wales. The vision here was to reinvigorate Wales's economy by building upon research strengths in key areas seen to have academic, translational, and commercial value

The strategy (including the Sêr Cymru investment) was directed at achieving **2 high level targets**. A brief retrospective evaluation of these two target objectives provides evidence of a positive direction of travel.

(i) Target 1: Improving Wales's performance Research Excellence Framework in the 2014: specifically grow the proportion of Welsh research achieving 3* and 4* quality and impact levels to reach the highest UK level or its equivalent.

In **REF 2014**, Wales's university based research showed a discernable improvement over the 2008 assessment. Wales significantly boosted its performance on the Research Fortnight Quality Index, ranking highest of all the nations. More than **three-quarters** of the research submitted by universities in Wales was assessed as being world-leading or internationally excellent and almost a third of submitted Welsh university research was rated as 'world leading'.

Wales's score of 46.4 beat England's 45.5, Scotland's 45 and Northern Ireland's 41.1. In 2008, Wales came last with 43.7 for quality, behind the other nation's cores of 47.9, 44.8 and 44.8 respectively. In particular in 2014, Wales's grew its proportion of Welsh research achieving 3* and 4* quality to reach the highest UK level in 4* (30.7) and near equivalent with UK average in 3* (47.0 versus 47.5).

Although Wales's research secured the highest Quality Index of the 4 UK countries in 2014, it did so by submitting 28% fewer staff (723) than it did the RAE 2008.

IMPACT: The 2014 Research Excellence Framework was the first UK Government exercise to formally assess the impact of research beyond the usual academic metrics. 154 UK HEIs higher education institutions (HEIs) submitted a total 6,975 impact case studies. The submission of case studies required institutions to select their *strongest examples of impact, underpinned by the submitted unit's 'excellent research', and describe the evidence of this impact.*

In REF 2014, Wales 272 case studies outperformed all other UK nations in terms of its overall level of REF impact profile with 49% of its impact profiles rated 4* (see Table 1 below). This was 5% above the UK average and 3% ahead of Scotland.

Table 1: 2014 Research Excellence Framework Impact Sub-Profiles for UK country and UK.

	Impact:				
	% of the submission meeting the standard for				
	4*	3*	2*	1*	u/c
Wales	49%	37%	10%	3%	1%
England	44%	39%	14%	2%	1%
Scotland	46%	40%	11%	3%	0%
Northern Ireland	42%	45%	10%	3%	0%
UK	44%	40%	13%	2%	1%

The Learned Society of Wales and partners have commissioned the Policy Institute at King's College London to carry out a formal quantitative analysis of the Welsh HE sector impact case studies so as to better understand, promote and market the contribution of Higher Education research to Wales and beyond. This report (expected in early March 2017) would be important when communicating the added value and intellectual vitality of Wales and might also provide a useful template when preparing for the next REF in 2021.

(ii) Securing a quantifiable uplift in Wales's share of U.K. Research Council funds: specifically to increase Wales's share of UK Research Council funding from 3.3 % to 5 % by 2017.

Securing Wales's standard share of UK research council funding (5%) has being and remains a high-profile ambition and public target for the Welsh Office and Welsh Assembly Government (WAG) since 1993. In 2014/15, Wales' share of total Research Council income remained at 3.0% of the UK total. This figure has remained unchanged since 2012/13 and has never moved above 3.4% over the past 2 decades.

The inability to achieve this input dependent target contributed in large part to the perception that Welsh universities were underperforming with regard to the quality and quantity of research. However, as Halligan and Bright (2015) and an earlier HEFCW review (2011) chaired by Professor Robin Williams showed, one the main reasons why Welsh universities were unable to secure their standard population share of total UK research council income was that Welsh universities secured proportionally less research income from the high-spending science and medical research councils. Using Wales's population share of total UK academics engaged in research, Halligan and Bright (2015) showed that the academic research workforce in Wales was some 0.5% below its population standard share and with most of these occurring in the STEMM disciplines. Employing evidence from the independent Elsevier bibliometric study (2013), Halligan and Bright's concluded that the critical problem lay not in the quality of the science being done in Wales, but rather with the inadequate size of the science base and the number of researchers in STEMM that could apply and secure RC funding.

