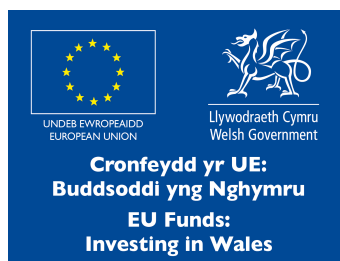


FINAL EVALUATION OF HIGH PERFORMANCE COMPUTING WALES

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Date: September 2015



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EXECUTIVE SUMMARY

The Innovation Partnership Ltd was commissioned in April 2015 to undertake the final evaluation of the High Performance Computing Wales (HPC Wales or 'the Project') part ERDF-funded project.

HPC Wales (a company limited by guarantee) is a Special Purpose Vehicle (SPV) established by six Welsh universities, namely Aberystwyth, Bangor, Cardiff, Swansea, University of South Wales and the University of Wales, representing alliance universities across Wales, for the sole purpose of delivering the HPC Wales project. HPC Wales is an innovative collaboration that provides businesses, researchers and students access to world-class, secure and supported HPC facility and training.

HPC Wales – The Vision

“Build state-of-the-art High Performance Computing (HPC) capabilities across the Universities of Wales to provide enabling technologies that deliver research, innovation, high-level skills development and transformational ICT for economic benefit”.

This was the long-term vision embodied within the original business plan, published in March 2010, which was approved by all funders including WEFO, UK BIS, HEFCW and the academic partners. The extent to which this vision has been realised is set out in the table below, which demonstrates the impact achieved to date against the strategic aims of the project.

HPC Strategic Aims – Impact and Delivery

STRATEGIC AIM	IMPACT and DELIVERY
1. A World-class HPC Capacity	
Capacity and capability that meets the needs of partners and key innovation projects	17,000 core, state of the art distributed HPC infrastructure. 98% availability provided throughout the project.
HPC support and access to business & academic innovation networks	In excess of 2,500 users, 116 Collaborative projects and 150 million compute hours delivered. All backed by a dedicated multi layered support team.
Connect and enable research across Wales in priority sectors	Projects spanned Advanced Materials and Manufacturing, Life Sciences, Energy and Environment, ICT and Creative Industries.
2. A Research and Innovation Institute	
Research and innovation outputs that	Over 500 new Products, Process and Services

have economic impact in Convergence Wales.	including research outputs
Stimulate ICT industry growth and enhance inward investment opportunities	£3.8 million of direct investment induced.
Engage with priority sectors and individual enterprises through assistance and collaborative projects to support job creation and innovation	Over 100 collaborative projects in partnership with SMEs, commercial organisations and research institutes; 20 funded PhD studentships
Support collaborative R&D projects and innovation across the priority sectors	Collaboration with multiple bodies supporting MRC Farr Institute, Business Innovation Centres, Welsh Wound Innovation Centre, Tech Hub, ASTUTE
3. An HPC Skills Academy	
Deliver improvement in advanced computing skills	Trained over 2,200 individuals from both academia and industry.
Supply the qualifications and training needed to up-skill Convergence Wales to harness the opportunities of HPC technology	Designed and delivered accredited courses and modules throughout Wales
Innovative multimode and multi-model methods of blended and credited HPC learning	Both on-line interactive and classroom based learning materials provided
Provide specific outreach support to train individuals in the use of HPC and to address particular individual requirements	Bespoke training supplied through HPC Wales staff and external resources. Achieving high scoring satisfaction levels from participants

CONCLUSIONS

Our report has identified seventeen detailed conclusions, drawn from the evaluation and these are outlined within Section 8 of the main body of the report. A summary of each conclusion is set out below. In addition the seven key recommendations then follow.

The overriding conclusion is that HPC Wales delivered the project in line with funders' expectations. As reported in the mid-term evaluation (April 2014), the Project suffered from delays principally caused by a number of interrelated factors. These were being dealt with through specific measures taken and prior to the start of the mid-term evaluation, a clear drive to focus on ERDF targets was initiated. This was accompanied by a desire to reprofile the resources and associated output targets leading to a de-commitment of grant funding. Part of the de-commitment reflected a reduction in resources required and a reallocation of resources targeted at performance enhancement. The resultant impact was a successful delivery of output performance against these revised WEFO targets.

The infrastructure established performed well and proved to be extremely robust and reliable and provided the platform from which all services were delivered.

There appears to have been a failure by both HPC Wales senior management and stakeholder institutions alike to consider fully the long term sustainability of the project. This ultimately led to the Member Institutions decision to significantly downsize the operation for the transition period between HPC Wales I and II. This has weakened the skills base and diminished the level of service that can be provided.

The planning for HPC Wales II is underway and should incorporate the lessons learned from HPC Wales I. We believe that there is huge potential to build and extend on academic activity from HPC Wales I, given the new R & I focus in the 2014/20 programme. It should be ensured that the foundations from the original project on business engagement and skills are not lost.

Our summarised conclusions are listed below and provided in more detail at Section 8 of the report.

i. **CONCLUSION 1: THE SPECIAL PURPOSE VEHICLE.** The SPV was identified as the most appropriate vehicle for HPC Wales as it facilitated the purchase of HPC infrastructure and networks, mitigating risk and trade. The SPV has governed the project for all the University members throughout the HPC Wales funding period.

In practice, it became evident that board members sometimes acted in the best interest of their respective organisations. It also became clear that information did not always cascade within the stakeholder organisations. What is now clear is that the associated Project Board – the HPC Wales stakeholder Group – should have been inaugurated soon after project start. This would have provided a suitable forum for stakeholder specific issues to be debated, enabling the SPV to operate in the best interests of HPC Wales. **The overriding conclusion is that whilst the board delivered its statutory functions, the project would have been improved had there been more engagement and institutional support, and a recognition of potential conflicts of interest.**

ii. **CONCLUSION 2: RISK AND RETURN.** At the time of inception, HPC Wales was a high-risk investment and venture. It was a novel initiative whose inputs consisted of an emerging and disruptive technology (HPC) for the SME market, a predominantly latent market, and the need to establish route-to-market and a product/service offering that was SME-centric. These challenges were fully recognised by those who had crafted the business plan, informed by a series of workshops and meetings with key stakeholders in both the HE sector and Welsh Government. Thus despite the risk (in terms of successfully achieving targets), stakeholders still felt it worthy of investment. **What is clear is that whilst many of the risks were mitigated and outcomes achieved, the full benefits of the programme will only materialise from long-term investment and promotion.**

iii. **CONCLUSION 3: PROJECT LAUNCH AND DELAYS.** Whilst the overall performance of HPC Wales has been good, progress has been constrained by a number of factors, the impact of which could, in hindsight, have been minimised. HPC Wales encountered severe delays in its formative years from an operational point of view. The key areas in which delays occurred:

- **A protracted procurement process,**
- **Establishment of a distributed infrastructure system**
- **Operational Staff Recruitment.**

The delays noted above were the prime reasons for the initial underperformance in terms of ERDF and (less so) ESF targets in the early stages of the project. This perception drove the

performance of the SPV which focused more on the potential impact of claw back rather than helping HPC Wales address the impact of time slippage. **However much of the slippage was ameliorated in the subsequent period, and the re-profiled targets largely achieved.**

iv. **CONCLUSION 4: BUSINESS ENGAGEMENT.** From an operational and tactical perspective, the Project also encountered challenges in engaging businesses due to a lack of awareness of the technology in the target market. The concept was also little known at the outset amongst those recruited in the role of Training and Outreach Mentor (TOM), suggesting that **a more in-depth awareness and greater expertise in HPC amongst those recruited should have featured in the essential skills associated with the positions.** This would undoubtedly have accelerated the outreach agenda and marketing approach to the SME community.

v. **CONCLUSION 5: THE HPC WALES PRODUCT OFFERING.** **The product, service, skills and training offered by HPC Wales is comprehensive and flexible.** In addition to delivering outputs and outcomes, the Project has progressed significantly in creating know-how in HPC, has laid foundations and has created capacity. As a result of its activities and reputation, HPC Wales was able to build and lead a consortium to bid (and win) to set up Europe's H2020 funded programme Network of HPC Competency Centres for SMEs. (SESAME Net) with partners from 15 Member States. **What is clearly required is in-house expertise in applications (performance tuning, scalability etc.) and domain-specific support in helping users to exploit the full potential of HPC.** The short-term solution was provided by NAG and FLE (Fujitsu Lab. Europe), but this was an extremely expensive solution. **This class of support will be critical in HPC Wales II.**

vi. **CONCLUSION 6: HPC WALES PERFORMANCE AND PERCEPTION.** It is clear that amongst funding stakeholders there is a mixed perception on the performance of HPC Wales. This is largely due to insufficient interactions between HPC Wales and stakeholders. There is a clear requirement to ensure that internal stakeholders are made fully aware of the positive image of HPC Wales within EU and UK. **It is evident that successive CEOs failed to cultivate a meaningful relationship with the VCs of the stakeholder institutions.**

The Project achieved well against its targets, secured H2020 funding, and completed four successful WEFO claims audits, three successful EFAT audit reviews and one successful PIVT audit, and was commended for a number of its processes.

vii. **CONCLUSION 7: ERDF TARGETS.** There is a general acceptance that the original ERDF targets were ambitious for a project of this nature, which were reduced as part of a re-profiling exercise. **The HPC Wales delivery window for achieving its 5 year targets was compressed to just over two years given the problems highlighted at project start, and the loss of staff during the final stages. The Project fully achieved 8 of the targets, 5 achieved over 80%, with just 2 targets achieving just over 60%.**

viii. **CONCLUSION 8. HPC WALES, RESEARCH SUPPORT VS. ERDF.** There is an inherent tension between research objectives and ERDF commitments in the 2007-13 programme. Whilst ERDF was an appropriate mechanism to fund business engagement, research and "big science" is more appropriately funded through BIS, the Universities, Research Councils, and the EU. However, **the volume of measurable research outcomes generated as a result of HPC Wales' existence was extremely positive and competitive with other HE institutions nationwide.**

ix. **CONCLUSION 9: OPERATIONS.** HPC Wales established various policies and procedures, which achieved ISO 9001 accreditation. **Operations were affected by the distributed nature**

of the team, with the mix of directly employed staff and secondees (both in terms and conditions of employment and line management) presenting challenges in workload management, communications and operations. These challenges were made increasingly difficult with the departure of key staff from the organisation during the final year of the project.

x. **CONCLUSION 10: STAFF RETENTION.** Loss of staff over the final twelve months of the project proved a real hammer blow and impacted on the operational performance of the project. **Failure by the Board and Stakeholders to recognise the impact and take appropriate action should perhaps have been factored into plans for the final phase of the project.**

xi. **CONCLUSION 11: HPC WALES, OUTREACH/SALES.** The initial project provided a location-specific activity for HPC Wales, however in order to balance workload and leverage on sector expertise, led to an increased sector focus, whilst taking into account geographical opportunities. **The sector approach was agreed by both consultants and senior management as being the way forward, and implemented subsequently.**

xii. **CONCLUSION 12: HPC WALES, THEMES FOR FUNDING IN HPC AND BIG DATA.** HPC Wales is well placed to benefit from ongoing funding programmes from UK BIS, TSB, and Research Councils. There appears to be a great number of opportunities to secure funding and receive support from many quarters that fit with the Project's overall agenda. **HPC Wales has achieved demonstrable success in attracting funding from H2020, Innovate UK and TSB.** Notable in this regard is the successful HPC Wales led Horizon 2020 EINFRA bid to create an EU Network of HPC Competency Centres (SESAME Net), worth €2m with partners in 15 member states.

xiii. **CONCLUSION 13: BUSINESS SURVEY. Two-thirds of the businesses surveyed at the point of the mid-term review suggested that HPC was important to the success of their company.** In terms of future needs, they wanted more of the same, an update in the equipment and software as technology develops, and enhanced service delivery from HPC Wales, not only in terms of hardware and software, but also access to the expertise available. It can be said that **HPC Wales has had a measurable impact on beneficiary businesses and there is ongoing demand for the HPC Wales service.** That the successor project appears focused on WEFO Strategic Objective 1.1 and is driven by enhanced Research Capacity rather than business engagement is inconsistent with these findings.

xiv. **CONCLUSION 14: FUTURE FACILITIES.** Investment in the ownership of a HPC facility is high. HPC Wales has regularly evaluated the Total Cost of Ownership (TCO) and advantages of sourcing additional core hours from HPC academic led initiatives, e.g., at STFC Daresbury Laboratory, Edinburgh University or alternatively by core hours in the open market from Cloud providers such as Amazon and Google. While these analyses consistently point to **the current ownership model being the most cost effective** (particularly after the investments in infrastructure made by HPC Wales), it is true that the perception exists within some senior management in the Stakeholder institutions and WEFO/WG, incorrectly in our view, that expenditure on HPC technology is not cost-effective vis-à-vis the outsourced rental model. We refer to two analyses conducted by HPC Wales staff that support this view; (i) the costs of siting existing technology in commercial data centres compared to continued use of the

existing HPC Wales Hubs¹, and (ii) a cost and performance analysis of carrying out an HPC workload on cloud-based facilities compared to the use of in-house HPC clusters².

Many clearly believe that the facility should remain in-house and work alongside other HPC facilities throughout Welsh universities, particularly ARCCA. Our research has shown that **it is very important to provide the interface between the facility and staff**. This has been referred to as the “wrap-around” support and it is clear the interpretation of need, the use of optimised software, firmware and hardware will lead to better projects and better outputs and outcomes. This will require revenue funding to ensure that the right personnel are in place.

xv. **CONCLUSION 15: TRAINING.** It is the Consultants understanding that training will not be a core deliverable under HPC Wales II and ERDF funding. Results from the training analysis indicated that **training was very useful, created a great degree of awareness, and would lead to future projects, tenders and long-term benefits**. The Consultants believe that **there is a continuing requirement for training** that should be considered under a separate bid, and managed and delivered by a separate team.

xvi. **CONCLUSION 16: MARKETING.** It is clear that HPC has used an array of marketing messages and channels to reach its target audiences. On the whole, marketing has proved to have had a positive impact, and particularly useful when it is focused on delivering internally. **HPC Wales has become a globally recognised brand in part due to marketing activities alongside other promotional activities. It is essential that this brand is not lost in the transition to a future project.**

xvii. **CONCLUSION 17: PROGRESSION TOWARDS SUSTAINABILITY AND/OR EXIT AND BUILDING ON INVESTMENT.** It was clear at the midway point that all internal stakeholders and the majority of external stakeholders saw this as a long-term initiative and there was enthusiasm for long-term sustainability. It is clear that **HPC Wales has provided a strong foundation on which to build a long-term sustainable model**. Typically this is based on a jointly funded arrangement with 1/3 core grant, 1/3 commercial/project income and 1/3 from competitively sourced grant income (or partner institutions). HPC Wales ability to achieve this has been eroded with the reduction in the resource/capacity base, principally the staff, and initial decisions to reduce the company's activity. Subsequent agreement has been reached to fund transition activities until a second programme starts. Within HPC Wales II there is now a complete focus on supporting academic endeavour, an activity that can indeed lead to a great number of institutional benefits, not least:

- Winning grants (UK and Rest of EU)
- Improving the quality of academic research work
- Enhancing the standing of the Welsh Universities.

The research undertaken for this evaluation clearly shows that **such activity is valid and can be sustainable through reinvestment and the positioning of HPC as delivering emerging opportunities, such as research into major social, environmental and commercial opportunities.**

¹ *HPC Wales: Stage-2 Technology Hosting Options – A Preliminary Analysis*, paper to the HPC Wales Business Planning Group, September 2015.

² *Commercial provisioning of ARCCA Services*, ARCCA-OG-96, paper to the ARCCA Oversight Group, February 2015, and *Application Performance in Chemistry and Materials Science: Local vs. Cloud HPC Resources*, invited presentation at the Computing Insight UK 2015 conference, Ricoh Arena, 8 December 2015.

Furthermore, the Consultants conclude that **this activity should not be considered in isolation but should be augmented by the ongoing provision of services to business, and to a training and skills activity** to build on the highly successful Skills Academy from the first project.

RECOMMENDATIONS

xviii. **RECOMMENDATION 1: THE SUCCESSOR PROJECT.** Based on the evidence provided from the Stakeholder interviews, and from their own analysis of the HPC ecosystem, **the Consultants provide a strong recommendation and endorsement for the proposed HPC Wales II project.** This report recognises that HPC Wales II will be different, for it is now well timed in terms of University needs and the academic agenda, coupled with a different landscape to HPC Wales I that is framed by a general international recognition of the ability of HPC and data – now seen as a new and attractive science.

Alongside this endorsement, the Consultants recommend that **consideration should be given to both the ongoing provision of services to business, and to a training and skills activity** to build on the highly successful Skills Academy from the first project. It is the Consultants understanding that training will not be a core deliverable under HPC Wales II and ERDF funding. Results from the training analysis suggested that training was very useful, created a great degree of awareness, and would lead to future projects, tenders and long-term benefits. The Consultants believe that there **is a continuing requirement for training that should be considered under a separate bid**, possibly managed and delivered from a separate team.

xix. **RECOMMENDATION 2: DURABILITY OF HPC WALES.** The Consultants would draw HPC Wales and its Stakeholders attention to a requirement by WEFO-funded projects to ensure the durability of projects co-financed by the Structural Funds with an obligation to maintain the investment in accordance with Article 57 of Regulation 1083/2006 and as amended by Regulation (EU) No 539/2010 of 16 June 2010. Project sponsors are required to inform WEFO of any substantial modification to their project within 5 years of its completion or 3 years from the completion of a project for the maintenance of investments or jobs created by SMEs which:

- Affects its nature or its implementation conditions or gives to a firm or public body an undue advantage: and
- Results either from a change in the nature of ownership of an item of infrastructure or the cessation of a productive activity

Furthermore, the failure to maintain the investment will result in recovery of the structural funds contribution. Therefore the Consultants recommend that **the HPC Wales II consortium give due consideration to compliance with Article 57 within their business planning processes.**

xx. **RECOMMENDATION 3: TRANSITION ARRANGEMENTS.** The consultants recognise the substantial assets in infrastructure, resources and services that have arisen from the major investments made by WEFO and WG during HPC Wales. They strongly recommend that **the Stakeholders representing HPC Wales II ensure that adequate transition arrangements are put in place to secure these assets and future operation of HPC services.** It is important that the foundations in terms of skills and business engagement are not lost to Wales.

xxi. **RECOMMENDATION 4: REALIGNMENT OF HPC ACTIVITIES.** Following the suggestion of many of those interviewed, the Consultants recommend that **HPC activities within the Stakeholder institutions are aligned alongside the successor HPC Wales II project.** Many clearly believe that the associated facility should remain in-house and work alongside other HPC facilities throughout Welsh universities, particularly ARCCA at Cardiff University. In terms of strengthening this support infrastructure for research, the consultants recognise the importance of providing the interface between the facility and research staff. This has been referred to as the “wrap-around” support and it is clear that the expert interpretation of requirements, the use of optimised software, firmware and hardware will lead to better projects and better outputs and outcomes. This will require revenue funding to ensure that the right personnel are in place (see also recommendation 6).

xxii. **RECOMMENDATION 5: SUPPORT FOR THE HORIZON 2020 SESAME.NET.** The Consultants believe that HPC Wales has established an important brand and presence within the HPC ecosystem during its 5 years of operation. In recommending that this brand be exploited moving forward, the Consultants recognise that HPC Wales and its deliverables (e.g. big data) are topical, and that these are areas that are likely to receive strong financial and non-financial support in the future, from multiple sources. HPC Wales should capitalise on their successful and high profile Horizon 2020 EINFRA bid to create the EU Network of HPC Competency Centres (SESAME.Net), worth €2m with partners in 15 member states. This will provide further opportunities to leverage on all these sources of funds. The consultants recommend that **SESAME.Net network is retained by HPC Wales moving forward**, providing a platform to bring future EU funding into Wales.

xxiii. **RECOMMENDATION 6: RETAINING AND AUGMENTING THE EXPERTISE AND IP FROM HPC WALES.** The Consultants recognise the value of the expertise, products and services and brand name owned by HPC Wales Ltd. There was widespread support from those users interviewed for the product, service, skills and training offered by HPC Wales, with a picture of comprehensive and flexible support that is clearly state-of-the-art. In addition to delivering outputs and outcomes, the Project has progressed significantly in creating know-how in HPC, has laid foundations and has created capacity. It is our view that **consideration should be given to how these assets should be retained and developed for Wales, within and beyond the current HPC Wales II proposal.**

As highlighted in Recommendation 4, **the current service should be augmented by in-house expertise in applications (performance tuning, scalability etc.) and domain-specific support in helping users to optimally exploit the potential of HPC.** This class of support will be critical in HPC Wales II.

1. INTRODUCTION

1.1 Final Evaluation of HPC Wales

The Innovation Partnership Ltd (TIP or the Consultants) was commissioned in April 2015 to undertake the final evaluation of the High Performance Computing Wales (HPC Wales or 'the Project') part ERDF-funded project.

The evaluation was specifically required to cover the following key activities and outputs:

1. Achievements of the Project's ERDF outputs
2. The Project's impact on SMEs by type and location, including potential and the ability to create jobs/sustainability, including those outside but serving;
3. Effectiveness of the SPV approach, a model for project delivery, and project governance structure;
4. Integration with existing High Performance Computing (HPC) infrastructure and skills development activities;
5. The uptake of HPC tools and techniques by enterprises (ERDF) and individuals (ESF);
6. HPC Wales' response to the recommendations from the mid-term evaluation, reported in 2014
7. Progression towards sustainability and/or exit and building on investment.

1.2 HPC Wales, Overview

HPC Wales (a company limited by guarantee) is a Special Purpose Vehicle (SPV) established by six Welsh universities, namely Aberystwyth, Bangor, Cardiff, Swansea, University of South Wales and the University of Wales, representing alliance universities across Wales, for the sole purpose of the HPC Wales initiative.

HPC Wales is an innovative collaboration that provides businesses, researchers and students access to world-class, secure and supported HPC facility and training. As stated in HPC Wales' business plan (May 2010), the vision is to:

"Build state-of-the-art High Performance Computing (HPC) capabilities across the Universities of Wales to provide enabling technologies that deliver research, innovation, high-level skills development and transformational ICT for economic benefit".

The three key strategic aims of the Project are to establish:

1. A World-class HPC Capacity

- Capacity and capability that meets the needs of key innovation projects identified by the partner universities and their business community.
- Provide HPC support and access to business and academic innovation networks
- Connect and enable research across Wales in priority sectors

2. A Research and Innovation Institute

- Deliver research and innovation outputs that have economic impact in Convergence Wales.

- Work with and stimulate ICT industry growth and enhance inward investment opportunities in this field
- Engage with priority sectors and individual enterprises through assistance and collaborative projects to support job creation and innovation
- Support collaborative R&D projects and innovation across the priority sectors

3. An HPC Skills Academy

- Deliver significant improvement in advanced computing skills via outreach support across the economy
- Supply the qualifications and training needed to up-skill Convergence Wales to harness the opportunities of HPC technology
- Provide and facilitate innovative multimode and multi-model methods of blended and credited HPC learning in particular for industry and commerce
- Provide specific outreach support to train individuals in the use of HPC and to address particular individual requirements

The HPC Wales project received funding from four sources, namely the European Regional Development Fund (ERDF) via the Welsh European Funding Office (WEFO), the 'Strategic Investment Fund' (SIF) via the Department for Business, Innovation & Skills (BIS), the Higher Education Funding Council for Wales (HEFCW), and the participating universities (HEI matched) as follows:

Table 1: HPC Wales, 2010-2015 Funding

£Ms	REVENUE	CAPITAL	TOTAL
UK SIF	1.00	9.00	10.00
EU Convergence – ERDF	7.08	12.54	19.62
HEFCW – Reconfiguration	2.06	2.94	5.00
HEI Match Funding	2.32	1.06	3.38
Income (private sector, research, other grant, non-EU income)	2.00	N/A	2.00
TOTAL	14.46	25.54	40.00

Source HPC Wales Business Plan 2010

WEFO awarded HPC Wales £19.62m, which was the single largest ERDF grant under Priority One, Theme Two “*ICT Infrastructure and Information Society for All*” of the Welsh Operational Programme. This theme supports sustainable ICT infrastructure development and demands stimulation and adoption of ICT.

The UK Strategic Investment Fund (SIF) managed by BIS, provided £10m in funding to HPC Wales as one of five HPC pilot initiatives in the UK. HEFCW's contribution of £5m was via the 'Reconfiguration, Research and Collaboration Fund' to support HPC Wales activities. The Universities are to provide a total of £3.38m of match funding.

In addition, HPC Wales is targeted to gain £2m of trading income via chargeable activities over the stated period. Acceptable sources of income include private sector, research organisations, other grants, and non-EU income.

