

Dadansoddi ar gyfer Polisi



Analysis for Policy



Llywodraeth Cymru
Welsh Government

SOCIAL RESEARCH NUMBER:

62/2018

PUBLICATION DATE:

27/11/2018

Evaluation of Sêr Cymru 1

Final Report

Mae'r ddogfen yma hefyd ar gael yn Gymraeg.

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Evaluation of Sêr Cymru 1

Final Report

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SQW

Full Research Report: Duggett, J. and Wilkinson, C. (2018). *Evaluation of Sêr Cymru 1*. Cardiff: Welsh Government, GSR report number 62/2018
Available at: <https://gov.wales/statistics-and-research/evaluation-ser-cymru-1/?lang=en>

Views expressed in this report are those of the researcher and not necessarily those of the Welsh Government

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Glossary

Acronym/Key word	Definition
AdEM	Engineering Research Network Wales
HEFCW	Higher Education Funding Council for Wales
LCEE	National Research Network for Low Carbon Energy and Environment
LiSH	Life Sciences Research Network Wales
NRN	National Research Network
STEMM	Science, technology, engineering, mathematics and medicine
RCUK	Research Councils UK

1. Introduction and background

- 1.1 The Welsh Government commissioned SQW in March 2018 to undertake an evaluation of Sêr Cymru 1. This report sets out the findings and recommendations of the evaluation.

About Sêr Cymru 1

- 1.2 The Sêr Cymru (“Stars Wales”) programme is designed to strengthen Wales’s research capabilities. The programme was developed as part of the 'Science for Wales' strategy announced in 2012.¹ This strategy set out a vision for the Welsh Government to develop a strong and dynamic science base that can contribute to economic development and the broader welfare of society.
- 1.3 The first phase of this ongoing programme – Sêr Cymru 1, the focus of this evaluation – sought to deliver against this intent through attracting scientific talent into research posts in Wales, and supporting the development of the existing research infrastructure. Sêr Cymru 1 comprised two complementary ‘Strands’:
- **Research Stars (herein ‘Stars’)** – the appointment of four internationally-renowned academics to chairs at Welsh universities, with additional support for their research teams and other research infrastructure requirements: Professor Yves-Alain Barde, Chair in Neurobiology (Cardiff University); Professor James Durrant, Sêr Cymru Chair in Solar Energy Research (Swansea University); Professor Andrew Barron, Chair in Low Carbon, Energy and Environment (Swansea University); and Professor Diana Huffaker, Chair in Advanced Engineering and Materials (Cardiff University).
 - **National Research Networks (NRNs)** – establishing and supporting research networks in 'Grand Challenge' areas identified in Science for Wales.² The Networks provide a combination of research funding, capability development, and networking activity to develop research communities and capacity in key areas. The Networks were: Advanced Engineering and Materials; Life Sciences; and Low Carbon, Energy and Environment.

¹ Welsh Government (2012) *Science for Wales*

² *ibid.*

- 1.4 Sêr Cymru 1 was a five-year programme, launched in 2012 with planned expenditure of c.£40m, co-funded by the Welsh Government and HEFCW: £18m for the Research Stars, and £21m for the NRNs. The formal funding for the programme will come to a close at the end of March 2019, with the exception of support for Prof. Huffaker, whose funding covers up to March 2021 (reflecting a 2016 appointment).
- 1.5 Sêr Cymru 2, launched in 2015, involved attracting a large number of early-mid career scientists (and those on a career break), into research posts in Wales. This element of the programme is being evaluated separately.³

Purpose of the evaluation

- 1.6 The objectives of the evaluation of Sêr Cymru 1 were to:
- Assess the programme's effectiveness in achieving its objectives and anticipated activities, outputs and outcomes.
 - Identify what has worked well/less well, and the reasons for this.
 - Review the strategic and economic context around the programme, and assess its ongoing need.
 - Recommend management and implementation improvements for future programmes.
 - Recommend actions to continue and/or enhance the work of Sêr Cymru 1 and other Government-funded scientific research in Wales.
- 1.7 The evaluation covered both Strands of Sêr Cymru 1 individually, and the programme as a whole, including considering whether the Strands have together brought about results greater than would have been realised individually.

Structure

- 1.8 This report is structured as follows: Section 2 sets out the evaluation approach and method; Section 3 considers the context, rationale and objectives of the programme; Sections 4 and 5 set out the evaluation evidence on the achievements of the NRNs and Research Stars; Section 6 discusses programme management and monitoring; and Section 7 sets out conclusions and recommendations.

³ See <https://gov.wales/statistics-and-research/evaluation-ser-cymru-ii-programme/?lang=en>

2. Methodology

2.1 This Section sets out the overall approach, sources of evidence, and analytical approach used for this evaluation.

Overall approach

2.2 The evaluation was structured around a 'logic model' approach. Logic models are recommended for use in policy evaluation: they help to identify the evaluation objectives and research questions, inform the types of data and information to be collected, and provide a transparent assessment framework. The overarching logic model used for this evaluation is set out in Figure 2.1, with Strand-level logic models set out in the subsequent sections.

2.3 The logic models were developed following a review of background documents and data, and scoping discussions with the Steering Group, involving representatives of the Welsh Government and HEFCW. The logic models were approved by the Steering Group prior to the main research phase of the evaluation. They have been used to: review the context and assess need; test whether the expected activities, outputs and outcomes have been realised for each Strand and overall; and provide the context for the assessment of programme performance and lessons.

2.4 It is important to note that the context for the programme is changing. There is uncertainty over the implications for research and science of the UK's departure from the European Union in 2019, whilst the Reid Review of Government funded Research and Innovation in Wales was published during the evaluation research.⁴ Implications of both the UK's departure from the European Union and the Reid Review are drawn upon in the Recommendations for the programme going forward.

Research methods

2.5 A mixed methods research approach has been adopted for the evaluation, involving five main elements:

⁴ Reid, G. (2018) *Review of Government Funded Research and Innovation in Wales*

- **Desk review of relevant programme documents and data.** This included quarterly and annual reports of progress and performance of each component of each Strand, initial grant award letters, and financial and monitoring data. The websites and other publication from the NRNs were also reviewed for context.
- **Consultations with programme partners.** This included: the programme manager at the Welsh Government; programme sponsors at the Welsh Government and HEFCW; Research Stars, and their relevant project manager at their host institution (in some cases, consultations also included other senior members of the Stars' research team); and NRN Directors and project managers.
- **Consultations with programme stakeholders.** This included: directors of Research and Innovation (or equivalent) at each Welsh university; and external stakeholders in the wider research and innovation landscape within Wales and beyond. This included a mix of stakeholders focused on each of the three Grand Challenge areas specifically, and those with a broader remit across the Welsh research base e.g. Research Councils, charities, sector bodies and Government departments. The consultees were drawn from a list of stakeholders drawing on the recommendations of the NRNs, the Welsh Government and the study team.
- **An online survey of PhD students and research fellows supported by Sêr Cymru 1.** The survey was distributed to all current PhD students/fellows/post-docs, with 88 responses received. The survey was piloted with a small number of respondents, and open over a six-week period in June/July 2018. The exact circulation list is not known to the evaluators (as the survey was distributed via the Welsh Government confidentially). However, monitoring data indicate 262 PhD/research fellow/post-doc positions were supported by the programme. Indicatively, the 88 responses represent 34% of individuals supported by Sêr Cymru 1 for PhD students/fellows/post-doctoral research.
- **Six case studies.** Two types of case study were completed: 'thematic' case studies to capture evidence on the contribution of the programme to the development of a particular area of research; and 'activity' case studies to capture evidence on contribution of the programme to the broader research and innovation landscape and capacity in Wales. One case study type of each type was completed for each of the three Grand Challenge areas. Each case study

(set out in Table 2.1) involved a document review, and interviews with relevant partners/stakeholders involved in the research area/activity, including in some cases direct ‘beneficiaries’ of the Sêr Cymru 1 funding.

Table 2.1: Case studies

Grand Challenge area	Thematic case study	Activity case study
Energy and Environment	Resilcoast (research cluster focused on salt marshes)	Returning Fellowship Fund
Life Sciences	Oncology drug discovery research	Annual Congress
Advanced materials and manufacturing	Compound semiconductor research	TWI ⁵ -led industrial engagement

Source: SQW

2.6 In total, over 160 people involved in research and innovation in Wales provided evidence to inform the evaluation.

Analysis

2.7 Data has been analysed through quantitative analysis (online survey and monitoring data) and qualitative analysis (consultations, case studies, and qualitative questions in the online survey) underpinned by documentary evidence. Consistent with the evaluation requirements, the analysis has been completed principally at the level of the two Strands (i.e. NRNs and Research Stars), with findings set out at this level. However, the analysis also sought to understand relationships and linkages between the Strands, and overall programme performance.

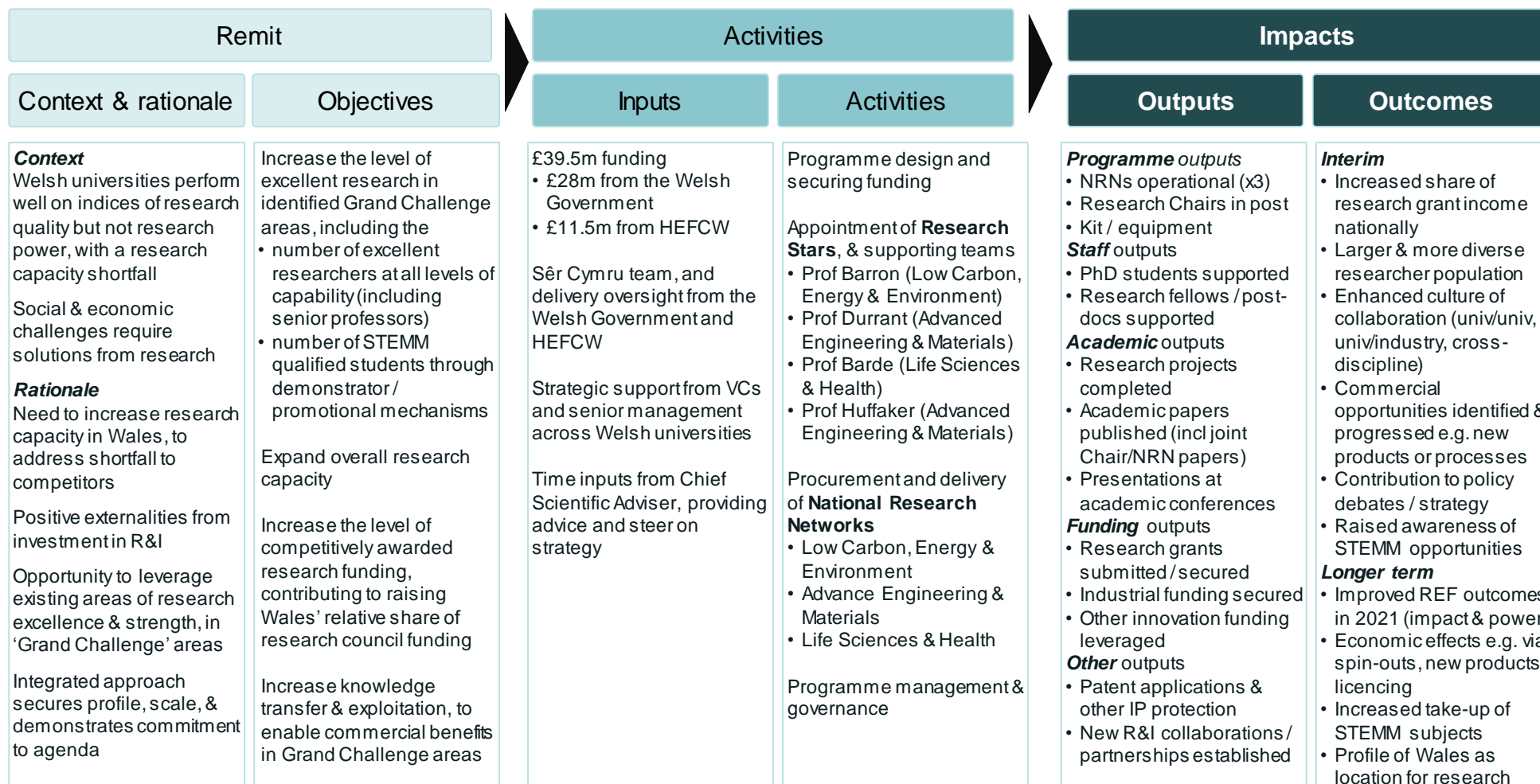
2.8 Issues were encountered in the consistency, accessibility and quality of monitoring data and financial information. Data was collected by the individual Research Stars and NRNs and reported to the Welsh Government. There has been significant variation in data quality and coverage across these, and no integrated dataset that captured data on the programme as a whole. This has had implications for the analysis, and this is noted in the report and discussed in detail in Section 6.

2.9 The findings of the analysis were tested with the Steering Group via a detailed interim findings output, prior to the production of this report. Further detailed data

⁵ The Welding Institute. TWI specialises in innovation, knowledge transfer and problem solving across all aspects of manufacturing, fabrication and whole-life integrity management. TWI currently operates from 54,000 square metres (581,000 square feet) of manufacturing, testing and training space

and evidence was provided to the Welsh Government and HEFCW as programme sponsors in a separate accompanying 'Evidence Annex'.

Figure 2.1: Sêr Cymru 1 programme-level logic model



Source: SQW

3. Context and rationale, and objectives

3.1 This Section considers the policy context and rationale/need for Sêr Cymru 1. This draws on consultations with those involved in developing and delivering the programme and programme stakeholders, and a review of relevant background documents. The Section also comments on the objectives of the programme, and how these may have informed activity across the two Strands.

Context and rationale

- 3.2 Sêr Cymru 1 emerged in the context of a well-developed body of evidence that indicated the challenges and opportunities for the Welsh research base. Science for Wales indicated that Welsh universities had demonstrable excellence – reporting that half (49%) of Welsh science ranked in the top two categories in the 2008 Research Assessment Exercise, and that citation impact exceeded the UK – but that Wales underperformed in attracting competitive research council income: in 2010, Wales attracted 3.3% of total competitive RCUK funding, a level lower than its relative population (5% of the UK population) would suggest. By contrast, Scotland with 8.4% of the UK population secured 14.8% of competitive RCUK funding.⁶
- 3.3 Later work (from 2015) that considered the research base in Wales in more detail, identified that the core deficit responsible for the under achievement of research funding could be explained by the shortfall in the scale of the research base in Wales. Halligan and Bright identified an estimated shortfall of 600 researchers below optimum capacity in key STEMM areas.⁷ This analysis post-dated the programme launch but validated further the underpinning case and context for the Sêr Cymru 1 at its outset.
- 3.4 Science for Wales also recognised the opportunity for Wales to exploit more fully its strengths in areas of science where it possessed both excellence in academic, clinical or translational capabilities, and a business base to maximise commercial advantage. Three Grand Challenge areas of ‘Life sciences and health’, ‘Low carbon, energy and environment’ and ‘Advanced engineering and materials’ had

⁶ Welsh Government (2012) *Science for Wales*

⁷ Halligan, P.W. and Bright, L. (2015) *Case for Growing STEMM Research Capacity in Wales*

been identified by the Welsh Government. This focus drew on international evidence on the benefits of significant investment in research and education in a small number of priority areas.⁸

- 3.5 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 policy context and underpinning evidence base was therefore strongly supportive of an intervention to enhance and grow the research capacity in Wales; Sêr Cymru 1 was a direct response by the Welsh Government and HEFCW to this agenda.
- 3.6 In turn, the rationale for the programme was predicated on the twin imperatives of a need to address: i) the deficits in the level of competitive research income secured by the Welsh research base (relative to comparators), and; ii) the shortfall in research capacity (notably in STEMM fields) that underpin this research income deficit, particularly in Grand Challenge areas.
- 3.7 This was in the context of a recognition of a need to enhance the research base in Wales over the long-term, not as a short-term fix. As set out in Science for Wales:
- “Science policies and funding need to be long-term, over decades not years. This is to match the longer time frame for innovation and research, external investment decisions, career choice, and the pursuit of those careers. It can take 10 years to build a major research capability, but it can be lost by inconsistent funding decisions or uncertainty over policy or strategy.”⁹*
- 3.8 The rationale for Sêr Cymru 1 was recognised and accepted by the strategic and policy-level consultees engaged in this evaluation. Consultees – both those very involved in the programme, and those less closely linked – recognised the challenges facing the Welsh research base, and agreed that Sêr Cymru 1 met a need at the outset.