Recognising the inadequate size of the current science base as an ongoing challenge to securing the RC target, the Chief Scientific Adviser for Wales (CSA) acted swiftly in 2015 to progress a multifaceted Sêr Cymru 2 programme aimed at increasing and sustaining Wales's science research capacity. To deliver this, the CSA brought together a number of initiatives involving COFUND funding from the EU Horizon 2020 and the European Regional Development Fund in association with Welsh Universities. This amounted to over £60M directed at supporting a number of capacity building programmes to fund over 100 new fellowships in science. Assuming that the recent reconfiguration of the RC (UKRI) does not negatively impact on the access from researchers of devolved nations for competitive UK RC funding, then the current strategy of building capacity in STEMM disciplines should provide a better platform from which to grow Wales's total RC income.

Two additional factors to consider:

(a) Expanding the assessment indicators used: An important issue regarding the evaluation of the Sêr Cymru projects that should be considered at this juncture is the need to broaden the range of metrics used by WG to assess Sêr Cymru performance. Disproportionate reliance on one input measure, although annually updated does not provide a comprehensive picture about the quality or performance of the Welsh research base particularly as RC funding comprises less than a quarter of Wales's total research income. Moreover, this indirect performance measure fails to confront the more important questions of research productivity, impact, and efficiency and most importantly, how income is converted into outputs and impact, while controlling for the differential levels of research intensity and research capacity. This latter point is

important, as Wales has the lowest levels of research intensity (R&D expenditure as a percentage of GDP) and one of lowest levels of R&D investment (GERD) in the UK amounting, in 2012 to only 2% of the total UK expenditure.

To secure a better appreciation of Wales's university research sector performance going forward, it is recommended that a fuller range (basket) of input and output performance indicators as employed by HEFCW are used. These to include the five yearly REF, normalised bibliometric indicators such as research productivity (publications per researcher), efficiency (publications per unit of GERD) and research impact (average number of citations received per paper relative to rest of the world) together with the use of relevant similar sized regional and country comparisons.

(B)The need for careful monitoring and modelling of the BREXIT consequences for research in Wales : The reputation of UK universities and the international research base are already under threat because of the fallout from the EU referendum result, which is making the UK an unfriendly place for overseas scholars and students, as well as cutting off access to an important stream of research funding and to a vibrant and well-developed ecosystem for collaborative work.

Welsh universities have been significant beneficiaries of successive EU research and innovation Framework Programmes including Horizon 2020. Some regions of the UK, such as Wales, however are more dependent than others on EU funding in maintaining research capacity and infrastructure, and as a result could suffer disproportionate adverse impacts if this source was withdrawn.

Estimates of the dependency for Wales, vary, but according to HEFCW reports over the past 9 years, income classified as coming from EU sources has been growing steadily from 7.9% in 2006/7 to 13.4% (£39M) of total Wales research related income. This is an underestimate as relevant structural funds for Wales are designated under UK Central government bodies in the HESA return.

A recent Million Plus submission to the House of Commons Science and Technology Select Committee Wales (2016) confirmed that the proportion of all research income for Research and contracts income from the EU was 18.2% for Wales; the largest of all the UK home nations with Scotland at 12.2% and England at 14.2%.

According to a recent CASE report on the effects of Brexit for regional research (2016), London receives (£176m) followed by Yorkshire and the Humber (£80m) and **Wales (£79m)**. While Regions with greatest dependence on UK *Research Council and HEFCs re-current research* funding include the East Midlands, the West Midlands, the South West and Scotland the CASE report showed those with the greatest dependence on EU government funding included the South West (12%), North West (11%), Scotland (11%) and **Wales (10%)**.

CASE also found variations in regional reliance on EU funding by discipline. For engineering research, the region with the greatest dependency on EU government funding was Wales (27%), followed by the North East (19%), with Wales receiving a large proportion of its funding for engineering from EU government bodies but a relatively small proportion from EU industry.

The UK's withdrawal from the EU will curtail access to Horizon 2020 and successive EU Framework Programmes. Although the UK Government's commitment to underwrite Horizon 2020 funding with new money is welcome and significant, it is not possible at this stage to anticipate the outcome of Brexit negotiations on science for Wales and how the UK government plan to disperse the newly announced funds.

Following Brexit, maintaining Wales's International participation and collaboration particular with European partners will be critical to avoid losing the benefits from growing Wales research capacity and ultimately increasing Wales RC and other competitive funding.

In the following months, the UK Government will decide the terms on which it wishes to negotiate continued access and participation in EU- funded research. This will not be without challenge as negotiations will necessarily cover issues which have been devolved within the UK and where it will be important that Wales's voice and interests are clearly heard when establishing any new future UK arrangements.

The Learned Society of Wales, together with other UK National Academies have argued publically that such negotiations should include the key principles of safeguarding the UK's assets in research, scholarship and innovation and seek the closest achievable association with the EU research programmes while maintaining, as minimum total current levels of funding support for research.