1.3 HPC Wales, Outputs, Results, and Targets (2010 to 2015)

HPC Wales aims to deliver on ERDF and European Social Fund (ESF) outputs (there is no direct ESF funding in HPC Wales). The ESF targets are driven by the Skills Academy aspect of HPC Wales, which has been created to capitalise on the potential impact of the available state-of-the-art HPC network and the associated and additional opportunities that HPC brings. The Skills Academy is driving the up-skilling, training, and education of the user community in Wales. The targeted ERDF & ESF outputs and outcomes for the five-year (2010-2015) Project have been summarised below:

Table 2: ERDF Target Outputs and Outcomes – 2010-2015

Year	1	2	3	4	5	Total
Jobs Created	20	40	80	120	145	405
Diagnostics (D)	6	30	90	90	114	330
Assistances (A)	4	20	60	60	76	220
Total Enterprises Assisted (D+A)	10	50	150	150	190	550
New P/P/S created	6	30	60	60	60	216
Collaborative Projects	-	30	20	30	40	120
Investment Induced £k	-	960	640	960	1280	£3.84m
New P/P/S Registered	-	-	30	30	40	100
Enterprises Created	-	-	2	4	4	10

Source: HPC Wales business plan 2010

Table 3: ESF Target Outputs and Outcomes – 2010 - 2015

Year	1	2	3	4	5	Total
Workshops	6	22	32	32	32	124
Courses (online cumulative)	1	2	3	4	5	5
Participants	110	375	500	490	485	1,960
Participants entering further learning from workshops/online courses	8	32	48	48	48	184
Participants gaining qualifications as Level 4+	-	90	230	270	270	860

Source: WEFO-approved HPC Wales business plan 2010

The Project is also targeted to deliver on two WG and WEFO key cross-cutting themes, as follows:

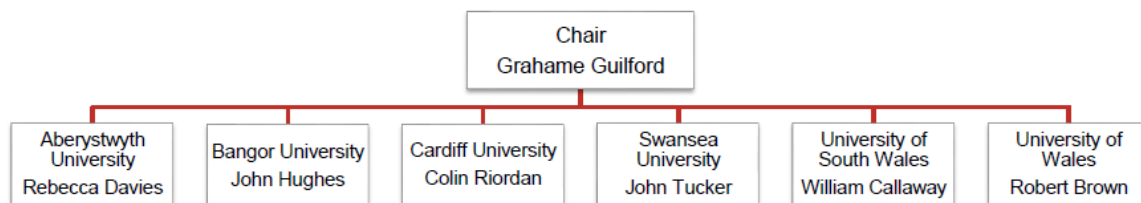
- Enterprises adopting and implementing Environmental Action Plans, 2010 to 2015 (target 30 SMEs)
- Enterprises adopting or improving equality strategies and monitoring systems (target 30 SMEs)

An independent report on HPC Wales (commissioned by BIS to review the impact of the SIF Programme) completed by ORC International in August 2013 stated that due to the significant set-up investment in time, money, and effort **“HPC Wales has only been operating in a steady state, and has effectively been open for businesses, since February 2012”** (effectively the start of Year 3). This has been identified and confirmed on several occasions during both the mid-term and this evaluation by the Project Board, Management and other stakeholders.

1.4 HPC Wales, a Special Purpose Vehicle (SPV)

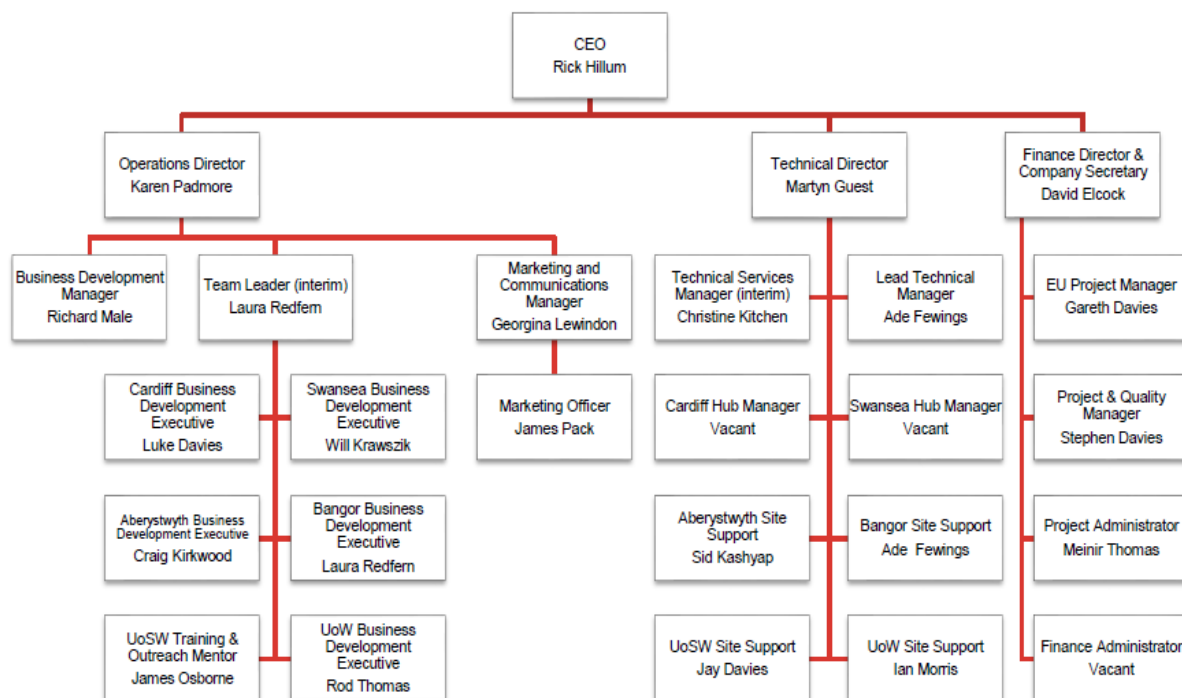
HPC Wales was established as an SPV to create a legal entity to allow the Project to operate a collaborative initiative on behalf the Member Institutions. HPC Wales' status is a private limited company, incorporated in Wales on 8 March 2010 (company number 07181701). The structure of the SPV consists of a Board (Figure 1), and the 'SPV organisation' (Figure 2), with two committees – the 'Audit & Risk Committee' and the 'Remuneration Committee' – reporting to the Board.

Figure 1: SPV Executive Board at Close of Project



Source: HPC Wales

Figure 2: HPC Wales Organisational Chart



Source: HPC Wales

**Interim positions;
Nick Musembi – Zabbix support (Bangor)
Deborah Price – Creative Assistant (UoSW)*

2. FINAL EVALUATION METHODOLOGY

2.1 Evaluation Methodology

The Consultants proposed and delivered a discrete Work Package (WP) approach to complete this final evaluation. This WP methodology was approved at the project inception meeting in Cardiff, on 28 April 2015, attended by David Elcock, Finance Director, and Gareth Davies, EU Project Advisor, HPC Wales. The WP evaluation methodology employed has been summarised in Figure 3 below:

Figure 3: Evaluation WP Workflow Diagram

WORK PACKAGE	ACTIVITY	OUTPUTS
WP 1	Inception Meetings: 28 April 2015 & 28 May 2015	Inception Document/Work plan/Data Collection & Evaluation Strategy
WP 2	Contextual and Performance Review	Performance Review of ESIF/ERDF Outputs and Outcomes
WP 3	Internal Stakeholder Interviews	13 Interviews undertaken with SPV board members, management and operational staff
WP 4	External Stakeholder Interviews	Interviews undertaken and reported
WP 5	Beneficiary Surveys, Researchers, Academics and Students	366 responses analysed and reported
WP 6	Review Actions from mid-term evaluation	Actions reviewed by HPC Wales Board and key stakeholders. Progress is reported in Section 7
WP 7	Outputs, outcomes and impact Assessment	Assessment of outputs, projected impact to date
WP 8	Report Presentation	Final report delivered October 2015

Source: The Consultants

WP 1: Inception Meeting

Following the evaluation Inception meetings and follow-on discussions, the Consultants produced an inception report on 28 May 2015 (available upon request). The inception report confirmed the key evaluation tasks and methodology, documents to be reviewed, key contacts, timings, and reporting requirements, which were followed during this exercise.

WP2: Internal Data Sources, Reports, and Performance Review

The key data sources engaged in the scope of the evaluation have been outlined below:

- "HPC Wales: WEFO Summary Report, 2014/15 – Project Completion"
- "Unlocking the ICT Growth Potential in Europe: Enabling People and Businesses" 2013, European Commission

WP3: SPV Board Members and HPC Wales Staff Interviews

The Consultants prepared SPV Board member and staff questionnaires, which were approved by HPC Wales' senior management team. The questionnaire was of sufficient detail to capture fully the views, experiences, and observations of a range of internal stakeholders and staff, and was followed as closely as possible. Face-to-face interviews were undertaken but, when not possible, interviews were completed via telephone. In contrast to the mid-term evaluation, opportunities for interviews were more restricted due to the fact that a high number of staff had recently left the Project and their availability and contactability was limited. Together with the resource constraints imposed by the timeframe available for the review, it was decided not to pursue this group. All remaining staff were interviewed. We did however interview five out of seven SPV board members.

Interviews focused on Project performance, product/service positioning, connections, and likely future structure and delivery. Results have been reported under three group headings: Board Members, Management, and Operational Staff. The interviews were undertaken between July and September 2015, and have been reported in Section 5 of this report. 13 interviews were successfully completed.

WP4: External Stakeholder Interviews

Based on the internal stakeholder questionnaire; the Consultants produced an amended and abbreviated questionnaire for external stakeholder interviews. External stakeholders principally consisted of HPC Wales funding organisations and other programmes/initiatives with whom HPC Wales has collaborated. These interviews were conducted in person or via the telephone. The interviews provided feedback on the position and strategic importance of HPC Wales, the perception of performance, and recommendations on future activity and direction. Again, interview numbers were restricted, with two interviews being successfully completed.

WP5: Beneficiary Surveys

The research took place over two time periods - January to March 2014 and August to September 2015, and the following cohorts were consulted as part of the evaluation:

- Participants receiving training, either as student attendees of the HPC units undertaken as part of their degree or master's programme, as participants of HPC introductory workshops, or as participants of intermediate and advanced training courses.
- A business survey of those participating in HPC Wales support activity.
- A survey of the researchers and academic staff that managed or led the HPC training

The findings are non-attributable and 366 respondents were consulted about their participation in HPC activity, representing a response rate of 13.2% overall. Note: the Consultants have, where possible, combined the results with the mid-term evaluation and the results from each of the four surveys have been reported separately in section six of this document.

WP6: Review of Activities Actioned after Mid-Term Evaluation

As part of the mid-term evaluation, the Consultants made several recommendations relating to the remaining Project duration, and to possible future activities. As part of this final evaluation process, HPC senior management were asked to provide an update on actions that had occurred as a result of those recommendations and relevant comments have been included in Section 7 of this report.

WP7: Impact Assessment

As part of this evaluation, the Consultants have provided estimated employment and training impacts, including a high-level net GVA impact analysis of the two elements of the HPC Wales Project using survey findings and recognised benchmarks. We have updated the mid-term position using the same methodological assumptions.

WP8: Final Report, Conclusions and Recommendations

This final report details the final evaluation, draws key conclusions and outlines the future for HPC Wales, as seen by board members, staff and other stakeholders. The report has been prepared in detail so all stakeholders have an understanding of HPC Wales and its performance thus far, the challenges the Project has faced, its current position, lessons learned and future opportunities.

3. HPC WALES CONTEXTUAL AND PERFORMANCE REVIEW

3.1 The Policy and Strategy Context

The mid-term evaluation clearly set out the Project's context in terms of the long-term policies and strategies both on a sector-specific and a geographic (EU, UK and Wales) basis. As stated, the HPC Wales business plan makes reference to the Project's strategic alignment with a range of key UK and Wales policy and strategy statements. In terms of the key strategies, little has changed since the mid-term, with the Science and Innovation Strategies still in place. One addition since the mid-term review was undertaken, is the EU-commissioned report, "**Unlocking the ICT Growth Potential in Europe: Enabling people and businesses**", which clearly identifies the key driver that HPC will play for enterprises.

Under the subtitle 'Benefitting from the next ICT wave', the report states that, "*Internet and communication capital have been important because they enabled networked computing and improvements in business processes throughout the economy. With big data and high performance computing (HPC) now rapidly becoming key to future ICT strategies, having the appropriate "connective tissue" HPC business applications, as well as the skills to exploit them, will be equally important.*

HPC is used for a wide range of activities, such as product design and testing applications conducted in large industrial R&D labs, plant layout design, logistics and traffic monitoring, financial market pricing/trading/event monitoring, medical imaging/patient monitoring/disease tracking, as well as network traffic routing in telecom. Currently, only large firms tend to possess the scale for HPC systems, though this is likely to change as the cloud becomes more widely adopted and more vendors offer big data solutions. Providing HPC availability more broadly, especially to small and medium-sized businesses with intermittent needs, will undoubtedly require harnessing the cloud and other Internet "second wave" forms of communication.

To optimise networked computing for business HPC computing, countries require a high-class communication infrastructure – both in general businesses as well as its publicly accessible networks – to harness the power of ICT. This will be crucial as the data traffic on those networks continues to grow exponentially. HPC itself is also a form of ICT infrastructure and it should be of concern to European policymakers and business leaders that Europe's capabilities in industry are lagging while its resources in the academic sector are rich (Byrne and Corrado, forthcoming, Chapter 3 of the Background Companion Report)."

By way of background, Appendices III and IV provide (i) a variety of thematic case studies that illustrate the range of projects undertaken on the HPC Wales infrastructure (**Appendix III**), and (ii) the product offerings developed by HPC Wales during the course of the project (**Appendix IV**).

3.2 HPC Final-Term Performance

During the mid-term evaluation, HPC Wales' senior management team, WG and WEFO, acknowledged that ERDF targets were potentially over ambitious for such a Project. The Consultants challenged WG and WEFO as to why they were so ambitious, with the belief being that the HPC staff responsible for producing the original ERDF business plans

particularly over-estimated the size of the Welsh SME addressable market. Evidence obtained from the interviews undertaken at both the mid-term and final evaluation indicated that the targets set for the Skills Academy were more accurate/achievable, given better market understanding.

Table 4 on the following page shows the final performance figures for the Project, as at 30 June 2015.

It can be seen that the skills development activities of the Project have performed particularly well, with the Skills Academy delivering across Convergence Wales, as presented in the performance below. The time lag in award of qualifications presents an end-project position below target, though participants in progress will draw in line with the target position.

Table 4 above shows that the Project, although short on several target areas, made good progress against identified metrics since the mid-term evaluation was undertaken (**Appendix I: Table of ERDF Performance Indicators at the mid-term evaluation in 2014**)

'New products/processes and services created' and 'new products/processes, services registered' were particular areas of strength when examining the ERDF metrics. Possibly more significant is the fact that the Project attained 85% against the 'jobs created' metric in spite of the challenging economic conditions under which the Project was launched.

When examining the ESF targets, it can be seen that the Project achieved targets in relation to 'workshops' and 'online courses' (105% and 174% respectively), and was particularly strong in terms of 'participants entering further education' (364%).

'Participants gaining Level 4 Qualifications' (64%) and 'traded income' (62%) were the weakest areas in terms of Project performance, although £720k of traded income has been secured to date. It is worth noting that there is a cohort of students who have benefitted from HPC Wales training who will not attain their final qualification until post the WEFO-funded project end date. These are not currently captured within the WEFO output achievements, but will ultimately be a beneficial outcome from the Project.

The project was successful in securing over £750k of income, which was used to contribute to the gap in funding. The original business plan had included a figure of £2m, and so the shortfall was managed through the re-profiling exercise which resulted in an overall decommitment and reduction in costs of over £6m. According to HPC Wales' CEO, towards the end of the project HPC Wales had a sales pipeline of circa £1m, to which he attached a probability of sale at +60%. HPC Wales commented at the inception meeting that there had been significant decay in the sales pipeline due to inactivity and uncertainty caused by the Project losing staff and the winding down process.

Table 4: Project performance against Targets (ERDF and ESF)

Evidence Received Dashboard - to 30 Jun 15		ORIGINAL WEFO TARGET					COMPLETE EVIDENCE				REPROFILE WEFO TARGETS		
							Total To 30 Jun 15	Target To 30 Jun 15	Variance	Variance		Variance	Variance
ERDF													
Project Year	1	2	3	4	5	Total			Act. Vs Target	% Target Ach.	Total	Act. Vs Target	% Target Ach.
Jobs Created	20	40	80	120	145	405	170	405	-235	42%	200	-30	85%
Diagnostics (D)	6	30	90	90	114	330	154	330	-176	47%	180	-26	86%
Assistances (A)	4	20	60	60	76	220	93	220	-127	42%	120	-27	78%
Total Enterprises Assisted (D+A)	10	50	150	150	190	550	247	550	-303	45%	300	-53	82%
New P/P/S created	6	30	60	60	60	216	537	216	321	249%	381	156	141%
Collaborative Projects	0	30	20	30	40	120	116	120	-4	97%	125	-9	93%
Investment Induced £M's	0	960	640	960	1,280	£3,840	3,738	3,840	-102	97%	4,600	-862	81%
New P/P/S Registered	0	0	30	30	40	100	231	100	131	231%	176	55	131%
Enterprises Created	0	0	2	4	4	10	9	10	-1	90%	8	1	113%
Enterprises adopting and implementing Environmental Action Plans	0	0	10	10	10	30	29	30	-1	97%	23	6	126%
Enterprises adopting or improving equality strategies and monitoring systems	0	0	10	10	10	30	16	30	-14	53%	16	0	100%
ESF													
Workshops	6	22	32	32	32	124	198	124	74	160%	188	10	105%
Online Courses	1	1	1	1	1	5	61	5	56	1220%	35	26	174%
Participants	110	375	500	490	485	1,960	1,622	1,960	-338	83%	1,877	-255	86%
Participants entering further learning	8	32	48	48	48	184	382	184	198	208%	105	277	364%
Participants gaining Level 4+ qualifications	-	90	230	270	270	860	459	860	-401	53%	700	-241	66%
TRADED INCOME													
Traded Income (net of VAT)	0	0	0	982.5	982.5	1,965	720	1,965	-1,245	37%	1,169	-449	62%

Source: HPC Wales

3.3 Estimated Employment and Training Impacts

This section provides a high level net GVA impact analysis of two elements of the HPC Wales programme using survey findings and recognised benchmarks from the Homes and Communities Agency (2014). It updates the mid-term position using the same methodological assumptions. It does not provide a full cost benefit analysis³ of the programme, which was not within the remit of the study.

Table 5: Employment Impacts

	Jobs Created to 30.6.15	Current	Future (3 years)	Total	Source
	Gross Jobs	174	522	696	WEFO Dashboard where completed evidence
Less	Deadweight	157	470	626	Informed by survey
	Leakage	149	446	595	HCA Additionality Guide Fourth Edition 2014
	Displacement	141	424	565	As above
	Substitution	134	403	537	As above
Plus	Multiplier	168	1.25	1.25	As above
	Net Jobs	168	503	671	
	GVA	£14,046,461	£42,139,382	£56,185,843	ICT GVA Per head estimate based on BRES/GVA ONS ⁴ data
	Return on Investment	2.1	6.3	8.4	20% of HPC total claimed to June 2015

It is possible to assess, in general terms, the likely GVA employment impact of the Project.

That said, an estimated 168 net jobs have been created to date once appropriate adjustments have been made (what would have happened anyway and so forth). With persistence⁵ of 3 years (503 jobs) added the total jobs rise to some 671. The current return on investment based on 20% of HPC costs claimed is around 1:2.1 (only a proportion of total costs was spent on supporting SMEs). Put another way every ERDF pound spent on business assistance can generate £2.10. **This rises to £8.40 when added to future projections based on 671 jobs generating some £56.2m of GVA.**

Our estimate is that the net participants have generated an estimated total GVA of £0.4m to date rising to £2.3m when taking into account future GVA (with an assumed persistence of 5 years based on survey evidence). **It will eventually generate a resultant RoI of 1:0.6 (i.e. £0.60 for every £1 spent on training).** It is quite normal for training impacts to result in a lower return on investment than business assistance.

³ We also note that in parallel an internal HPC Wales cost/benefit analysis approach has been conducted. This is an equally valid way of looking at the various costs and benefits of the programme using various benchmarks and scenarios.

⁴ The Business Register and Employment Survey/Gross Value Added from the Office of National Statistics.

⁵ The period of time over which the benefits generated will endure.

Table 6: Training Impacts

		Current	Future (5 years)	Total	
	Participants	1622			WEFO Evidence
Less	Deadweight	697			Informed by survey
	Leakage	663			HCA Additionality Guide Fourth Edition 2014
	Displacement	629			As above
	Substitution	598			As above
Plus	Multiplier	1.25			As above
	Net participants	747			
	GVA per participant	£517			Average annual NPV per unit informed by BIS estimates (link here)
	Total GVA	£386,394	£1,931,968	£2,318,361	
	Rol	0.1	0.5	0.6	Based on HPC training budget to date

There will be additional impacts as a result of long-term infrastructural development and research activity. These have not been considered here as they were not part of the proposed study method. A technical note on key aspects of the net impact methodology is provided in **Appendix V**.

The employment and training figures need to be read with caution as it is difficult to disentangle the costs of business assistance and the majority of the adjustments are based on benchmarks.

4. EVALUATION FINDINGS

For the purposes of this final evaluation, the Consultants completed face-to-face interviews (telephone interviews where face-to-face was not possible) with key stakeholders of the Project, as identified and agreed beforehand with HPC Wales' senior management. In difference to the mid-term evaluation, the Consultants did not undertake a detailed external stakeholder review for the final evaluation, however, we did speak with representatives of other ERDF projects aligned to HPC Wales, WG and WEFO.

Evidence and commentary from the completed interviews (Executive Board Members, Senior Management and Staff) have been utilised to inform the commentary and analysis under specific headings below.

4.1 SPV Executive Board Members

The Consultants interviewed five board members and the following represents their collective response to key evaluations topics, namely:

- Progress since the mid-term evaluation;
- HPC Wales performance to-date;
- Project management performance;
- Future for HPC Wales.

4.1.1 Progress since the Mid-Term Evaluation

Whilst there was recognition from Board members that the Project had experienced difficulties with its set-up and early operations, it was evident that significant progress has been made since the midway point. It was commented that the mid-term evaluation was correct in its conclusions and recommendations and that management had acted upon those recommendations to improve Project performance. Staff changes, and a clearer focus on roles and activities, were seen as being the catalyst for change and enhanced performance.

Interviewees generally accepted that everything stated in the mid-term evaluation's conclusions and recommendations section was correct. That report specifically focused on a future programme and, as a result, a model/management structure/facility needed to be created through ERDF that was fit-for-purpose and also deliverable.

There was recognition that the SPV model, although chosen for specific reasons and after legal consultations, presented a number of challenges related to Stakeholder interests, and possible conflicts of interests, and did create an additional level of complexity. However, it did focus stakeholder attention on delivery outcomes, and four of the six stakeholders will be proceeding to HPCW II, taking on board lessons learnt.

Key Board members have recently been occupied with the creation of a new, more appropriate and flexible structure to move the Project forward, and they were keen to share this with the Consultants during this final evaluation exercise. It is now accepted that the follow-on ERDF bid will be based on a 'first amongst equals' model, led by Cardiff University. This model will facilitate the academic-focus identified by senior management within the Member Institutions as the correct way

forward and the Consultants agree that this approach has the ability to achieve short-term goals. SPV representatives also now have greater faith in terms of collectively targeting outputs, outcomes, and indeed, impact, based on lessons learnt.

4.1.2 HPC Wales Performance

The Board members were less forthcoming when answering questions on the performance of the Project. They generally believed that when they began to focus specifically on ERDF targets, progress was made. They believed that if resources and focus were committed early on in the Project, all objectives would have been reached. The only one that would have generally caused concern was commercial income. Whilst they believe that this is a legitimate activity, as all universities need to work with commerce and industry to put a monetary value on such activities, this could have changed the nature of relations and is possibly not the best way to build longer-term partnerships.

In terms of moving forward, members were keen to see a new programme focused on increasing academic capacity but realised also that academia needs to work with industry, be that SMEs or large organisations.

4.1.3 Project Management

Board members were all in agreement that the Project turned a corner under the direction and stewardship of the new chairman and CEO, and that the relevant issues were addressed. SPV board members praised the efforts of management, specifically in terms of turning things around and responding to requests from the Board.

“Management worked hard to improve Project performance and they responded professionally to requests from the SPV (facilitating decision-making in relation to strategic direction), provided good data, and enhanced the overall performance of the Project and the HPC facility.”

It was recognised that, towards the end of the Project, there was a focus on cash flow and making sure that WEFO targets were being met, possibly to the detriment of continuity of service and succession planning. The Consultants are, however, confident that the focus and direction are now present to make a success of any future programme.

4.1.4 Future of HPC Wales

The Board was unsure about the future of HPC Wales until quite late in 2015, with initial thoughts based around continuing in much the same way as previously. However, this changed to a focus on a second programme based on providing capability to academics and researchers.

The agreed understanding that there will be three core partners - Cardiff, Bangor and Swansea - representing the more research-intensive universities in Wales and those where greater academic/researcher support is required. Decisions have not been finalised as to how other partners will engage, although SPV Board members support the new structure and it is very likely that there will be a 'first amongst equals' model employed, with Cardiff being supported by Bangor and Swansea University, and that a further partner will be HPC Wales Limited. The latter will retain the assets from the Project, will operate as an SME and will therefore be able to win grants and enter into

contracts not normally open to HEIs, including identified areas that a future HPC Wales programme could become involved in, such as cyber security, which was referenced on more than one occasion.

This new structure will mean a move away from supporting businesses, particularly SMEs. The universities willing to continue with the Project under the stewardship of Cardiff University agreed that such a programme would be feasible, commenting that once this had bedded down there may be the opportunity to look at other forms of academic or enterprise support. They recognise the value of the Horizon 2020 contract and believe that future training, business support and, indeed, governance, needs to be looked at but, importantly, accommodated correctly and separately to the main ERDF programme.

It is clear that HPC Wales suffers from low levels of recognition and understanding throughout the Welsh Universities, not being seen as a facility that has the ability to support non-computing, interdisciplinary departments and budget holders. Board members identified that this will be addressed in any future programme via good internal marketing. From general discussions with the university partners, the Consultants would suggest that building links with facilities such as the Bio-composites Centre at Bangor University and beyond to the likes of the Centre of Excellence in Mobile Applications and Services (CEMAS) at the University of South Wales, would facilitate enhanced internal marketing processes.

It was then discussed whether owning or renting a HPC facility would be the most appropriate strategy for future programmes, with interviewees unanimously deciding that owning was the only way forward.

“If it is onsite, people know about it because they become curious and enquire. Owning it means that you invest in people and resources (software and support) that can maximise its use.”

“Why pay the likes of Amazon and Google a profit contribution, when we can keep it within the organisation for the benefit of the partners?”