⁸ Welsh Government (2012) *Science for Wales*

⁹ *ibid.*

- 3.9 Reflecting the feedback, one consultee summarised this as being about making a “*strong statement of intent in order to move the dial*” on research funding in Wales, address issues of capacity in STEMM and to secure competitive RCUK funding, and another that Sêr Cymru 1 had a “*sensible rationale and mission, with a clear need to support capacity building and collaboration with industry*”. Many stakeholders described the key issue to be addressed as Wales’ perceived (and evidenced) underperformance in terms of the volume of competitive research funding it attracted, despite the quality of the research base.
- 3.10 Alongside the formal evidence-based case for Sêr Cymru 1, consultees also highlighted the need for a programme with the profile of Sêr Cymru 1, to provide a visible ‘symbol’ of a commitment to research funding by both HEFCW and the Welsh Government.
- 3.11 Consultees highlighted that the programme was developed at a time of significant challenge in the financial and funding landscape for science in Wales. The previous ‘Reconfiguration and Collaboration Fund’ led by HEFCW that focused on supporting mergers, partnerships and collaboration across the Welsh research base had closed in 2011. Therefore, although Sêr Cymru 1 funding was in relative terms modest by the context of the total non-competitive research funding in Wales – with quality-related (QR) funding¹⁰ of £71m p.a. over the programme period – consultations suggest that the timing, strategic alignment and profile as a national programme mean that Sêr Cymru 1 was more important strategically in delivering against the aims of Science for Wales than its relative share of funding suggests.
- 3.12 The specific focus on Grand Challenge areas – with the ability to support development in well-defined areas of strength – accentuated this role. This said, the relative scale of Sêr Cymru 1 compared to the wider research funding landscape does need to be recognised in testing its contribution to the overall performance of the Welsh research base and wider outcomes.
- 3.13 Consultees engaged in the evaluation also highlighted the case for the programme in terms of addressing a need to develop the reputation and profile of science in

¹⁰ This is funding that is allocated by HEFCW selectively to recognise and reinforce research excellence, based on a formula taking into account the results of the 2014 Research Excellence Framework (REF)

Wales, including amongst students and staff to help attract and retain quality researchers. As one consultee noted in the context of the case for Sêr Cymru 1:

"We want to develop people that stay in region and help generate new ideas and products. This is really important to our 5-10-year outlook, because we want people to choose Wales."

3.14 In summary, the evaluation indicates that the rationale for Sêr Cymru 1 was timely and proportional. The programme was grounded in a solid evidence-base, and was located within a well-established policy context that sought to promote the enhancement of the research capacity of Wales, as a key element of wider economic and social development. The need for the programme was consistently identified as sound by stakeholders, with Sêr Cymru 1 recognised as one of the key mechanisms through which the vision established in Science for Wales would be realised practically.

Objectives

3.15 The high-level targets of Science for Wales were to:

- Secure a quantifiable uplift in Wales's share of UK Research Council funds: specifically to increase Wales's share of UK Research Council funding from 3.3% to 5% by 2017.
- Improve Wales's performance in the Research Excellence Framework 2014: specifically to grow the proportion of Welsh research achieving 3* and 4* quality and impact levels to reach the highest UK level or its equivalent.¹¹

3.16 The first target – reflected a 'notional population share' of total competitive UK research income and had long been an ambition for the Welsh Government. In 2014/15, Wales's share of total Research Council income remained at 3.0% of the UK total. This figure has remained unchanged since 2012/13 and has remained below 4% over the past two decades.

3.17 This was recognised by stakeholders engaged in this evaluation as an ambitious stretching target, which would require a long-term perspective.

¹¹ Welsh Government (2012) *Science for Wales*

- 3.18 The programme's focus was on realising a *contribution* to raising Wales's share of competitive research income, with a focus on STEMM-focused Grand Challenge areas. This was aligned strongly to the underpinning rationale and provided Sêr Cymru 1 with a well-defined overall strategic level aim.
- 3.19 However, this headline aim was not underpinned by a set of SMART (Specific, Measurable, Achievable, Realistic, Time-limited) objectives. Given the high-level nature of the aim to reach 5% of RCUK competitive research funding, and the wide range of factors influencing this performance not related to Sêr Cymru 1 (e.g. the level of QR funding, investments in research infrastructure elsewhere, funding/strategic decisions by research councils), this did mean there was some uncertainty over what Sêr Cymru 1 was intended to achieve specifically and directly, and how this would be measured.
- 3.20 With no SMART objectives, there was also no strategic imperative or framework to ensure that the two Strands of Sêr Cymru 1 that were subsequently delivered worked together in order to 'leverage' fully the shared expertise and networks of partners and teams supported through the programme. This appears to have been a missed opportunity.
- 3.21 The lack of SMART objectives appears to relate to the absence of a formal process of project appraisal, development and business planning for Sêr Cymru 1. As set out in the Green Book the development and testing of SMART objectives should, in principle, be a core element of policy development:
- "Clear objectives are vital for successful policies, programmes and projects. Identifying objectives begins at the outset or when making the case for change ... A lack of clear objectives limits effective appraisal, planning, monitoring and evaluation."*¹²
- 3.22 This may reflect the strategic momentum behind the programme, and the need for ensuring progress in delivery following the publication of Science for Wales. However, in hindsight this formal process would have been beneficial to ensure clarity of objectives and to inform delivery. We return to this issue in Section 6.

¹² HM Treasury (2018) *The Green Book: Central Government Guidance on Appraisal and Evaluation*

- 3.23 The second target in Science for Wales was improving Wales's performance in the Research Excellence Framework 2014 (REF 2014): specifically to grow the proportion of Welsh research achieving 3* and 4* quality and impact levels to reach the highest UK level or its equivalent. No contribution to this target by Sêr Cymru 1 was anticipated, as the end of the assessment and publication period covered by REF 2014¹³ was in 2013, the same year the programme was launched.
- 3.24 However contextually, it is worth noting that in REF 2014, Wales's university-based research showed a discernible improvement over the 2008 assessment. Wales significantly boosted its performance on the Research Fortnight Quality Index, ranking highest of all the UK nations. More than three-quarters of the research submitted by universities in Wales in 2014 was assessed as being world-leading or internationally excellent and almost a third of submitted Welsh university research was rated as 'world leading'.
- 3.25 Research Fortnight Quality Index figures show 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 nations' scores of 47.9, 44.8 and 44.8, respectively. In 2014, Wales grew its proportion of Welsh research achieving 3* and 4* quality to reach levels comparable with the rest of the UK. The proportion of 4* in the overall quality profile for Wales was identical with that for the UK as a whole (30% in both cases), and proportion of 3* for Wales (47%) was slightly higher than for the UK as a whole (46%).
- 3.26 Although Wales's research secured the highest Research Fortnight Quality Index of the four UK nations in 2014, the sector submitted 28% fewer staff (723) than it did for the Research Assessment Exercise (RAE) 2008. The 2014 Research Excellence Framework was the first UK Government exercise to formally assess the impact of research beyond the usual academic metrics. In REF 2014, Wales's 272 case studies outperformed all other UK nations in terms of overall level of REF impact profile; the overall impact profile for Wales had 49% at 4*. This was 5% above the UK average and 3% ahead of Scotland.

¹³ See <https://www.ref.ac.uk/2014/about/timetable/>

Objectives for the evaluation

3.27 To inform this evaluation, a set of objectives for Sêr Cymru 1 were agreed with the Client Steering Group. These reflect what are recognised to be the objectives of the programme, albeit developed at the evaluation stage. The objectives cover both Strands of activity, and highlight how they were expected to work together, with objectives relevant to both Strands in most cases. The objectives also demonstrate the broad remit of Sêr Cymru 1 covering research excellence, capacity, income; and expected innovation/knowledge transfer benefits.

3.28 The objectives agreed are:

- **Increase levels of excellent research in Grand Challenge areas**, covering: Excellent researchers at all levels of capability; and STEMM qualified students through demonstrator/promotional mechanisms.
- **Expand Wales's overall research capacity.**
- **Increase the level of competitively awarded research funding**, contributing to raising Wales's share of research council funding.
- **Increase knowledge transfer and exploitation** to enable commercial benefits in the Grand Challenge areas.

3.29 These programme-level objectives are underpinned by Strand-level objectives that were identified at the outset of the programme, for the NRNs and Research Stars. These objectives are discussed in more detail in the subsequent sections, however three points are worth noting at a programme level.

- First, whilst there were consistent objectives for the NRNs and Research Stars, there was variation in the terminology and indicators used to measure performance against these objectives for components within each Strand; this does limit the extent to which the objectives can be assessed at an integrated level. The objectives also did not reflect fully the different focus of the NRNs and Research Chairs in how they would realise outcomes.
- Second, and related to this, the objectives varied by Research Star, which suggests that the objectives were influenced by activities, rather than objectives being used to inform and determine these activities as would be expected, applying standard programme development and appraisal processes.

- Third, a range of other more detailed ‘objectives’ were agreed through the negotiation process with funders, and set out in their Grant Award Letters, for some of the Research Stars and NRNs. These were formally activities (i.e. what needed to be done) not objectives (i.e. what should be achieved), but this highlights further some variation in the strategic focus of the programme, and how this varied across its different Strands.

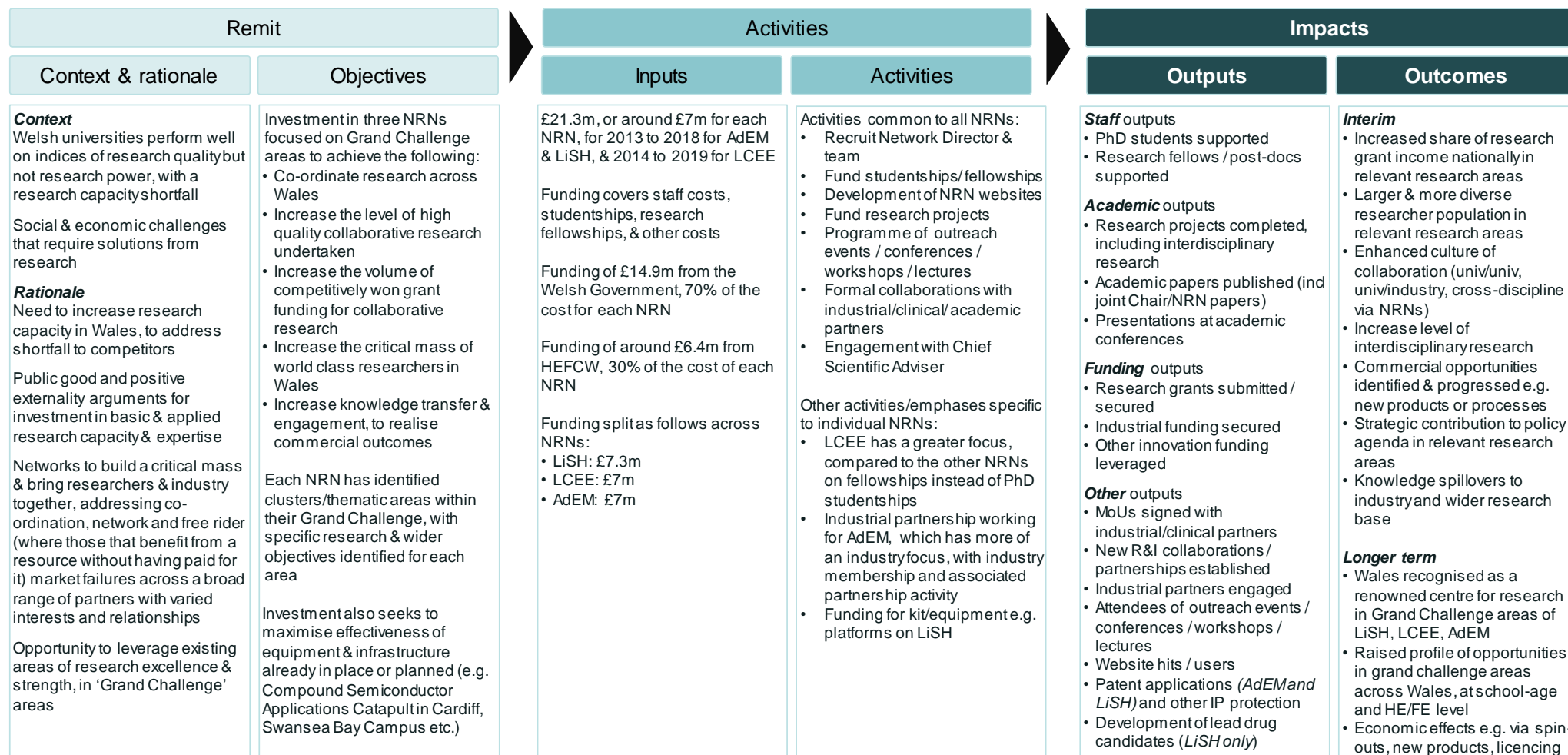
- 3.30 The absence of formal programme-level objectives, and the variation in the Strand level objectives was reflected in the consultations with programme partners and stakeholders around the objectives of Sêr Cymru 1. The overall strategic aim and purpose of the programme was recognised. However, there were differing views on whether the programme was – and should have been – seeking to support an economic as well as research capacity agenda i.e. whether Sêr Cymru 1 was also set-up to try and deliver a short-term economic effect (through job creation and retention, increased R&D investment, and business innovation).
- 3.31 Related to this, perspectives on the expectation around industrial engagement and knowledge transfer, and whether this was a priority for Sêr Cymru 1, was varied across consultees. Put simply, for some, this was seen as crucial to the objectives (and therefore ultimate success) of Sêr Cymru 1, for others it was not.
- 3.32 In part these issues are influenced by the perspectives and roles of consultees – for example, those from an innovation perspective were more likely to highlight this role of the programme. However, the evaluation evidence indicates that, beyond the strategic aim to help contribute to raising the level of competitive research income secured by Wales (itself influenced by many other factors), greater clarity on what Sêr Cymru 1 and its individual Strands were seeking to achieve was possible. This provides important learning for any successor schemes.

4. National Research Networks

Coverage and context

- 4.1 In this section we consider in detail the National Research Network (NRN) Strand of Sêr Cymru 1. This covers the establishment and support for the Engineering Research Network Wales (AdEM); National Research Network for Low Carbon Energy and Environment (LCEE); and Life Sciences Research Network Wales (LiSH).
- 4.2 The context and rationale for Sêr Cymru 1 at a programme-level was discussed in Section 3. In this section we consider the specific rationale for the NRNs, framed around the logic model presented in Figure 4.1, and the subsequent elements of the logic model i.e. inputs and activities, outputs and outcomes.
- 4.3 Contextually, two points are important in framing the assessment of the NRNs:
- First, it is not within the remit of this evaluation to review or assess the selection and appraisal process. However, it is important to note that the NRNs were selected through an open call for bids from Welsh research organisations to lead NRNs in the Grand Challenge areas in 2012. Four organisations submitted bids: Bangor University for LCEE; Cardiff University for LiSH; Swansea University for AdEM; and TWI (The Welding Institute) for AdEM. Bangor and Cardiff's bids were successful in their applications, and Swansea University and TWI were encouraged by the Welsh Government to collaborate to take forward the AdEM NRN. The two organisations subsequently formed a partnership, with TWI identified explicitly as industrial partner to help translate the supported research to manufacturing and product development.
 - Second, each NRN is a significant organisation, with dedicated staff, and (variously constituted) management, governance boards, and advisory boards to steer and oversee delivery, and different partnership models. The evaluation does not comment on the work of individuals in the delivery of the NRNs, and the focus in terms of any process issues, is where these relate to the performance and outcomes of the NRN and key lessons that may inform future similar activity.