A critical focus for any refreshed WG Science strategy will therefore be to (i) establish the extent and pattern of dependent EU revenue supporting different aspect of Welsh research and (ii) and develop a contingency plan for dealing with any disproportionate adverse impacts when these EU sources are withdrawn and if their replacement is not fully supported by UK funds.

1. WHAT ARE THE AREAS OF WALES'S CURRENT SCIENTIFIC STRENGTH?

This depends on the scale (e.g. sector, institutional/subject discipline), country comparators and metrics chosen. The following considers both where relevant current evidence is available.

Sector Level:

As a small country, the first CSA recognized that Wales cannot be a leader in all areas of enterprise, research and innovation and so the original *Science for Wales* strategy was based on targeting investment in areas of perceived research strength that had demonstrated steady growth. These included the large multidisciplinary themes of:

- ***Advanced Engineering and Materials***
- ***Low carbon, energy and environment***
- ***Life sciences and health***

International Comparative Performance of the Welsh Research Base (2016): The main findings of this recent independent bibliometric report showed that, collectively, the Welsh research base continues to perform above its research income, and accounts for a disproportionately high share of the world's published academic articles, global citations and highly cited articles, despite a relatively small researcher base.

The **2016 Elsevier** report showed that:

- Welsh Universities produce the largest proportion of research (88%)
- In 2014, Wales accounted for 0.47% of global citations despite having only 0.24% of the world's published articles
- With 0.14% of the world's researchers Wales secured 0.59% of the world's top 1% most cited articles, and 0.49% of the world's top 5% most cited articles.

Productivity

- Wales remains more productive than the UK average in publications per researcher in 2014, only bettered by Scotland.
- The average number of citations per researcher for Wales increased from 7.6 in 2007-2011 to 9.6 in 2010-2014, (2 points more than the UK average).
- Wales ranks first among comparator countries in both citations received per million dollars GERD and citations received by publications per million dollars HERD.
- Wales ranks second among UK constituent countries in both publications per million dollars spent on R&D (GERD) and publications by the academic sector per million dollars R&D expenditure performed by the higher education sector (HERD).

Citation Impact;

- Welsh research results in high field-weighted citation impact. In 2014, Welsh publications were being cited 68% more often than the world average, compared to 59% above the world average in 2011.
- The field-weighted citation impact of Welsh publications in Natural Sciences, Medical and Health Sciences, and Engineering and Technology increased from 2007-2011 to 2010-2014.

Academic Reach

- Welsh research is becoming more international
- In 2010-2014, 46% of Welsh publications result from international collaboration, an increase from 40.3% in the period 2007-2011.
- The field-weighted citation impact of internationally collaborative publications of Wales increased from 2.0 in 2007-2011 to 2.2 in 2010-2014

(2) Institutional/subject perspective: The REF 2014 saw strong performances over a range of subjects, with world-class achievements in a number of areas (see table below) including: Psychology/Neuroscience, Allied Health Professions, General Engineering, Geography/Environmental Studies/Archaeology, Sport and Exercise Sciences/Leisure and Tourism, English Language and Literature, Leisure and Tourism.

Research Excellence REF 2014 (Wales)

UK Ranking	Category	University
1	Civil & Construction engineering	Cardiff
2	Allied health professions, Dentistry, Nursing and Pharmacy	Swansea
2	Psychology, Psychiatry and Neuroscience	Cardiff
3	Sociology	Cardiff
=4	Allied health professions, Dentistry, Nursing and Pharmacy	Cardiff
=5	Education	Cardiff
6	Physics	Cardiff
=7	General engineering	Cardiff
=7	Sports and exercise sciences, Leisure and Tourism	Cardiff Met & Bangor
8	Clinical medicine	Cardiff
	Earth systems and Environmental sciences	Swansea
	Chemistry	Cardiff

The **REF Impact 2014** also saw some strong performances over a range of subjects, with world-class achievements in a number of areas (see table below)

Research Impact (REF 2014)