There are also clear operational benefits from ownership, e.g. if academics are using third-party HPC resources, they often have to get permission and funding to engage. This is often time-consuming and deters activity, particularly when tendering for work is usually time restricted. Moving forward, if HPC Wales is promoting to academia, it needs to know who the best academics to promote to are, get the most utilisation, and extract the most value.

Interviewees recognised that, as a tool, HPC Wales should be made available to train academics and young graduates. Whilst nothing has been discussed on the future of the Skills Academy, ESF bids would make great sense and would have the backing of the Board members.

It was also acknowledged that a lot of the software uses open source, which results in the need to build applications etc. On any new programme, these skills need to be retained in-house for sustainability.

HPC Wales II will work on the assumption that the current equipment will be fit-for-purpose up until 2017. It is likely that the Dylan Thomas Centre would have a longer life, being at least 12 months newer, and being based on the Sandy Bridge chipset from Intel. HPC Wales II will see a modest refresh and investment, planned to take place in early 2017.

Board members viewed HPC Wales as providing a good learning experience, generating knowledge, creating a structure and doing a lot of groundwork for a HPC Wales II Programme. There were a lot of lessons learnt; the primary one being that you cannot shoehorn a ten-year programme into a five-year exercise.

It was recognised that HPC Wales is currently in a place where it is more useful for academia than SMEs. Board members accepted, however, that there is great benefit in having your own HPC facility. Interviewees claimed that a good HPC facility should be used as a tool to promote Wales to the world, and should contribute to Wales winning competitive R&D-type projects. It was also recognised that there is merit, albeit belatedly, in exploring the opportunity for a training academy. It was unanimously recognised that the facility needs to remain flexible, which will come from the staff running the facility, learning and employing better ways of driving value, and making sure that the resources are shared as best as possible.

4.2 Management and Operational Staff

The Consultants held personal interviews with eight senior, full-time members of staff, with the key points from the interviews expanded on below.

4.2.1 Project Management

As at the mid-term evaluation, management acknowledged that the Project had experienced a slow start, as well as problems in recruitment and targeting. They recognised that with the management changes, particularly the Chairman and CEO, greater direction was provided but by that time the focus clearly was on attaining ERDF outputs. Management worked with the resources that they had, but difficulties were encountered, particularly due to the uncertainty of the future of the Project.

It was generally acknowledged that project management during the second half of the Project focused on achieving ERDF outputs and developing future models, which would require SPV Board approval. Several models were discussed and presented, however, uncertainty from Board members until late 2015 meant that there was limited opportunity to create a follow-on Programme that continued with the current staff and resources. As a result, staff members began to leave because of uncertainty about their future job prospects. Management also recognised that the roles that they had created could not be filled, as people with the necessary skillset generally did not exist, and certainly did not exist in Wales. This again provided good lessons on how to move such programmes forward, demonstrated by the choice of a sales manager with limited previous experience, followed by the use of a consultant who started to build a robust sales pipeline within a very short period of time.

In terms of future activities, the Consultants are confident that the new Board appears to be committed and capable of taking activities forward into HPC Wales II.

4.2.2 Project Performance

Despite the continuing impact of the early delays, it was the opinion of HPC Wales' senior management that performance levels did improve in the second half of the Project, as evidenced in the outputs and outcomes.

Example comments included:

"The key driver was seen as being the operational team getting up to speed, being able to articulate the product offering in a more attractive way for SMEs, and starting to build applications and sector-specific expertise."

The phrase "wrap-around" was used to demonstrate a greater understanding of the augmented product, i.e. the fact that SMEs buy into results that are implementable, thus not only drawing on HPC but also on the application software and the skills of the staff to frame the research/activity, and interpret the results,

In terms of performance, the interviewees recognised that they had a 'golden period' between mid-2013 to mid-2014. During this time projects numbers and activity were doubled and if this had been sustainable, HPC Wales would have delivered all targets. The loss of staff in the final year of the Project had, however, a major impact on performance.

Interviewees identified that one of the key lessons learnt related to the time that it takes from initial contact with an SME to undertaking the actual engagement. Following discussions held during this evaluation, the Consultants are confident that, if the Project was to continue to target SMEs, management have views on how this process could be more effectively managed and engagement time reduced.

A second lesson learnt emerges from the comments made by the HPC Wales operational staff that project management often focused exclusively on the delivery of WEFO targets, with the suggestion that more attention should have been given to exploiting the real core competences and building sustainability into the Project. It can certainly be argued that while this focus on targets is inevitable in time limited programmes such as ERDF/ESF, a greater awareness of this tension by management and overall governance of the project would have enabled a more balanced assessment and focus on outcomes and outputs. Again, this is certainly a key learning point from HPCW-1.

Several interviewees identified that the change of Project duration from ten to five years was not properly reflected in the re-profiled targets. At the time, management believed that a more detailed re-profiling was required, rather than purely a scaling back of target outputs.

"The Project was originally designed for 10 years but then (due to the funding route) it changed to five years and outputs were scaled back. You don't scale back outputs, you re-plan them for a five-year programme, in difference to 10 years."

It should be emphasised, however, that while the original HPC Wales business plan had presented a 10 year programme to deliver the stated aspirations of HPC Wales, the funded project duration was only ever for five years. The initial targets were agreed by HPC Wales in full awareness of this project duration, and while the targets were potentially over ambitious, it is not the case that they were set too high.

4.2.3 Progress since the Mid-term Evaluation

All interviewees believed that overall progress since the mid-term evaluation was good and this progress has been attributed to a number of activities and events. The recruitment of a sales consultant, for example, facilitated the development of a robust sales pipeline, with management believing that having an experienced sales consultant at the start of the Project would have resulted in the two main targets being extremely achievable.

From the midway point, the Board was more strategic in its instructions and focused on delivery. There was clearly better communications between the management team and the Board, and between management and operational staff, which resulted in enhanced focus and direction.

"The mid-term evaluation provided a degree of focus and objectivity. We started to act upon that review. We saw better communications and commercial planning."

Interviewees also believed that support to businesses was fine-tuned to the needs of SMEs following the mid-term review, resulting in SMEs being more able to instantaneously understand HPC Wales' product and service offering and how it benefitted businesses. Clearly the SMEs that were supported were talking to other SMEs, and that provided an effective 'word of mouth' marketing channel.

One of the critical observations from the mid-term evaluation was that whilst HPC Wales had the appropriate HPC facilities, it did not necessarily have the correct software packages, nor did it have people with the right competencies and sectorial expertise to drive value from the system and the software. Management acknowledge that great strides were taken to address this, including understanding regional sales planning and getting staff more engaged with business.

It is clear to the Consultants that lessons have been learned by senior management in terms of the importance of having a well-planned HR and recruitment policy, detailed marketing plans, with clear roles and responsibilities for all staff. There would appear to be clear consensus as to how HPC Wales should proceed over the short term (focus on academic endeavours) and the Consultants are happy that Member Institutions' senior management know what is required in terms of strategic direction for any future HPC Wales programme.

4.2.4 Relationship with Fujitsu

It is clear from the evidence obtained during these interviews that the experience of working with Fujitsu was mixed, and whilst Fujitsu fulfilled its contractual obligations, the ability to forge a long-term strategic collaboration proved challenging. This is not to say there were no additional benefits, for example the PhD studentship programme proved to be successful in engaging academics, students and SMEs. Whilst the management team accepted that they had limited experience in scoping and negotiating such contracts, however, the competitive dialogue process (a process now no longer encouraged in procurement) turned out not to be the most appropriate vehicle to use.

In the variety of interactions throughout the Project, Fujitsu proved less flexible than anticipated, for it was difficult to substitute resources and change requests invariably resulted in relatively expensive solutions. The market opportunities to generate additional income were disappointing and little materialised, whilst communication between HPC Wales' management and Fujitsu was not as comprehensive as it might have been, although a number of working groups were set up to address this [for example Executive Partnership Board (EPB), Collaboration Partnership Team (CPT), and the Infrastructure Working Group (IWG) and Technology Evaluation Team (TET)]. There remained however some uncertainty regarding the obligations and roles, for example in managing 3rd party contractual relationships, such as 3rd party software and storage solutions.

4.2.5 Project Networking and SMEs

There was acknowledgement throughout the senior management stakeholder group that synergistic collaborations with similar programmes/initiatives should be considered for HPC Wales II, not only to strengthen funding bids going forward, but also to better serve the SME and/or the academic community.

A number of the management team communicated that HPC Wales II has no plans to engage with SMEs. Over the lifetime of the Project, 2,600 users held user accounts on the system, 2,000 of which were accessed via the Skills Academy. HPC Wales II should consider an ESF bid, which will accommodate the skills side.

We discussed how HPC Wales would collaborate and work closer with Advanced Research Computing @ Cardiff (ARCCA), and both management and operational staff were of the opinion that both facilities can be treated as one, and that would be seamless as far as end-users, i.e. researchers, are concerned.

“Having this facility would make the University more effective in European bidding. The University is signed-up to Vision 2020, a network of similar organisations and I expect that the University will be more successful with EU money going forward.”

There was also recognition that there may be a requirement for a UK-wide HPC network and that this is something HPC Wales II should be involved in:

“The UK wants to develop a regional HPC network, funded by such organisations as The Engineering and Physical Sciences Research Council (EPSRC) going forward. There is an attitude that we didn't do well. We have done well and we could do better. We have developed best practice, such as the escalation through the four stages as a prime example. That is seamless, as far as end-users are concerned.”

4.2.6 Future HPC Wales Programme

As stated, several interviewees discussed and promoted the 'first amongst equals' model going forward, potentially with Cardiff leading the Project.

In terms of the actual HPC equipment, management and operational staff, in agreement with Board members, unanimously accepted that it needed to be in-house rather than contracted.

“For resilience and sustainability, it is good to have two sites, but that does not necessarily mean that you have to have equivalent teams. A 'first amongst equals' model is likely to be much better. With an academic-led support objective, we need greater representation in the universities at academic levels so that they know the facilities are there, they can be supported in using it efficiently, and then create longer-term relations.”

Interviewees believed that any future HPC Wales programme needed to focus on:

- Generating research income for Wales.
- Working with WEFO more closely, one of WEFO's outputs is more work to Wales from the EU.
- Supporting the public sector (social, environmental, well-being studies).

Finally, 'Big Data' and 'Cloud Computing' was identified as an area that would provide increasing opportunities for any future HPC Wales programme:

“Big data would be core to a lot of sciences going forward, and to fundamental research. As a prime example, Cardiff has taken delivery of one of the largest brain scanners in the world. Such brain scanners produce massive amounts of data, which needs to be stored, accessed and interpreted. This cannot be done effectively without HPC. HPC can support such programmes and indeed help universities to win RCUK core funding. It is not just for big projects and big sciences but it could be for the lesser disciplines, i.e. smaller projects and social sciences, environment and other applications.”

In conclusion, the Consultants would suggest that the research undertaken for this evaluation clearly shows that such activity is valid and can be sustainable through reinvestment and the positioning of HPC as delivering emerging opportunities, including research into major social, environmental and commercial opportunities.

4.3 Conclusions from Stakeholder Interviews

- HPC Wales delivered well against its WEFO re-profiled output targets, however, this was sometimes to the detriment of wider strategic benefits.
- The HPC Wales II structure is beginning to take shape and it is likely that there will be a ‘first amongst equals’ model, led by Cardiff University and supported by Bangor and Swansea Universities, and that a fourth partner will be HPC Wales Ltd. HPC Wales Ltd will retain the assets from the Project, will operate as an SME and will therefore be able to win awards and grants that are not normally open to the universities.
- HPC Wales II will have an academic-led agenda and, in a similar scenario to that of the mid-term, there is still a requirement to educate and build awareness of what is available from HPC Wales and the benefits of HPC, this time to the academic user base.
- It is acknowledged that any future programme must have a clearly defined operational plan and that the correct staff, with the requisite skillset must be in place for the commencement of the programme.
- There is currently a general disagreement as to whether the training aspect should be included in any future programme. Similarly there are conflicting opinions about the ongoing provision of services to businesses, however Board members will make this decision.

5. HPC WALES RESEARCH OUTCOMES

The information below shows principle outputs of High Performance Computing in research evaluation and testing for Academics and businesses.

HPC Wales has prepared and undertaken an assessment of research endeavours and outputs and from this report we have provided the selected highlights below:

Table 10: Number of HPC Wales Research Outputs as a function of Institution over the period 2009-2015.

INSTITUTION	JOURNAL PUBLICATIONS	CONFERENCE PROCEEDINGS & PAPERS	INVITED LECTURES, PRESENTATIONS	POSTERS	RESEARCH PROJECTS ETC.	PHDS, STUDENT-SHIPS ETC.
ABERYSTWYTH	12	9	4	-	1	12
BANGOR	41	40	26	4	13	20
CARDIFF	25	23	40	9	24	12
BOTANICAL GARDENS	3	-	-	-	-	-
SOUTH WALES	43	11	3	8	5	3
SWANSEA	40	22	57	16	13	36
UNIV. WALES	2	3	-	-	1	2
TOTALS	166	108	130	37	57	85

Table 11: Number of HPC-related Journal Publications and Conference Proceedings as a function of Institution over the period 2009-2015.

	2009	2010	2011	2012	2013	2014	2015	Total
University of Bristol	82	139	187	260	-	-	-	668
University of Cardiff (ARCCA)	84	91	79	99	127	152	111 ⁶	743
HPC Wales	-	6	16	21	57	86	88	274
Imperial College	37	73	31	12	12	9	-	174
ARCHIE-West (Strathclyde)	2	19	27	36	36	27	7	154
Univ. of East Anglia	-	25	17	29	24	29	16	140
University of Bath	12	15	31	21	-	-	-	79
University of Exeter	15	16	8	10	2	8	-	59

The results show that relative to the size of the institution, key research outputs were shared across partner organisations. If you combine ARCCA and HPC Wales, the total outputs would be greater than the top UK HEIs. There is a clear opportunity for HPC Wales to support Wales' competitive position in HPC generated research outputs in the UK.

⁶ As of September 2015.

6. HPC BUSINESS AND SURVEY ANALYSIS

6.1 Introduction to the Evaluation Surveys

The following set of chapters summarise the findings from a series of online and telephone interviews completed as part of the evaluation. The research took place over two time periods: January to March 2014; and August to September 2015.

The following cohorts were consulted as part of the evaluation:

- Participants receiving training, either as student attendees of the HPC units undertaken as part of their degree or master's programme, as participants of HPC introductory workshops, or as participants of intermediate and advanced training courses.
- A business survey of those participating in HPC Wales support activity.
- A survey of the researchers and academic staff that managed or led the HPC training

The findings are non-attributable and 366 respondents were consulted about their participation in HPC activity representing a response rate of 13.2% overall. Despite this strong response rate the findings of individual surveys of more intensive support should be read with caution given the smaller numbers when the total cohort is broken down.

Table 12: Survey Response Rates

	Mid term	Final	Responses	Total Sample*	Response Rate %
Training Recipients on-line survey	164	117	281	2,628	10.7
Business Telephone Survey	32	25	57	91	62.6
Academic Staff and Researchers Telephone Survey		28	28	49	57.1
Overall	196	170	366	2,768	13.2

* Note where contact details provided by HPC Wales.

There are a few points to make about the survey. Two main methods were used – telephone surveys and on-line surveys. They both have advantages and disadvantages.

An on-line survey was chosen for use with training recipients as it was the most cost effective and efficient to administer. Also many of the participants had moved on from their institutions this was the only feasible means of tracing them (and it would have been difficult to secure a higher response rate through other means). The reader should bear in mind that on-line surveys have a risk of self-selection bias. That said the beneficiary data provided only included an e-mail address which meant any weighting adjustment to reduce bias was not feasible.

Telephone interviews were used with businesses and these were felt to be most cost effective and quickest way of securing as many interviews as feasible within the study timeframes and budget. HPC Wales requested that the consultant team focused on

the experience of those businesses who had had more than just a diagnostic. All beneficiaries were approached and 63% responded. An analysis of how representative these 63% was not undertaken as beneficiary profiling characteristics were not provided to the survey team. Telephone interviews were also used with academics and researchers for the same reasons as above. HPC Wales were very keen that we secured a good cross selection of users based on the consumption of computing hours. All beneficiaries were approached and 57% responded but these covered over 90% of the 90 million computer hours consumed by this cohort.

The reader should bear these points in mind when digesting the following results.

6.2 HPC Participants' Profile and Motivations

This chapter provides a profile of participants, their motivation and satisfaction and the degree to which they have been able to apply their learning.

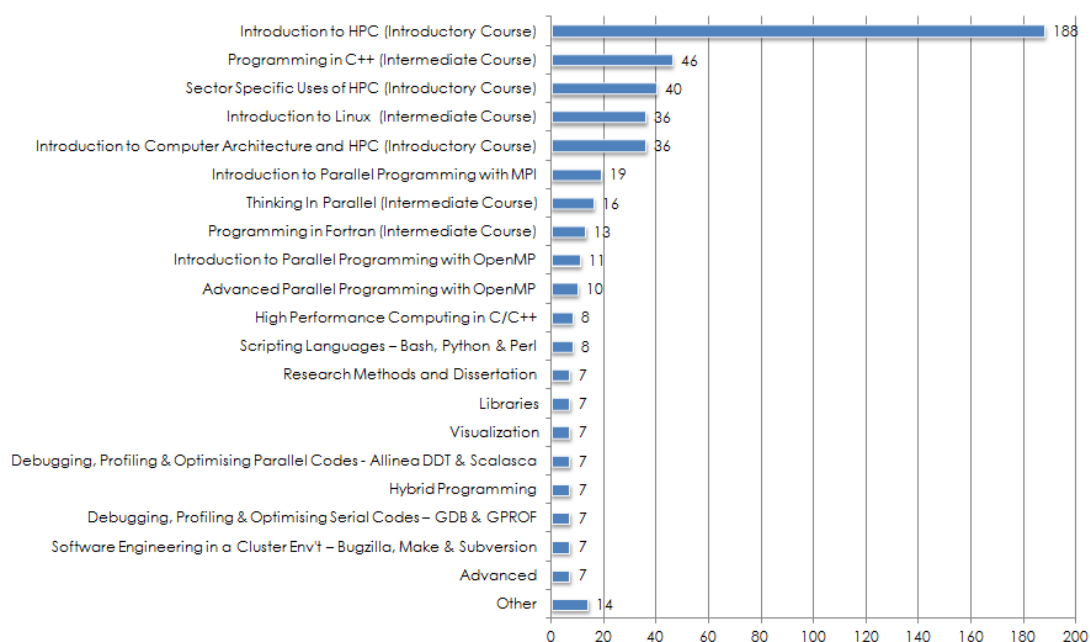
Profile

The participant survey was circulated to three different groups:

- Students undertaking HPC units as part of a degree or Masters programme (among the August to September 2015 respondents in this category, approximately 75% were undergraduate and 25% were postgraduate)
- Participants of HPC introductory workshops
- Participants of intermediate and advanced courses

Among the January to March 2014 sample group, just over half fall into the first student group, while the remainder are split fairly equally between participants of the introductory and intermediate/advanced training. For the undergraduate and postgraduate students who participated in HPC units, the most frequently cited courses relate to Computer Science, Chemistry and Computing.

Figure 4: Courses Undertaken (Introductory, Intermediate & Advanced)



Source: The Innovation Partnership Survey, March 2014 and September 2015, n=238

6.2.1 Motivations for engaging with HPC training

The introductory and intermediate/advanced participants were asked about their motivations for engaging with HPC Wales training (see chart and box). Participants on introductory training quite simply wanted to find out more about HPC and its benefits (see Figure 5 overleaf).

Advanced and intermediate participants were interested in learning about and accessing HPC systems to speed up, undertake or develop new or existing (research and/or commercial) projects. They clearly viewed HPC as being a tool to produce better research outputs.

Motivations (introductory participants)

"To learn more about HPC and to see if it could benefit our business".

"Learning about the technology and possibilities for my own research".

"Find out relevant support and software available within the system".

"Better understanding of the product and how it can benefit learners".

"Hoping to learn more about supercomputers, how they work".

"To find out about what HPC Wales offer and how it might be of use in my organization".

Motivations (intermediate/advanced participants)

"Parallel programming using HPC Wales platforms".

"Help me to speed up my research experiments".

"To better understand HPC Wales and the systems they offer".

"Skills needed to complete research project".

"To introduce me to the HPC programming language".

"To learn and develop skills in cluster computing".

"Required skill for my PhD project that predominantly involves coding and simulations".

"To use HPC for my research: Normally simulations which (without HPC) can take many hours".

"I would like to improve productivity and knowledge by attending training events".

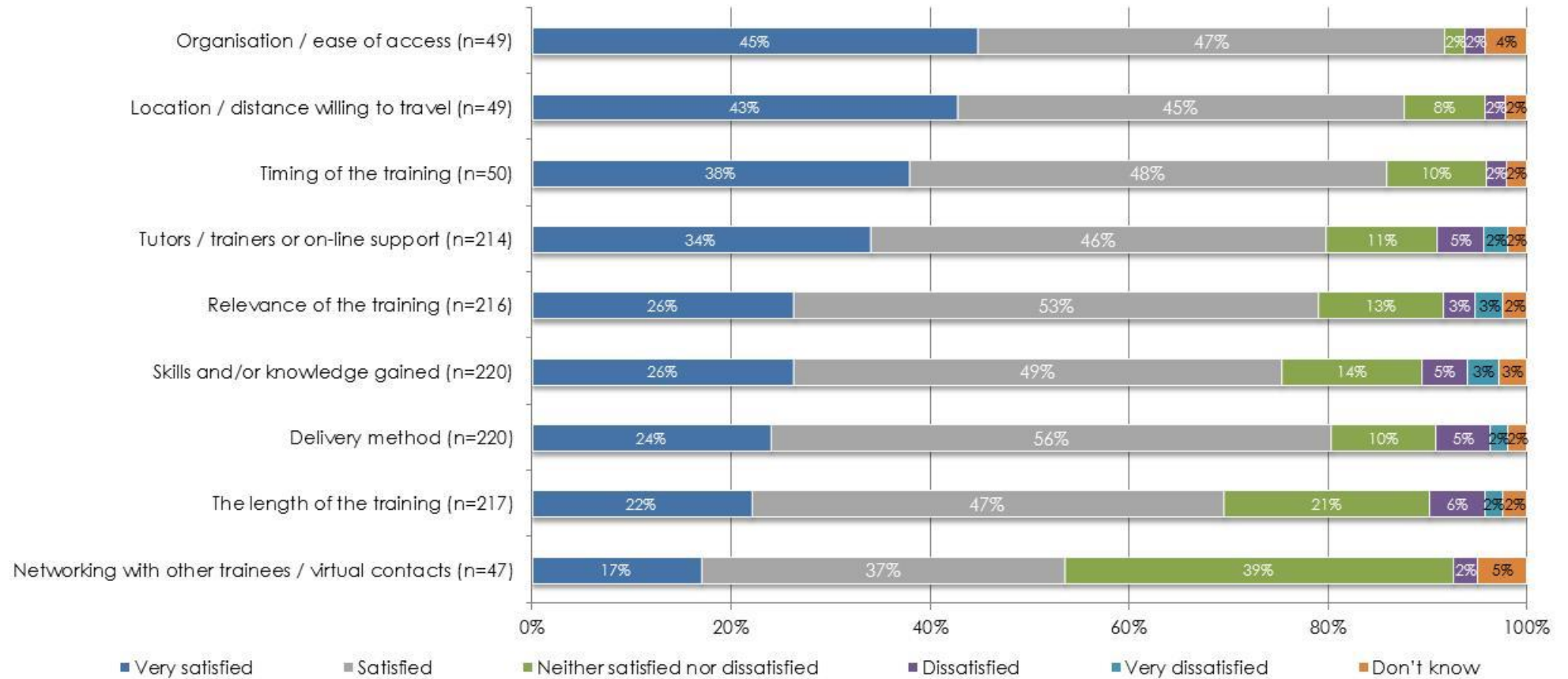
"Try and understand how HPC is being used by others, and for ideas that I could use to understand the software".

"We were interested in the capabilities of the various pieces of infrastructure".

"Receiving information to start my own projects on HPC Wales computers".

"To learn about MPI programming".

Figure 5: Factors Involved in Analysing Attendees Satisfaction with Training

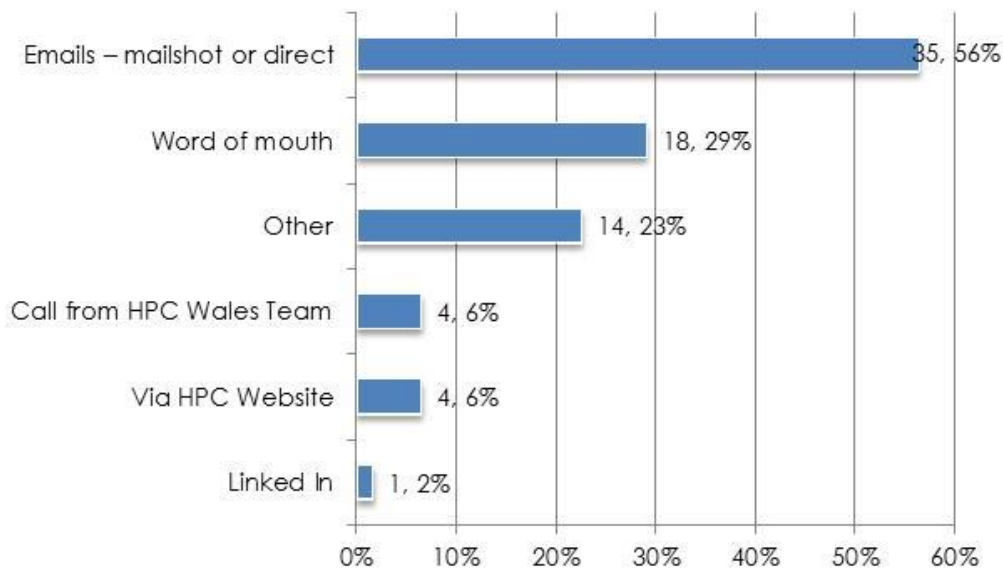


Source: The Innovation Partnership Survey, March 2014 and September 2015

* excludes Not Applicable responses

Looking at how participants found out about HPC in the graph, email was the most common route for over half (56%). Word of mouth was also important for many (29%) while others cited their Higher Education Institutions/Supervisors (especially for introductory services). The proportions finding out through calls from the HPC Wales team (6%), the HPC website (6%) and/or social media (2%) are considerably less.