Figure 4.1: National Research Network Strand-level logic model



Source: SQW

Rationale

- 4.4 There are two core elements to the rationale for the NRNs. First, the NRNs responded to the need to build further the research capacity of Wales in the identified Grand Challenges areas. Providing research funding – particularly, but not exclusively – for early career researchers, to Welsh researchers or those based in Wales, was regarded as necessary in order to address the shortfall in absolute scale of the research base in Wales, as discussed in Section 3.
- 4.5 Second, and alongside this, the case for the NRNs was based on perceived ‘co-ordination’ and ‘network’ failures. These failures were seen to prevent or discourage academics from collaborating with other academics in separate institutions and disciplines, and limit levels of industrial collaboration and knowledge transfer. Both barriers were seen to limit the potential of the Welsh research base – with collaboration recognised as conducive to quality research, strong funding applications, and effective knowledge transfer to realise the potential for tangible (longer term) economic outcomes from university-led research.
- 4.6 These issues are far from unique to Wales. They present a challenge for academia and industry more broadly, one that has been increasingly recognised by governments in recent years. For instance, the £100m Connecting Capabilities Fund in England, administered by the Higher Education Funding Council for England (HEFCE), centres on addressing these twin challenges, with the specific aim of increasing collaborative research between institutions, and increasing knowledge exchange. A series of programmes in Wales have also sought to address the ‘valley of death’ in the commercialisation of university research.¹⁴
- 4.7 No formal assessment of the level of academic and/or industry collaboration was undertaken at the outset of the programme to test fully this failure. However, amongst consultees engaged for this evaluation, there was recognition that, whilst some collaboration between institutions in Wales was evident before Sêr Cymru 1 in

¹⁴ There is typically more readily available funding for fundamental research and for research that is very close to commercialisation than is the case for research in between these two phases (which nevertheless often requires substantial time and resource). This period, between fundamental research and later commercialisation activity, with funding relatively scarce, is therefore termed the ‘valley of death’.

the Grand Challenge areas, it was at a sub-optimal level, with researchers generally working in ‘silos’ within their own institution. Particular issues were noted by consultees for early career researchers, who typically had less well-established relationships and where cross-institution working was especially challenging.

- 4.8 Two other themes emerged from the consultations with partners and stakeholders in the evaluation regarding the rationale and need for the NRNs. First, consultees noted the importance of the development of a ‘research community’ within the Grand Challenge areas. Whilst these areas had been identified as potential strengths and opportunities for Wales, there was a need for an ‘organising mind’ to catalyse and corral individuals from across the research base to change behaviours and attitudes to collaboration. Feedback from Research and Innovation Directors at the institutions that did not host NRNs engaged in this evaluation pointed particularly to the important role of networks in building this community, to ensure that researchers from across Wales were supported by, engaged with, and could contribute to, the outcomes of, the Sêr Cymru 1 initiative, beyond specific research project funding.
- 4.9 Second, consultees recognised the complexity of the innovation ecosystem in Wales (and beyond). The case for a mechanism to help academics navigate the range of events, industry contacts and collaborative funding opportunities was regarded as important in this context.
- 4.10 These two points emphasise the case for a *network*, not just a funding stream, in order to bring researchers together as a community, to share expertise, and stimulate collaborations. This said, the evaluation consultations highlighted the importance of ‘tangible’ research funding to underpin this collaborative intent. Stakeholders (including Research and Innovation Directors at the universities in particular) reported that funding was regarded as essential to catalyse and incentivise collaboration research, providing the ‘glue’ that holds together collaboration efforts.

Objectives

- 4.11 Four headline objectives were identified for each NRN:
- Objective 1: Establish and maintain a first class Sêr Cymru Graduate School/Academy.
 - Objective 2: Increase the volume of high quality collaborative research.
 - Objective 3: Increase the volume of competitively-won grant funding for collaborative research.
 - Objective 4: Increase user engagement/knowledge transfer and outreach activities.
- 4.12 In practice the first of these has not been delivered. As a new Chief Scientific Adviser was appointed early on in the programme, the emphasis shifted from supporting PhD students to Research Fellows, meaning Graduate Schools were not created. The objective has remained as a 'principle' against which NRNs report outputs against e.g. number of PhD students supported. LCEE started later than the other NRNs and so from the outset was more focused on Research Fellows than the other NRNs as a result of this changing emphasis.
- 4.13 Three key points are noted from an evaluation perspective on these objectives:
- Given the broad set of objectives there is also a lack of clarity as to how important commercialisation and realising economic effects are to the NRNs mission, versus achieving research-focused objectives. For the Welsh Government, economic effects have been important from the outset, hence the encouragement of Swansea University working with TWI to deliver the AdEM NRN, with a more explicit focus on industrial engagement than the other NRNs. However, this emphasis is not fully articulated in the four broad objectives.
 - The objectives place little emphasis on the 'connecting' rationale to address co-ordination issues, with some ambiguity over what the NRNs were seeking to achieve in this regard. This is surprising given the underpinning co-ordination issues and rationale for establishing networks, with the risk that the NRNs become funding vehicles only, without the focus on developing networking capacity and capability. Although some indicators relating to this are captured there are few, and these differ by NRN.

- The objectives do not set out any specific expectations on the NRNs in terms of their ‘strategic’ role in Grand Challenge areas. Consultees highlighted the strategic role of the NRNs as being an important factor underpinning their rationale, with the absence of specific objectives in relation to this potentially limiting their contribution.

4.14 The evolving and different focuses of the NRNs create a somewhat complicated picture of what the NRNs, as a group, are seeking to achieve. This is compounded by a large array of monitoring indicators – around 20 in total, with many not comparable across NRNs, making assessment of performance challenging.

4.15 It is also difficult to assess whether the objectives and related targets were appropriate, and to assess how effective the NRNs have been in genuinely enhancing research excellence and capacity, due to a lack of baseline data against the agreed indicators (e.g. what was the scale of research income secured pre-Sêr Cymru 1, how many papers were published annually by Welsh researchers in these areas). A set of ‘SMARTer’ objectives, aligned fully to the underpinning rationale, would have been helpful to frame delivery, and inform monitoring and evaluation.

Inputs

4.16 The NRNs Strand was awarded £21.3m of Welsh Government/HEFCW funding over the 2013/14 to 2018/19 period. Table 4.1 sets out spend of this Welsh Government/HEFCW funding to the end of June 2018 by each NRN, and at a Strand level. Actual expenditure was £18.2m by the end of June 2018. This was equivalent to 94% of planned expenditure at this point, suggesting, in headline terms, effective financial management in NRN delivery.

Table 4.1: Spend by the NRNs to the end of June 2018

	Spend to end June 2018 (£m)	Target to end June 2018	% of target to end June 2018	Overall target (£m)	% of overall target
AdEM	6.41	6.64	97%	7.00	92%
LCEE	5.15	5.86	88%	7.00	74%
LiSH	6.60	6.81	97%	7.30	90%
Total	18.16	19.30	94%	21.30	85%

Source: SQW analysis of NRN Quarterly Reports

- 4.17 It is noted that LCEE expenditure was 12% below target at end-June 2018, in absolute terms some £700k below expected expenditure. This reflected underspend against expected spend in the last three quarters of data available at the time of the evaluation. For LCEE, substantial expenditure is therefore required in order to achieve the target spend by the end of 2018 (when funding for the NRNs ends).
- 4.18 However, the LCEE NRN also distributed research funding over a series of waves, unlike AdEM and LiSH where the research funding was ‘front-loaded’ early in the delivery period. Whilst this has meant that planned expenditure has largely been delivered as planned by AdEM and LiSH (both at 97% by end-June 2018), this has given them less flexibility to fund further research later on in the programme.
- 4.19 The activity that the funding has supported (and how this has been distributed) is discussed below. However, from an input perspective, it should be noted that each NRN is led by a tight dedicated team (each 3-4 staff), with salary costs covered by the NRN funding; LCEE, for instance, is managed by 2.5 FTEs¹⁵.
- 4.20 Further time inputs are provided by members of the management, governance, and advisory boards across the NRNs. In total, over 60 individuals provide inputs to the governance and delivery of the NRNs through these mechanisms, highlighting the scale of activity supporting the activity. This includes a mix of Welsh-based and external representatives, covering academic, industry, and public-sector agencies.
- 4.21 This time input is not covered in the expenditure set out above, and represents a further contribution to the delivery of the NRNs from partners across the research and innovation landscape in Wales, and outside. This should be taken into account when considering the total costs of the NRN activity supported by Sêr Cymru; the programme has relied on additional support to realise its activity.

Activities

- 4.22 The NRNs have delivered three broad activity-types: first, funding research projects delivered by Wales-based researchers; second, hosting networking events and other similar activities; and third, managing external communications and

¹⁵ Full time equivalent workers

awareness raising, through a website, publications, social media and other channels.

- 4.23 Funding research projects has been the principal activity of the NRNs, with over 80% of Sêr Cymru 1 monies allocated to this purpose. Collectively, by end-June 2018, the NRNs had provided some £22m to support directly research activity to Welsh-based researchers, including support from the host institutions.¹⁶
- 4.24 Whilst the NRNs are pan-Wales entities, in terms of research funding they have been focused on the more research-intensive institutions, with Cardiff University and Swansea University involved in the largest numbers of projects, albeit this will include some collaborative projects with other Welsh institutions e.g. LCEE NRN adopted a cluster approach with each cluster required to involve multiple Welsh institutions. The NRNs were open to the other institutions, but applications were very limited. For example, for the LiSH NRN, Cardiff Metropolitan submitted four applications for research funding, of which none were successful, compared to 276 applications for Cardiff, with 87 successful.
- 4.25 Notably, across all NRNs, expenditure on networking activities and events comprises a modest share of total expenditure – under 5% in all cases. This reflects in part the relatively low cost of networking activity compared to research funding, and also that some of the research funding requires collaboration. However, given the underpinning case for the NRNs to address co-ordination failures, this low level of active networking support is noteworthy. This activity is particularly important to ensure that the NRNs do embody a national remit, encompassing researchers from across the university base in the context of the concentrated focus of research funding discussed above.
- 4.26 Beyond these broad categories, the specific activities delivered by the NRNs have varied substantially. Table 4.2 seeks to provide an overview of the different approaches that have been taken by the NRNs. These include different ways in which research has been funded, as well as specific schemes bespoke to individual NRNs. Consultations with NRN Directors and Managers highlight these activities

¹⁶ This figure is higher than overall spend of Sêr Cymru 1 monies from the Welsh Government/HEFCW, as the host institutions have contributed further costs.

have been designed to meet the needs and requirements of the research communities they work with, reflecting the flexibility of the NRN model. This flexibility was highly valued by the NRNs, and appears to be an important characteristic of Sêr Cymru 1 that has helped to support effective delivery.

Table 4.2: Overview of NRN activities

AdEM	LCEE	LiSH
Research funding level		
Research funding distributed broadly equally to PhD students and Post-docs	Research funding focused on supporting Research Fellows	Even funding for PhD students and Research Fellows
Thematic approach		
Research focus on sensors and devices, computational engineering and advanced materials , with a fairly even split between the three	Research based around 'research clusters' , with two calls for new cross-institution collaborations. Eight clusters funded, with awards ranging from £450k-£920k. Clusters not in pre-determined research areas	Research focus on drug discovery , with specific focus on oncology (35% of projects), infectious disease (32%) and neuroscience (18%), with 15% in other areas
Other activities		
Explicit focus on industrial engagement (via TWI, including industry workshops), with 22% of NRN costs incurred on such activities Participant Costs Fund – up to £2k to encourage researchers to attend conferences and network, covering event costs and travel expenses (4% of costs) Large programme of STEMM outreach e.g.: National Eisteddfod; Engineering Wales Conference 2017 and 2018.	Returning Fellowship Scheme to support people to return to science after an absence e.g. after maternity leave (£126k) Research Development Fund has awarded £125k to researchers for workshops or events to support new collaborations Proposal writing fellowships received £104k of funding Funding also used for events and other engagement activities undertaken by the NRN.	Funds 'platforms' , technologies available to academics/industry in drug discovery (£626k in total) Focus on translation of research , including Impact Awards (£696k), Translation Awards (£56k) and links to Life Science Bridging Fund Other activities include Endeavour Awards to pump-prime research (£92k), Congress , an annual gathering of the research community (£191k), and other events and engagement.

Source: SQW, based on consultations with NRN Directors

- 4.27 The scale of the activity is significant, particularly in terms of the research funding, and each NRN has delivered a wider range of activity that seek to underpin the development of the Welsh research base in the relevant area. Given the breadth of activity across the NRNs, there have been challenges in delivery, including some delays early-on in the delivery period that could potentially have been avoided. However, taken together, and recognising the broad spread of activity across the three NRNs, the evaluation evidence suggests that the activity that was expected to be delivered by the NRNs has been, or is being, delivered.
- 4.28 However, five points are noted in the context of this overall finding on the activity delivered by the NRNs. First, at this evaluation stage there remains some uncertainty over the extent to which the NRNs are sustainable; each was asked to develop a plan for the period following the close of Sêr Cymru 1, with a particular focus on how activity could be sustained without further public support. At this point, the prospects for this appear limited and the NRNs are expected to close at the end of the funding period, meaning that the momentum and infrastructure put in place will be lost.
- 4.29 Second, despite the modest level of expenditure allocated to non-research funding activity, the feedback from stakeholders engaged in the evaluation on network events that have been held – such as the annual congress events for LiSH and LCEE – has been positive. The events were regarded as well-run, involving the right people and an important part of the developing landscape for the research base in Grand Challenge areas in Wales. Sustaining these ‘network activities’ going forward is likely to be important.
- 4.30 Third, some consultees did comment that the NRNs had been overly focused during the delivery period on operating essentially as ‘funding programmes’, rather than more flexible, active and strategic players in the research and innovation landscape. This was seen to have limited their potential to influence, as well as to fund directly, the research base in Wales. A more strategic approach was in some cases recommended. We return to this issue below related to outcomes, and in the conclusions and recommendations.

- 4.31 Fourth, there has been limited delivery-focused and strategic engagement with the Welsh Government, and the Chief Scientific Adviser (there have been three Chief Scientific Advisers since the programme started). This appears to have been a missed opportunity to deliver strategic outcomes by building the profile of the NRNs overall, and of the Welsh research base, to a wider science and policy audience.
- 4.32 Fifth, the NRNs have worked together to a limited extent. This is not surprising given they operate in different research fields, and so to a large extent work with different research communities. The NRNs have collaborated on an annual conference bringing together PhD students funded by the three NRNs. Cross-NRN events have also been delivered focused on diversity in science, and on antimicrobial resistance (which spans research issues across the NRNs). The NRN central management teams also have quarterly update meetings, which are useful for sharing best practice and lessons learned on delivering the NRNs. A greater focus on cross-Grand Challenge opportunities (including related to UK-level Grand Challenges that cross the NRN boundaries including an ageing society, clean growth, and the future of mobility), may be important going forward to maximise the opportunities from collaboration and research funding.

Outputs

- 4.33 18 output indicators have been recorded by the NRNs against their four objectives. However, only four of these indicators are common across the NRNs, partly covering Objectives 1 to 3 (no indicators under Objective 4 were shared across all NRNs):
- PhD students supported by the NRN.
 - High quality, original research papers published by the NRN in peer reviewed journals.
 - Abstracts accepted for presentation at national and international conferences.
 - Competitively-won grant funding for research (£m).
- 4.34 The latest data against these four indicators (to the end of March 2018) against their total targets (covering the full programme period) are presented in Table 4.3.