Uk Ranking	Category	Universities
1	Psychology, psychiatry & neuroscience	Swansea joint 1 st
1	Civil & construction engineering	Cardiff 1 st
1	General engineering	Cardiff joint 1 st
1	Architecture, built environment & planning	Cardiff joint 1 st
2	Allied health professions	Cardiff
2	Sociology	Cardiff
2	Modern languages and linguistics	Bangor
4	Chemistry	Cardiff joint 4 th
5	Physics	Cardiff
5	Sport & exercise science, Leisure & tourism	Swansea
6	Psychology, psychiatry & neuroscience	Cardiff
6	Agriculture, veterinary & food science	Aber/Bangor joint submission
6	Sport & exercise sciences, leisure & tourism	Cardiff Met/Bangor joint submission
7	Clinical medicine	Cardiff
7	General engineering	Swansea
8	Biological sciences	Cardiff
8	Geography, environmental studies & archaeology	Swansea
9	Biological sciences	Bangor joint 9 th
9	Geography, environmental studies & archaeology	Aberystwyth
9	Education	Cardiff

2. COULD NEW AREAS EMERGE IN THE NEXT 5-10 YEARS AND WHAT COULD THEY BE?

There are some possibilities.

1. European Structural and Investment Funds

During 2015/16, there was a series of major projects funded from the European Structural and Investment Funds (ESIF), administered by the Wales European Funding Office (WEFO) that could provide the basis for new areas to emerge.

FLEXIS: This is a five-year £24 million research programme led by Cardiff University's School of Engineering in partnership with Swansea University and the University of South Wales. It is designed to investigate how flexible energy systems can meet modern day energy requirements, and particularly the challenges that arise when new sources of energy are integrated into the grid.

The Computational Foundry: Based at the Swansea Bay Campus, the Computational Foundry (supported with £17 million from the European Regional Development Fund) is intended to drive research into computer science and make Wales a global destination for computer scientists and industrial partners. It will include research and development laboratories, postgraduate and researcher areas as well as networking and inspiration space. The Foundry is

Materials and Manufacturing Academy (Swansea University) £8.6 million of European Structural and Investment Funding (ESIF) has been announced for Swansea University's Materials and Manufacturing Academy (M2A). Swansea will partner with the business sector to deliver training in specialist technical and

management skills key to the advanced engineering and materials sector in Wales. Valued at £14 million in total, in addition to the EU investment, the project will also be financed by the participating businesses, Swansea University and the Engineering and Physical Sciences Research Council.

Astute 2020 will capitalise on university expertise to boost the Welsh manufacturing industry. It will enable academics to *collaborate with industry to tackle a series of manufacturing challenges with a view to developing sustainable, higher-value goods and services for the global market*. Led by Swansea University alongside Cardiff, Aberystwyth and the University of Wales Trinity Saint David the total value of the programme is around £15 million, of which £10 million will be provided from the European Development Fund and £4.7 million from participating institutions.

2. New developments funded by the *Sêr Cymru* programmes could be expected to emerge in several fields including possible novel and ingenious proposals for tidal, wave, and wind power generation (e.g. the Swansea Barrier)

- Big data (or data oceans) and data analytics across a range of fields such as health and agriculture. Wales could be a good laboratory for many areas as it is large enough for sensible outcomes but small enough to have manageable projects.
- Robotics, autonomous transport, drones, and the change in the nature of work due to automation. Swansea are planning 'a factory of the future' to evaluate new approaches. The input of social scientists will be crucial
- Ageing and health continue to be major drivers.

3. Cross modal imaging sciences: Cardiff New £44M University Brain Research Imaging Centre (CUBRIC) which was opened by the Queen in June 2016 houses a combination of neuroimaging equipment and staff unique in Europe. This includes Europe's most powerful brain scanner, the Siemens 3 Tesla Connectom MRI system. The new facility has been part-funded by the Engineering and Physical Sciences Research Council (EPSRC), the European Regional Development Fund through the Welsh Government, the Medical Research Council (MRC), the Wellcome Trust, the Welsh Government and the Wolfson Foundation.

3. IN THE NEXT 10 YEARS WHAT RESEARCH IS LIKELY TO TRANSLATE OR BEGIN THE PATHWAY TO TRANSLATION?

This is not easy to predict given the challenges of converting world-leading research into new products and services. Possibilities however include Wales' contribution to the UK-wide network of **Catapult Centres**, overseen by Innovate UK.

Precision Medicine Catapult (PMC): this is one of six hub centres in the UK, funded by a £50 support designed to drive personalised medicine, new diagnostics and e-health systems and to identify and resolve barriers to building a leading UK precision medicine industry. The Wales' centre situated in Cardiff, will be delivered by a consortium, headed by the Welsh Government, NHS Wales, Cardiff & Swansea Universities and will work on local programmes – building expert teams across the city and seeking to research and develop innovative technologies for the UK healthcare sector.