Figure 6: How did you find out about the training?

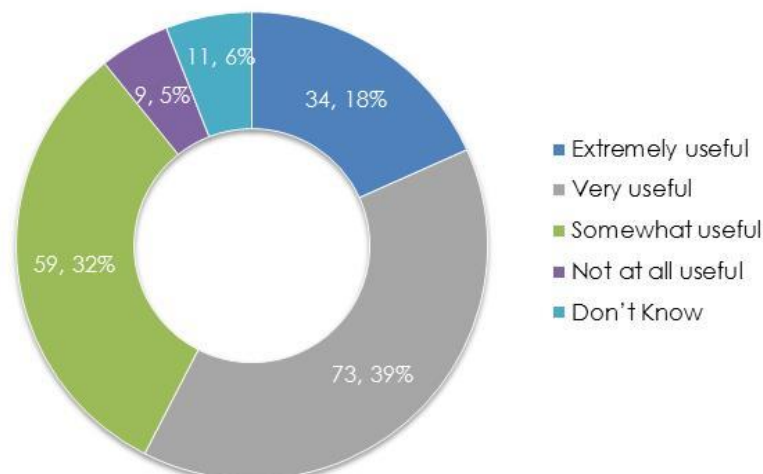


Source: The Innovation Partnership Survey, March 2014, n=62

6.2.2 Training quality and satisfaction

Students generally felt that the training provided a good insight into HPC (see graph and text box comments) with 89% finding it extremely, very or somewhat useful. There was a slight difference of opinion on the pitch and focus of the training – whilst most found it just right, there were a few respondents that found it either too basic or too advanced. Comments suggested students were really interested in the wider applications of HPC and particularly engaged when experiencing the facilities in a hands-on way.

Figure 7: How Useful did you find the training?



Student observations on usefulness of HPC:

"Great insight into HPC" "Introductory sessions were very good and informative".
"Opened my eyes to another area of computing that I had not looked into / knew about before".
"I was able to try true supercomputer scale software, not possible on a smaller Linux cluster."
"The programmes utilised in the school were interesting and seemed to have great utility in industry."
"It's extremely beneficial to get a perspective of HPC in the real world and be able to interact with the systems themselves. It's an experience that is not normally available through university otherwise."
"It was great to find out about HPC and how I could use their computers to do heavy processing work like rendering video".
"Interesting to see how we can use super computer clusters to undertake multiple tasks from around the country".
"I would have learnt a lot more if it had some aspects of self-learning and a longer session. A two hour course had very little time to allow the message to sink in and allow opportunity to learn".
"The content wasn't completely understandable for someone with little or no knowledge of how high performance computers work."
"Far too technical for beginners!"
"We knew a lot of it already and didn't challenge us".

These sentiments were generally reflected when participants were asked what had worked well and less well (see box).

Student observations on what worked well

"I thought the course in general was very good and I wouldn't make any changes to it at all".
"The practical lab sessions where we learned how to use the cluster and use tools to edit our programs using Vi and Emacs".
"Working through the booklet step by step made the learning very easy."
"Getting set up with HPC wales accounts and logged in to the system was very simple and easy."
"Found the information covered in the course to be relevant and interesting. The tutors assigned to be insightful and incredibly helpful".
"Hands on approach was good for me as I could see what it was all about more than the lecture prior to it".
"I found the example of HPC uses in medical research amazing".

And less so...

"The explanation on how to use HPC wales and how it relates to our coursework needed to be improved".
"It was too low-level and the complexity increase was too slow".
"The whole thing is not at BSc 3rd year level, no thought given to adapting course to clients".

"The lecture slides were hard to engage in."

"Spend less time on bash commands and use of Linux."

"It would have been helpful to have more lab time".

"More understanding required for downloading log files and being able to use them".

"A lot of the lectures were quite long and filled with technical jargon/lingo which was really hard to follow for someone who has little knowledge of such terms. The booklets really helped to complete the exercises which were simple yet improved skills and understanding".

"I would really like some literature on how to use or benefit from HPC Wales".

"The capabilities themselves are fantastic and the fact it's Welsh is incredible but definitely needs to compete more with render farms abroad. Render Farms abroad have usually a 24/7 helpline which can come in very useful. I understand HPC Wales operates 9-5 which doesn't really fit into a creative's needs".

Final Observations...

"Really good course, keep the project going".

"The lectures I undertook were very interesting and I hope to be using more of your computing programmes in the future (hopefully next semester)"

"After taking the course I am much more able to use HPC and it [is] now a lot less daunting."

"They [HPC] were very informative and help improve my skills a great deal".

"I gained a lot of new skills and knowledge".

6.2.3 Satisfaction with training

Survey evidence paints a positive picture in terms of the delivery of training for participants. All participant cohorts rate the tutors, trainers and on-line support highly. Respondents were particularly satisfied with the organisation, location and timing of the training. Respondents were positive but more ambivalent about networking and meeting others through the programme.

Results for the January to March 2014 respondents find that the highest levels of satisfaction for skills gained were among the intermediate and advanced cohort and that their rating overall was generally higher than the other two cohorts. This suggests that satisfaction generally increases in line with the level of training offered.

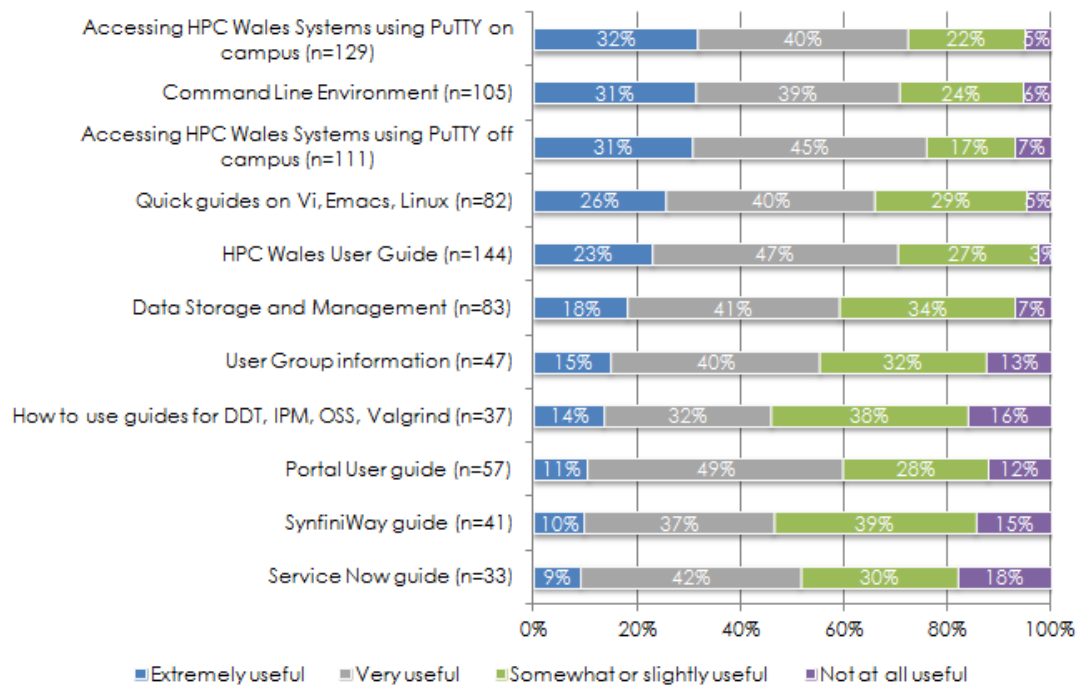
6.2.4 Meeting business/participant needs

For nearly 90% of those who responded who attended the advanced or introductory courses, the training and workshops provided by HPC Wales exceeded or fully or partially met their personal needs.

6.2.5 Degree to which support was used and found useful

The participants were asked about how useful HPC user guides have been (see **Figure 8**). Generally, the guides appear to have been well received by those that have used them especially the 'Accessing HPC Wales Systems' guides.

Figure 8: Which HPC user guides have you used and how helpful were they?



Source: The Innovation Partnership Survey, March 2014 and September 2015

6.2.6 Summary

- Participant motivations to engage in HPC were often quite simply a desire to find out more about HPC.
- Email is the most common way participants attending introductory and intermediate/advanced training found out about it.
- 89% of students who responded to the survey generally found the training extremely, very or somewhat useful but there may be scope to tailor it more to student capabilities.
- The delivery of training was generally highly rated by all participants surveyed.
- For nearly 90% of respondents surveyed who attended the advanced or introductory courses, it fully, partially or exceeded their personal needs.
- All respondents have generally found the guidance quite useful.

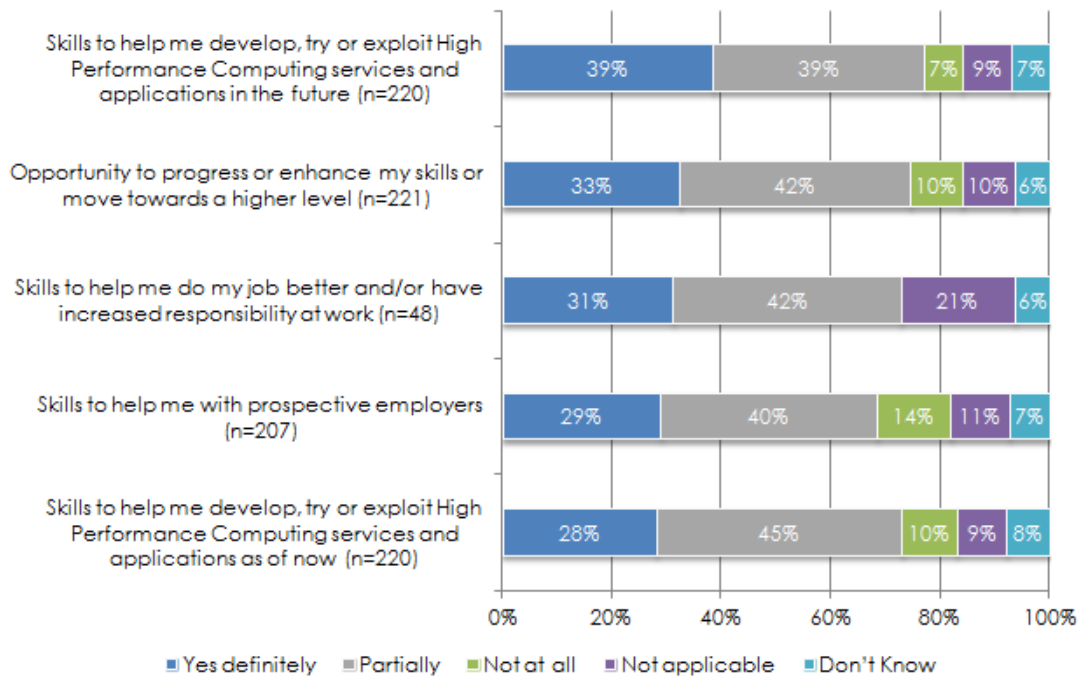
6.3 HPC Employability, Personal and Professional Skills Gained

The chapter highlights the skills gained by the respondents as a result of HPC training including employability, personal and professional skills.

6.3.1 Employability and personal skills

There is a clear sense that those who have participated feel they have gained opportunities to work on HPC services or applications (either now or in the future) and to progress their skills to a higher level. Around two-thirds of respondents also appear confident that their HPC skills have improved their employment prospects.

Figure 9: How has as the training helped you to achieve the following employability skills?

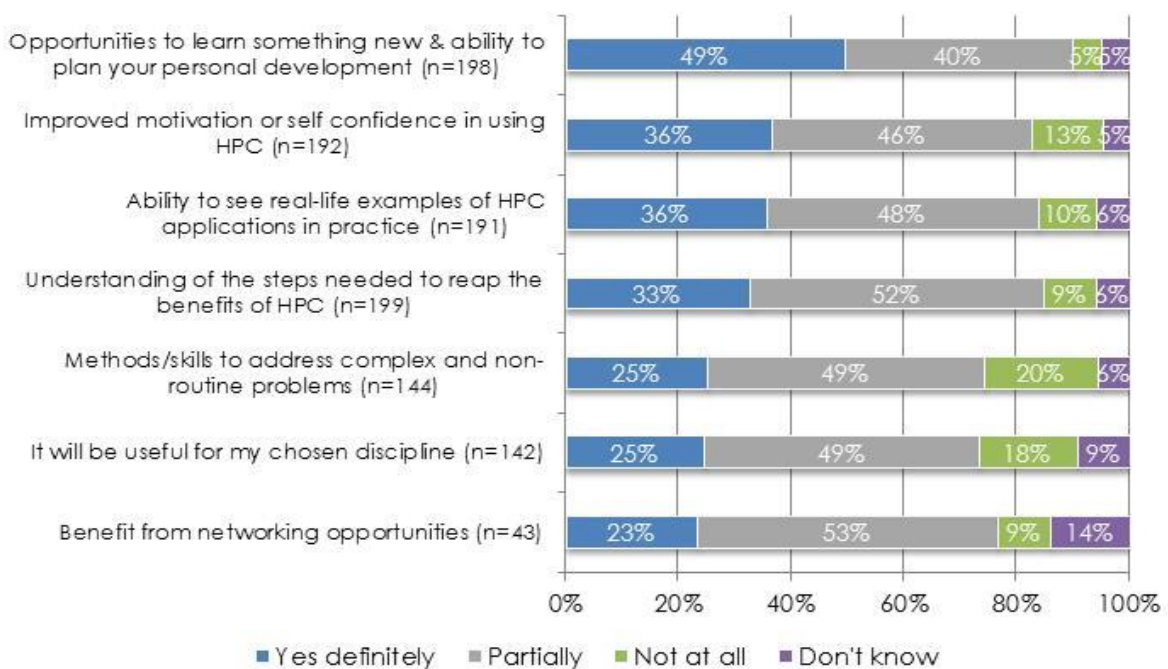


Source: The Innovation Partnership Survey, March 2014 and September 2015

6.3.2 New personal and professional skills or knowledge as a result of CPD training

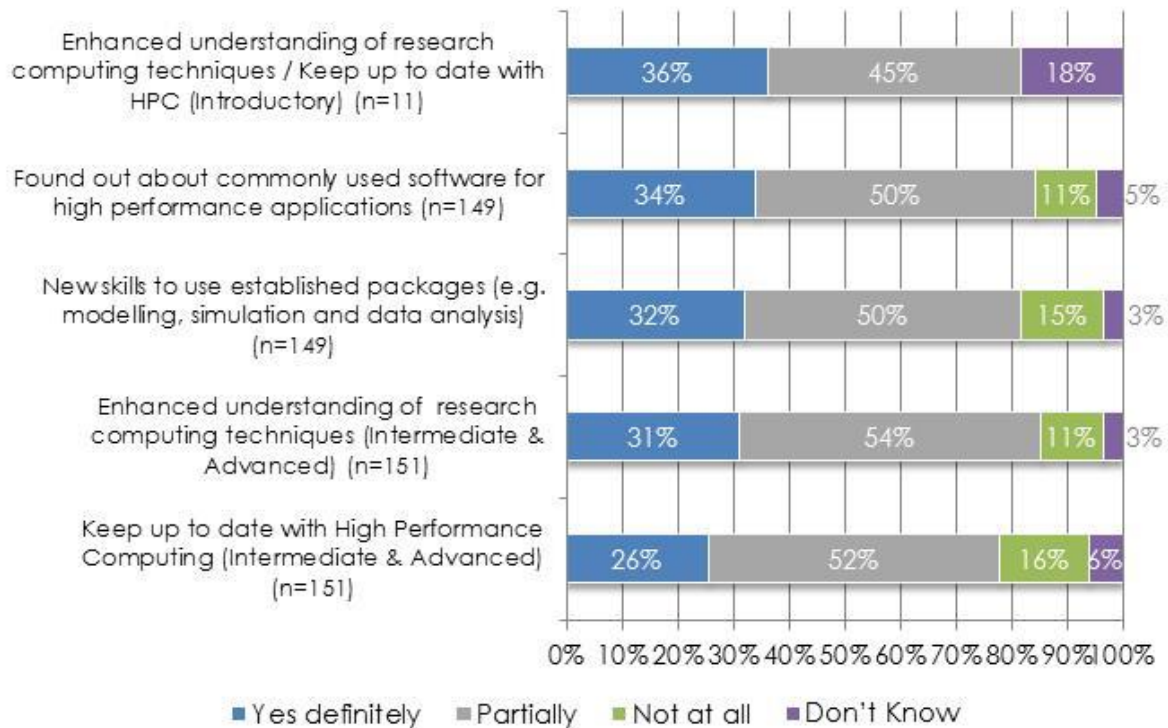
Looking at the new personal and professional skills gained (see Figure 10) it would appear that trainees have experienced improved motivation and self-confidence in using HPC and the steps required to reap the benefits. Trainees particularly welcomed the opportunity to learn something new and appear to have welcomed the ability to see real life examples.

Figure 10: Which new personal or professional skills or knowledge have you applied or do you hope to apply as a result if the training/workshops



Source: The Innovation Partnership Survey, March 2014 and September 2015,
 * excludes Not applicable responses

Figure 11: Which new technical/IT skills have you achieved or do you hope to achieve as result of the units/lectures?



Source: The Innovation Partnership Survey, March 2014 and September 2015
 * excludes Not applicable responses

Participants were also asked about IT skills achieved or anticipated as result of the training. Basically the training has helped them find out about commonly used software, enhanced their understanding of HPC and given them new skills to use established packages.

6.3.3 Degree to which skills/knowledge acquired will be used in the future

Nearly 90% of survey respondents think that they now have the skills and knowledge to engage in HPC in the future as a result of the programme.

Summary

- Participants feel they have gained an opportunity to progress their skills onto a higher level and have a better understanding of HPC.
- HPC training has increased the confidence of participants to apply HPC skills in the future and it has improved their employability confidence and self-motivation.
- Nearly 90% now feel comfortable that they have the skills and knowledge to use HPC in the future.

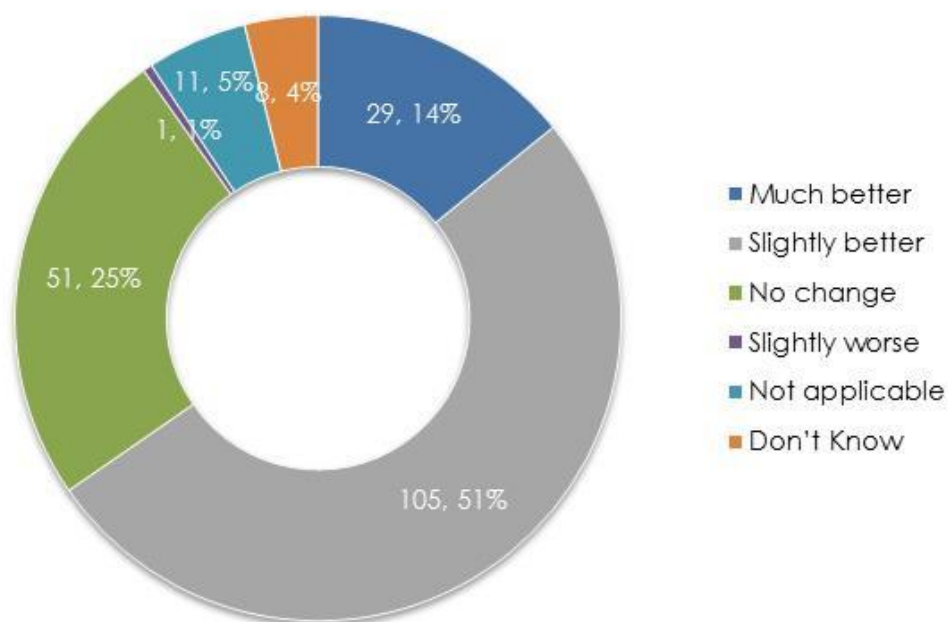
6.4 Participant impacts and future requirements

This chapter explores the impacts and wider benefits of the HPC training for participants. It concludes with an assessment of future training needs.

6.4.1 Employment outcomes and impacts

Two-thirds (65%) of survey respondents claim that their longer term job prospects are now much better or slightly better. When asked about the importance of the HPC training towards improving their job performance, 70% believe that it has been important or very important.

Figure 12: How do you think your long-term job prospects have changed as a result of the HPC training?

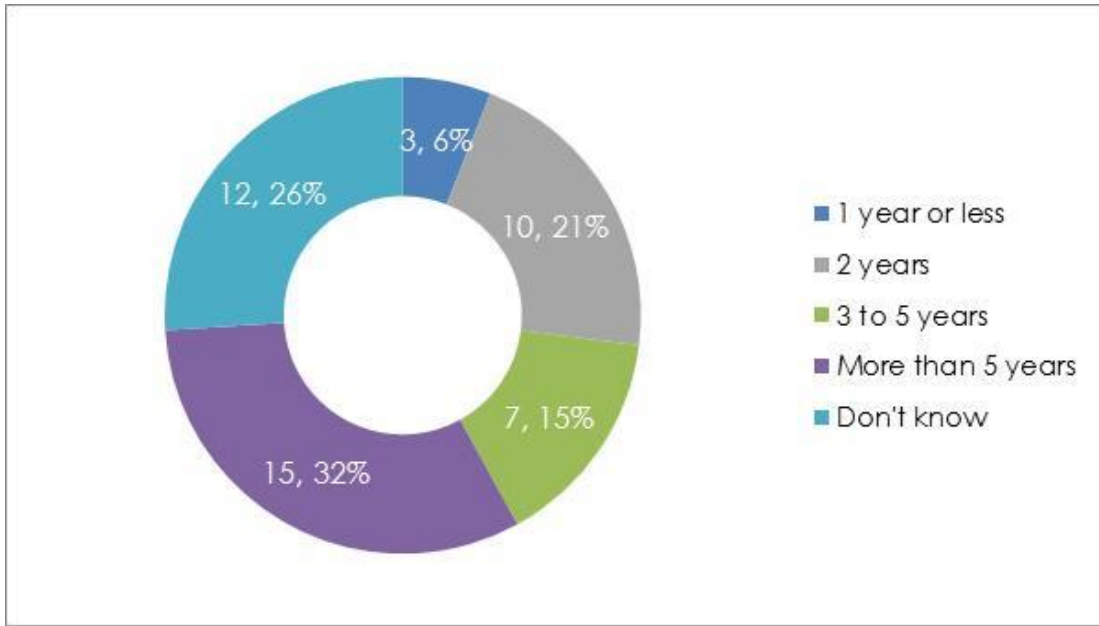


Source: The Innovation Partnership Survey, March 2014 and September 2015, n=205

6.4.2 Longevity of Impact

Looking at just the intermediate and advanced cohort, it is clear that many of the benefits of the training are expected to last more than a year. Over two-thirds (68%) of respondents claimed they would last two years or more.

Figure 13: How long do you expect the benefits of the HPC training to last?

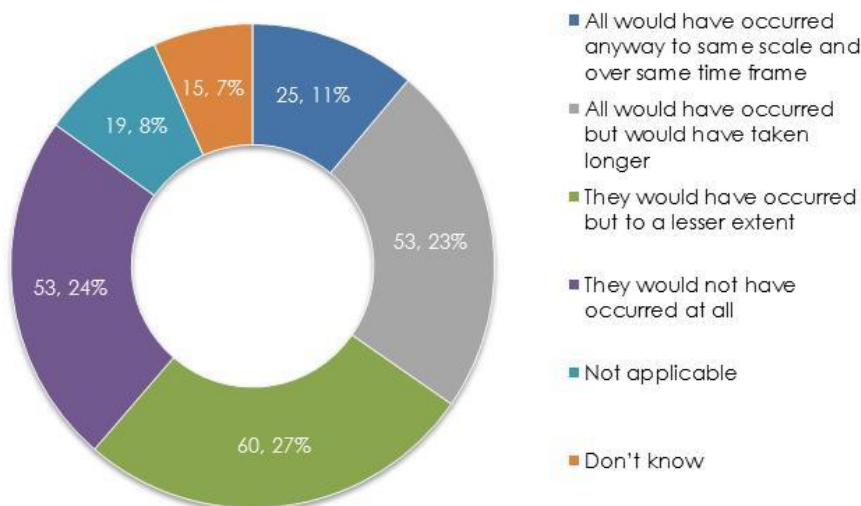


Source: The Innovation Partnership Survey, March 2014, n=47

6.4.3 Additionality

This question gives a good insight into the added value of the training across the participants. Whereas 11% of participants report programme deadweight (where the benefits would have been achieved anyway without the programme), about one-quarter (24%) report pure additionality (benefits fully due to the programme). A further 23% report 'time additionality' and 27% report 'scale additionality'.

Figure 14: To what extent would the outcomes that you have achieved occur without HPC training?