Table 4.3: Outputs achieved by NRNs up to the end of March 2018

Objective and indicator	AdEM			LCEE			LiSH			Total NRNs		
	Target	Actual	% of target	Target	Actual	% of target	Target	Actual	% of target	Target	Actual	% of target
Obj 1: PhD students supported by the NRN	40	40	100%	10	12	120%	58	56	97%	108	108	100%
Obj 2: High quality, original research papers published by the NRN in peer reviewed journals	70	180	257%	100	76	76%	100	108	108%	270	364	135%
Obj 2: Abstracts accepted for presentation at national and international conferences	30	253	843%	50	203	406%	80	348	435%	160	804	503%
Obj 3: Competitively-won grant funding for research (£m)	15	15.8	105%	10	12.7	127%	10	33.8	338%	35	62.2	178%

Source: SQW analysis of NRN Quarterly Reports

- 4.35 The data indicate strong performance against output targets by the NRNs collectively. Targets for each of the consistent outputs were met, or exceeded, in some cases very substantially. Aggregate outputs include over 100 PhD students supported, 400 high quality, original research papers published, and £62m of competitively-won grant funding secured.
- 4.36 On the first of these it is notable that LCEE has a relatively low target for PhDs. This reflects the greater focus from the outset for LCEE on more experienced (albeit still early career) researchers. AdEM and LiSH focused initially on PhDs, with higher targets established. In this context, in addition to the 108 PhD students, around 150 post-doctoral researchers/research fellows were supported by the NRNs.
- 4.37 Of the reported £62m of competitively-won grant funding for research secured via the NRNs, over £20m was claimed from European Research Council and Horizon 2020, £15m from RCUK sources, £13m from industry and Innovate UK, and £12m from other sources.¹⁷ This income was secured from around 300 projects.
- 4.38 Several routes have been evident by which NRNs have claimed competitive grant funding. The most common routes are funding secured by researchers to continue the research funded initially through the NRN (e.g. where a PhD student funded by the NRN secures a grant from a Research Council to continue their research at post-doctoral level), and funding secured by researchers to undertake research that has been initiated following the results of the research funded through the NRN. Other routes include:
- Grants and income claimed in relation to the other activities funded by the NRNs e.g. funding secured for further research by users of the LiSH 'platforms', and commercial income for the use of these platforms.
 - Income secured from industry through AdEM's industrial engagement activities.
 - Income secured by 'returning fellows' supported by LCEE's Returning Fellowship Fund to develop new collaborations.

¹⁷ This includes £11.4m as the total value for one project, however, there are 26 partners involved from across fourteen countries in Europe and across the globe including Canada, Japan, Korea and the US.

- 4.39 For Objective 4 – Increase user engagement/knowledge transfer and outreach activities – the output indicators are different for each NRN. However, performance has been strong on NRN-specific measures. For example, 121 new collaborations with companies on research projects with NRN partners against a target of 20, for AdEM; 341 new demonstrable partnerships with non-academic partners against a target of 40, for LiSH; and 71 partnerships delivering research and/or developments as a result of NRN activities against a target of 2, for LCEE. This said, these indicators focus on intermediate effects - that is new partnerships and collaborations, and no data is provided on the intensity or nature of this activity. It is also noted that a target established for AdEM for post-doctoral researchers employed in anchor companies/regionally important companies had not been met at this point, with two reported against a target of 20.
- 4.40 Whilst the outputs data suggests positive performance by the NRNs, three caveats are noted. First, variations in the methods employed by the NRNs in claiming research funding income present challenges in assessing the NRNs' performance, with some potential 'double counting' or 'over counting' suggested from a review of selected projects. For instance, it is unclear if NRNs have taken a consistent approach to attributing outputs to the programme based on the Welsh Government's and HEFCW proportion of the full economic cost of delivering the NRN (including in-kind support from the host institution), whilst inconsistencies are also noted in how much of the value of a project is claimed where non-Welsh partners are involved.
- 4.41 Second, significant over-delivery against targets suggests that appropriate targets were not set at the outset. Establishing a baseline may have helped to ascertain appropriate targets but, as noted previously, this was not done. Further, when it became clear that these targets were inappropriate (given very significant over delivery), they could have been revised to reflect the achievements of the achievements of the programme in practice, and inform constructively activity.
- 4.42 Third, in some cases, the outputs give no sense of the quality of the outputs e.g. the profile and prestige of the conferences for which abstracts were accepted is not collected. It is recognised by the evaluators that it is challenging to capture what are

inherently more subjective outputs, but this is important to consider in understanding what the NRNs have achieved. These issues should be considered in any future similar schemes.

Outcomes

4.43 Outcomes were identified in the NRN logic model, with interim outcomes the particular focus for this evaluation, notably the following:

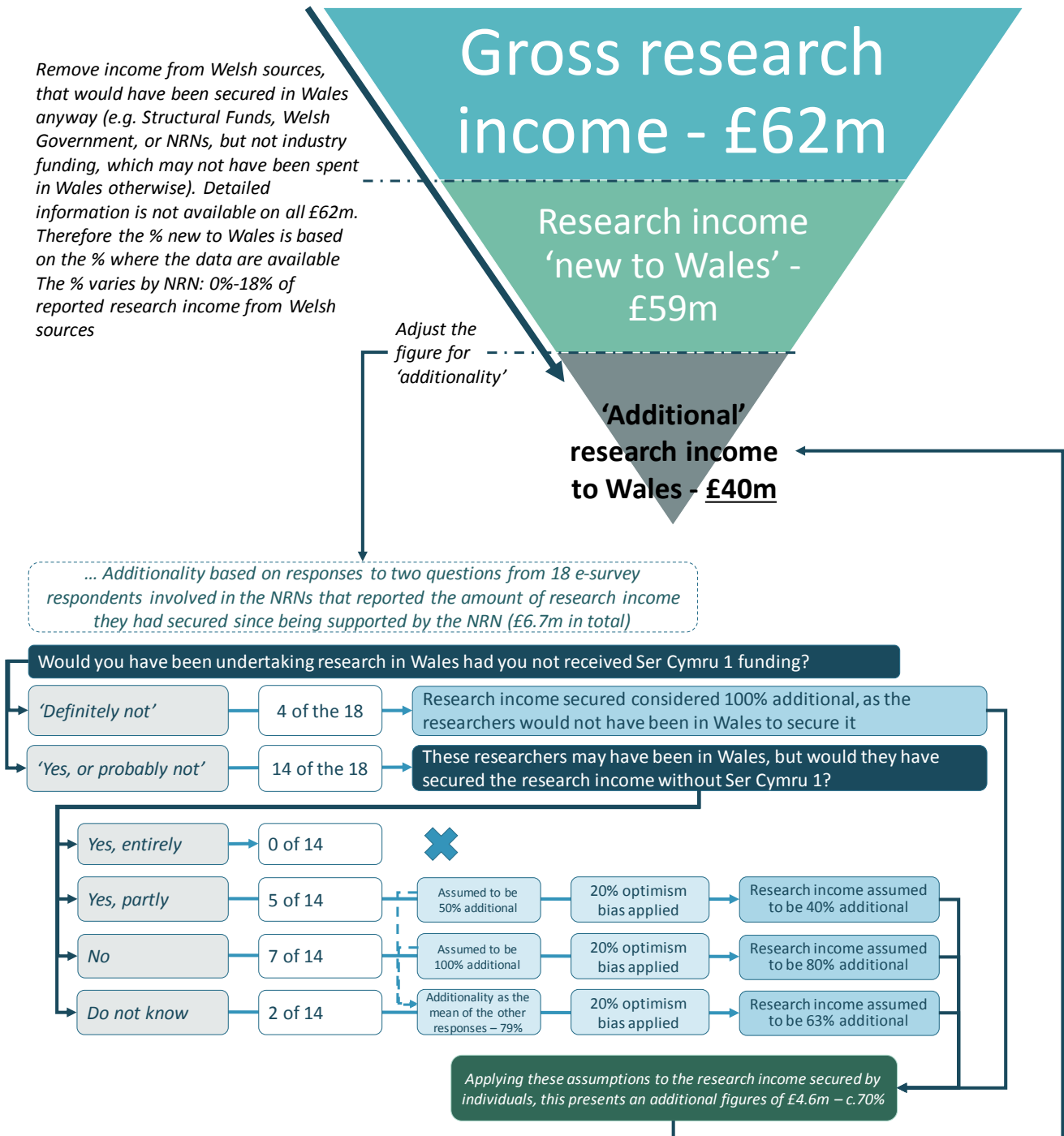
- Research funding outcomes, including an increased share of research grant income nationally in relevant research areas.
- Research capacity and behaviour outcomes, including a larger and more diverse researcher population, increased level of interdisciplinary research, and enhanced research collaboration.
- Market outcomes including new commercial opportunities and knowledge spillovers to industry.
- Strategic outcomes influencing the policy agenda in the Grand Challenge areas.

4.44 These outcomes are considered in turn below. Evidence on these was captured via the researcher e-survey, case studies, and qualitative interviews, comprising over 100 responses/consultations in total.

Research funding outcomes

4.45 Research funding outcomes draw on the self-reported level (gross research income) of competitively-won grant funding for research secured by the NRNs above. To understand the effects of the NRNs, we have taken these gross data – £62m in total – and sought to identify an indicative ‘additional’ figure i.e. income that would not have been secured for Wales without the Sêr Cymru 1 programme. The approach taken, and results are summarised out in Figure 4.2 below. Note that the second stage, converting the ‘new to Wales’ data to an indicative additional research income to Wales figure, relies on self-reported evidence, from the sample of researchers that responded to the researcher e-survey. There is no control group or counterfactual. As such, this should be treated as highly indicative and subject to change.

Figure 4.2: Indicative calculation of additional research income



Source: SQW analysis of output data, based on NRN Quarterly Reports and researcher e-survey

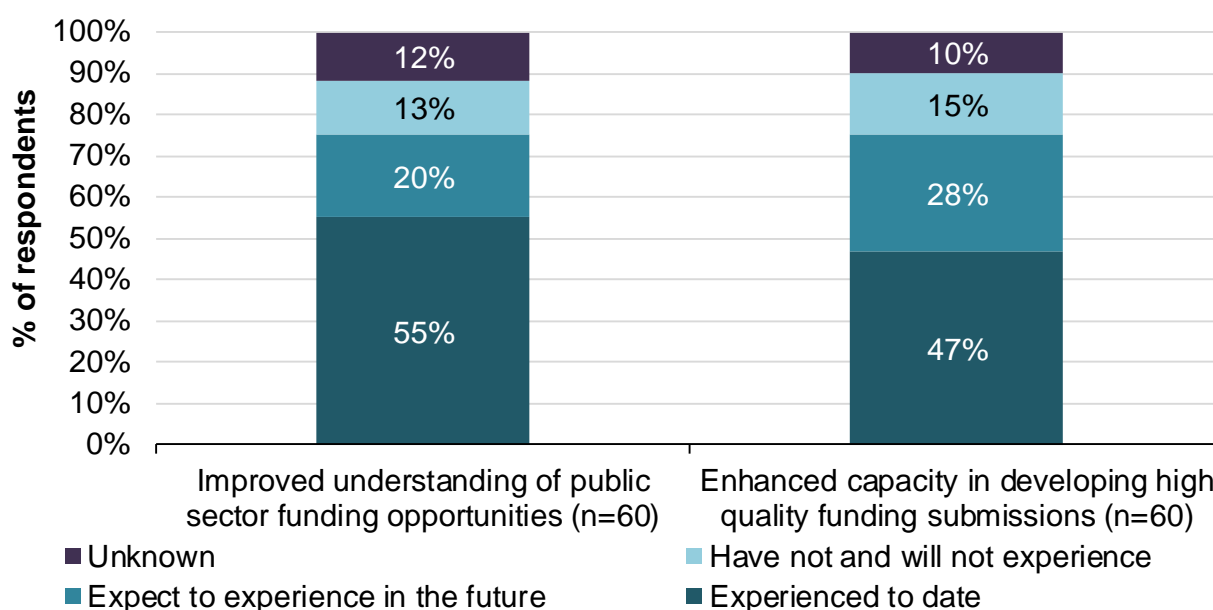
4.46 The analysis provides a suggested additional research income secured for Wales generated by the NRNs of £40m to the end of March 2018.

4.47 This is a positive finding, but the data should be regarded as an indicative ‘snapshot’, and not a definitive assessment. We have sought to account for the relative contribution of the NRN funding through the use of the e-survey to adjust for additionality, however, three points remain:

- The data do not (and cannot) take account of the extent to which the existing reputation and credibility of the departments within which researchers are based may have helped to contribute to this income.
- There are some inconsistencies in recording research income, meaning that definitive assessments (e.g. on what is ‘new to Wales’) is not possible.
- It does not account of future income, including relating to any outstanding grant applications, where the outcome is not known.

4.48 The e-survey also suggests an important contribution by the NRNs to developing the capacity in Wales for securing research income in the future. As shown in Figure 4.3, 55% of respondents involved in NRN non-funding activity reported they had experienced an improved understanding of public sector funding opportunities as a result of the NRN, and a smaller proportion reported effects on developing high quality funding submissions. For both outcomes, more than a further 20% of respondents expect to experience these outcomes in the future.

Figure 4.3: Capacity development in Wales for securing research income



Source: SQW analysis of e-survey data

- 4.49 Some consultees raised the concern that the scale of NRN research funding available had not sufficiently incentivised applications to RCUK and other ‘open’ competitions. Specifically, with the NRN funding open to Welsh-based researchers only (or for applicants seeking to undertake research in Wales) there was the risk of a ‘perverse incentive’ for researchers to not apply for RCUK funding, meaning that researchers do not establish a track record and reputation with the Research Councils, harming their long-term ability to secure such funding in future, when NRN funding is not available. This is regarded as misaligned with the overall aim of the programme to increase the level of competitive research income secured by Wales.
- 4.50 The positive (self-reported) findings on enhanced capacity and capability in bid writing through specific activities delivered by the NRNs, may in part help to mitigate this issue. Activity has also been delivered to support researchers to develop external funding bids (e.g. the LCEE funding for proposal writing fellowships).
- 4.51 A match-funding requirement could also have helped to mitigate the perverse incentives noted above, with requirements that researchers leverage funding from non-Wales sources at the same time as securing NRN funding. In practice, there was no match-funding requirement for any of the NRNs.

Research capacity and behaviour outcomes

- 4.52 The evaluation provides positive evidence of outcomes related to the scale and diversity of the research population in Wales. As noted, over 200 early career researchers have been supported by the NRNs since 2013, including 100 PhDs. This is a substantial contribution; by way of context, around 900 individuals start doctoral research in Wales each year across all academic disciplines.
- 4.53 The e-survey also indicates a high proportion of non-Welsh researchers supported by the NRNs, notably PhD students, with the funding attracting them to Wales. Notably, 60% of the PhD researchers funded by the NRNs surveyed would not have studied in Wales without the NRN support; and in most cases they would have undertaken a PhD elsewhere in the UK. Also, around half of Research Fellows surveyed would not have been at their current institution without NRN funding. This demonstrates the role of the NRNs in attracting and retaining researchers in Wales, helping to build the research base.

4.54 E-survey respondents also highlighted a range of qualitative benefits from the funding provision, networking and events, and collaboration activities of the NRNs related to their research capacity and behaviours. Some quotations are set out in Figure 4.4. The quotations reflect the range of views expressed and have been included to be representative broadly of the nature of the comments provided by all respondents, both in terms of the number of selected quotes identified for specific outcome types, and the nature of the quotations. However, there is considerable variation across the survey, and the Figure does not seek to provide a quantitatively representative sample.

4.55 These responses highlight two other key benefits from the NRNs in relation to research capacity and behaviour identified in the e-survey:

- Raised profile for researchers. Close to two thirds of those engaged with the NRNs felt that their involvement had already raised their profile across the research community in Wales. This is a particularly important outcome for early career researchers who typically do not have large networks, especially beyond their own institution.
- Increased collaboration. These outcomes have been realised through networking activities and through funding for collaborative research. Some two-thirds of e-survey respondents that had been engaged with the NRNs reported new or improved collaborations with academics in other institutions in their disciplines to date, with just under half saying the same of academics in other institutions in other disciplines to date. Positively, over half stated that they have experienced new/improved collaborations with industry to date or expect to in the future.

Figure 4.4: How has your engagement with the NRN team contributed to your academic and career development?