UK Catapult Semiconductor Applications Centre: Wales will host the headquarters of the eleventh UK Catapult following the establishment in 2015 of the Compound Semiconductor Centre – a collaboration between IQE, the world-leading supplier of advanced compound semiconductor wafer products and Cardiff

University, It will receive £50 million in the period to 2020-21. The worldwide market for CS is estimated to stand at around £125 billion by 2025. They lie at the heart of much of the technology we use daily – mobile phones, satellite communication systems, new high-efficiency lighting, novel imaging techniques for a variety of uses in important areas such as security and medical diagnostics and future electronic vehicles.

SPECIFIC is a research-led and industry-inspired innovation Centre delivered by Swansea University with Tata Steel, BASF, NSG Pilkington and Cardiff University. The new investment is intended to help progress the commercialization of technologies to transform ‘**buildings into power stations**’ by enabling them to generate, store and release their own solar energy. The total value of the new investment is £26 million, consisting of £15 million from the EU, £4 million from the Engineering and Physical Research Council and Innovate UK, and £7 million from the academic and industrial partners.

The **BEACON** partnership was established in 2011 and is led by Aberystwyth University and is designed to enable scientists from Aberystwyth, Bangor and Swansea universities working with industry to develop renewable materials, fuels and chemicals as well as modified and new environmental and economically sustainable processes. It will assist companies to achieve competitive advantage, sustainable growth and to create jobs in the green economy. The total value of the investment is £12 million, of which £8 million is provided from ESIF.

CEMET: The Centre of Excellence in Mobile and Emerging Technologies (CEMET) is designed to help Small and Medium Sized Enterprises (SMEs) in the Valleys, West and North Wales design and test new mobile and emerging technologies to create products and services for commercial success. It will be led by the University of South Wales. As part of the project, CEMET will also provide a comprehensive package of support through product road-mapping and knowledge transfer to help SMEs explore the process of developing new and emerging technologies, converting their ideas into products and services and then taking them to market. The total value of the programme is £6.4 million, of which £4.2 million will be provided by the European Development Fund.

MRC Centre for Neuropsychiatric Genetics and Genomics (Cardiff University), Recognised for their ground-breaking insights into the causes, diagnosis and treatment of mental illness this leading centre which won a Queen’s Award is investigating causes of major psychiatric and neurodegenerative disorders and how to design new diagnostic approaches and also identify new targets for treatment. Since the MRC Centre was launched in 2009, they have pioneered understanding of the genetic underpinnings of diseases including Alzheimer’s, ADHD (Attention Deficit Hyperactivity Disorder), bipolar disorder and schizophrenia, including the first specific genetic risk factors for them. The Centre is already translating these findings into new approaches to treatment and prevention, using a range of cutting-edge techniques and planning to become a leading centre of translational neuroscience, over the next decade. They are also applying genetic findings to epidemiology – studying the impact of genes at a population level. This will improve prediction and diagnosis. They are also examining how environmental and social factors interact with genetic predisposition to cause mental illness.

4. SHOULD WELSH GOVERNMENT CONTINUE TO SUPPORT RESEARCH CAPACITY (SÊR CYMRU) AND INFRASTRUCTURE?

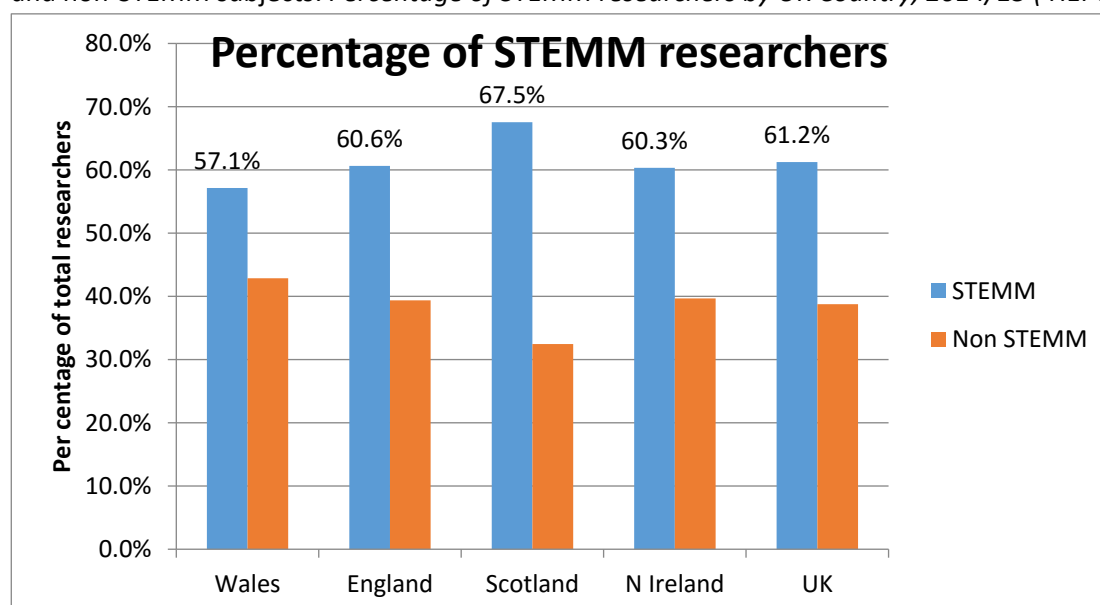
Yes : *The Case for Growing STEM Research Capacity in Wales* (Leadership Foundation for Higher Education, 2015) provided evidence backing the need to build further on the original Sêr Cymru actions of 2012. This