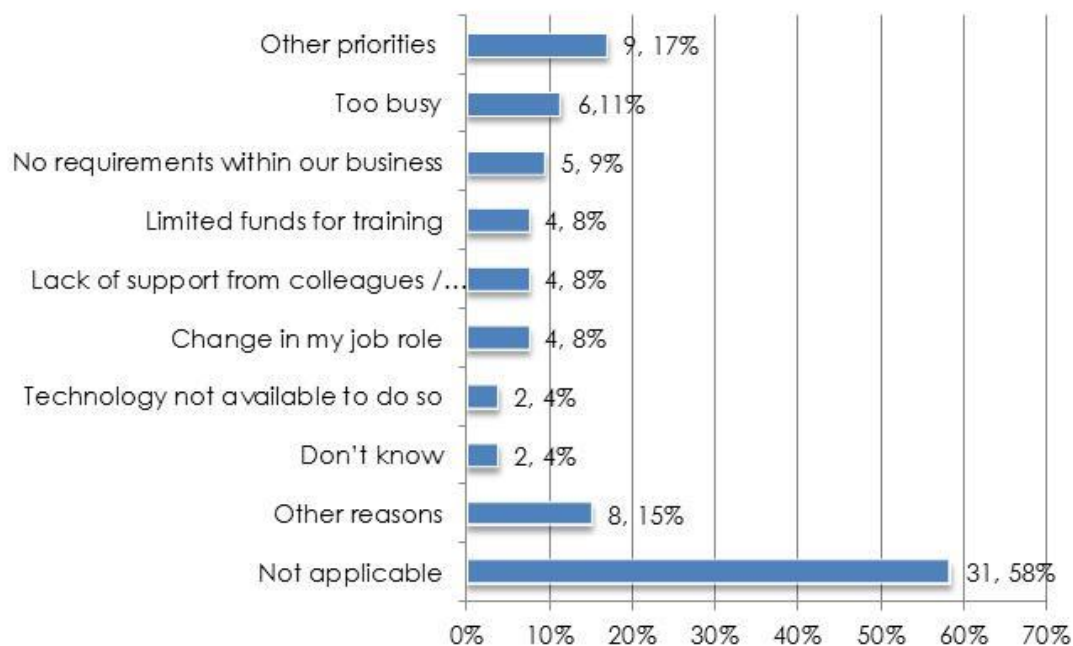


Source: The Innovation Partnership Survey, March 2014 and September 2015, n=225

6.4.4 Barriers to applying new knowledge

'Other priorities' and 'being too busy' were the key barriers to applying HPC learning amongst trainees. Within some firms and organisations, it would appear the potential significance of HPC has yet to be fully realised or exploited. It is interesting that technology does not appear to be a major inhibitor.

Figure 15: What are the barriers to applying new knowledge?



Source: The Innovation Partnership Survey, March 2014, n=53

6.4.5 Future training requirements

The text box shows that there appears to be an appetite to undertake future training. Looking at the next generation (students) and the introductory participants there appears to be a desire to understand programming and more specialist HPC applications. The intermediate and advanced respondents are looking to develop particular advanced software and programming skills (graphics processing unit programming for instance).

Further HPC knowledge required in next two years (students)

- "C++ programming and language".*
- "The manipulation of more complicated molecules using the software".*
- "How it could benefit the creative industry and what programs could be offered".*
- "More advanced cluster commands".*
- "Graphical computing processing."*
- "Experience of real-world HPC programs instead of tutorials and coursework."*
- "How to effectively program parallel code."*
- "Any training on general Concurrent and Parallel computing environments".*
- "Any that can aid in the computation in chemistry".*
- "The use of chemical quantum computing"*
- "Finite Element modelling".*

"Middleware design".
 "Monte Carlo Techniques".
 "Graph theory problems", "Data and image analyses".
 "HPC specific algorithms", "HPC in Big data problems".
 "HPC 7 / 13 Dwarfs".

Further HPC knowledge required in next two years (introductory participants)

"Parallel programming courses, perhaps with online video tutorials".
 "About the operating systems and how it can help the hospitals in the future".
 "Bioinformatics, in depth knowledge of bash or python".

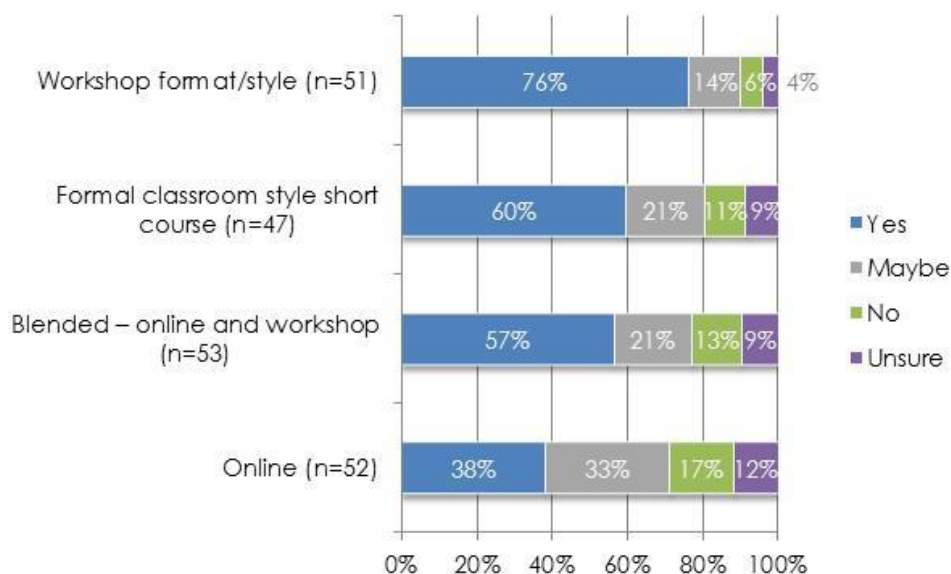
Further HPC knowledge required in next two years (intermediate/advanced participants)

"Programming languages and perhaps some workshops working through case studies which reveal the many applications of HPC".
 "Computational chemistry".
 "Use of ANSYS Multi-Physics (MFX) Software on HPC Wales".
 "Parallel programming".
 "Advanced MPI". "GPU, CUDA programming".
 "Solving the forward and inverse problem in 3D Simulations.
 "A roadmap of different levels of training".
 "GPU programming, compiler optimization".
 "Knowledge in the use of GPGPU's".

6.4.6 Delivery of future training

In terms of the delivery of training, the next figure shows there is a modest preference for workshop style/format training over pure online provision. Over half of participants would also consider blended learning. Workshops, short courses and blended learning would probably all be acceptable to trainees but purely online training would need to be introduced carefully as a minority might be resistant to this approach.

Figure 16: What is your preferred delivery format for future training?



6.4.7 Summary

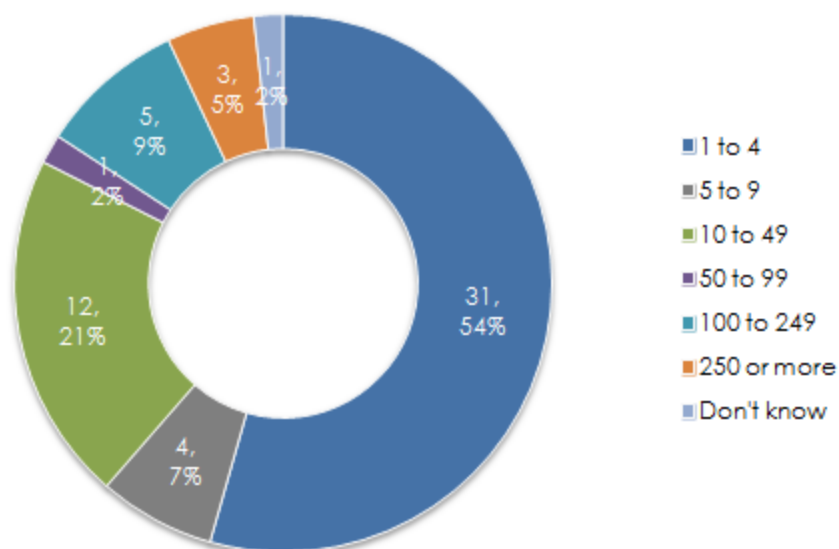
- Improvements in job performance are a key benefit of HPC training and this is pronounced amongst intermediate/advanced participants.
- 65% of participants claim that their job prospects are better as a result of the training and 68% expect the benefits to last more than 2 years.
- Three-quarters of HPC Wales trainees report pure, scale and time additionality while 'deadweight' occurs amongst one-in-ten.
- Technology does not appear to be a major inhibitor to applying new HPC knowledge - 'other priorities' and 'being too busy' were the principal barriers cited.
- There is an appetite to undertake further training, including programming and specialist applications.
- Workshops are the preferred format for training, followed by blended learning.

6.5 Business Survey Results

6.5.1 Introduction and profile of businesses and organisations involved

Interviews were conducted with 57 (63%) businesses out of the 91 provided with contact details who had had more than just a diagnostic. The following chart illustrates the numbers of businesses employing full-time equivalent staff.

Figure 17: How many full time equivalent staff are employed by your business?



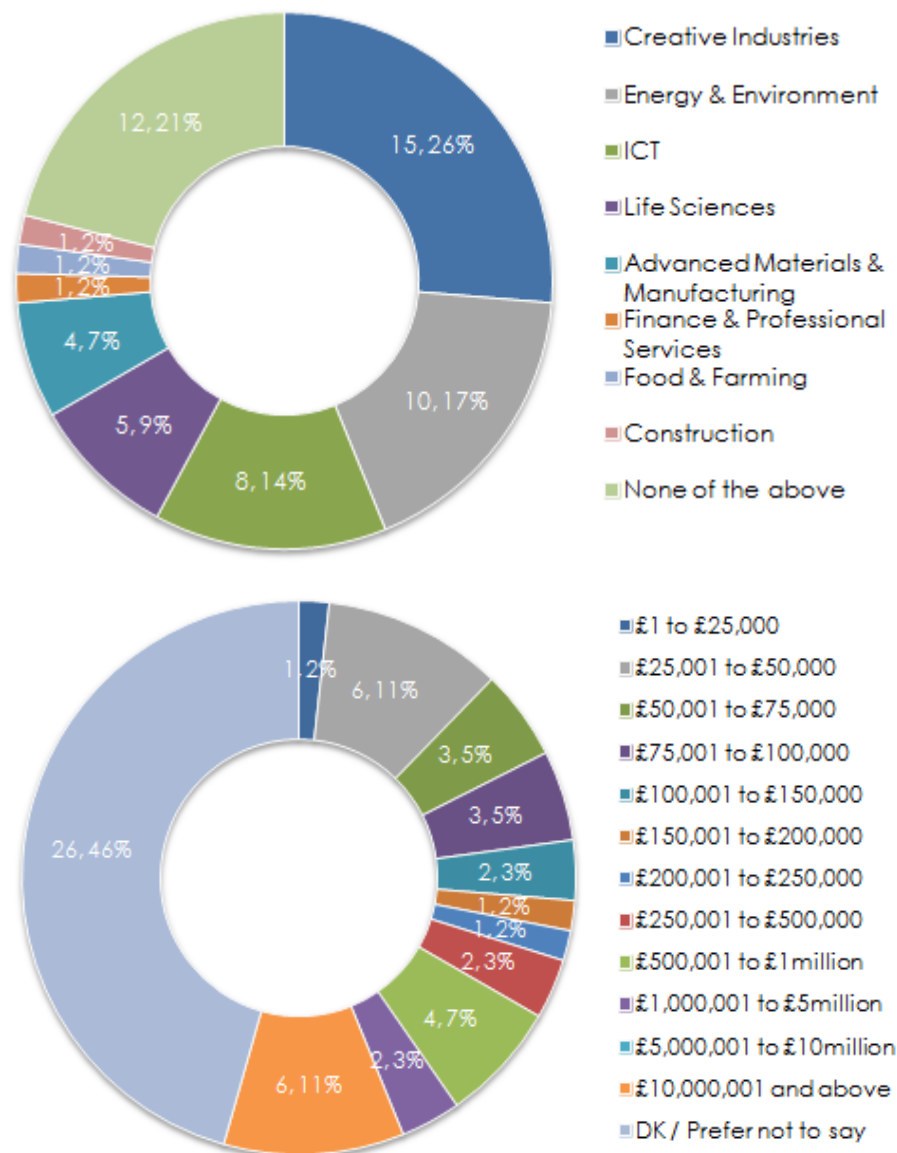
Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

61% of the sample are micro businesses employing less than 10 people, compared to the *Business Population Estimates (BPE) for the UK and Regions* survey which indicates 81.5% of UK employers. As a consequence, there is a higher proportion of each of the other larger employer size bands in HPC Wales companies. Generally this seems a sensible approach

and it makes sense to focus on the larger end of the SME cohort where the gains are likely to be highest.

The sectoral coverage of businesses is illustrated in the following chart. The sample includes four of the Nine Welsh Government Priority Sectors. Just over a quarter of businesses were in the creative industries, and energy, ICT, life sciences, and advanced materials and manufacturing (AMM) are also represented. Just over a fifth (21%) did not recognise themselves in the sectoral list provided. A recommendation from interim evaluation was to consider exploiting wealth-creation potential of technology/software within some of these other sectors (life sciences and advanced materials and manufacturing for instance) to achieve additional economic benefits. The analysis shows this has occurred.

Figure 18: Coverage of Welsh Priority Sectors and Turnover Bands



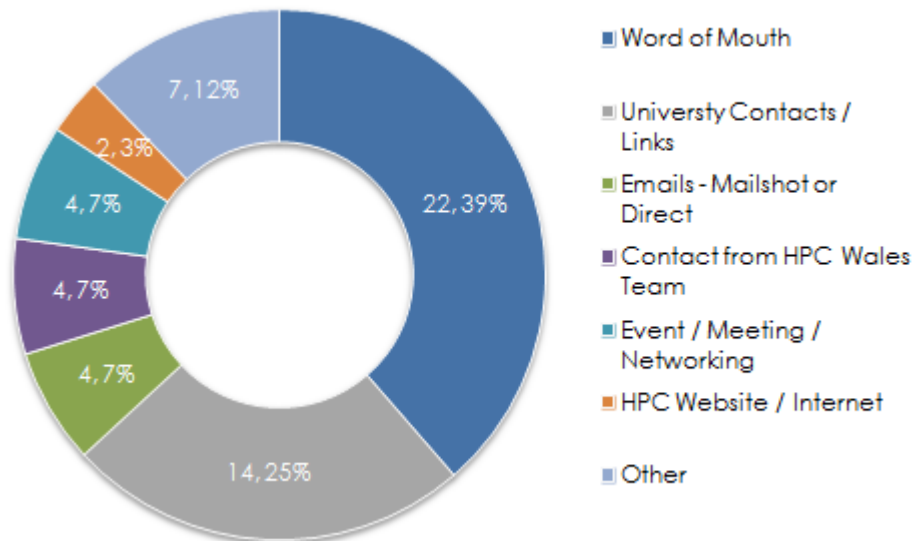
Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

HPC Wales has managed to target a good spread of businesses in terms of the turnover size of participating companies.

6.5.2 Motivation for engaging with HPC services

Looking at how participants found out about HPC, word of mouth was the most common route, accounting for 39% the businesses interviewed followed by University links (25%) – these had increased significantly since the mid-term. The impact of direct marketing was considerably less.

Figure 19: How did you find out about HPC?



Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

Motivations for accessing HPC systems fell into two broad categories. The first was to get access to computing power, the equipment and software, often to improve and speed up performance, achieve project deadlines and provide problem solving capability. The second motivational factor was more skills related, either to access technical support and advice but also to learn and train in the use of the systems and understand how to use a high performance computer.

Motivation for accessing HPC support

“Access to equipment and software and improve performance”
“We needed a computer to solve equation on moves and we needed it done quicker than we could ourselves.”
“Our research is based on HP computing and I needed the cycles on their computers.”
“We needed help in completing a piece of work and achieving our deadline.”
“Their computing platform is very powerful and interesting. No one else has anything like it to offer.”

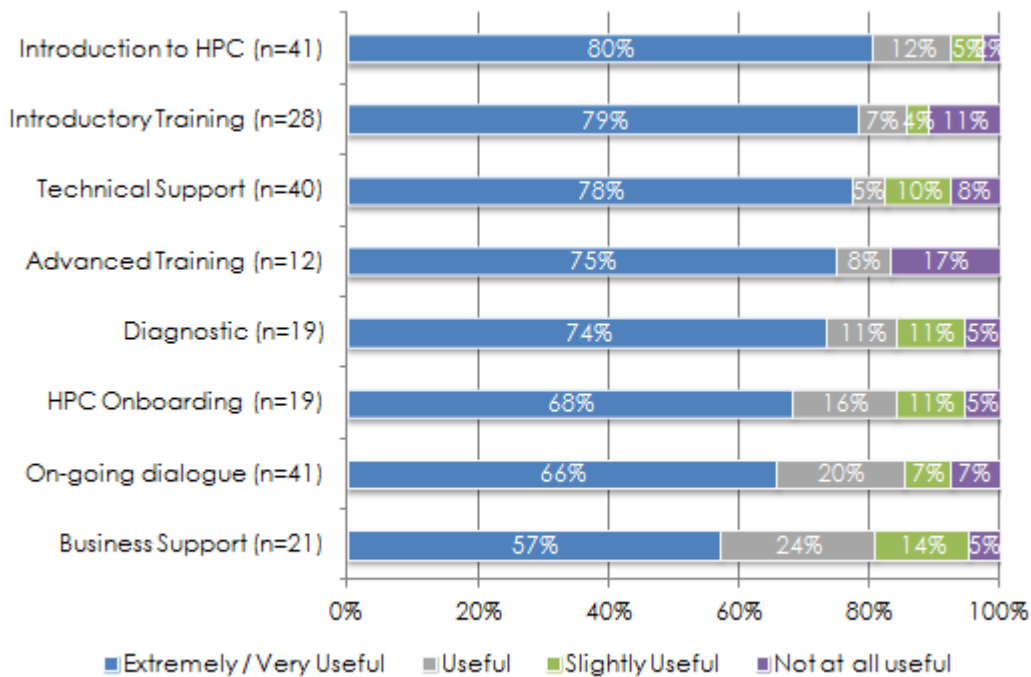
“To obtain technical support and learn about the system”
“To learn how to use a high performance.”
“It was new territory for us and we needed guidance.”
“We need technical support in rendering.”

"To get help to develop a product."
 "In order to access business opportunities we needed training."

6.5.3 Service quality and client satisfaction

The responses to the quality of service and client satisfaction were very positive. The large majority of participant businesses found the experience to be either 'extremely' or 'very useful', particularly being introduced to HPC (80%), the introductory training (79%) and technical support (78%). Advanced training and diagnostics (75% and 74%) were also thought to be extremely/very useful. A handful of the businesses said their experience was 'not at all useful' (the training stands out here). Companies clearly benefit and appreciate relevant and tailored business support programmes.

Figure 20: How useful was the service or support you received?



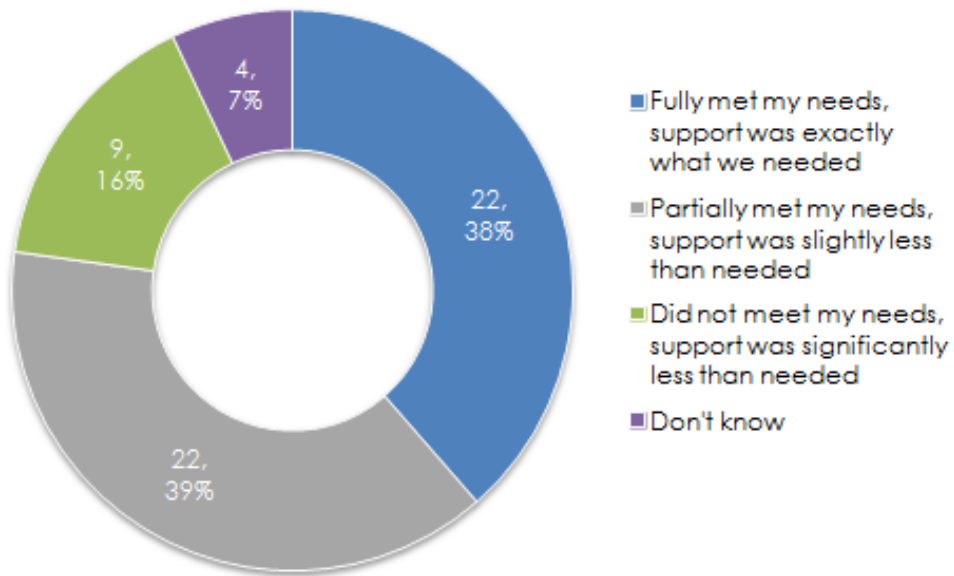
Source: The Innovation Partnership Survey, March 2014 and September 2015

* excludes Don't know / Not applicable responses

In terms of the effectiveness of HPC support, 77% of respondents reported that the help they received either fully or partially met their needs. 16% did not meet their needs, while 7% were unable to provide an assessment.

This would imply that the Project was successful but it does need to be considered in the light of the other responses. See 'further comments' later in this chapter.

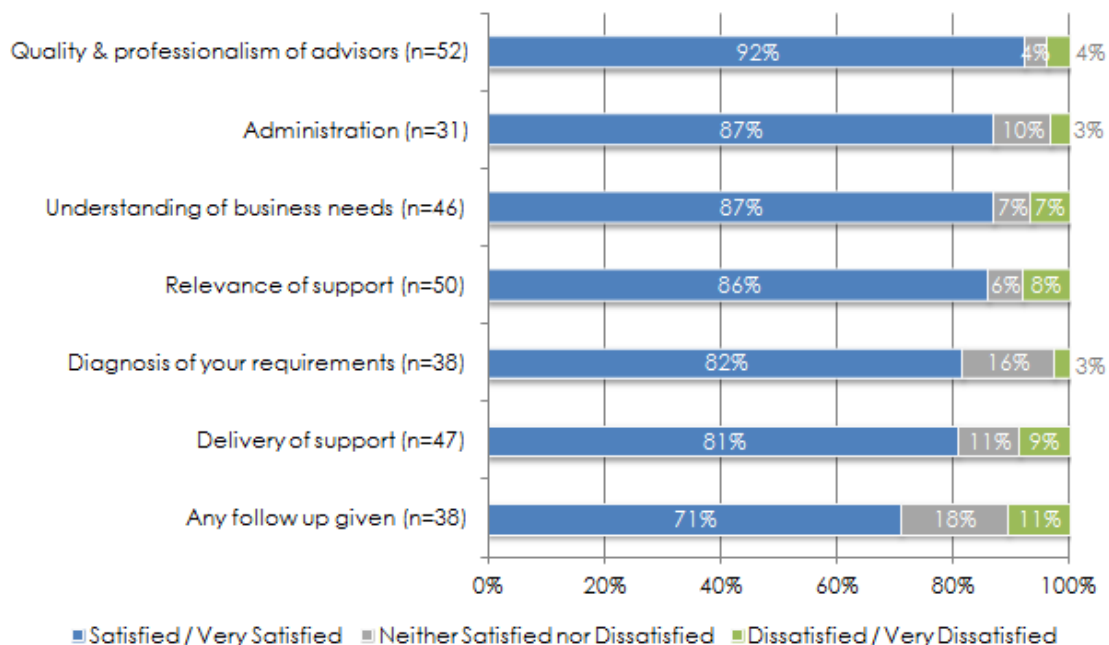
Figure 21: To what degree did the support meet your business needs?



Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

The large majority of respondents were either 'very satisfied' or 'satisfied' with the service and support provided, particularly the quality and professionalism, and the relevance and understanding of their business needs (Administration also recorded high levels of satisfaction (87%). There were elements of dissatisfaction in 'any follow up' that was or was not provided, as well as 'delivery of support' and 'diagnosis'.

Figure 22: How satisfied were you with the service or support you received?



Source: The Innovation Partnership Survey, March 2014 and September 2015

* excludes Don't know / Not applicable responses

Companies were asked whether there was anything stopping them from taking forward what they had learned from HPC. Like the participant surveys being too busy was a common barrier as was focusing on other priorities. Expense was only mentioned by two businesses. Over half said the question of barriers was not relevant to them.

However several companies complained about other factors needing to progress first such as technical support from HPC they are waiting for, more guidance and training and lack of access to computers and individuals. For example "I'm waiting for additional training", "it's more specialised than we thought", and "we have a number of issues to resolve and getting access to the person who can help is taking time".

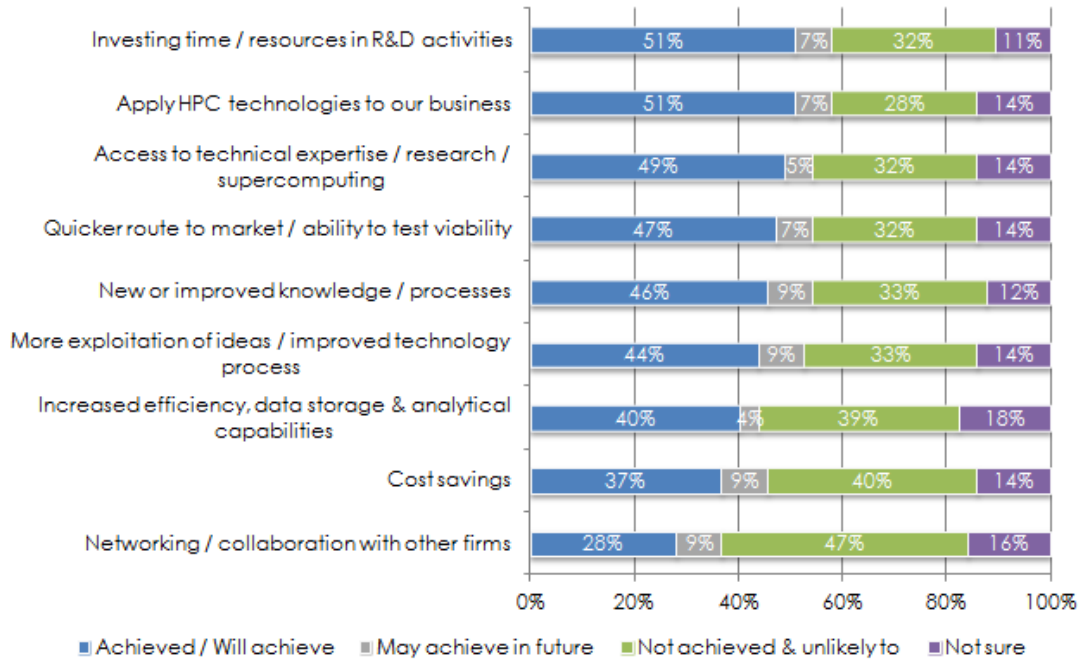
6.5.4 Impact and outcomes

Most interventions and investments are required to provide positive measurable outcomes. Twenty-four, or 75% said they had not achieved any clear tangible benefits to date suggesting some HPC benefits take time to come to fruition (see later). Six (10%) reported increased sales; eight (14%) increased their profits, and ten (18%) said they had either created or safeguarded jobs. Other benefits included turnaround time/time saving had improved and another reported that the support helped the company benefit from new research. The numbers of firms reporting impacts were slightly higher in the final evaluation stage.