Source: SQW e-survey analysis

- 4.56 Three case studies exemplify these benefits: Drug Discovery Congress (LiSH); Resilcoast (LCEE); and the Returning Fellowship Fund (also LCEE). The ways in which these activities have delivered these benefits are set out below.

Case study cameos: networking and collaboration benefits... the case of the Returning Fellowship Fund, Drug Discovery Congress and Resilcoast

These three case studies cover activity that differs substantially in scope and format, but share a common focus on support for networking and collaboration across the research base.

The **Annual Drug Discovery Congress** comprises an annual conference held over two days, bringing together PhD students supported by LiSH, their academic supervisors, and selected key note speakers and special guests. Through bringing the research community together, Congress presents early career researchers with the opportunity to: meet future employers or mentors, such as senior academics or industry representatives; develop skills in presenting to senior academics and industry representatives (each PhD student is expected to deliver a brief overview of their research); receive feedback on their research from internationally-respected academics; and meet academics from other institutions and disciplines. Congress also provides opportunities for more senior researchers and industry representatives to make new contacts, providing the opportunity for potential future collaborations or recruitment. Ultimately, these outcomes have the potential to deliver lasting effects on researchers' culture around collaboration, including across disciplines and in relation to commercialisation, helping to build Wales's research base.

Resilcoast is one of LCEE's research clusters, each of which are required to comprise new cross-institution collaborations. The research cluster involves 15 individuals – 12 based at five Welsh universities, and three based elsewhere – focused on understanding salt marsh resilience. The funding was used to fund two PhD students and two Research Fellows within the cluster. A requirement of the funding was that the partnership that has come together to form this research cluster must be a new one, with the NRN therefore supporting a new cross-institution collaboration. Alongside advancing science in salt marsh resilience, the cluster has

had important effects on the team members, helping them to develop better relationships with their fellow researchers, and learn from their colleagues, including across disciplines. The case study indicates that members of the partnership believe that the activity helped them to submit stronger research funding applications than previously, drawing on this shared knowledge and experience.

LCEE's **Returning Fellowship Fund** supports recent returning fellows (in practice, women returning from maternity leave, although technically open to any returning fellows) to develop their networks, which have diminished during their absence from science. Funding can be used to: bring in other staff to free them up from teaching commitments; travel to and attend conferences and events, as well as meetings with potential new collaborators to present their work; pay for fieldwork; and to bring collaborators to them (given many have young families and so often cannot be away from home). In funding these activities, the Returning Fellowship Fund has supported returning fellows to rebuild their networks, establish new collaborations, carve out more time to undertake research (instead of teaching), and has raised their confidence in returning to research. The feedback was very positive on the effects of the Scheme on the behaviours and confidence of Fellows related to networking benefits: one Fellow commented that *“Networking without the scheme would be really poor – the scheme forces you to get back into networking.”*

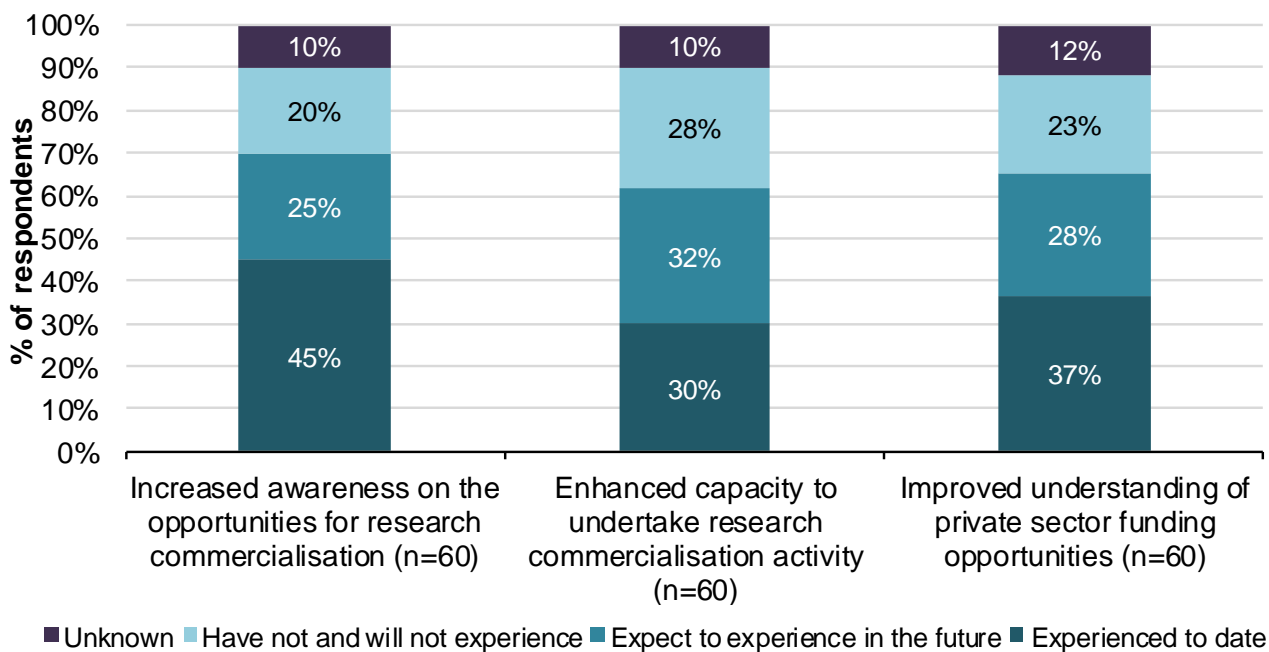
- 4.57 Positively, the NRNs appear to have engaged academics from across the Welsh science base. Consultees from non-lead universities report that they and their researchers have been involved in the NRNs, generally finding them to have been genuinely pan-Wales in outlook, and helping to promote a sense of a Welsh research community in the Grand Challenge areas. This has helped to bring together researchers from other universities and helped to raise the ambitions of those in less research-intensive institutions, through exposure to high quality academics elsewhere. It has also meant that all institutions, not just the lead ones, have been able to contribute to achieving the aims and objectives of the programme. The non-funding activity has been crucial here: as noted above, nearly

all of the direct research funding provided by the NRNs has been allocated to four of the eight universities in Wales.

Market outcomes

4.58 On market outcomes, the focus at this stage is on intermediate effects, given the time-paths to commercialisation, and the NRN’s focus on funding early stage research and early career researchers. In this regard, there is some encouraging evidence from the e-survey on both capacity development and progress in supporting new products and services. As shown in Figure 4.5, 30-45% of the 60 respondents that have been engaged with the NRNs have experienced an increased awareness of opportunities for commercialisation, an enhanced capacity to undertake research commercialisation, and/or improved understanding of private sector funding opportunities. A further 25% expect to experience increased awareness of opportunities for commercialisation, 32% expect to experience an enhanced capacity to undertake research commercialisation, and 28% expect to experience improved understanding of private sector funding opportunities in the future.

Figure 4.5: Market outcomes for commercialisation



Source: SQW analysis of e-survey data

- 4.59 In addition, 25 of the 60 respondents reported that Sêr Cymru 1 support had led to, or is expected to lead to commercial opportunities in the future, with 11 reporting that it had already led to the identification of a potential market/demand for a commercial opportunity, and two reporting that it had already led to the introduction of new/improved products or services to the market.
- 4.60 The AdEM NRN exemplifies the potential to realise market outcomes, as explored in the following case study focused on industrial engagement.

Case study cameo: industrial engagement outcomes... TWI engagement with AdEM

The AdEM NRN has an explicit focus on industrial engagement. The Welding Institute (TWI) is a formal partner, bringing an explicitly industrial dimension to the research projects funded through the NRN. The TWI's role is partly fulfilled through a dedicated Technology Transfer Manager whose role is funded by the NRN, alongside the TWI's Regional Manager. The TWI's role in relation to the NRN includes linking academics to companies (including brokering introductions and setting up meetings), promoting industry collaboration and sharing best practice (both through the TWI attending events), and informing researchers of potential funding opportunities. TWI's first activity in delivering this role involved developing an Industrial Roadmap for stakeholders, that brought industrial partners and academics together to share aspirations and priorities for industrial engagement.

Over 200 researchers have been linked to the 62 research projects funded by the NRN. The TWI has had regular contact with around half of these, working particularly intensively with a quarter. This was felt by the TWI to be a high proportion of researchers being involved in industrial engagement. Reported benefits by TWI include new and enhanced relationships between academics and industry, a greater willingness by academics to collaborate with industry, and a better understanding of the needs of the industrial base. The TWI's engagement with the programme was also reported to have led to the universities being less protective of their industry contacts, allowing researchers in other Welsh institutions benefit from these linkages through collaborative R&D activity.

Strategic outcomes

- 4.61 The NRNs were reported by consultees as important for raising the profile of research in the Grand Challenge areas in Wales, through their activities and websites, and provided a good opportunity for the institutions to promote their work to a wider audience. There are some interesting examples of activity to note, such as overseas visits, meetings with policy makers, and attendance at and delivery of major events/conferences, which may lead to strategic effects over the longer term. The LiSH NRN was noted, by LiSH consultees, as being important in the setting up of the Life Science Bridging Fund. The case study undertaken for this evaluation relating to compound semiconductor research is an example of the NRNs, in this case AdEM, also supporting strategic priorities for Wales.

Case study cameo: strategic outcomes... investment in compound semiconductor research

The development of a South Wales compound semiconductor cluster is a major priority for the Welsh Government. Several large-scale investments have been made to support the development of the cluster including the use of City Deal monies for the development of a facility for IQE to manufacture compound semiconductors; the Institute for Compound Semiconductors; and the Compound Semiconductor Applications Catapult. Sêr Cymru 1 has supported this strategic agenda via both Strands. First, the AdEM NRN has supported research projects focused on compound semiconductors. Second, the appointment of Prof. Diana Huffaker has brought an internationally leading academic in compound semiconductor research to Wales, and specifically Cardiff, to help drive forward the research and commercialisation agenda. Strategic consultees reported that the Sêr Cymru activity had been highly complementary to the wider investments in the cluster, directly supporting and contributing to the Welsh Government's ambitions to develop the area as a globally leading cluster for compound semiconductor research and commercial exploitation. The NRN was also reported to have played an important role in encouraging universities to work together, broadening the cluster development efforts from Cardiff to incorporate academics from elsewhere (notably Swansea

University).

- 4.62 This said, evidence of the strategic outcomes of the NRNs to date is generally limited, with feedback from consultees suggesting that there was a ‘missed opportunity’ for the NRNs to play a more strategic role as ‘champions’ for their research areas. This perhaps reflects greater focus – in terms of objectives and activities – on funding research than achieving strategic outcomes.

Overall reflections and lessons

- 4.63 The evidence base collected for this evaluation indicates that the scale of activity, outputs and outcomes generated through the NRNs would not have been realised without Sêr Cymru 1. Put another way, without Sêr Cymru 1, the same level of focus of research funding and networking in these Grand Challenge areas may not have been achieved, and whilst there was some research collaboration before the NRNs were established, the evaluation suggests that this has been enhanced by the NRNs. Bringing these different elements together is an important aspect of the NRN, with the twin approach of funding research and delivering activities to increase networking and collaboration helping to build and pull together the research community.

Case study cameo: ... supporting research in oncology

LiSH has funded 48 research projects in oncology – around a third of the projects funded by the NRN. The NRN is just one of many organisations funding oncology research in Wales – others include Tenovus, Cancer Research Wales, and Health and Care Research Wales, alongside mainstream UK cancer research organisations. With a large number of research organisations funding oncology research in Wales, the NRN’s relative role in funding this research is modest, and it has focused on providing funding where there was a recognised gap, between seed-corn funding and major grants (the latter generally provided by research councils, major health charities, and industry). The case study suggests that the role of the NRN has been particularly important and valued through its role as a network, bringing the oncology

research community together through its various activities. For example, oncology researchers are given the opportunity to network and develop new collaborations e.g. through Congress and Platforms. The network element also helps to disseminate the research within the oncology research community in Wales, with a more integrated approach to oncology research helping to forge stronger alliances between Welsh researchers and organisations and with a wide range of international partners, helping to raise the profile of Welsh oncology research. Stronger alliances between researchers and cancer research organisations and industry have been reported as an outcome of the NRN networking, helping to generate a more integrated approach to oncology research in Wales. In addition, through the NRN's links to the Life Science Bridging Fund, the research community has an increased awareness and appetite for commercialisation.

- 4.64 Notably, one stakeholder also suggested that the NRNs may have been important in supporting Sêr Cymru 2, by helping to instil a collaborative culture and by putting in place a supportive infrastructure.

“The NRN model has allowed PHDs, Fellows, Returning Fellows and other academics to collaborate with colleagues at other Welsh HEIs and take part in useful activity, whenever a relevant opportunity is identified. This engagement can be seen to have paved the way for far greater access and benefit under Sêr Cymru 2.”

- 4.65 In terms of lessons, three are highlighted. First, a well-resourced central team for each NRN has helped to deliver, coordinate, and shape their activities, with the NRNs broadly considered to have been delivered well by these teams. As is common with any multi-year programme, there have been changes in personnel, with the potential that this may impact on progress. In this context, a full-time Director, retained through the programme, can be helpful in maintaining momentum and providing the capacity required to deliver against expectations.
- 4.66 Second, there are some process improvements that could have been made in setting up and delivering the NRNs.

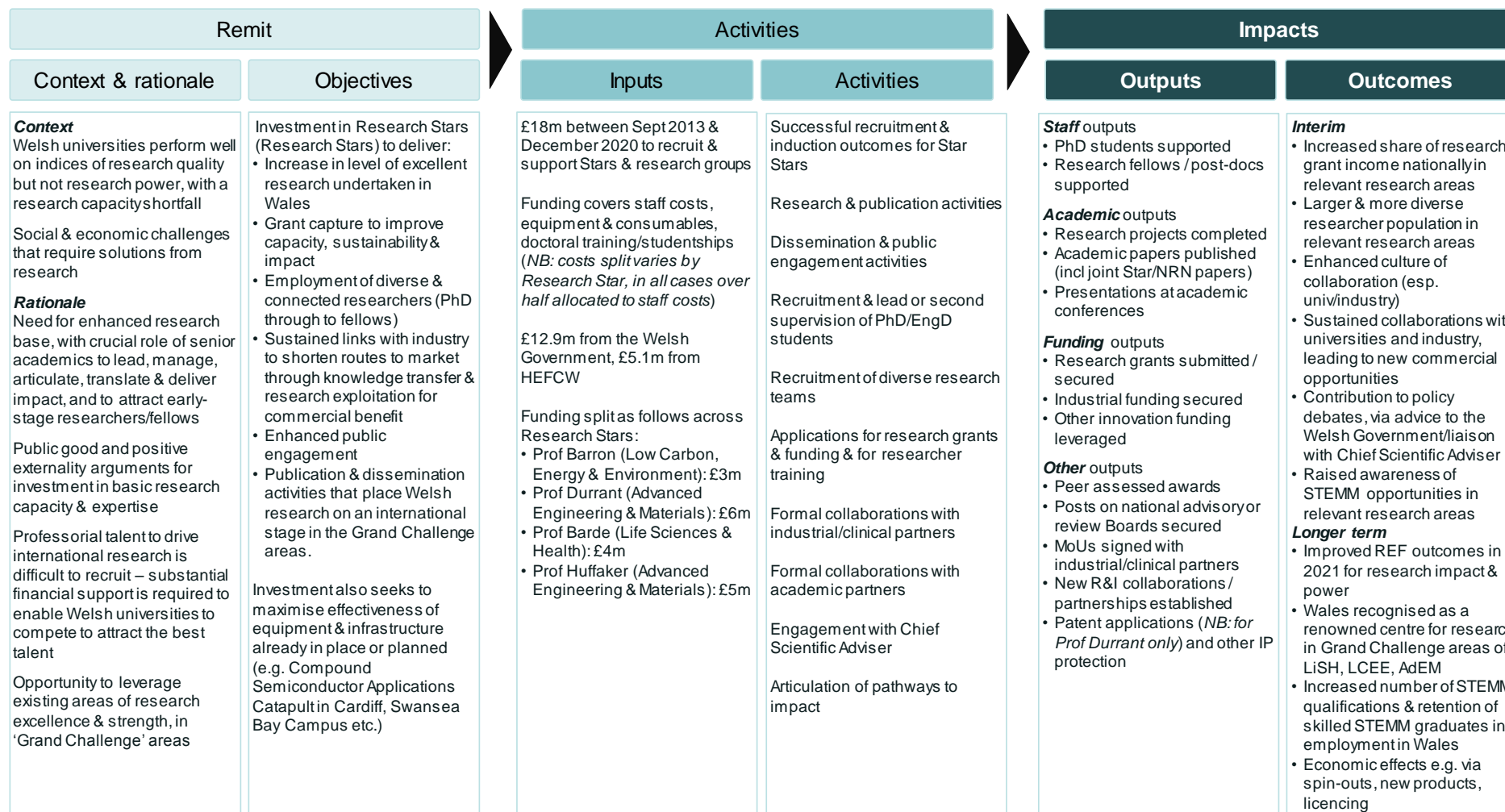
- Establishing clear and SMART objectives and a baseline from the outset would have helped to ensure that each NRN was focused on a clear set of objectives from the outset that all of those delivering and funding the NRNs would have had to agree on, and could have helped to focus the NRNs on achieving greater coordination and strategic outcomes.
- Greater input from project sponsors at this setup stage could have helped to guide the development of sensible and consistently measured indicators and targets, enabling more efficient and informative performance management.
- A mid-term review would have been helpful for the project sponsors and NRN Directors to identify which parts of the NRNs were most successful, enabling them to focus on these for the remainder of the funding period. A mid-term review was originally anticipated but was not delivered.