research showed Welsh universities had not secured their expected percentage of competitively-awarded research funding due in large part to the long-standing shortfall of several hundred researchers mainly in STEMM subjects, with large deficits in clinical medicine; biosciences; physics; electrical and computer engineering; mechanical, aero and production engineering, and maths – the fields gaining funding from the high-spending MRC and EPSRC. While the Welsh Government designed a series of Fellowship schemes, collectively called Sêr Cymru II, to help bridge this gap, it should be remembered that the 2013 Elsevier study noted that the size of Wales' researcher base was relatively small, comparable to the size of countries such as Ireland and New Zealand. Indeed one of the main reasons for the impressive efficiency was the relatively slow growth of the researcher population over the last decade. The Welsh researcher base has grown only modestly over the past 5 years and is the slowest among comparator and UK constituent countries.

Using researchers defined as academic staff on research or a research and teaching contract, HESA and HEFCW figures show that there are 5,627 researchers (FTE) in the Welsh HE sector. In 2014/15, this meant that Wales had 4.2% of the total researchers in the UK, a proportion which had decreased slightly from the previous years, as shown in Table below: *Table: Share of Researcher Numbers by UK Country (HEFCW)*

	% of total UK Staff on R or R&T contracts		
	2012/13	2013/14	2014/15
Wales	4.3%	4.3%	4.2%
England	83.1%	82.9%	83.2%
Scotland	10.7%	11.1%	11.0%
N Ireland	1.9%	1.6%	1.6%
UK	100%	100%	100%

In 2014/15, according to HEFCW **57%** of researchers in Wales were in Science, Technology, Engineering, Mathematics and Medicine (STEMM) subjects. This is the lowest proportion of STEMM researchers in any part of the UK. In Northern Ireland, 60% of researchers are in STEMM subjects, 61% in England and 68% in Scotland. This shortfall in the number of STEMM researchers is consistent with the findings of the report *The Case for Growing STEMM Research Capacity in Wales*. The % of STEMM and non-STEMM researchers in each country of the UK are shown in the figure below showing the proportion of total researchers in STEMM and non-STEMM subjects: *Percentage of STEMM researchers by UK Country, 2014/15 (HEFCW)*



Continuing to build Wales research capacity will be required, though a balance between the acquisition of star research capability, essential support staff, and provision of equipment and infrastructure, all of which will need to be re-adjusted with time. The top priority, however, should be maintaining “excellence”. For Wales, and for Sêr Cymru excellence is the most important parameter. Funds for kit, infrastructure, technicians and support staff should be judged as part of the setting up or maintenance of an overall world class group, and not be approved if the ultimate aim of world class research is not the top priority.

5. SHOULD WELSH GOVERNMENT FUND RESEARCH MORE BROADLY, e.g. PROJECTS AND PROGRAMME GRANTS?

Given the strategic contribution of research to build a healthy, sustainable and prosperous Wales, the answer has to be Yes, However it would also be important to consider ensuring that research in Wales remains an attractive career option, that Wales is an open, welcoming and appealing prospect for researchers to progress their research career and that the quality of Wales’s research system further enhances the reputation and demand for Welsh researchers

Currently, Wales is rolling out a series of significant but nevertheless time-limited initiatives that cover many, but not all of the ‘rungs’ on the researcher development ladder. Over and above the contribution to PhD funding and training already made by the larger five research focused universities in association with RC, the ‘star’ Research Chairs of **Sêr Cymru I** (funded in large part by Welsh Government) cater exclusively to the top of the research ladder.