Only 17 respondents were able to provide a 'counterfactual' response to a question on what would have happened if there was no engagement with HPC Wales. 12 claimed the impacts achieved on job creation, safeguarded jobs, increased sales and profits would not have materialised. This suggests that some of the respondents are able to reflect on the added value of the support, which shows 'pure additionality' and is clearly encouraging.

Once interventions had taken place, 51% were able to invest time and resources into R&D activity and a further 51% said they either achieved or were going to achieve the use of HPC technologies in their business. 49% were accessing technical expertise and supercomputer hardware, 47% were finding quicker routes to market; 46% were able to exploit new knowledge ideas or technologies (44%). 37% were making cost savings and 47% said that networking with other businesses have not and are unlikely to happen.

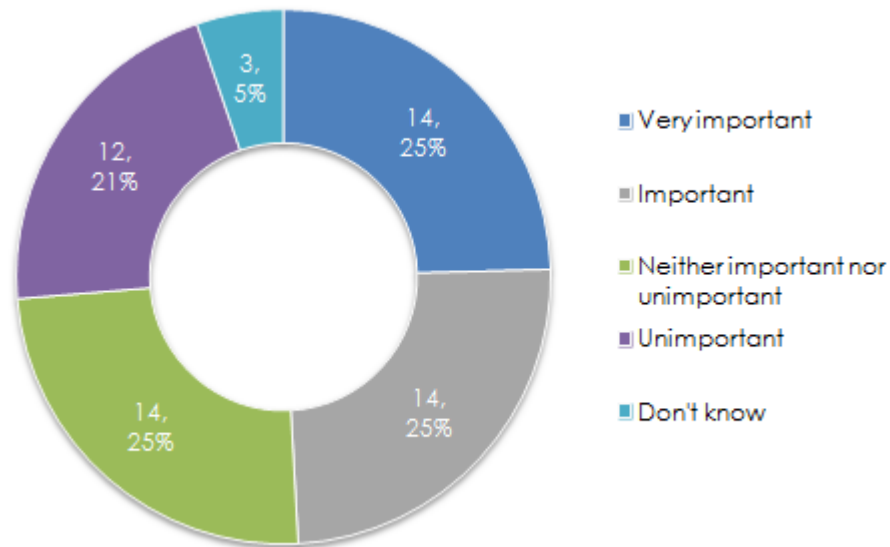
Figure 23: What is the likelihood of achieving technology benefits with HPC help?



Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

The support received from HPC has been either 'important' or 'very important' to the success of half the businesses. The rest were either undecided or saw little importance to the future success of the business due to the intervention.

Figure 24: How important is HPC support to the future success of your business?



Source: The Innovation Partnership Survey, March 2014 and September 2015, n=57

* Note: percentage figures do not sum to 100% due to rounding

When asked what they would want from HPC in two years' time, many said they would want more of the same, particularly where clients and their projects needed that type of support.

Some wanted more up-to-date software and equipment especially if the technology has moved on.

Businesses were asked whether they had any additional comments regarding the service and support. There were more positive comments, largely linked to the help that was provided in improving company performance and quality, and the provision of practical solutions to problem solving. Negative, or less positive, comments mainly focused on the capacity of the service. The view was expressed that team could be larger to reduce waiting times. Other comments were linked to businesses not having enough time to pursue their project to the end, with some pulling out midway through the process.

Further comments on HPC Wales and support received

"Good service and support".

"They were fantastic. We achieved much higher quality in much less time. Turnaround was so quick. If we have rendering projects in the future then I will definitely be contacting them again."

"They stand out from other business advisers in Wales. They are the only people I know of who offer practical support and assistance as well as business advice."

"Fantastic support, really up to date."

"If they are serious about developing this I think they should get a bigger team and ring-fence more resources for businesses."

"An increase in current HPC capabilities would be really good for our research."

"We don't appear to be on their priority list. I'm not sure if it's because we are a small company. We are hoping they will get back to us with a solution to the technical problem."

"I think they should take the initiative and offer support. I am likely to ask for more technical support in the future."

6.5.5 Summary

- Those who responded to the survey were concentrated in the larger employer groups.
- Representation in Welsh Priority Sectors has improved since the mid-term evaluation when it was suggested that the wealth-creation potential of technology/software within some of sectors could result in additional economic benefits.
- Businesses found out about HPC through word of mouth and Universities mainly (the role of Universities has increased since the mid-term evaluation).
- Motivational factors for accessing HPC were linked to wanting to work with the hardware/equipment, improving business performance, obtaining technical support and being trained to use supercomputers.
- There were high levels of satisfaction for the programme's delivery of services, meeting business needs and perceiving their involvement as being a useful exercise.
- The benefits from the collaboration in many instances are likely to take time to come to fruition. There is however some evidence of 'pure additionality' from

respondents able to comment on the added value of the support. These included new and safeguarded jobs, and an increase in sales and profits.

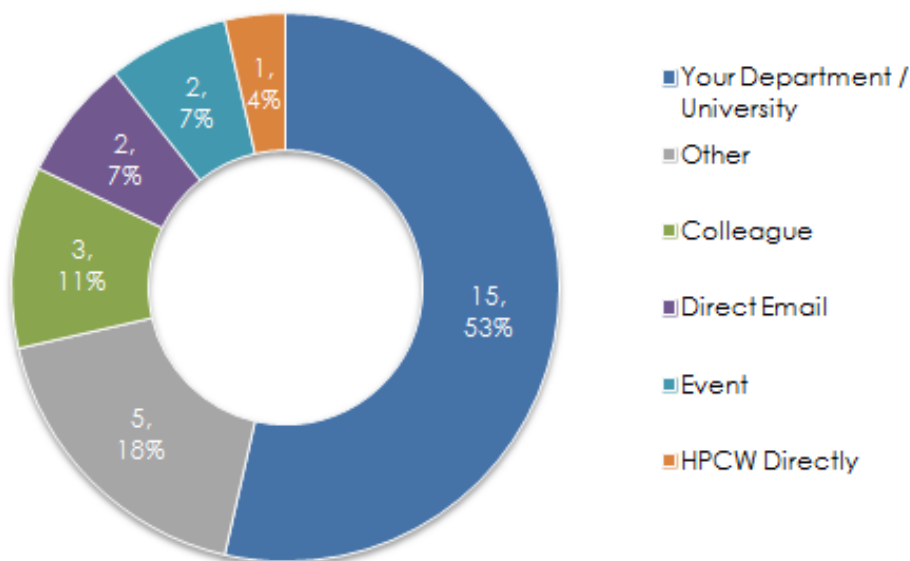
- Achievements included progress in R&D, applying HPC to their workplace, developing quicker routes to market, exploiting new ideas and developing new knowledge. Networking however was identified as something that companies were not achieving or perhaps reluctant to achieve.
- Half of businesses said that HPC was important to the success of their company. In terms of future needs, they wanted more of the same, an update in the equipment and software as technology develops, and an improvement in service/technical capacity.
- Further comments were largely positive but a clear observation related to the capacity of the team. It was felt it could be bigger.

6.6 Academic and Researcher Survey

6.6.1 Introduction and Motivations

This chapter highlights the findings from the academics and researchers. 57% of contacts were consulted focusing on those who had consumed the most computing hours (respondents covered over 80% of 125m hours consumed).

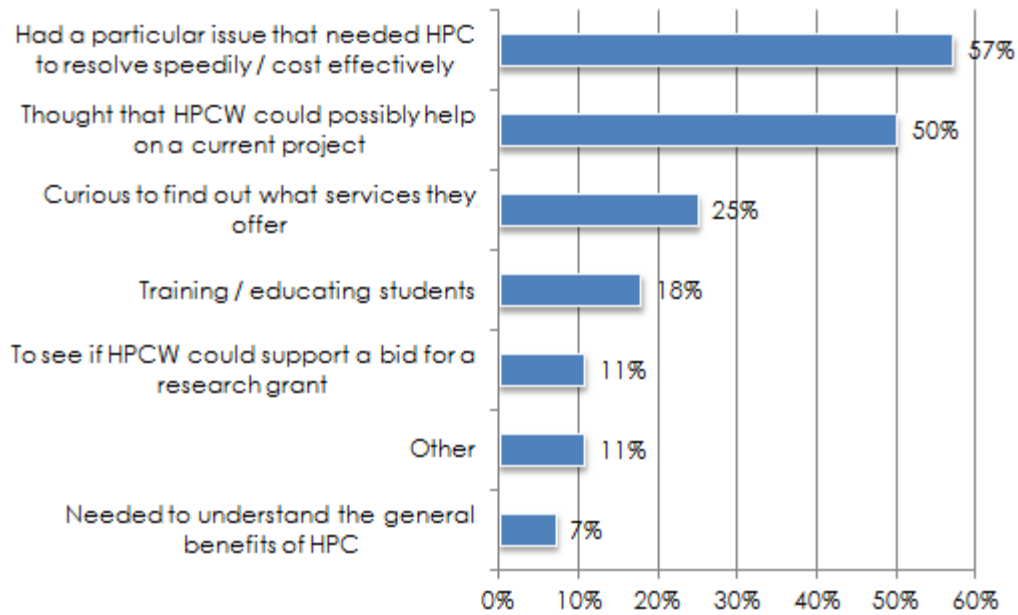
Figure 25: How did you find found out about HPC support?



Source: The Innovation Partnership Survey, September 2015, n=28

Most academics/researchers found out about HPC through their department or a colleague. Others found out about it through departmental meetings, or presentations. Universities appear to be effective at spreading the word internally.

Figure 26: What were your reasons for originally contacting HPC?

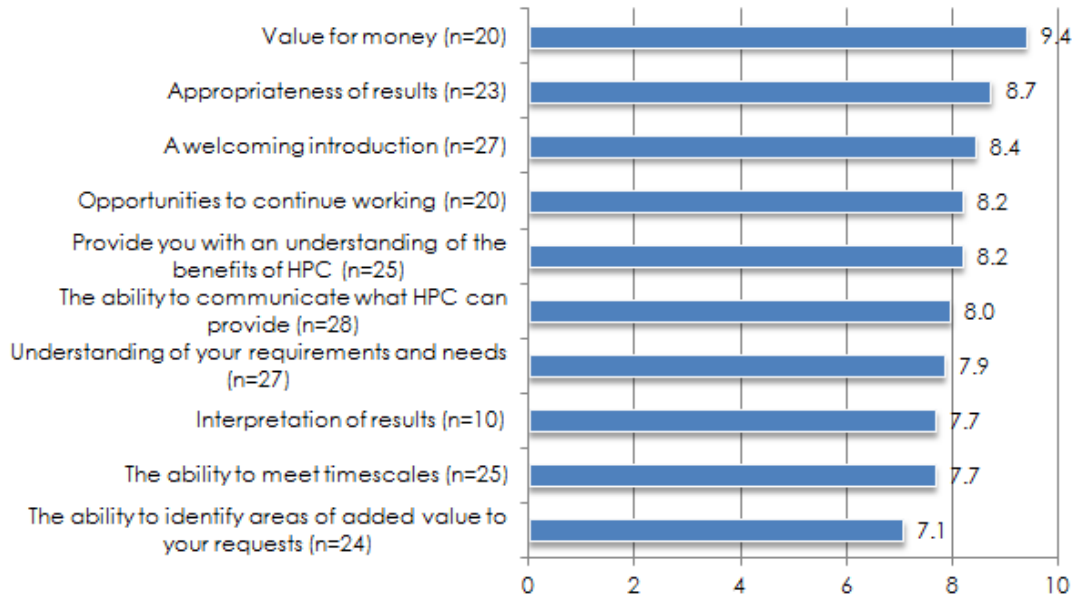


Source: The Innovation Partnership Survey, September 2015, n=28

The principal motivation for academics/researchers engaging was a particular issue that needed resolving or a current project that HPC Wales could help with.

Service quality and client satisfaction

Figure 27: Satisfaction engaging with HPC Wales (1=very poor, 10=excellent)



Source: The Innovation Partnership Survey, September 2015

Overall the satisfaction levels of participants were high with value for money and the appropriateness of results scoring highest. When asked further about their experiences (see box) issues around capacity and technical support emerged.

Experiences

Capacity and understanding

"As there is only one team member in Bangor dealing with a lot of people, it would sometimes mean that I had to wait for things to get done".

"HPC Wales evolved to understand my needs which were biological and pharmacological in nature. Their understanding got better over time"

"I was generally very happy with the service. They gave a good service and quick response".

Resolving technical issues

"The software created a lot of temporary files which took up a lot of storage and, when I told them this they said there was nothing they could do".

"HPC Wales have been great all the way through".

"There were a few issues with computational efficiency".

"Overall, it was very useful. A few technical issues but they got ironed out quickly".

"It has been a challenging project but HPC Wales rose to the challenge".

"HPC Wales was very slow to put the tools that users needed actually into the system"

There were some areas suggested where more information or understanding would have been useful (see box). Though it should be noted most participants said 'no', 'not really' or 'none at all'.

Further Information / Understanding that would have been Useful

"I felt the architecture of the machine was unnecessarily complicated. The way it is distributed across hubs adds to this problem".

"Information on whether codes can be imported would have been useful".

"More clarification on what services I could use".

"Better documentation support from HPC staff".

"I noticed there wasn't enough storage. At one point I was using 95% of the available storage. I think more information should be given on how to run HPC efficiently, so that people can avoid excessive use of storage".

"More software support".

"We run out of space. We have a huge amount of data and it's where to put it".

"The transition at the end of project".

"Opportunities to continue working - I haven't really heard anything back and I would like to find out more about opportunities to continue working".

6.6.2 Impact and outcomes

Participants were asked if the HPC Wales operating system and software applications were appropriate for their project(s) and were asked to make suggestions on new software, support or services. The vast majority of respondents felt that the operating system and software was appropriate. Some suggested improvements were made. The comments included requests for more processing time, storage space and flexible access. There was a specific request for improved software to include more 'computational chemistry codes' and generic observation on increasing the number of software experts.

In terms of the added value that HPC brought most respondents were very satisfied. Principally HPC Wales sped their project work up (See box) and allowed a complexity of analysis that would not otherwise have been possible. Some projects simply would not have been able to proceed without HPC Wales.

Added Value

"HPC Wales has enabled me to increase the rate at which I can get through simulations".

"Without HPC WALES I would not have had the access to state of the art technology".

"HPC Wales primarily provided the computing resource which allowed me to progress with my project and achieve a time and scale that would not have been possible with the alternatives to HPC Wales".

"I've been able to do much more science and everything would've taken 10-20 times longer without HPC".

"Without HPC Wales I would have been forced to work with a very narrow group of compounds and I also would not have been able to assess the potential toxicity of the compounds".

"The project would not have happened without the support of HPC Wales".

"In terms of the development timescales, we couldn't have done it without HPC Wales".

"Without the support, it would take too long to compute what we had to compute".

"HPC Wales enabled analysis that would not have been possible otherwise".

"This type of resource is not common to come across so it was very useful to have".

"We wouldn't have been able to do it without HPC Wales. We needed the computer capacity. We don't have the storage alone".

"I wouldn't have done the calculations required for hundreds of nodes without HPC. It would have taken years".

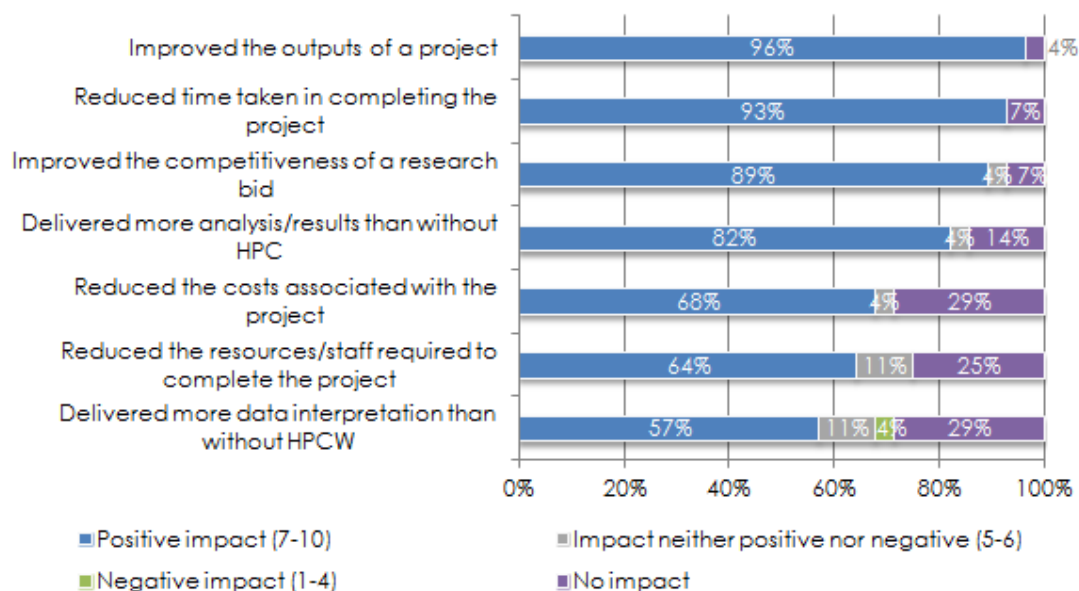
"It allowed us to do more complicated calculations and provided a more refined analysis than would be possible with other sources".

"[HPC Wales] Allowed me to do more complex simulations for my project".

"The volume and accuracy of the results were only possible because of HPC".

The above comments are reflected in the following perceived impacts.

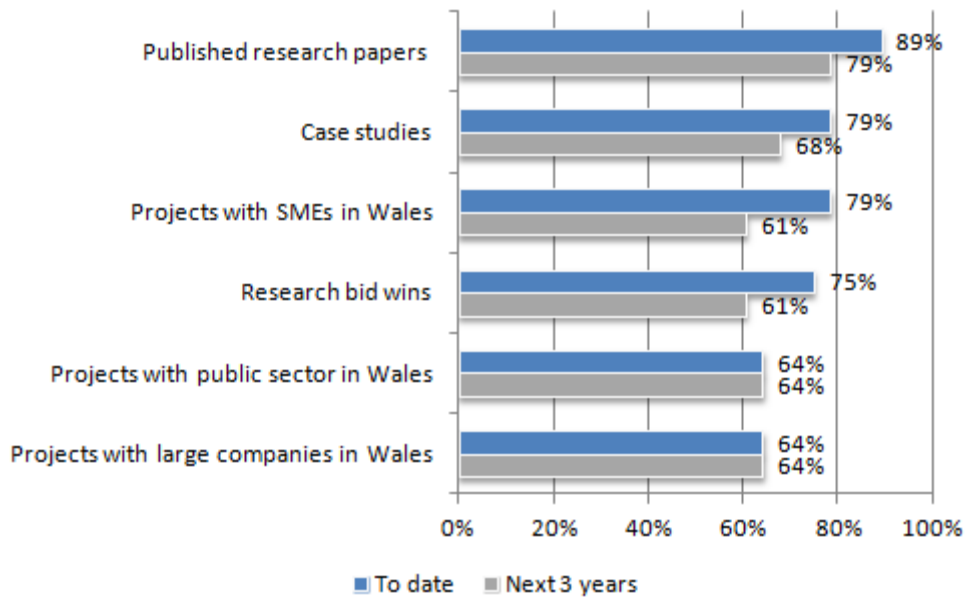
Figure 28: Scale of impacts achieved from the HPC Wales support



Source: The Innovation Partnership Survey, September 2015, n=28

The tangible outcomes achieved by academics and researchers are impressive. To date 89% have published papers and 79% have developed case studies or worked with SMEs in Wales. A large proportion (three quarters) have won research bids a result.

Figure 29: Which of the following tangible outcomes have been achieved as a result of HPC support?



Source: The Innovation Partnership Survey, September 2015, n=28

6.6.3 The Future

71% of respondents believed that training provided by HPC will encourage more academics/researchers to use HPC Wales (18% were unsure and 10% (3 respondents) said no). 68% of respondents believed that an in-house HPC facility is better than renting from a 3rd party (18% were unsure and 10% (3 respondents) said no). The main reasons were control, cost, support and access. No respondents gave a convincing narrative for using a third party suggesting some sort of university led arrangement seems sensible.

"You lose the level of control when you rent from a 3rd party".

"The cost is better and an in-house facility can respond to what users need".

"The whole system can be tailored to specific needs with an in-house system".

"Better access and support. The responsiveness and accessibility has been great".

"Easier to deal with/ get access".

"In house training and skills better with HPC Wales".

In terms of future requirements from HPC Wales many academics and researchers would be happy with the status quo.

"Continuing the level of support I am receiving now".

"In the future, I will need exactly the same support as I have received so far".

"We will continue to use it for the prime project and for large scale closely coupled processors".

Others have suggested more specific requirements.

"My future needs will almost certainly involve genomic applications, environment and evolution".

"I would require access to finite elements software and CFD software".

"GPU usage, open MP usage. Continued trivial parallelization".

And some have requested new capabilities.

"Until HPC Wales are capable of providing the processing capabilities that I require, I don't see how they can help me in the future".

"Improved memory".

"Continuous hardware updating".

Respondents were asked to make observations, conclusions and recommendations for the future (see box). They included suggestions around technical capacity, storage and flexibility of access.

Suggestions

"Speed up technical support would be an improvement".

"I felt that perhaps a larger team, instead of a small team, dealing with a lot of people would make HPC Wales more efficient. The inclusion of a centralised support service may also improve efficiency. This is because I only find out things are needed at the very last minute, so it is important that things are done quickly".

"I think the program could be more flexible with the amount of hours it allows someone to use HPC. Additionally, I think it could provide temporary storage facilities to people who need them. They could offer someone a little bit more storage on a weekly basis for example".

"I think HPC Wales could allow users to use HPC for longer periods of time. I also think there could be fewer barriers to using HPC. If a user had HPC needs which are not intensive, I don't see why they should have to apply to use HPC. If their needs are intensive, a requirement for them to apply would be understandable then".

"I noticed that the program has a time limit on it for particular jobs, i.e. the program would only process data for 3 days before stopping. I needed a longer running time for my project and I think this could be improved".

"There should be very strong user training and there should be an administrative system that has very strong user rules in place".

"I found it a little difficult to access at first. HPC Wales have a very strict requirement that academics collaborate with a business before they offer support. I think academics would find it a lot easier if this requirement was relaxed".

"I feel the money should be used to teach people how to get the best experience out of the facilities. For academics, there should be clear topic areas, allowing academics to collaborate with each other. For businesses, the focus should not be on the hardware, but how to make the best use of facilities like the Amazon cloud and things like that. I also feel that custom software would be an improvement".

There were some quite specific requests too.

"I think it would be handy if people had access to HPC Wales for blue sky research, instead of being forced to go to the national clusters".

"I would like more access to CPU's and GPU's. I would also like more people who are skilled in parallelisation and scaling".

Summary

- The universities and departments appear to be the most common way of making academics and researchers aware of HPC. In the future departmental

leads and senior university staff will be able to promote any future activity should this element continue.

- High satisfaction levels overall were reported. There were some suggestions for further information and participants requested sufficient capacity to resolve technical issues when they arose.
- The added value of the project in terms of speed and capacity of computing power was mentioned by many – for many they would not have got their project completed without HPC Wales.
- No major changes were suggested to the operating environment or software and many believe that the training provided will encourage more academics/researchers to use HPC Wales. An in-house HPC facility is preferable than renting from a third party. Nobody gave a strong case for using a third party.
- Suggestions for the future include technical support, a flexible access regime and increased storage capacity.

7. MID-TERM EVALUATION RECOMMENDATIONS, RESPONSES AND ACTIONS

For the purposes of this final-term evaluation, the Consultants asked HPC Wales senior management to provide an update on activities instigated as a result of the recommendations made during the mid-term review. Relevant comments have been provided below. (Note: in addition to the comments above, **Appendix II** provides an extract on 'Lessons Learned' by HPC Wales senior management, taken from the report provided by David Elcock entitled, "*Higher Education Funding Council for Wales Reconfiguration and Collaboration Fund, Final Monitoring and Evaluation Report – HPC Wales*".)

Recommendation 1: De-Commitment on Targets and Grant funding

The Consultants recommend that HPC Wales senior representatives seek de-commitment on targets and spend, as a priority. This will allow WEFO to allocate shortfall to other programmes, thus ensuring that monies within the current ERDF framework, benefit Wales.

HPC Wales Mid-Term Response 1: De-Commitment on Targets and Grant Funding

This recommendation was well received, as ERDF/ESF output performance had been a primary focus of all HPC Wales activity over recent times. The HPC Wales management team worked with the evaluators to examine existing, 'pipeline', and potential realistic overall outturns. This was used as the basis for a proposed re-profile which incorporates as noted by the evaluators the seven of the fifteen indicators achieved or surpassed, five which are on target for completion, and remainder where de-commitment is required. With regard to the key indicator of Gross Jobs Created the team is committed to maximising project performance. However the proposed re-profile has been projected in line with the evaluator's observation that performance of "under half of the profiled target (44%) and the Consultants would suggest that this is consistent with the challenging economic context facing the Project and delays experienced during the set-up process. For indicators without projected over-performance, including in particular ESF indicators, these would be increased accordingly within the delivery profile, allowing WEFO to balance across its overall programme.