4.67 Looking forward, without continued funding, the NRNs are likely to cease to operate at the close of Sêr Cymru 1. This is likely to impact on the longer-term effects of the NRNs, with their legacy diminishing without continued focus on building the capacity and research communities. However, this needs to be balanced against the need to ensure the NRNs act as a mechanism to meet the overall aim of Sêr Cymru 1 – and the Welsh Government more broadly – to lead to an increase in competitive research income, over the longer-term. We return to this issue in the final section.

5. Research Stars

- 5.1 Four Research Stars, and their research teams, were supported by Sêr Cymru 1, covering the three Grand Challenge areas: Professor Yves Barde, Professor of Neurobiology at Cardiff University (LiSH); Professor Andrew Barron, Founder and Director of the Energy Safety Research Institute at Swansea University, specialising in nanotechnology applications in energy (LCEE); Professor James Durrant, specialising in solar energy research, and appointed to Swansea University (AdEM); and Professor Diana Huffaker, Scientific Director at the Institute for Compound Semiconductors at Cardiff University (AdEM).
- 5.2 The appointment process involved prospective host universities putting forward candidates for the role as Sêr Cymru Professor to the Welsh Government and HEFCW for their recruitment. The candidates were then assessed by a panel, to ascertain whether they met the criteria of the programme as internationally leading academics that could help to build the Welsh science base in the Grand Challenge areas. All four candidates were successful, with a grant offer agreed, setting out delivery expectations and roles. The process also involved negotiations to develop a package of support to secure their appointment. As such, the recruitment in one case took weeks, but in another took 18 months.
- 5.3 All Welsh universities were able to seek Star appointments. Of the four appointed, two were at Swansea University and two at Cardiff University. In two cases the host institution had an existing relationship with the Star via previous collaborations, and in the other two cases there was no pre-existing relationship, with one of the Stars recommended to the host university by an industrial partner. Consistent with the objectives of Sêr Cymru to attract leading researchers from elsewhere, all four Stars were new to Wales at the time of their appointment: two were based at universities in the US, one in mainland Europe, and one in England.
- 5.4 The logic model presented overleaf, developed by the evaluators, builds on the programme-level logic model presented in Section 2, but focuses specifically on the Research Stars. In this Section we explore the different elements of this logic model i.e. the context, rationale, objectives, inputs, activities, outputs and outcomes for the Stars.

Figure 5.1: Research Stars Strand-level logic model



Source: SQW

Rationale

- 5.5 Further to the programme rationale set out in Section 3, the case for the Research Stars Strand of Sêr Cymru 1 was based on the premise that attracting senior academics to Wales was crucial in delivering against the aim to enhance the scale and excellence of the research base. Such academics can play a crucial role in leading, managing, translating and delivering impact, and crucially attract both funding and other researchers through their research excellence, profile and credibility. One stakeholder described the role of senior academics as ‘beacons’ that increase the visibility of Wales within their area of research, making a clear statement of Wales’s strengths.
- 5.6 However, universities face substantial challenges in making such appointments. There is a highly competitive and international labour market for academic talent, particularly at the high-end, with universities and research institutions competing internationally to make senior and high-profile appointments to support their research and wider strategic agendas. The challenge stems from the rapid growth of higher education worldwide, with increasing demand for academics¹⁸. Owing to this, attracting the best academics can be costly, time-consuming, and complex.
- 5.7 At the same time, universities in Wales face a challenging funding environment, and have many competing priorities – as well as seeking to deliver research impacts, they also have important roles as drivers of economic development and widening participation, including through teaching and efforts towards commercialisation. External funding therefore was considered necessary to enable and de-risk investment for very high-quality researchers.
- 5.8 Most stakeholders consulted for this evaluation agreed with this rationale. They also noted the potential for Stars to build the profile and reputation of Wales as a place for science and research, benefiting the country’s wider scientific community. A national programme was also considered important to attract very senior academics, providing a level of credibility and profile to the roles, alongside an appropriate institutional ‘offer’.

¹⁸ The Association of Commonwealth Universities, 2006, *Trends in academic recruitment and retention: A Commonwealth perspective*

- 5.9 It is important to note that high profile senior academics already work at Welsh universities, but consultees felt that there was not enough of these to achieve a step-change in research income performance within the Grand Challenge areas, with several approaching retirement or having retired in recent years.
- 5.10 Importantly, in assessing the rationale for the Strand, the evidence from the evaluation via primary research with the four Research Stars is that each of the four Research Stars would likely *not* have taken up positions in Wales without Sêr Cymru 1 and the financial offer and associated support this involved. Further, the host institutions would likely not have funded these appointments without Sêr Cymru 1 and the additional financial support that this provided. Put another way, the evaluation provides strong evidence that without Sêr Cymru 1 the four internationally significant academics would not now be part of the Welsh research offer and landscape.
- 5.11 The programme involved providing the Stars with a flexible funding ‘pot’ to use to fund research and staff members. This is not typical. In many cases, an academic would need to come into a new post and secure additional funding to bring in team members, which means it can take time to build teams at a new institution. By contrast, Sêr Cymru 1 provided Stars with the resource to fund team members immediately and/or use the funding for other purposes such as equipment, enhancing the attractiveness of the offer. This flexible funding model meant that Stars could (in principle) quickly recruit team members and make progress in research.
- 5.12 This all said, it is important to recognise that the programme was in all cases complemented by other factors that influenced the decision of the Stars to locate to Wales. Other contributory factors included the wider research environment in Wales, the reputation of the host institution, the quality of the facilities on offer, and wider investments into their area of research. In addition, two of the Stars had existing working relationships with their host institution before their appointment, which were important in attracting them.

5.13 The relative contribution of these factors is complex and varies across the four Stars. However, in all cases the Sêr Cymru 1 funding was necessary, but it was not sufficient, to attract the Stars to their host institutions.

Objectives

5.14 Four formal headline objectives were identified for each Star:

- Objective 1: Establish a renowned research centre.
- Objective 2: Increase the volume of high quality research.
- Objective 3: Increase the volume of competitively-won grant funding for research.
- Objective 4: Increase user engagement, knowledge transfer and outreach activities

5.15 These four headline objectives were set by the project sponsors, and broadly reflect the overall rationale for the Strand i.e. to expand the research base and increase the level of research income secured in Wales, with the increase in high quality research in part a function of the former and prerequisite for the latter. It is also important to recognise the additional role of the Stars in maximising the potential of other investments and interventions at their host institution, which is not captured by any of these objectives.

5.16 It is less clear the role that the objectives have played in informing delivery by the Stars. The evaluation indicates that in some cases, Stars have placed emphasis on 'leaving a legacy' through their roles, whilst continuing to pursue research. This includes mentoring and developing a new cohort of researchers. This is not reflected formally in the objectives but has been core to the approach taken in some cases. Similarly, monitoring indicators have only been recorded in relation to the final objective by two of the four Stars, but the reason for this is not clear, and this does not appear to have influenced levels of industry engagement and collaboration, which has been evident in all cases.

5.17 Having relatively broad and non-prescriptive objectives has been regarded as valuable by the Stars, allowing them to take forward their role in a flexible fashion. However, it does indicate that the Stars have been provided with significant

independence and freedom to progress their research - and utilise Sêr Cymru funding – with modest levels of oversight by programme funders.

- 5.18 Two other points are noted. First, in some cases the monitoring indicators do not reflect fully the intent of the objectives or the activities undertaken. For example, the indicators identified for Objective 1 focus on the *scale* of research teams (e.g. the number of PhDs and other awards), but they do not capture the focus of the objective fully in terms of '*renown*' which suggests a judgement of quality and profile. In advance of the next round of formal research assessments (through REF 2021) this is challenging to assess, however, the programme could have considered perception-based measures for reputation or renown externally e.g. number of approaches by academics from elsewhere to be part of collaborative projects.
- 5.19 Second, the monitoring indicators vary between individual Stars, perhaps reflecting the lack of more specific objectives or business plan for the programme to guide these. Over 20 monitoring indicators have been reported by the Stars overall, with these varying by Star. The different monitoring indicators make it difficult to assess and compare performance across the Stars overall. Moreover, no baseline data was collected against which targets could be appropriately set and success measured.
- 5.20 A set of more specific SMART objectives would have been helpful to clarify what exactly the Stars were required to achieve, with a more consistent approach making it easier to assess their performance individually and as a group, for both the evaluators and for the Welsh Government/HEFCW as programme sponsors.

Inputs

- 5.21 In total, £18m of Sêr Cymru 1 funding was awarded to the Research Star Strand. This was split as follows: £6m for Prof. Durrant, £5m for Prof. Huffaker, £4m for Prof. Barde and £3m for Prof. Barron. Funding for the Stars is for five years, with three funded from 2013/14 to 2018/19, and one (Prof. Huffaker, a later appointment) funded from 2015/16 to 2020/21.
- 5.22 Actual expenditure of this Welsh Government/HEFCW funding by the end-June 2018 was £13m, 91% of target spend to that point, with much of the outstanding expenditure allocated to Prof. Huffaker (as expected, given the later appointment

and funding period to 2021). Overall, actual expenditure by the Stars has matched closely expected expenditure. However, one of the four Stars has experienced significant underspend, owing to delays in expenditure as a result of the required facilities not being put in place to enable research activity.

- 5.23 The split of total expenditure to the end of June 2018 suggests broad consistency of approach across Stars. Over half of expenditure has been allocated to staffing costs and related overheads for three of the Stars. The exception is that in one case the majority of expenditure to the end of June 2018 has been used for equipment costs to enable research activity (in advance of building a research team). This reflects the flexibility of the funding allocation discussed above, which has been valued by Stars.

Activities

- 5.24 Once recruited, the Stars were expected to deliver the same broad activities, i.e. to:
- Build a diverse research team (including through the appointment of and support for new and existing researchers).
 - Undertake research, including with industrial and academic partners.
 - Publish research papers.
 - Apply for research funding.
 - Articulate pathways to impact.
 - Disseminate their research and undertake public engagement.
 - Engage with the Chief Scientific Adviser.
- 5.25 In practice activity has been implemented quite differently by each Star, reflecting the flexibility in how the Stars used their funding to meet their needs and expectations and 'light touch' oversight from programme sponsors. For example:
- The research teams the Stars have formed vary greatly in size, with one Star working with a research team of 68 researchers, and in another case a research team of 13 (in one case, the team remains even smaller but this related to issues in recruitment linked to delays in expenditure as a result of the required facilities not being put in place to enable research activity).

- Three Stars funded a research team only at their host institution, one funded researchers at two other Welsh institutions as part of their research team.
- Three Stars were appointed full-time in Wales, one continued to work jointly with their previous/existing institution.
- Three Stars have funded PhD students using Sêr Cymru 1 funding, one has not.
- For one of the Stars, Sêr Cymru 1 has been used to co-fund a second professor, already in position at the host institution.

5.26 Consultation evidence does not suggest that there is a ‘right’ or ‘wrong’ way for these activities to be undertaken. However, the approach taken by one Star that has remained in post at their original institution was reported to have worked particularly well, as it meant that it was possible to build a stronger relationship between the two institutions, leading to further collaborative activities. Moreover, research team members gave positive feedback on the time that the Stars had spent in supporting their development.

5.27 Involvement in the NRNs has been fairly limited generally, but varies by Star, with this largely relating to how closely aligned the research focus of the Stars is with the NRNs remit. In some cases, NRN funding has been used to support members of Stars’ research teams, and Stars have been involved in NRN events; the case study in the Annual Drug Discover Congress for example highlighted the role of Prof. Barde.

5.28 However, the limited relationship between the two Strands is a ‘missed opportunity’, especially given the focus on Grand Challenge areas on both Strands. There is very limited evidence that the two Strands – Stars and NRNs – have worked together substantively to seek to deliver a ‘programme’ that is more than the sum of its parts.

Outputs

5.29 Outputs were monitored against the four formal objectives identified above. However, as noted earlier, the monitoring indicators vary between the Stars, with just one monitoring indicator shared by all four Stars – competitively-won grant funding for research.

5.30 Against all outputs, performance is mixed by Star, but appears strong overall, although as with the NRNs, it is unclear whether targets were appropriately set, due to the lack of a baseline for the Stars.

Research income

5.31 The evaluation finds positive performance overall in relation to competitively-won grant funding for research. To the end of March 2018, some £63.5m of grant funding has been reported, against a target of £29.5m. This can be expected to increase further in the future, as all of the Stars have longer to secure income, notably Prof. Huffaker. There are different routes through which this income has been secured:

- By the Star themselves, as a Principal Investigator for research.
- By other academics funded through the Star strand as members of the Stars' research teams, including: senior academics, as Principal Investigator for research; junior academics, such as PhD students securing further funding e.g. fellowship funding.

5.32 However, two points are highlighted here. First, over half of research income secured by the end of March 2018 is from RCUK sources, with modest levels from industry/Innovate UK (11%) or ERC/Horizon 2020 (2%). Over a third (36%) is classified as 'other' in the data, with these categories used in quarterly reports to the Welsh Government. This level of grant funding reported as 'other' is unhelpful for understanding the sources of grant funding, and crucially the extent to which this is genuinely 'new' for Wales. This should be addressed in any future programmes, and potentially for the final period of Sêr Cymru 1, resource allowing.

5.33 Second, whilst the overall performance against the target is positive, it has been mixed by Star. Three Stars have performed well – with one delivering over four times against target – whilst one had (by end-March 2018) underperformed significantly, reporting at 18% of their target. The latter performance is explained by the Star as owing to issues in the availability of facilities at the university to enable the planned research, which has led to delays in applying for and securing grant funding. Given the programme will close later this year, this represents a major

issue for the programme, which has relied on significant over-performance elsewhere to meet planned targets.