The associated Research Networks have made some good progress with the recruitment of Ph.D. research studentships and appointment of Post-doctoral Research Associate posts (PDRAs) and Research Fellow posts. Collectively, they include some 74 Ph.D. studentships and 67 Fellows and PDRAs.

Building on the progress made by the Ser Cymru investment, will require formulating a national research infrastructure roadmap that provides a coherent and affordable national policy on structured progression for researchers given Wales conspicuous poor level of PGR provision compared to other UK nations (see below) . This should ensure a clear career pathway for researchers to help maximize their personal potential and, as a consequence, help maximize the return on Wales’s investment in innovation and research. This will include investment to ensure selective strands of additional competitive funding are available that increase the attractiveness and growth of researchers being able to develop their careers progression ambitions in Wales.

PG provision: According to HEFCW between 2007/08 and 2014/15, PG numbers grew by 14% in Wales and by 13% in the UK as whole. In Wales, however the growth in PG has been entirely due to an increase in PGT, whereas in the UK as a whole both PGT and PGR numbers have increased.

PGR numbers in Wales, however, grew slowly in the early part of the period, but has decreased each year since 2011/12 and are now roughly back at the same level as in 2007/08. In the UK as a whole, the steady upward trend in full-time PhD numbers has continued throughout the period. Full-time PhD numbers in Wales however plateaued from 2011/12 to 2013/14 and dropped by 195 FTE (7%) between 2013/14 and 2014/15. In 2014/15, Wales had only 3.8% of the total PhD students in the UK, below the 5% notional share for Wales’ UK higher education activity.

When comparing to the other home countries in term of PGR provision, it is clear that the postgraduate situation in STEM for Wales is concerning, given that for all other subject areas Wales’ postgraduate

participation is roughly on-par with England and, largely with Scotland too. Using data from 2013/14 shows that :

- For **physics**, the postgraduate physics population, compared to the undergraduate population, is 10% in Wales, 27% in England, 29% in Scotland and 52% in Northern Ireland.
- For **chemistry** it is 23% in Wales, 26% in England , 37% in Scotland and 52% in Northern Ireland.
- For **biology** it is 16% in Wales, 21% in England, 24% in Scotland and 62% in Northern Ireland.
- For **all other subjects** it is 35% in Wales, 35% in England, 37% in Scotland and 29% in Northern Ireland.

In Wales also, the second phase of the Knowledge Economy Skills Scholarships (KESS2) launched in July 2016 will make a big difference in applied **research areas**. Building on the success of its predecessor and led by Bangor University in partnership with seven other universities in Wales, KESS2 will offer Research Masters and PhD opportunities in collaboration with companies in West Wales and the Valleys. The scheme will provide more than 600 scholarships over the next six years with funding of £36 million, of which £26 million will be provided from EU sources.

Although research-intensive universities will remain a critical engine of Wales's research infrastructure, one important aspect for sustaining the health of the academic research base will be having other vehicles that nurture and retain highly skilled people, trained in a knowledge-rich environment with relevant competencies and abilities across a diverse range of disciplines.

Key to keeping this Welsh research base competitive and retaining and recruiting the brightest and most creative researchers, will be earmarking some form of **annual competitive funding** that will enable good researchers to progress their career development path.

Diamond Review (2016). In addition to making recommendations regarding the sustainability of University Funding and Student Finance Arrangements in Wales, the Diamond Review made several recommendations relating to the **Importance of growing the next generation of Postgraduate researchers**.

The Review drew attention to the importance of developing the next generation of researchers (p56/57) and proposed comparable student support for part-time and postgraduate students, with PGT course fees at Welsh universities 'soft capped' at £9,000. In addition and given the insufficient critical mass of researchers in Wales the Review proposed that the *'Welsh Government establishes an ambitious programme to train a new generation of researchers in Wales.'* Specifically, the Review recommended (and the Welsh Government supports) the setting up a Post Graduate Research Scholarship Scheme involving 150 scholarships per year where the costs are *"funded in a three way equal partnership between the Welsh Government, the University in which the research student will be based, and another funder either from the private, public or third sector"* . The scholarships would *"be available for study in any area of research, as long as the three-way partnership described above existed"*. The Review proposes *'that these scholarships could be administered on an annual basis by the **Learned Society of Wales (LSW)**, subject to agreement of the proposal relating to the LSW later in this section'*.