The HPC Wales Management team representatives presented these in draft form to the WEFO PDM/PDO for consideration prior to submission of the proposed re-profile.

In relation to decommitment of funds, HPC Wales has reviewed its funding, budgets and predicted expenditure to the end of the Project. Three possible scenarios were explored:-

Scenario 1 Return of uncommitted funds to WEFO with no further Capital Investment in Phase 3 Technology: The underspends that are apparent both in current reduced spend against profile and predicted final outturn levels below the original business plan budget levels would be returned to WEFO, offset by two items where spend pressures are being experienced (replacement of staff IT kit and office rental). The potential total level of grant decommitment being £3.1million. However, as noted in the evaluation, such a scenario would not involve expenditure required to ensure continued operation of the Project as it would preclude essential investment needed for continuity of existing infrastructure.

Scenario 2 As scenario 1 but retaining Capital Investment of £1.4m in Phase 3 Technology as suggested by Recommendation 6 of the Evaluation. This compares to the £3m capital investment in the existing delivery profile. This option produces an overall decommitment level of £2.9m

Scenario 3 This has been introduced following discussions with WEFO at the formal review meeting (6th June 2014) and is based around initial calculations of total underspends, with the options of virement to utilise some of these unspent resources to assist HPC Wales with problematic resource issues. This also assumes the original level of WEFO funding for the Capital (Phase 3 Technology) Investment (£567k).

Scenario 3 (Recommended) represents the HPC Wales preferred option, as this allows resources to be used on addressing staff retention difficulties, providing resource to drive research engagement and technical support. Thus maximising the opportunities to achieve predicted output levels. In addition it utilises offset funding to reduce the requirement to deliver traded income levels, thus de-risking the basis of funding underpinning the capital investment. This scenario builds upon *Scenario 2* and responds to the Evaluation observation for need to enhance effectiveness at the interface between technical and outreach staff. Furthermore, it would manage risk relating to achievement of outputs and results as profiled in the latter months of the project.

These three scenarios were put before WEFO, with *Scenario 3* firmly identified as the preferred option for HPC Wales, with a request to allow a reprofile reflecting the revised level of output targets alongside the virement and reduced decommitment (£2.3m) proposal.

Scenario 3 was agreed with WEFO and implemented. This allowed resources to be used on addressing staff retention difficulties, providing resource to drive research engagement and technical support. Thus maximising the opportunities to achieve predicted output levels. In addition it utilises offset funding to reduce the requirement to deliver traded income levels, thus de-risking the basis of funding underpinning the capital investment. This scenario builds upon *Scenario 2* and responds to the evaluation observation for need to enhance effectiveness at the interface between technical and outreach staff. Furthermore, it manages risk relating to achievement of outputs and results as profiled in the latter months of the project. This facilitated a decommitment of £2.3m.

Final Evaluation Update:

The decommitment arrangements were agreed in principle by WEFO, with HPC Wales finally decommitting in excess of £3million from the original grant allocation. This was agreed over a series of meetings with WEFO PDO's that did allow these funds to be diverted to other Strategic Funds project. At WEFO's request it was agreed that the decommitment and consequent output delivery target reduction would be rolled into the final wash up of the Projects final reconciliation.

Recommendation 2: Workflow Analysis

The mid-term evaluation recommended that HPC Wales undertake a workflow analysis in relation to ERDF/ESF progress. A bottleneck (skills gap) was identified in terms of staff capabilities, when taking instructions from the outreach team on potential projects. Individuals with the relevant skills are required to collate the relevant resources and engage with technical staff to ensure the smooth delivery of each project. This may require retraining of some staff or additional recruitment.

HPC Wales Mid-Term Response 2: Workflow Analysis

As discussed with the Consultants, the identified skills gap is an inevitable consequence of the expertise within the Training and Outreach mentors – recruited primarily on their outreach capabilities – and that within the Technical Team who, at least at the outset, were primarily system administrators. Thus the “missing ingredient” – the ability to provide computational

science and engineering (CSE) support to the end customer, is well understood, and is being pursued by a variety of mechanisms, specifically:

1. Using the contracted resources of the Numerical Algorithms Group (NAG) and Fujitsu Laboratories of Europe (FLE) to bridge the gap through increasing contact with the users. Thus NAG are now part of each on-boarding process, working with the Technical Team to better understand user requirements from the moment they start to use the system.
2. Again using NAG and FLE to up-skill the Technical team through the provision of training sessions and regular meetings.
3. Looking to refocus the Technical team, and introduce fresh skills into that team as the focus shifts from infrastructure deployment to a customer facing and support role. The new resources identified as part of the Phase 3 proposal are specifically earmarked to promote these capabilities within the Team.
4. The Skills gap is a major consideration within the Business Planning process for Stage 2 of HPC Wales, where the current mix of support staff will be balanced to introduce greater expertise in CSE.
5. Within the proposed re-profile would enhance the overall technical capacity and skills base, allowing expertise to be more effectively managed across the project portfolio.

The Consultants identified that there is a need for people with both sector/end-user technology and computing expertise. The problems are both insufficient supply and low retention, with poor career development opportunities for those supporting academic research. The long-term competitiveness of HPC Wales depends on people with skills to both support and exploit its HPC infrastructure. It must provide training programmes to keep pace with the rapid evolution of the science, methods and technologies, and must put in place more attractive career structures for software developers.

Final Evaluation Update:

The problems of technical staff and skills shortages were a recurrent theme throughout the Project. This was addressed through a commitment to training and development for the technical team, a programme of skills transfer from Fujitsu and through the introduction of specialists via recruitment e.g. the engagement of Sid Kashyap, who rapidly became a big data expert. The ongoing relationship with NAG and FLE provided opportunities for training and knowledge transfer.

Recommendation 3: Sales Review

Evidence suggests that HPC Wales would significantly benefit from the undertaking of a sales process review and from the deployment of professional sales and forecasting systems aligned to the CRM system. This will give the Project the opportunity for best planning and forecasting, the opportunity to develop products and services that have a higher GVA, and the opportunity to improve commercial sales.

HPC Wales Mid-Term Response 3: Sales Review

The Management team agree that there was further work to be done with the CRM and extracting the most from the system to effect more sales. The CRM system was purchased less than 12 months before the Mid-Term Review, and there has been significant progress made on entering data going back over the period. The team have all been trained, however there is a need to review the reporting options, and to develop some of these

further. The proposal is to run a refresh training course to look at functionality currently deployed, and establish ways in which we can get more from the system.

There has continued to be a parallel system maintained in an Excel spreadsheet specifically to track WEFO outputs, and a separate one specifically for traded income opportunities. The traded income opportunities have been relatively few in number to date, which is reasonable given the delays noted elsewhere in getting the system up and running, and servicing the Collaborative Projects and SME requirements, however it is hoped that this will now change as efforts to generate traded income are increased.

The focus on the sectors will also help to define those opportunities that offer the greatest potential for securing a high GVA. Actions instigated, as identified in the final evaluation, include changes to personal, contracting a HPC sales consultant and focusing the effectiveness of the outreach team on individual sectors.

Final Evaluation Update:

During the latter years of the Project the CRM system had become embedded in the routines of the business and with familiarity came greater use of the system by both the Training and Outreach, and the Technical and Head Office Teams. This in turn translated into a better experience for customers when contacting HPC Wales. Additional in-house training was provided and allied with the employment of a sales professional led to all team regular scheduled conference calls where improvements and consistency was sought in customer engagement practices.

Recommendation 4: Sector-specific Development

HPC Wales' management requested that the support teams create specific sector strategies and plans for those key sectors identified in this report. Plans for these sectors need to be constructed on a strong understanding of end-user needs, addressing the requirements captured to date and expected income.

HPC Wales Mid-Term Response 4: Sector-specific Development

When presenting the mid-term evaluation, Karen Padmore advised the Consultants, that this exercise had just started. [Note: Karen had only been with HPC Wales for three months at that time]. We commenced with a re-profile, however, as staff numbers fell the ability to follow such an approach drastically reduced.

In addition to the 'Wales' perspective, work has been ongoing to align activities and the strategic approach with each of the sectors represented on the E-Infrastructure Leadership Council. The team have engaged with the key Catapult Centres (CDEC & HVM) expected to lead on the On-ramp initiatives in their respective sectors, and is in fact spear-heading the initiative to ensure that funding is secured for these services along with the other Regional HPC Centres.

Final Evaluation Update:

The HPC Wales teams had already started to operate along priority sector lines at the time of the mid-term evaluation. HPC Wales reported activity by sector within its monitoring of KPI's. The anticipated progress was significantly constrained due to the departure of key staff.

Recommendation 5: Marketing Focus

The Consultants recommend that the Management review its marketing strategy and planned short-term actions. This review should examine the opportunity to refocus resources

on delivering both short-term targets (ERDF) and long-term sustainability of the Project, building on capacity and the good reputation already achieved. There is a general understanding that the framework for strategic marketing needs to be predicated on the selection of, and importance associated with, each key market opportunity, defined as research development, large enterprises (worldwide), Welsh SMEs, and Public Sector, and possibly interrelated to key sectors identified, i.e. advanced engineering/materials, creative industries, life sciences.

HPC Wales Mid-Term Response 5: Marketing Focus

The Consultants recommended a six-monthly review of the Marketing Plan, reviewed by the Chairman. For the first review, we will address the comments made by key stakeholders in the mid-term evaluation, with both Cake Communications and relevant in-house team members. This will be followed by a revised action plan, that addresses both the stakeholder communications and marketing, but also any necessary action to address the sector specific approach proposed. In particular additional sector-specific events are proposed, and more concentrated engagement with WG is now being delivered.

Final Evaluation Update:

A review of marketing strategy was undertaken by the Chief Executive with one of the key actions being an increase in Stakeholder engagement. This included a renewed emphasis on the HPC Wales User Group with regular video sessions linking all Institutions during the final year of the project. In addition a review of the PR support activities was completed as part of the wider marketing reviews

Recommendation 6: Phase 3 System Refresh

The Consultants recommend that the Phase 3 Refresh be adopted to deliver capacity as specified in the refresh document signed off by the Technical Director.

HPC Wales Mid-Term Response 6: Phase 3 System Refresh

The importance of the planned Phase 3 refresh in maintaining performance for indicators during the remainder of the Project is noted by the evaluation. The evaluators examined the process and outcomes of the Phase 3 scoping, which was undertaken to ensure maximum relevance and impact of the investment. As recommended, the requirements and impact (including the reduced expenditure) of the refresh document have been factored into the proposed re-profile.

Final Evaluation Update:

The Phase 3 refresh was scaled back because of affordability constraints, but a modest investment in software and licensing was made to ensure the system was able to provide continuous service to clients' beneficiaries and commercial users. This totalled just under £300k, to be compared with the original planned investment of £3M.

Recommendation 7: Future Funding and Income

The Consultants stated that, as there is an immediate requirement to secure follow-on funding, HPC Wales should identify current sources of available funding that align with the Project's capabilities and objectives over the longer-term.

HPC Wales Mid-Term Response 7: Future Funding and Income

HPC Wales has identified a number of potential funding sources and is working on all of these. HPC Wales is leading the initiative to secure funding from BIS for the Regional Centres

to deliver a 'horizontal cross-cutting territorial' service to SMEs and Industry that can complement the activities being proposed by the Catapult Centres. A two-page summary was submitted to the last E-Infrastructure Leadership Council (ELC) meeting and, as a result of this paper and subsequent meetings with the Minister and BIS officials, BIS has been persuaded to consider a bid from the Regional Centres that can be submitted or consideration into the Autumn statement. There will be meetings coordinated between the Centres, and a five-case Business Plan will need to be developed. It is expected that HPC Wales will be invited to give a presentation to the ELC on 7th July.

The team are also looking at both Structural Funds and Horizon 2020, and have identified a couple of key opportunities to explore within the Horizon 2020 programme that were suggested to the reviewers. These are being actively pursued through both the ETP4HPC network, and through direct contact with the Commission. Meetings are being arranged for ISC 2014 taking place in June. The discussions about Structural Funds 2015-21 are underway, albeit at an early stage. Outline plans will form part of the response to WEFO, and will be incorporated into the Strategic Plan.

The Training and Outreach team are continuously encouraging academics using the system to consider including the costs of HPC in grant proposals. It has been mooted that this may be something that can be addressed at the institutional level in the Research Offices, and ideally going forward each institution could include in the 'approval' process a tick box for 'do you need any HPC related services, and if yes an indication of level required. This is something that needs to be discussed with the board, and suggested personnel in the institutions.

HPC Wales is already exploring collaboration with other HPC Centres, as described above across the UK. We have a joint project with EPCC, and were recently part of a submission involving all the PRACE centres and Fortissimo partners (74 organisations in total), and whilst this wasn't funded, discussions are underway to follow this up. This is a pan-European initiative.

Opportunities in the public sector are being explored. There is a project recently started with the Betsi Cadwallader University Health Board (BCUHB) through an SBRI (small business research) initiative, and meetings are scheduled with a number of WG departments and ONS. We are also looking to exploit HPC Wales' listing on the G-Cloud 5, through publications and attendance at the next Cloud Forum event.

HPC Wales also successfully led a Horizon 2020 EINFRA bid to create an EU Network of HPC Competency Centres (SESAMENET), worth €2m with partners in 13 member states – further enhancing the opportunities to leverage on both these sources of funds.

Final Evaluation Update:

The delivery of a HPC Wales II plan was completed and an initial expression of interest was presented to WEFO by HPC Wales Ltd. This led on to the submission of Operational Logic Tables that were accepted by WEFO and HPC Wales Ltd was invited to submit a full business plan. A successful Horizon 2020 bid had been accepted and other initiatives to deliver funding were underway. However, the decision of the Member Institutions to close HPC Wales Ltd and create a new University Consortium to lead a second WEFO funding bid and consequent project has meant that these plans have now been shelved.

The Consultants acknowledge that significant effort was made by HPC Wales' senior management and staff to address the recommendations made during the mid-term

evaluation. Such actions were recommended to build foundations for a HPC Wales II programme, which would continue to deliver on ERDF/ESF targeted outputs, provide greater reach, and move towards long-term sustainability. However, in the short term, the Member Institutions wish to have a more narrowly defined objective and delivery vehicle, with a particular focus on supporting academic endeavour. The Consultants believe, and have indicated in this report, that this does make sense initially but also that there is greater opportunity to extend activity and reach over the medium term.

8. CONCLUSIONS & RECOMMENDATIONS

The overriding conclusion is that HPC Wales delivered the Project in line with funders' expectations. As reported in the mid-term evaluation (April 2014), the Project suffered from delays principally caused by a number of interrelated factors. These were being dealt with through specific measures taken and prior to the start of the mid-term evaluation; a clear drive to focus on ERDF targets was initiated. This was accompanied by a desire to reprofile the resources and associated output targets leading to a de-commitment of grant funding. Part of the de-commitment reflected a reduction in resources required and a reallocation of resources targeted at performance enhancement. The resultant impact was a successful delivery of output performance against these revised WEFO targets.

The infrastructure established performed well, proved to be extremely robust and reliable and provided the platform from which all services were delivered.

Possibly as a result of a clear focus on, and alignment with, ERDF/ESF objectives, there appears to have been a failure by both HPC Wales senior management and stakeholder institutions alike to consider fully the long term sustainability of the project. This ultimately led to the Member Institutions decision to significantly downsize the operation for the transition period between HPC Wales I and II. This has weakened the skills base and diminished the level of service that can be provided in the short term. The planning for HPC Wales II is underway and should incorporate the lessons learned from HPC Wales I. We believe that there is huge potential to build and extend on academic activity from HPC Wales I, and this aligns well with both the new R & I focus in the 2014/20 programme under SO1.1, and also the stakeholders' overarching aims to enhance and support the research base, supporting both the Science and the Innovation Strategies in Wales. However, it should also be ensured that the foundations and experiences from the original project on business engagement and skills are not lost.

i. **CONCLUSION 1: THE SPECIAL PURPOSE VEHICLE.** The SPV, as a result of the universities seeking legal advice, was identified as the most appropriate vehicle for HPC Wales as it facilitated the purchase of HPC machining and networks, mitigating risk and trade. The SPV has governed the project for all the University members throughout the HPC Wales.

In practice, it became evident that there were conflicts of interest and at times it was difficult for members not to act in the best interest of their respective organisations. It also became clear that information did not always cascade within the stakeholder organisations, leading to a disconnect between HPC Wales and the stakeholder organisations. What is now clear is that the associated Project Board – the HPC Wales stakeholder Group – should have been inaugurated soon after Project start. This would have provided a suitable forum for stakeholder specific issues to be debated, enabling the SPV to operate in the best interests of HPC Wales. **The overriding conclusion is that whilst the board delivered its statutory functions, the Project may have benefitted from more engagement and institutional support.**

Moving forward, the structure, governance and management is likely to change for a future programme to address the lessons learned; HPC Wales Ltd will continue to own the assets and will support the new programme for which £10m ERDF funding is being considered. It is being planned that this will be a first amongst equals models. Current thinking is that this will be led by Cardiff University and include Swansea and Bangor Universities. The remaining HPC Wales partners are considering how they will maintain access to the faculty, i.e., as a junior

partner or on a pay as you use basis, etc. This includes both Aberystwyth University and University of South Wales.

ii. **CONCLUSION 2: RISK AND RETURN.** At the time of inception, HPC Wales was a high-risk investment and venture. It was a novel initiative whose inputs consisted of an emerging and disruptive technology (HPC) for the SME market, a predominantly latent market, and the need to establish route-to-market and a product/service offering that was SME-centric. These challenges were fully recognised by those who had crafted the business plan, informed by a series of workshops and meetings with key stakeholders in both the HE sector and Welsh Government. Thus despite the risk (in terms of successfully achieving targets), stakeholders still felt it worthy of investment. **What is clear is that whilst many of the risks were mitigated and outcomes achieved, the full benefits of the programme will only materialize from long-term investment and promotion.**

iii. **CONCLUSION 3: PROJECT LAUNCH AND DELAYS.** Whilst the overall performance of HPC Wales has been good, progress has been constrained by a number of factors, the impact of which could, in hindsight, have been minimised. HPC Wales encountered severe delays in its formative years from an operational point of view. The key areas in which delays occurred being:

- **A protracted procurement process**, requiring full competitive dialogue. This procurement model was driven through by the then Head of the Procurement Team in spite of advice from his technical counterparts that it would prove over complex and lengthy. The procurement occupied the majority of the senior management team then in place for the duration of the process. We would note however that, although protracted, HPC Wales completed the process in a significantly shorter time (nine months) than is considered normal practice for a "Competitive Dialogue" procedure. Nevertheless, progressing other components of the Project was slowed significantly by the choice of procurement model, and by the involvement of senior staff in the procurement.

- **Establishment of a distributed infrastructure system:** Challenges associated with this establishment were caused by two factors that were not anticipated at the outset – Data Centre Issues and Supplier Issues. Considering the former, in spite of reassurances at project outset, the sites provided by a number of the institutions were not fit for purpose and required significant refurbishment e.g. Aberystwyth and University of South Wales. That the University of Swansea were unavailable to provide a suitable Hub site until almost three years after the start of the project also caused excessive delays in infrastructure deployment. One of the major benefits of HPC Wales that is rarely mentioned is the resulting improvement in IT infrastructure at many of the stakeholder institutions.

In terms of the chosen supplier, Fujitsu, it soon became clear that the company did not have sufficient technical staff and engineers to carry out concurrent, multi-site installations. Again this was not made clear at project outset. As a large service-driven organisation, they also proved highly conservative and risk averse, insisting on change control notices at every turn. This again slowed down system deployment, delays that were further exacerbated by the excessive times taken for the installed systems to pass acceptance tests. It is clear that any supplier involved in future stages of HPC Wales needs to be agile and technically proficient in its UK operations.

- **Operational Staff Recruitment:** Delays in the recruitment of required operational staff (in part a result of skill shortages in the region). The move to hire the senior management team before recruitment of the TOMs and Technical Team meant that the operational role

out of the project was delayed, as was the engagement with prospective customers. Early recruitment of the TOMs could have accelerated the customer identification and subsequent engagement, together with the associated requirements analysis.

The delays noted above were the prime reasons for the initial underperformance in terms of ERDF and (less so) ESF targets. This perception drove the performance of the SPV who, operating in the best interests of their parent institution rather than the best interests of HPC Wales, focused more on the potential impact of claw back rather than helping HPC Wales address the impact of time slippage. **However much of the slippage was ameliorated in the subsequent period, and the re-profiled targets largely achieved.**

iv. **CONCLUSION 4: BUSINESS ENGAGEMENT.** From an operational and tactical perspective, the Project also encountered delays in progress in relation to business engagement given that HPC is “difficult to sell” due to a lack of awareness of the technology in the target market. It should be noted that planning for HPC Wales took place in 2009, a time when HPC was a novel concept that, although a well-known research enabler in the academic community, was less well known in the SME arena. That the concept was little known at the outset amongst those recruited in the role of TOMs suggesting that **a more in-depth awareness and expertise in HPC amongst those recruited should have featured in the essential skills associated with the positions.** This would undoubtedly have accelerated the outreach agenda and marketing approach to the SME community.

v. **CONCLUSION 5: THE HPC WALES PRODUCT OFFERING.** **The product, service, skills and training offered by HPC Wales is comprehensive and flexible.** In addition to delivering outputs and outcomes, the Project has progressed significantly in creating know-how in HPC, has laid foundations and has created capacity. However, a growing issue with service delivery occurred at the interface between the outreach and technical teams. **What is clearly required in the future is in-house expertise in applications (performance tuning, scalability etc.) and domain-specific support in helping users to optimally exploit the potential of HPC.** Sustainability of HPC Wales and its competitiveness in the market place relies on this class of support. The required expertise was not present in the TOMs, and although growing in a Technical Team with essentially system administrator skills, fell short of the levels required. The short term solution was provided by NAG and FLE (Fujitsu Lab. Europe), but this proved an extremely expensive solution that is certainly not sustainable. **This class of support will be critical in HPC Wales II.**

vi. **CONCLUSION 6: HPC WALES PERFORMANCE AND PERCEPTION.** It is clear that amongst original funding stakeholders there is a mixed perception on the performance of HPC Wales, largely due to insufficient interactions between HPC Wales and specific stakeholders. There is a clear requirement to ensure that internal stakeholders are made fully aware of the positive coverage of HPC Wales in the media, and within EU and UK BIS. **It is evident that successive CEOs failed to cultivate a meaningful relationship with the VCs of the stakeholder institutions.**

Performance monitoring evidence, focusing on three indicator areas, namely ERDF, ESF (including induced investment), and income generation, was collected by HPC Wales on a monthly basis and reported on quarterly to WEFO. The Project completed four successful WEFO claims audits, three successful EFAT audit reviews and one successful PIVT audit.

- a. At the time of the mid-term review, taking incomplete evidence into account, seven of the fifteen indicators achieved or surpassed targets, with five of the remaining indicators showing good progress towards achieving targets. It should

be noted that momentum significantly increased since the procurement and recruitment phases, and that performance figures should be viewed against the complex set-up environment endured by the Project.

- b. However, a delay in the announcement of Structural Funding for Wales (2015 – 2020) coupled with the failure by the project to progress the HPC Wales II Business plan in a timely fashion led to additional issues throughout the final year of the project. HPC Wales Operational staff were not convinced of a viable future in spite of assurances from the CEO and senior managers, culminating in an accelerated loss of staff, and with it a loss in momentum that had been firmly established throughout 2013. So at exactly the time when accelerated delivery of targets was called for, HPC Wales lost many of the operational team essential to delivery. This whole situation was certainly not helped by the unexpected resignation of the CEO in late 2013.