Other outputs

- 5.34 The Stars have supported over 100 staff through Sêr Cymru 1, including over 30 PhD students and over 70 post-doctoral researchers/research fellows. Team members are a mix of new researchers recruited into Wales, and existing researchers in Wales that have joined the Stars' teams.
- 5.35 Reputational benefits of working alongside the Star help to recruit staff, but suitable facilities and equipment are also required: where the Stars have failed to build up their teams to the expected size, this has typically been where they have been hindered by a lack of facilities. It is important to recognise that, even with the Stars' presence, challenges remain in recruiting and retaining researchers in Wales, due to a very competitive labour market.
- 5.36 The larger teams have generally achieved higher outputs in terms of publications. Over 230 research papers have been accepted for publication/have been published, with over 200 from the two Stars with larger teams. This is not surprising – a larger team means more academics undertaking research, leading to additional research outputs and more grant income – although the research area may also be a factor in publication habits. In addition, over 200 abstracts have been accepted for presentation at conferences.
- 5.37 Given the very similar activities and roles of the Stars, there appears to be significant scope for consolidation of output indicators and monitoring requirements, ensuring that outputs are consistent and relevant to their objectives. This would not necessarily make the reporting more burdensome – which the Stars are keen to avoid. Indeed, the opposite may be the case, with fewer, but more relevant, monitoring indicators, that would be valuable for capturing robust and comparable data on the Stars' achievements.

Outcomes

- 5.38 A range of outcomes were identified in the Research Star logic model, with interim outcomes the particular focus for this evaluation:

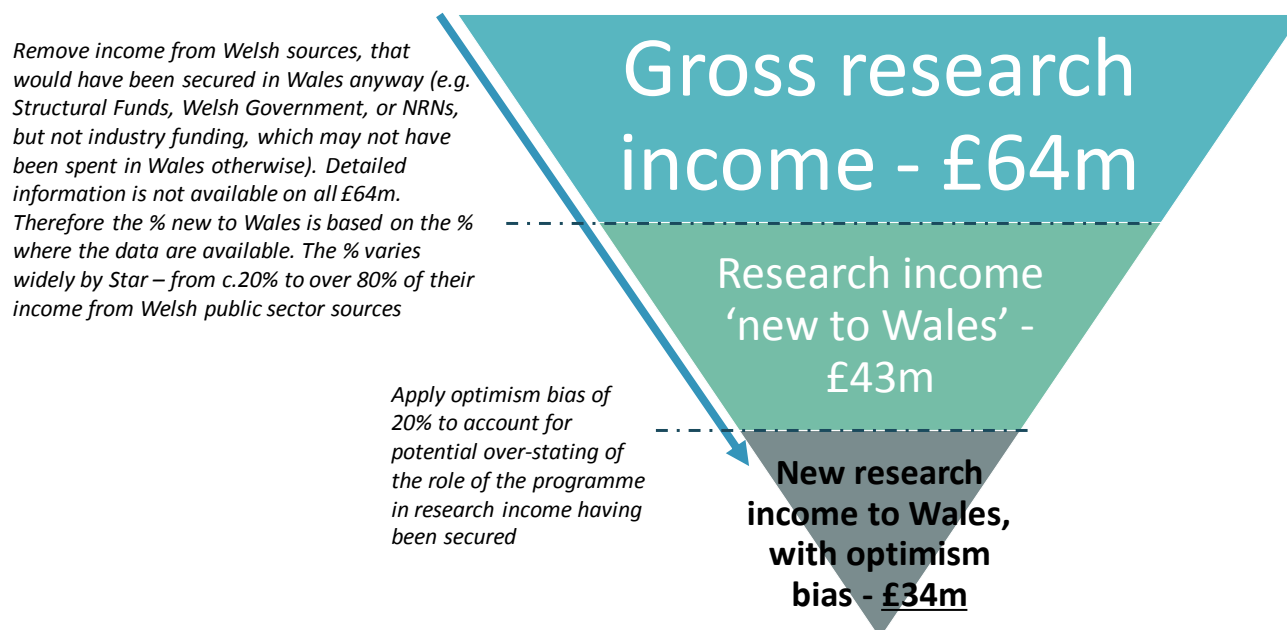
- Research funding outcomes, notably an increased share of research grant income nationally in relevant research areas.
- Research capacity and behaviour outcomes including: a larger, and more diverse researcher population; increase level of interdisciplinary research, and enhanced research collaboration; develop the skills and networks of the research team.
- Market outcomes including new commercial opportunities and knowledge spillovers to industry.
- Strategic outcomes contributing to the policy agenda in the Grand Challenge areas.

5.39 These four groups of outcomes are considered in turn below. Given the scope of this Strand, the evidence base on outcomes is drawn particularly from outcomes reported by the Stars and their teams. It also draws on evidence from stakeholder consultations and the small number of researchers who responded to the e-survey that had worked with one of the Stars.

Research funding income

- 5.40 Research funding outcome data draws on the data presented earlier in this report. We then take only the research income that is not from Welsh public sector sources from the gross total research income of £63.5m, and apply optimism bias to arrive at a 'new to Wales' figure, as set out in Figure 5.2.
- 5.41 Note that this does not take account of additionality – the extent to which research income would have been secured in Wales anyway. The e-survey did not provide robust evidence related to the Research Stars, and the research indicates that the Stars would not have been in Wales without the programme.
- 5.42 Based on the analysis, the suggested net new research income for Wales from the Stars, to the end of March 2018, is £34m.
- 5.43 These figures should be treated as an indicative 'snapshot', as they represent an estimate at a specific point, and will likely change as further submissions flow through, and funding decisions are made. The issues set out in the NRNs section (e.g. the existing reputation of the departments, and inconsistencies in recording data) also apply.

Figure 5.2: Gross to ‘new to Wales’ calculation for research income



Source: SQW analysis of output data from Research Star Quarterly Reports

Research capacity and behaviour outcomes

- 5.44 Stakeholders and researchers supported by the Stars reported that they brought important expertise, experience, networks and name recognition that have helped both to attract new researchers and develop staff to become better researchers.
- 5.45 Although a small sample, it is worth noting that of the eight e-survey respondents that have worked in the research team of one of the Stars, four said that the opportunity to work with the Star was very/extremely important to their decision to come to Wales, with another saying it was moderately important.
- 5.46 Positively, the Stars are reported by consultees as having delivered qualitative outcomes in relation to:
- Upskilling and retaining existing researchers through their extensive experience, as well as attracting, through their reputation and profile, and then upskilling new high-quality researchers, including from outside Wales.
 - Developing new collaborations for research team members through the Stars’ typically extensive networks and their reputations.
 - Changing the behaviours of researchers, such as encouraging researchers to submit papers to higher impact journals.

- Through the upskilling, links to the Stars' networks, and by increasing their level of ambition, also accelerate the careers of researchers.
- There have also been some diversity benefits e.g. one of the Stars has pulled together a team that is 50% female.

5.47 Stakeholders from within the host institutions recognise this valuable role:

“The standing and profile of the Stars has been beneficial in terms of attracting high quality research teams, that have enhanced the research capacity and reputation of the University.”

“The investment in the Stars allowed universities to appoint some real exemplars to drive efforts to develop excellence and capacity, and to raise the profile of Welsh research and universities.”

“Both appointments have made major contributions to the research capacity and performance of the University. They are high profile appointments who are seen as leaders in their respective fields.”

5.48 Five of the eight e-survey respondents that have worked in the research team of one of the Stars described how being a member of the Star's team contributed to their academic and career development:

“As a member of the Sêr Cymru 1 Chair's research team, I have the opportunity to work with the best researcher [sic] leaders in Wales, UK, and internationally. Thanks to our leader we are in a fast pace, ambitious, highly motivated, creative, independent research environment, unique to any I have been working in before, including the USA. This is unprecedented, a once in a life time opportunity.”

“Fundamental in my career development.”

“Sêr Cymru has allowed me to further develop my professional career and expand my network.”

“It has developed my scientific skills... Other PhD and Post Docs sponsored by Sêr Cymru has added to the expertise in the area and helped my development as a researcher.”

“If I achieve the grade of doctor (on going) then it will be a huge bonus on my CV, plus I have become expert in [my] field and learnt many transdisciplinary skills and research practices.”

- 5.49 Two final points are noted here. First, PhD students can benefit substantially from the efforts that the Stars put into developing their research staff. However, e-survey evidence shows that they are also less likely to secure grant funding in the short term. When considering the performance of the Stars, therefore, it is important to consider both the effects on the researchers’ abilities, as well as the grant funding secured; focusing only on the latter does not give a full picture of the outcomes. Moreover, the Stars have taken different approaches, with only two recruiting PhD students. The balance between these short-term and long-term outcomes should be considered fully at the outset of any successor interventions.
- 5.50 Second, the outcomes related to research capacity and behaviours have been realised principally at the Star’s host institutions. The exception to this is where the Star has worked with researchers at two other Welsh institutions.

Market outcomes

- 5.51 To date, market outcomes have been limited from Star activity. This is not surprising, given the early stage nature of much of the research undertaken by the Stars and their teams. Nevertheless, some positive outcomes have been recorded that highlight the potential for longer term benefits. For example, all of the Stars reported industrial collaboration activity since taking up the post in Wales, and in some cases industrial funding has been secured. Further, one Star has filed two patents to date, with another three to be filed in the future. As with the ‘developmental’ outcomes above, the extent to which commercialisation outcomes have been achieved depends on the experience and emphasis of the Stars, as well as their research area.
- 5.52 The potential for the Stars to help, in the longer term, to attract innovative firms to locate in Wales was noted by consultees. A wide range of factors would influence any firm’s decision to locate in Wales, but the profile and reputation that the Stars bring may be one of these. However, this is not an outcome that has been realised to date and will rely on the long-term presence of the Stars.

Strategic outcomes

- 5.53 The strategic outcomes of the Stars appear to relate principally due to their presence at this stage, rather than through specific inputs to policy debates and decisions. Simply put, their profile and reputation precede them, helping to raise the profile of the Welsh research base at an aggregate level. This was reported as a benefit by stakeholders at non-hosting universities.
- 5.54 The Stars have also had important roles in maximising the impact of existing infrastructure and investments, such as the Institute for Compound Semiconductors, SPECIFIC, the Energy Safety Research Institute, and in encouraging further investment in the science base by the host institutions. It is important to recognise that the universities had invested heavily in the Grand Challenge areas and reported they had existing research strengths in these areas. There was therefore an opportunity, with the Stars, to build on this. One stakeholder noted:

“[The appointment of one of the Stars] was a missing jigsaw piece, that could unlock an area of major strategic importance”

- 5.55 That said, consultees, including the Stars themselves, felt that more could have been done to leverage their presence in Wales, given their experience, profile and knowledge. This might have included engaging them at a strategic level with Government and policy makers, and also with industry. For example, there appears to have been very little engagement with the Chief Scientific Adviser by the Stars. Some wider public engagement has been undertaken by the Stars and their teams, but this has depended in large part on the enthusiasm of team members; where this has been limited, little has been achieved from a strategic perspective.

Overall reflections and lessons

- 5.56 The Stars are regarded by stakeholders as having been successful appointments, delivering important outcomes in raising the profile and reputation of science in Wales, and helping to build the research base. More could have been achieved in terms of strategic outcomes if a more proactive approach was taken by all parties, including the Welsh Government, and the evaluation suggests this would be welcomed by the Stars. Without funding from Sêr Cymru 1, it is unlikely that any of

the Stars would have taken up an academic position in Wales. Whilst not the only factor in attracting them to Wales, it was a fundamental one, with the flexibility of the funding and the ability to use it to build a research team being particularly attractive.

- 5.57 In this context, four key lessons are identified. First, where facilities have not been put in place in advance of the appointment (e.g. office, lab space, equipment), this has been a significant drag on the Stars outcomes, hindering their ability to recruit a research team, and secure research funding. This is an important lesson for any future schemes.
- 5.58 Second, the Star that retained links with their original institution has demonstrated that a full-time Star may not always be necessary in order to deliver positive outcomes. Retaining this link to their original institution has helped to develop the links between this leading university and the Star's host Welsh institution.
- 5.59 Third, whilst widely observed to have been successful, process improvements could have been made that might have led to greater outcomes being delivered by the Stars. In particular, establishing clear and SMART objectives as well as a baseline from the outset would have helped to ensure there was clarity on what the Stars were expected to achieve, and facilitated robust and comparable data to aid understanding of how successful the Strand has been.
- 5.60 Fourth, looking to the future, positively all Stars expect to remain working in Wales beyond the end of Sêr Cymru 1. As such, there is the potential to secure longer-term outcomes through their continued presence – such as continued research income, as well as new commercial outcomes – as well as the potential for the research teams and their strengths to be further embedded within Welsh universities.

6. Programme management and monitoring

6.1 This section focuses on the management of Sêr Cymru 1 by the Welsh Government and HEFCW, including set up and monitoring arrangements.

Programme set-up

6.2 The development of Sêr Cymru 1 does not appear to have involved a formal process of options appraisal, business case development and business planning at the outset. Instead, the 'case' for the programme was strategic, based on the Science for Wales strategy.¹⁹ This ensured strong strategic alignment, as the programme came directly from this strategy. However, this background does appear to have had some implications, which have been identified in the evaluation.

6.3 Five points are noted:

- This strategic case did not translate into a clear depiction of SMART objectives, including the expected contribution to the overarching aim of the Science for Wales strategy to increase Wales's share of RCUK income to 5% of the UK total, taking into account the other factors that would influence this.
- How the two Strands were expected to align with and complement each other was not identified at the outset, meaning this was not a priority in delivery even within each Grand Challenge area.
- No baseline evidence was collected on key indicators/conditions during programme set-up for Sêr Cymru 1 (e.g. level of competitive research income in research areas, scale of the researcher base, quantitative/qualitative proxies for reputation and research quality, citation data etc.); as such, the specific conditions that the programme was hoping to influence directly were not identified, meaning measuring progress is challenging.
- The method and form of evaluation was not identified at the outset in any detail; it was agreed that there would be a mid-term review and final evaluation, but these were ultimately combined into this evaluation, falling somewhere between the two.

¹⁹ Welsh Government (2012) *Science for Wales*

- Monitoring indicators were varied across the elements of the programme, with limited consistency and read-across, which has implications for how the progress and success of each Strand can be assessed accurately; we return to this issue below.

6.4 These issues have not prevented the programme from delivering outcomes. However, in hindsight, more might have been achieved – and the performance of the programme could have been more clearly identified, including through the use of robust quantitative measures – had a more formal process of programme development, appraisal, and set-up been employed. This provides important learning for the future.

Programme oversight and management

- 6.5 From the perspective of the NRNs and the Stars, programme oversight and management have been generally appropriate, from the appointment through to delivery, with a largely ‘hands-off’ approach to the latter from the Welsh Government and HEFCW reported as a positive aspect. Positive feedback was also reported from non-hosting institutions; they appreciated being involved in discussions around the programme, despite being non-hosting institutions, as it helped them to feel ‘bought in’ to the process and their views valued.
- 6.6 The ‘light touch’ approach does have implications, with some significant issues of underperformance (as reflected in monitoring data for individual NRNs/Stars) not addressed fully, and no actions put in place to reflect changing programme contexts and performance.
- 6.7 In part, this approach may be a function of the limited resource from the Welsh Government and HEFCW for managing the programme. There has been a single programme manager and no on-going formal governance mechanisms in place to provide strategic oversight, manage risk, and address issues at a ‘programme’ level. Relative to the scale and complexity of the programme (with two Strands, and seven components, each of which is complex in itself), the level of central management resource and oversight appears modest.

- 6.8 The 'formal' processes of monitoring and annual reporting have not been used to manage actively programme delivery as it progressed e.g. the Welsh Government responded formally to only the first annual reports produced by the Stars and NRNs.
- 6.9 Taken together, the evaluation suggests the capacity of sponsors to review, assess, challenge and steer the NRNs/Stars has been limited across delivery. Given the scale, profile, and complexity of the programme, continuous improvement and strategic direction have not been optimal.

Programme monitoring

- 6.10 The NRNs and Stars felt generally that the monitoring requirements for the programme were reasonable. As a group, they were keen that the process of monitoring does not become more onerous.
- 6.11 However, the evaluation has identified significant issues in terms of the consistency, quality, and transparency of the monitoring systems and processes in place for Sêr Cymru 1. Providing a comprehensive, consistent and meaningful analysis of the financial and output delivery of the programme in the evaluation has proved very challenging owing to these issues.
- 6.12 The key points – some of which have been trailed throughout the report – include:
- Different approaches for recording/reporting financial information across Strands, including match and in-kind funding, which raises some questions over the attribution of outputs to the Sêr Cymru 1 funding.
 - Variation in the recording of outputs across the programme, particularly on research income secured; it was not within the scope of this evaluation to 'audit' grant claims, however, a review of a selection of projects, particularly the larger ones, indicates some variation in practice. e.g.
 - Outputs claimed from funding submissions that pre-dated the programme (e.g. successful funding applications and achieved publications being claimed as programme outputs when they were submitted before receipt of Sêr Cymru 1 funding).
 - Variation of how sources of grant funding are coded (e.g. EU funding).