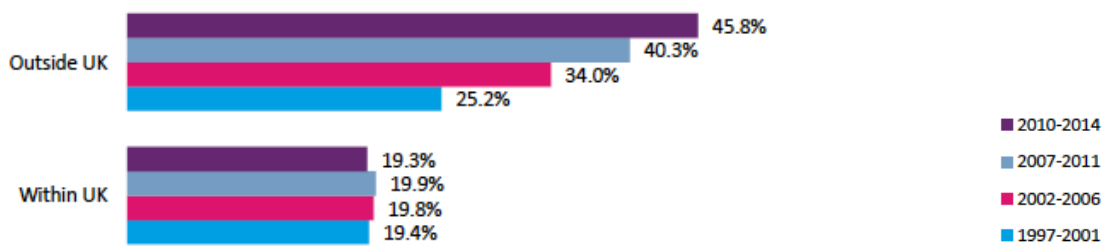
6. SHOULD WELSH GOVERNMENT SUPPORT INTERNATIONAL COLLABORATIONS AND IF SO HOW?

1. Yes, where possible. Welsh Government should support international collaborations as much of the most powerful and original science research typically comes from international teams which draw on different expertise from groups in different countries. Many grand challenges are global in nature and require global

responses. International collaboration rates are consistently rising and internationally co-authored papers tend to have a positive effect on citations.

The latest Elsevier report (2016: Fig below) showed that a large and growing majority of Wales's published outputs from 1997 to 2014 were co-authored with researchers from outside the UK. Such international research collaborations make up some 46% of Wales publication output in 2014, strong evidence that researchers are well connected internationally. Moreover, during the 4 year period 2010-2014 the Field Weighted Citation Impact (FWCI) for such international research was 120% above the world average

Figure 3.1 — Percentage of Wales' publications resulting from various collaborations for five-year blocks, 1997-2001, 2002-2006, 2007-2011, and 2010-2014. Source: Scopus.



Ensuring Welsh Universities remain global in outlook, internationally networked and an attractive destination for talented people from across Europe will be critical for ensuring that the dividend of the Sêr Cymru investments for Wales are retained and built upon while at the same time continuing to make the contribution it should to Wales's economic development.

2. The Welsh Government should support international collaborations by ensuring that it is fully engaged with UK cross cross-Government attempts to support international research as part of a wider international research and education strategy and where possible endeavour to selectively Invest in bilateral and multilateral research and innovation initiatives with existing key European academic partners.

Another opportunity for Wales comes in the form of a recommendation from the recently published 2016 report from the *House of Lords Science and Technology committee* to further enhance the UK presence in the world of science and grow strong collaboration links. The Report recommends ***“that the Government asks National Academies and the new UKRI to search the globe for outstanding scientific leaders, and attract them to the UK with compelling offers of research funding for their first 10 years in the UK and support for their immediate families as they settle into the UK. This initiative should receive resources beyond the existing science and research budget to ensure that it does not undermine support for the existing UK science community.”***

Given that Wales has the experience and track record of successfully pursuing this type of initiative, with its own funds since such 2012 (and assuming the UK Government were content to support such a recommendation) then the **Learned Society of Wales** –Wales's National academy) would be eligible to apply for UK funds to search the world for outstanding scientific leaders, and attract them to the Wales with compelling offers of research funding for their first 10 years Such high profile figures attract further funding and talent but also provide the basis for building strong collaborative links with the home departments.

7. SHOULD THERE BE CLOSER TIES BETWEEN ACADEMIC RESEARCH AND PARTNERS SUCH AS INDUSTRY, NHS, and PUBLIC SERVICES & GOVERNMENT?

In many areas such collaboration is already in place. Wales is good at such collaboration, and Wales is particularly active in life sciences, physical and engineering sciences. The culture of involvement with knowledge transfer developed in Wales much earlier than in England. The HEFCW I&E support, together with A4B and related programmes, were undoubtedly crucial in establishing Welsh HEIs as leaders in the exploitation of research as demonstrated in the HEBCIS annual reports, ERC's Benchmarking Local Innovation and the Elsevier review.

This collaboration should be continued and expanded as needed. At present, however HEFCW has no money to support innovation and Wales could quickly lose its leading position. For some, the optimal Eco-system for Wales is for HE and HEFCW, (whatever form it takes) to be funded through the same WG department as economic development. This would enable knowledge transfer schemes and the like to be co-ordinated and a strategic approach to be developed.

The [Learned Society of Wales](#) (LSW) is an independent, all-Wales, self-governing, pan-discipline educational charity established in 2010. As Wales's first National Academy of science and letters, the Learned Society of Wales, like similar national academies in Ireland and Scotland, brings together the most successful and talented Fellows connected with Wales, for the shared purpose and common good of advancing and promoting excellence in all scholarly discipline across Wales.