- Variation in the proportion of grant funding claimed (e.g. in some cases, the full project total claimed, including funding for partners).
- The range of output indicators was very broad (with 20+ across both the NRNs and Stars), different definitions were used within Strands, and the inclusion of targets was selective; whilst it is reasonable that not all elements will report against all indicators, given the different emphases, consistent definitions and target-setting approaches would have enabled a more robust assessment of performance, and the explanation for why some elements were not expected to report against indicators is not clear.
- Objectives and their associated indicators and targets were not refreshed to reflect delivery progress; some targets have been significantly over-delivered (e.g. over 500% for NRNs at this stage on ‘abstracts accepted for presentation at national and international conferences’), which suggests they should have been revised at a mid-point – a mid-point review of objectives (and progress) may have been helpful, as raised by partners.

6.13 More practically, output data has not been collated into a central repository across the NRNs and Stars during implementation, except for research income. For all other outputs, analysis for this evaluation has involved reviewing scanned in claim documents showing data for ‘current quarter’ and ‘to date, except current quarter’, which are then added together by the reader to ascertain cumulative total outputs per NRN and Star. There does not appear to have been collation and analysis of meta-data as delivery has progressed, meaning that issues with consistency (as discussed above) could not be identified and addressed.

6.14 These issues across programme set-up, oversight and monitoring have not substantively adversely impacted delivery at the level of individual NRNs and Stars, but a more ‘managed’ approach may have helped to leverage fully the potential of the programme.

7. Conclusions and recommendations

7.1 This section sets out overall conclusions from the evaluation, including in relation to the programme's performance in increasing Wales's share of RCUK research income. It also sets out recommendations in relation to Sêr Cymru 1 and any future iteration of the programme.

Overall conclusions

7.2 It is too early to draw definitive conclusions on the ultimate success of Sêr Cymru 1. Both Strands – NRNs and Stars – are still operating, and even once completed it will take time for some longer term (especially economic) outcomes to be realised. This is consistent with the recognition that investment in the research base requires a long-term perspective and policy focus. Indeed, the amount of time needed to realise these outcomes fully will also depend on the type of research funded (whether early or later stage) and the area of research (e.g. life science research can take 10-15 years from fundamental research to commercial/economic outcomes). A fuller account of outcomes, albeit still not a definitive one, may be made in 2022, including the results of REF 2021.

7.3 That said, overall Sêr Cymru 1 appears to have performed well, exceeding output targets at this stage. One of the key aims of the programme was to deliver more research income to Wales from competitive sources, and on this measure the programme has been successful. Although some care is needed given issues of attribution and data collection approaches, the evaluation suggests that the two Strands may have secured close to £75m of additional research income for Wales.

7.4 Further, the programme is well regarded by consultees for its contribution to raising the profile of science in Wales, building research capacity, and improving the quality of its researchers and research. This includes building on what are already priority areas for the institutions. Two quotations from stakeholders reflect this perspective well:

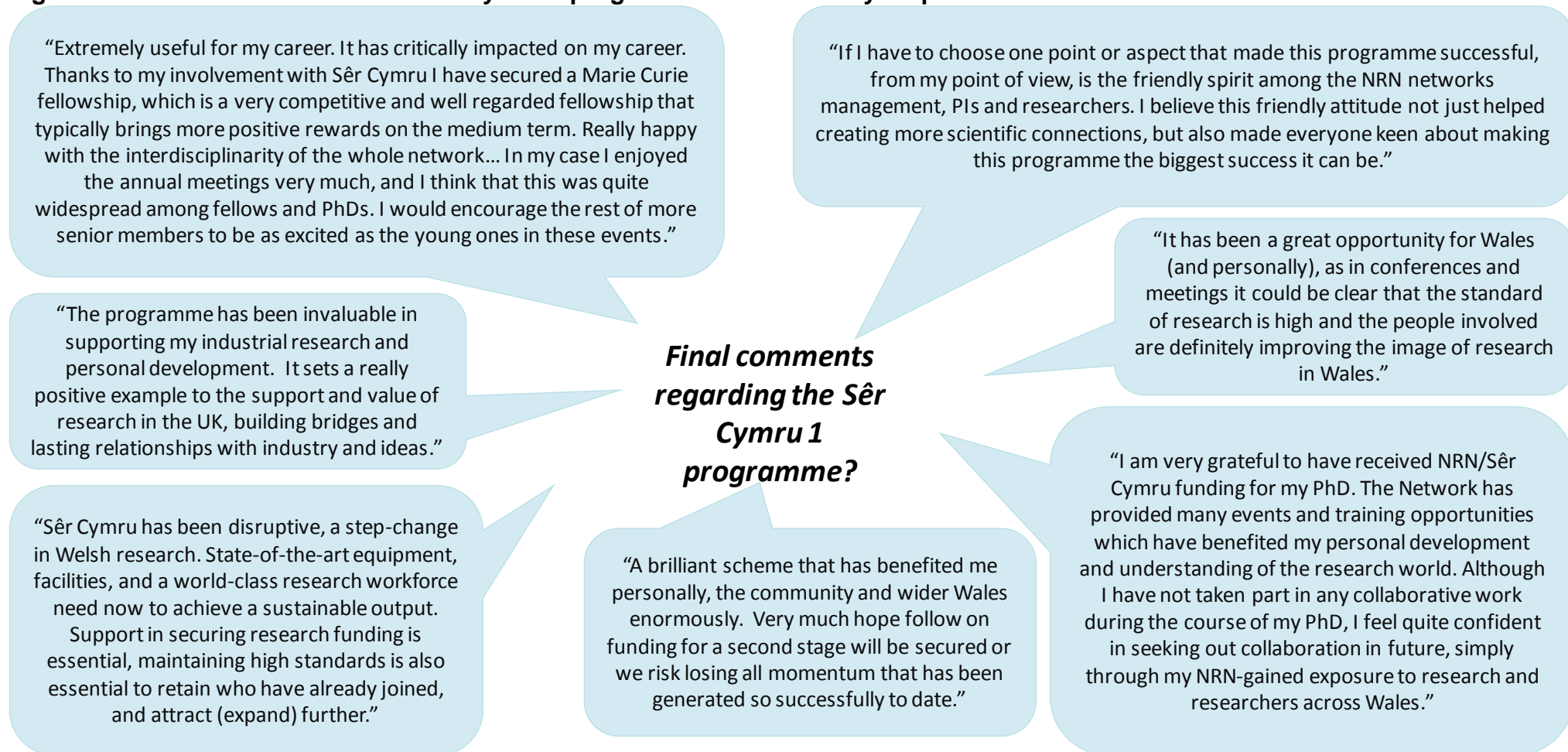
“The key research areas supported through Sêr Cymru 1 were already priorities for the University and there was already a certain amount of

momentum in terms of investment, staffing and research. However, Sêr Cymru 1 has significantly accelerated the pace and scale of achievements.”

“The strategy of appointing Stars in priority areas and putting NRNs in place was seen as a good starting point for the Sêr Cymru journey. The programme provided some key building blocks that have been instrumental to what has since been achieved.”

- 7.5 Feedback from researchers supported by the programme also highlights the positive role of the programme in their own development. Asked for any final comments on the programme, the responses were overwhelmingly positive, including those in Figure 7.1.
- 7.6 The evidence on the effects of both the NRNs and Research Stars on early career researchers is very positive, both in terms of attracting researchers to Wales and enhancing their capacities, confidence, and relationships. Notably, the e-survey with individuals supported by the NRNs provides strong evidence that the programme has both attracted to, and retained researchers in, Wales in the Grand Challenge areas. Given the long-term perspective required for addressing the challenges of the research base in Wales, this provides a strong foundation on which to build.
- 7.7 However, two points are important within this positive overall finding. First, performance has varied across the elements of the programme, particularly across the Research Stars. Whilst overall the Stars have been successful, there were variations in outcomes within that Strand. A more active approach to programme planning and management may have helped to address some of these issues at an earlier point.

Figure 7.1: Final comments on the Sêr Cymru 1 programme from e-survey respondents



Source: SQW analysis of e-survey

7.8 Second, there is limited evidence that the two Strands have operated as a programme that is ‘more than the sum of its parts’, rather than two independent Strands. The Strands are focused in different ways at addressing the rationale for the programme – NRNs seeking to develop existing local capacity, Stars drawing in excellent researchers from outside. This complementary approach should – in theory – encourage linkages, to generate outcomes that are greater than the individual components. In practice, there has been limited engagement between the NRNs, little between the Stars and NRNs, and virtually none between the Stars. This is not wholly unexpected, given the different focus and emphasis across programme elements. However, more could arguably have been achieved, particularly in relation to the strategic contribution of the programme (potentially via a stronger steer from the Welsh Government), to bring the elements together to seek to maximise the potential for shared learning and outcomes.

Increasing Wales’s share of RCUK research funding

7.9 The overall strategic aim of Sêr Cymru 1 was to contribute towards moving Wales’s share of RCUK funding from around 3% to 5%, as part of the wider Science for Wales strategy. Higher Education Statistics Agency (HESA) data on research income in universities for the 2013 to 2017 period indicates Wales’s national share of RCUK funding fluctuated between 2.8% and 3.6%. Ostensibly, the programme has therefore not contributed to moving Wales’s share of RCUK funding towards 5%.

7.10 However, this does not mean the programme has been unsuccessful. Instead, it is important to recognise that this was always an unrealistic target for the programme, given the wide range of factors that will influence this high-level target, and given that Sêr Cymru is just one, relatively small, intervention in the wider research funding landscape. Rather, the suggested ‘additional’ research income of £28m from RCUK secured through Sêr Cymru 1 has made a notable contribution to the total research funding for Wales over this period. This is equivalent to c.£5.5m p.a. over five years, which represents around 10% of total Welsh competitive RCUK funding over this period.

7.11 As such, while the programme has not directly moved Wales towards this relative target, it has made a major absolute contribution to the total level of competitive RCUK research funding secured over the funding period. This and other UKRI²⁰ funding sources (such as the Industrial Strategy Challenge Fund and the Strength in Places Fund) are likely to be increasingly important going forward, in the wake of the impending departure of the UK from the European Union, and uncertainty over access to European funding streams.

Recommendations

7.12 Seven recommendations are made to the Welsh Government and HEFCW: two in relation to the Stars; two in relation to the NRNs; two wider programme recommendations in light of the findings of the evaluation; and one regarding long-term impact evaluation.

Recommendation 1: A successor to the Research Stars Strand should be considered. This would be for researchers of an equivalent standing and scale to Sêr Cymru 1, and at a similar number (three to five) to balance deliverability and maintain quality. This would also need to be cognisant of the recruitment undertaken through Sêr Cymru 2. In delivering this activity the Stars should:

- Have an explicit focus in their objectives on their developmental and strategic contribution to the Welsh research base, the latter including a specific focus on ‘leveraging’ their individual and collective profile, networks, and expertise.
- Be selected to align with both local strengths and provide an opportunity for leveraging significant levels of UK-level income (through RCUK, Shared Prosperity Fund, and the Industrial Strategy).
- Be supported only where ‘infrastructure’ support is clearly in place to facilitate research activity. For international appointments particularly, there is a need to ensure familiarisation, integration, and support mechanisms in place.

Recommendation 2: The existing Research Stars should not receive any further direct Sêr Cymru funding over and above their existing agreements. Responsibility for retaining and leveraging fully the potential of the existing

²⁰ United Kingdom Research and Innovation

Research Stars should be transferred to their host institutions. This should be a realistic prospect, given the value that the Stars are perceived to have brought to their host institutions in terms of research impact, income, profile and reputation.

Recommendation 3: The existing NRNs should continue to be supported through Sêr Cymru (or equivalent) where funding allows, but explicitly as ‘networks’, focused on collaboration and capacity building in their areas (a ‘phase two’ model), not as mechanisms for the provision of research funding (albeit recognising that the research funding has been important for incentivising involvement in the networks initially). In delivering against this recommendation:

- The aim would be to maintain the momentum/relationships developed in ‘phase one’, but encourage sustainability in outcomes via a focus on securing external competitive research income.
- A particular focus would be on further capacity development support to the PhD students and other early career researchers funded via ‘phase one’.
- The discipline focus and scope should be reviewed to ensure this remains appropriate in each case, taking into account the evolving context.

Recommendation 4: The case for new NRNs on the existing model (i.e. funding and networking organisations) to focus on other disciplines/research areas should be considered, via a formal project development, appraisal and options development exercise. This should be undertaken in the context of the changing funding, research, and innovation context in Wales and policy decisions by the Welsh Government and partners in light of the recommendations of the Reid Review.²¹ If they are taken forward, new NRNs:

- Should have very clear and SMART objectives, to ensure clarity of purpose in terms of their role in the wider research and innovation landscape.
- Should be developed to align with potential external funding opportunities (including as potential match funding), alongside resource for internal ‘pump

²¹ Reid, G. (2018) *Review of Government Funded Research and Innovation in Wales*

priming' research funding, with an explicit focus from the outset on how sustainability will be realised post public funding (as per the 'phase two' model).

- Allow flexibility in delivery model and structure, although a full-time Director should be appointed to ensure that the 'strategic' role can be realised fully.

Recommendation 5: Future interventions should seek to leverage more fully the potential opportunities from supporting both Research Stars and NRNs.

The focus should be to ensure that the two elements do generate benefits greater than the sum of their parts, including how cross-disciplinary thinking and opportunities can be developed and exploited; this has not happened to any significant extent under the current programme.

Recommendation 6: In taking forward any future interventions, the evaluation findings around programme set-up, oversight and monitoring should be taken into account, and changes put in place in response. Key here will be:

- The development of a formal set of SMART programme objectives, and clarity on how they will be measured and evaluated in a consistent format.
- The collection of relevant baseline data on key conditions and indicators at the outset, to inform targets and allow for a robust account of performance.
- A mid-term/interim review, to assess progress and identify any required changes.

Recommendation 7: A long-term impact evaluation of the programme should adopt a theory-based, mixed methods approach to reflect the complicated and complex nature of the intervention (with very varied activities, many actors, and emergent outcomes). This should include:

- Adopting a 'contribution analysis' approach, drawing on a range of evidence, both quantitative and qualitative – to build up evidence to demonstrate the contribution made by Sêr Cymru 1 to key outcomes related to research capacity and competitive grant funding performance, while also identifying the other (external) factors that have influenced this performance.
- The use of bibliometric analysis including publications, citations, and Field-Weighted Citation Impact metrics to track the performance of Wales in relevant research areas over time, before and following Sêr Cymru 1; the focus of the programme on specific Grand Challenge areas should enable a detailed pre-and

-post assessment of performance in these detailed research areas, with qualitative research to consider the relative contribution of the programme – funders may consider identifying comparator research areas to provide evidence on the counterfactual.

- Collecting data on research grants secured by Star research teams to at least 2021 (the point of final closure for Research Stars), including ensuring that comprehensive data is provided, detailing the sources of funding and the ‘routes’ through which funding has been secured.
- Considering establishing a ‘panel’ of academic and industry representatives that can be engaged to understand in more detail how Sêr Cymru 1 investment - NRNs and Stars – are leading to wider outcomes and benefits in ‘real time’ following the programme close, including strategic effects.
- A longitudinal survey of early career researchers supported by NRN research funding, to track their career development within Wales; the scope to identify a comparison group of early career researchers that have not been supported by Sêr Cymru 1 (e.g. unsuccessful applicants) should also be considered.
- In-depth case studies on individual NRN and Research Star projects that have been taken through to commercialisation and/or attracted significant levels of grant funding to test routes to impact and identify any direct economic and spillover effects.