In summary, the Project achieved well against its targets, secured H2020 funding, and completed four successful WEFO claims audits, three successful EFAT audit reviews and one successful PIVT audit, and was commended for a number of its processes.

vii. **CONCLUSION 7: ERDF TARGETS.** There is a general acceptance that the original ERDF targets were ambitious for a project of this nature. Such targets occupied much of the discussions with WEFO over the last 18 months of the project and included an agreement in principle that as part of a reprofile the output targets would be reduced; reflecting both the reduced level of resources required and the environment HPC Wales was operating in. Overall, it should be noted that the ERDF results indicators did point to a positive picture at the mid-term review, with 'new product, process and services', 'investment induced' and 'enterprises created' all exceeding profiled targets. Although 'Jobs created' were under half of the profiled target (44%), this was consistent with the challenging economic context facing the Project and delays experienced during the set-up process. Given the rapid loss of staff in the last 6-9 months of the project, one could argue that **the HPC Wales delivery window for achieving its 5 year targets took place in just over two years given the problems highlighted at project start, and the loss of staff during the final stages. The Project fully achieved 8 of the targets, 5 achieved over 80%, with just 2 targets achieving just over 60%.**

viii. **CONCLUSION 8. HPC WALES, RESEARCH SUPPORT VS. ERDF.** There is an inherent tension between research objectives and ERDF commitments in the 2007-13 programme. Whilst ERDF was an appropriate mechanism to fund business engagement, an ESF route would have provided more appropriate funding for training and skills development. Research and "big science" would have been more appropriately funded through BIS, the Universities, Research Councils, and the EU, i.e. FP7. This evidence has been presented in terms of accountability being limited to third parties, and unclear policies on charging and augmented support. However, **the volume of measurable research outcomes generated as a result of HPC Wales' existence was extremely positive and competitive with other HE institutions nationwide.** This is covered in detail in Section 5 of the report.

ix. **CONCLUSION 9: OPERATIONS.** Up until the mid-point of the project, HPC Wales was still establishing internal and external management practices; indeed, as with any new, immature organisation, they were constantly refining and developing all of their practices/procedures. Note that progress here was demonstrated through achievement of ISO 9001 accreditation. **Operations were affected by the distributed nature of the team, with the mix of directly employed staff and secondees (both in terms and conditions of**

employment and line management) presenting challenges in workload management, communications and operations. These challenges were made increasingly difficult with the departure of key staff from the organisation during the final year of the project.

x. **CONCLUSION 10. STAFF RETENTION.** From an operational standpoint, loss of technical, outreach and administrative staff over the final twelve months of the project proved a real hammer blow. While the need for mechanisms to address the risk of staff lost had been raised at successive Board meetings, none of these were pursued; loss of over half the technical team to job offers from outside has led to the Team now being at sub-critical mass levels. This impacted on the operational performance of the project, given the potential need to support a community that has doubled over the final 12 months with a team that has reduced by the same factor over the same period. **Failure by the Board and Stakeholders to recognise the impact and take appropriate action should perhaps have been factored into plans for the final phase of the project.** (see 7. above).

xi. **CONCLUSION 11: HPC WALES, OUTREACH/SALES.** The initial focus at project outset provided a location-specific activity for HPC Wales that was relatively formulaic, e.g. each outreach person managed his or her own geographical patch. It became clear that some geographic locations (e.g. Swansea as opposed to Aberystwyth) had greater levels of demand, with latent opportunities based on the numbers and quality of qualifying SMEs. This led to an increased focus on virtual teams, with an increased sector focus, and an attempt to proposition the Welsh resources in a way that geographically represents opportunity. **This sector approach was agreed by both consultants and senior management as being the way forward, and subsequently implemented.** However, deploying such approaches became increasingly difficult during the final project stages as staff left the organisation.

xii. **CONCLUSION 12: HPC WALES, THEMES FOR FUNDING IN HPC AND BIG DATA.** HPC Wales is well placed to benefit from ongoing funding programmes from UK BIS, TSB, and Research Councils. There appears to be a great number of opportunities to secure funding and receive support from many quarters that fit with the Project's overall agenda. **HPC Wales has achieved demonstrable success in attracting funding from H2020, Innovate UK and TSB.** Notable in this regard is the successful HPC Wales led Horizon 2020 EINFRA bid to create an EU Network of HPC Competency Centres (SESAME Net), worth €2m with partners in 13 member states.

xiii. **CONCLUSION 13: BUSINESS SURVEY. Two-thirds of the businesses surveyed at the point of the mid-term review suggested that HPC was important to the success of their company.** In terms of future needs, they wanted more of the same, an update in the equipment and software as technology develops, and enhanced service delivery from HPC Wales, not only in terms of hardware and software, but also access to the expertise available. It can be said that **HPC Wales has had a measurable impact on beneficiary businesses and there is ongoing demand for the HPC Wales service.** That the successor project appears focused on WEFO Strategic Objective 1.1 and is driven by enhanced Research Capacity rather than business engagement is inconsistent with these findings.

xiv. **CONCLUSION 14: FUTURE FACILITIES.** Investment in the ownership of a HPC facility is high, and a refresh is continually required, with evidence suggesting that hardware should be refreshed every three-years. This is mainly due to the hardware aging, paralleled with constant technical developments that create more sophisticated and lower-costing facilities. Using a HPC facility does not necessarily require owning HPC hardware outright.

There are many instances (particularly with large organisations) where they have a core hardware capability, and then use additional external resources when required e.g., Rolls Royce. HPC Wales has consistently evaluated the Total Cost of Ownership and advantages of sourcing additional core hours from HPC academic led initiatives, e.g., at STFC Daresbury Laboratory, Edinburgh University or alternatively by core hours in the open market from Cloud providers such as Amazon and Google. While these analyses consistently point to **the current ownership model being the most cost effective** (particularly after the investments in infrastructure made by HPC Wales), it is true that the perception exists within some senior management in the Stakeholder institutions and WEFO/WG, incorrectly in our view, that expenditure on HPC technology is not cost-effective vis-à-vis the outsourced rental model. We refer to two analyses conducted by HPC Wales staff that support this view; (i) the costs of siting existing technology in commercial data centres compared to continued use of the existing HPC Wales Hubs⁷, and (ii) a cost and performance analysis of carrying out an HPC workload on cloud-based facilities compared to the use of in-house HPC clusters⁸.

Stakeholders appreciate that the current facility still has some years of useful life left, with only a minor refresh and software update being required throughout 2016. Beyond that point, the aging Sandy Bridge systems will need replacing, for they will no longer be competitive and will become increasingly expensive to maintain. It is expected that in the short term this will be housed as an organisation, HPC Wales Limited, and made available initially to academics, then maybe to outside organisations, on a contract-by-contract basis.

Many clearly believe that the facility should remain in-house and work alongside other HPC facilities throughout Welsh universities, particularly ARCCA. Our research has shown that it is very important to provide the interface between the facility and staff. This has been referred to as the “wrap-around” support and it is clear the interpretation of need, the use of software, firmware and hardware will lead to better projects and better outputs and outcomes. This will require revenue funding to ensure that the right personnel are in place.

xv. **CONCLUSION 15: TRAINING.** It is the Consultants' understanding that training will not be a core deliverable under HPC Wales II and ERDF funding, and that therefore the future programme will have a closer alignment with 2014-2020 funding streams. Results from the training analysis, however, suggested that **training was very useful, created a great degree of awareness, and would lead to future projects, tenders and long-term benefits.** The Consultants believe that **there is a continuing requirement for training** that should be considered under a separate bid, and managed and delivered from a separate team. We are also reminded that the capacity of HPC can be overstretched at times and therefore training needs to be closely aligned and planned with academic use.

xvi. **CONCLUSION 16: MARKETING.** It is clear that HPC has used an array of marketing messages and channels to reach its target audiences. On the whole, marketing has proved to be useful, and particularly useful when it is focused on delivering internally. Should HPC Wales II focus on delivering academic capacity, and working with academics, a new marketing model would have to be doctored. This should be driven by Cardiff University only

⁷ *HPC Wales: Stage-2 Technology Hosting Options – A Preliminary Analysis*, paper to the HPC Wales Business Planning Group, September 2015.

⁸ *Commercial provisioning of ARCCA Services*, ARCCA-OG-96, paper to the ARCCA Oversight Group, February 2015, and *Application Performance in Chemistry and Materials Science: Local vs. Cloud HPC Resources*, invited presentation at the Computing Insight UK 2015 conference, Ricoh Arena, 8 December 2015.

and focused on academics who are tendering for or are undertaking Welsh projects, where a HPC facility can demonstrate added value, in terms of improving the scope of the study research, improving its outputs and interpretation. It should also be called upon to support tenders for competitive research bids in the UK or Europe. **HPC Wales has become a globally recognised brand in part due to marketing activities alongside other promotional activities. It is essential that this brand is not lost in the transition to a future project.**

xvii. **CONCLUSION 17: PROGRESSION TOWARDS SUSTAINABILITY AND/OR EXIT AND BUILDING ON INVESTMENT.** It was clear at the midway point that all internal stakeholders and the majority of external stakeholders saw this as a long-term initiative and there was enthusiasm for long-term sustainability. It is clear that **HPC Wales has provided a strong foundation on which to build a long-term sustainable model.** Typically this is based on a jointly funded arrangement with 1/3 core grant, 1/3 commercial/project income and 1/3 from competitively sourced grant income (or partner institutions). HPC Wales ability to achieve this has been eroded with the reduction in the resource/capacity base, principally the staff, and initial decisions to reduce the company's activity. Subsequent agreement has been reached to fund transition activities until a second programme starts. Within HPC Wales II there is now a complete focus on supporting academic endeavour, an activity that can indeed lead to a great number of institutional benefits, not least::

- Winning grants (UK and Rest of EU)
- Improving the quality of academic research work
- Enhancing the standing of the Welsh Universities.

The research undertaken for this evaluation clearly shows that **such activity is valid and can be sustainable through reinvestment and the positioning of HPC as delivering emerging opportunities, such as research into major social, environmental and commercial opportunities.**

Furthermore, the Consultants conclude that **this activity should not be considered in isolation but should be augmented by the ongoing provision of services to business, and to a training and skills activity** to build on the highly successful Skills Academy from the first project.

RECOMMENDATIONS

xviii. **RECOMMENDATION 1: THE SUCCESSOR PROJECT.** Based on the evidence provided from the Stakeholder interviews, and from their own analysis of the HPC ecosystem, **the Consultants provide a strong recommendation and endorsement for the proposed HPC Wales II project.** This report recognises that HPC Wales II will be different, for it is now well timed in terms of University needs and the academic agenda, coupled with a different landscape to HPC Wales that is framed by a general international recognition of the ability of HPC and data – now seen as a new and attractive science.

Alongside this endorsement, the Consultants recommend that **consideration should be given to both the ongoing provision of Services to business, and to a training and skills activity** to build on the highly successful Skills Academy from the first project. It is the Consultants understanding that training will not be a core deliverable under HPC Wales II and ERDF funding. Results from the training analysis suggested that training was very useful, created a great degree of awareness, and would lead to future projects, tenders and long-term benefits. The Consultants believe that there **is a continuing requirement for training that should be considered under a separate bid**, possibly managed and delivered from a

separate team. We are also reminded that the capacity of HPC can be overstretched at times and therefore training needs to be closely aligned and planned with academic use.

xix. **RECOMMENDATION 2: DURABILITY OF HPC WALES.** The Consultants would draw HPC Wales and its Stakeholders attention to a requirement by WEFO-funded projects to ensure the durability of projects co-financed by the Structural Funds with an obligation to maintain the investment in accordance with Article 57 of Regulation 1083/2006 and as amended by Regulation (EU) No 539/2010 of 16 June 2010. Project sponsors are required to inform WEFO of any substantial modification to their project within 5 years of its completion or 3 years from the completion of a project for the maintenance of investments or jobs created by SMEs which:

- Affects its nature or its implementation conditions or gives to a firm or public body an undue advantage: and
- Results either from a change in the nature of ownership of an item of infrastructure or the cessation of a productive activity

Furthermore, the failure to maintain the investment will result in recovery of the structural funds contribution. Therefore the Consultants recommend that **the HPC Wales II consortium give due consideration to compliance with Article 57 within their business planning processes.**

xx. **RECOMMENDATION 3: TRANSITION ARRANGEMENTS.** The Consultants recognise the major investment in infrastructure, resources and services that has arisen from the major investments made by WEFO and WG during HPC Wales. They strongly recommend that the **Stakeholders representing HPC Wales II ensure that adequate transition arrangements are put in place to secure these assets and future operation of HPC services.** It is important that the foundations in terms of skills and business engagement are not lost to Wales.

xxi. **RECOMMENDATION 4: REALIGNMENT OF HPC ACTIVITIES.** Following the suggestion of many of those interviewed, the Consultants recommend that **HPC activities within the Stakeholder institutions are aligned alongside the successor HPC Wales II project.** Many clearly believe that the associated facility should remain in-house and work alongside other HPC facilities throughout Welsh universities, particularly ARCCA at Cardiff University. In terms of strengthening this support infrastructure for research, the consultants recognise the importance of providing the interface between the facility and research staff. This has been referred to as the “wrap-around” support and it is clear that the expert interpretation of requirements, the use of optimised software, firmware and hardware will lead to better projects and better outputs and outcomes. This will require revenue funding to ensure that the right personnel are in place (see also recommendation 6).

xxii. **RECOMMENDATION 5: SUPPORT FOR THE HORIZON2020 SESAME NET.** The Consultants believe that HPC Wales has established an important brand and presence within the HPC eco-system during its five years of operation. In recommending that this brand be exploited moving forward, the Consultants recognise that HPC Wales and its deliverables (e.g. big data) are topical, and that these are areas that are likely to receive strong financial and non-financial support in the future, from multiple sources. HPC Wales should capitalise on their successful and high profile Horizon 2020 EIFRA bid to create the EU Network of HPC Competency Centres (SESAME Net), worth €2m with partners in 15 member states. This will provide further opportunities to leverage on all these sources of funds. The consultants

recommend that **the SESAME Net network is retained by HPC Wales moving forward**, providing as it does a platform to bring future EU funding into Wales.

xxiii. **RECOMMENDATION 6: RETAINING AND AUGMENTING THE EXPERTISE AND IP FROM HPC WALES.** The Consultants recognise the value of the expertise, products and services and brand name owned by HPC Wales Ltd. There was widespread support from those users interviewed for the product, service, skills and training offered by HPC Wales, with a picture of comprehensive and flexible support that clearly state-of-the-art. In addition to delivering outputs and outcomes, the Project has progressed significantly in creating know-how in HPC, has laid foundations and has created capacity. It is our view that **consideration should be given to how these assets should be retained and developed for Wales, within and beyond the current HPC Wales II proposal.**

As highlighted in Recommendation 4, **the current service should be augmented by in-house expertise in applications (performance tuning, scalability etc.) and domain-specific support in helping users to optimally exploit the potential of HPC.** This class of support will be critical in HPC Wales II.

9. Appendix I: HPC Wales Performance Figures (MID-TERM)

ERDF Performance Indicators (Mid-Term)

ERDF Indicator	Cumulative claims to 31.03.14	Delivery Profile Target To Date	Achievement of profile target to date (%)	Pipeline evidence	Incomplete evidence <u>and</u> cumulative claim - achievement of profile target to date (%)	Project Final Target	Variance vs. May 15 Target
Jobs Created	106	240	44	0	44	405	26
Diagnostics (D)	110	201	55	24	67	330	41
Assistances (A)	78	134	58	80	118	220	72
Total Enterprises Assisted (D+A)	188	335	56	104	87	550	53
New P/P/S created	234	146	160	3	162	216	110
Collaborative Projects	83	75	111	42	167	120	104
Investment Induced £M's	3.451	2,400	144	183	151	3,840	95
New P/P/S Registered	49	55	89	0	89	100	49
Enterprises Created	5	5	100	1	120	10	60
Enterprises adopting and implementing Environmental Action Plans	2	18	11	0	11	30	7
Enterprises adopting or improving equality strategies and monitoring systems	1	18	6	0	6	30	3

ESF Performance Indicators (Mid-Term)

ESF Indicator	Cumulative claims to 31.03.14	Delivery Profile Target To 31.03.14	Achievement of profile target to date (%)	Pipeline Evidence	Incomplete evidence <u>and</u> cumulative claim - achievement of profile target (%)	Project Final Target	Variance vs. May 15 Target
Workshops	144	82	171	3	175	124	119
Online Courses	23	4	613	10	880	5	660
Participants	1,213	1,353	90	28	92	1,960	63
Participants entering further learning	55	124	44	10	52	184	35
Participants gaining Level 4+ qualifications	94	523	18	267	69	860	42

Traded Income Performance Indicator (Mid-Term)

Traded Income Indicator	Cumulative claims to 31.03.14	Delivery Profile Target To 31.03.14	Achievement of profile target to date (%)	Pipeline Evidence	Incomplete evidence <u>and</u> cumulative claim - achievement of profile target (%)	Project Final Target	Variance vs. May 15 Target
Traded Income (£ 000)	404	819	49	0	49	1,965	21

10. Appendix II: Lessons Learned

Taken from the following report provided by David Elcock:

HIGHER EDUCATION FUNDING COUNCIL FOR WALES RECONFIGURATION AND COLLABORATION FUND, FINAL MONITORING AND EVALUATION REPORT HPC WALES

Please provide information on lessons learned from the development of HPC Wales. This may include process, management, governance, financial and/or academic aspects.

- 1. Development and Operation of the Governance Structure.** Although it was widely recognised amongst the stakeholder groups that HPC Wales has established a novel and successful SPV Governance Structure, with equal and shared risk, it was noticeable that those appointed to membership of the SPV often operated – perhaps unconsciously – in the best interest of their respective organisations, rather than in the best interests of HPC Wales. It also became clear that the same individuals did not always cascade the business of the meetings within their own organisations, leading to a disconnect between HPC Wales and the stakeholder organisations. What is now clear is that the associated Project Board – the HPC Wales stakeholder Group – should have been inaugurated soon after project start. This would have provided a suitable forum for stakeholder specific issues to be debated, enabling the SPV to operate in the best interests of HPC Wales.
- 2. Risk and Return:** At the time of inception, HPC Wales was a high-risk investment and venture. It was a novel initiative whose inputs consisted of an emerging and disruptive technology (HPC) for the SME market, a predominantly latent market, and the need to establish route-to-market and a product/service offering that was SME-centric. These challenges were fully recognised by those who had crafted the business plan, informed by a series of workshops and meetings with key stakeholders in both the HE sector and Welsh Government. Thus despite the risk (in terms of successfully achieving targets), stakeholders still felt it worthy of investment. What is clear is that the full benefits of the Project will only materialise from long-term investment and promotion.
- 3. External Perceptions.** It is clear that amongst original funding stakeholders there is a mixed perception on the performance of HPC Wales. This is largely due to insufficient interactions between HPC Wales and specific stakeholders, which has prompted comments such as: 'HPC Wales is failing and we cannot afford it to fail'. This lack of communication was clearly both ways and needed addressing as a matter of urgency. There is a clear requirement to ensure that internal stakeholders are made fully aware of the positive coverage of HPC Wales in the media, and within EU and UK BIS. While a contentious point, it is evident that successive CEOs failed to cultivate a meaningful relationship with the VCs of the stakeholder institutions.
- 4. Project Launch and Delays.** Whilst we would argue that the overall performance of HPC Wales has been good, progress has been constrained by a number of factors, the impact of which could, in hindsight, have been minimised. HPC Wales encountered severe delays in its formative years from an operational point of view. The key areas in which delays occurred:

- **A protracted procurement process**, requiring full competitive dialogue. This procurement model was driven through by the then Head of the Procurement Team in spite of advice from his technical counterparts that it would prove over complex and lengthy. The procurement occupied the majority of the senior management team then in place for the duration of the process. We would note however that, although protracted, HPC Wales completed the process in a significantly shorter time (nine months) than is considered normal practice for a “Competitive Dialogue” procedure. Nevertheless, progressing other components of the project was slowed significantly by the choice of procurement model, and by the involvement of senior staff in the procurement.

- **Establishment of a distributed infrastructure system:** Challenges associated with this establishment were caused by two factors that were not anticipated at the outset.

- **Data Centre Issues:** In spite of reassurances at project outset, the sites provided by a number of the institutions were not fit for purpose and required significant refurbishment e.g. Aberystwyth and University of South Wales. That the University of Swansea were unavailable to provide a suitable Hub site until almost three years (!) after the start of the project also caused excessive delays in infrastructure deployment. One of the major benefits of HPC Wales that is rarely mentioned is the resulting improvement in IT infrastructure at many of the stakeholder institutions.

- **Supplier Issues:** The chosen supplier – Fujitsu – did not have sufficient technical staff and engineers to carry out concurrent, multi-site installations. Again this was not made clear at project outset. As a large service-driven organisation, they also proved highly conservative and risk averse, insisting on change control notices at every turn. This again slowed down system deployment, delays that were further exacerbated by the excessive times taken for the installed systems to pass acceptance tests. It is clear that any supplier involved in future stages of HPC Wales needs to be agile and technically proficient in its UK operations.

- **Operational Staff Recruitment:** Delays in the recruitment of required operational staff (in part a result of skill shortages in the region). The move to hire the senior management team before recruitment of the TOMs and Technical Team meant that the operational role out of the project was delayed, as was the engagement with prospective customers. Early recruitment of the TOMs could have accelerated the customer identification and subsequent engagement, together with the associated requirements analysis.

- The delays noted above were the prime reasons for the initial underperformance in terms of ERDF and (less so) ESF targets. This perception drove the performance of the SPV who, operating in the best interests of their parent institution rather than the best interests of HPC Wales, focused more on the potential impact of claw back rather than helping HPC Wales address the impact of time slippage.

5. **Business engagement:** From an operational and tactical perspective, the Project also encountered delays in progress in relation to business engagement given that HPC is “difficult to sell” due to a lack of awareness of the technology in the target market. It should be noted that planning for HPC Wales took place in 2009, a time when HPC was a novel concept that, although a well-known research enabler in the academic community, was less well known in the SME arena. That the concept was little known at the outset amongst those recruited in the role of TOMs suggests that a more in-depth

awareness and expertise in HPC amongst those recruited should have featured in the essential skills associated with the positions. This would undoubtedly have accelerated the outreach agenda and marketing approach to the SME community.

6. **The HPC Wales Product Offering.** The product, service, skills and training offered by HPC Wales is comprehensive and flexible, and is without doubt state-of-the-art. In addition to delivering outputs and outcomes, the Project has progressed significantly in creating know-how in HPC, has laid foundations and has created capacity. However, a growing issue with service delivery occurred at the interface between the outreach and technical teams. What is clearly required in the future is in-house expertise in applications (performance tuning, scalability etc.) and domain-specific support in helping users to optimally exploit the potential of HPC. Sustainability of HPC Wales and its competitiveness in the market place relies on this class of support. The required expertise was not present in the TOMs, and although growing in a Technical Team with essentially system administrator skills, fell short of the levels required. The short-term solution was provided by NAG and FLE (Fujitsu Lab. Europe), but this proved an extremely expensive solution that is certainly not sustainable. This class of support will be critical in HPC Wales II.
7. **HPC Wales Performance.** Performance monitoring evidence, focusing on three indicator areas, namely ERDF, ESF (including induced investment), and income generation, was collected by HPC Wales on a monthly basis and reported on quarterly to WEFO. The Project completed four successful WEFO claims audits, two successful EFAT audit reviews and one successful PIVT audit.
 - i. At the time of the mid-term review, taking incomplete evidence into account, seven of the fifteen indicators achieved or surpassed targets, with five of the remaining indicators showing good progress towards achieving targets. It should be noted that momentum significantly increased since the procurement and recruitment phases, and that performance figures should be viewed against the complex set-up environment endured by the Project.
 - ii. However, a delay in the announcement of Structural Funding for Wales (2015 – 2020) coupled with the failure by the project to progress the HPC Wales II Business plan in a timely fashion led to additional issues throughout the final year of the project. HPC Wales Operational staff were not convinced of a viable future in spite of assurances from the CEO and senior managers, culminating in an accelerated loss of staff, and with it a loss in momentum that had been firmly established throughout 2013. So at exactly the time when accelerated delivery of targets was called for, HPC Wales lost many of the operational team essential to delivery. This whole situation was certainly not helped by the unexpected resignation of the CEO in late 2013.
8. **ERDF Targets.** There is a general acceptance that the original ERDF targets were ambitious for a project of this nature e.g., the total number of SME assists: 550 (be it diagnostic or assistance), and jobs created: 405. Such targets occupied much of the discussions with WEFO over the last 18 months of the project. Overall, it should be noted that the ERDF results indicators did point to a positive picture at the mid-term review, with 'new product, process and services', 'investment induced' and 'enterprises created' all exceeding profiled targets. Although 'Jobs created' were under half of the profiled target (44%), this was consistent with the challenging economic context facing the Project and delays experienced during the set-up process. Given the rapid loss of staff in the last 6-9 months of the project, one could argue that the HPC Wales delivery window

for achieving its 5 year targets took place in just over two years given the problems highlighted at project start, and the loss of staff during the final stages of the project.

9. **HPC Wales, Research Support vs. ERDF.** There was an increasing mismatch in objectives between HPC Wales' research objectives and its ERDF commitments. This is inevitable due to the manner in which the Project was created and funded. Whilst ERDF was an appropriate mechanism to fund business engagement, an ESF route would have provided more appropriate funding for training and skills development. Research and "big science" would have been more appropriately funded through BIS, the Universities, Research Councils, and the EU, i.e. FP7. This evidence has been presented in terms of accountability being limited to third parties, and unclear policies on charging and augmented support.
10. **Operations.** Up until the mid-point of the project, HPC Wales was still establishing internal and external management practices; indeed, as with any new, immature entity, we were constantly refining and developing all of our practices/procedures. While such issues were perhaps to be expected, due in part to the distributed nature of the team, management were certainly aware of, and tried to deal with, process and communication issues, the task was made increasingly difficult with the departure of key staff from the organisation during the final year of the project.
11. **Staff retention:** From an operational standpoint, loss of technical, outreach and administrative staff over the final twelve months of the project proved a real hammer blow. While the need for mechanisms to address the risk of staff lost had been raised at successive Board meetings, none of these were pursued; loss of over half the technical team to job offers from outside has led to the Team now being at sub-critical mass levels. This impacted on the operational performance of the project, given the potential need to support a community that has doubled over the past 12 months with a team that has reduced by the same factor over the same period. Failure by the Board and Stakeholders to recognise the impact and take appropriate action should perhaps have been factored into plans for the final phase of the project? (see 8.).
12. **HPC Wales, Outreach/Sales.** The initial focus at project outset provided a location-specific activity for HPC Wales that was relatively formulaic, e.g. each outreach person managed his or her own geographical patch. It became clear that some geographic locations (i.e. Swansea as opposed to Aberystwyth) had greater levels of demand, with latent opportunities are based on the numbers and quality of qualifying SMEs. This led to an increased focus on virtual teams, with an increased sector focus, and an attempt to proposition the Welsh resources in a way that geographically represents opportunity. Again, deploying such approaches became increasingly difficult during the final project stages as staff left the organisation.
13. **HPC Wales, Context.** In many ways HPC Wales and its deliverables (e.g. big data) are topical, and there are areas that are likely to receive strong financial and non-financial support. The next round of funding has finally become available within Europe and there are ongoing funding programmes from UK BIS, TSB, and Research Councils. There appears to be a great number of opportunities to secure funding and receive support from many quarters and it makes good sense to map out where the funding sources are, their purpose, and where they chime with the Project's overall agenda. Interestingly, the Horizon 2020 unit at the WG provides grants of 50% under its programme to support EU research and development bids. Notable in this regard is the successful HPC Wales led Horizon 2020 EINFRA bid to create an EU Network of HPC Competency Centres, worth

€2m with partners in 15 member states – further enhancing the opportunities to leverage on both these sources of funds.

14. **Business Survey.** Two-thirds of the businesses surveyed at the point of the mid-term review suggested that HPC was important to the success of their company. In terms of future needs, they wanted more of the same, an update in the equipment and software as technology develops, and enhanced service delivery from HPC Wales, not only in terms of hardware and software, but also access to the expertise available. It can be said that HPC Wales has had a measurable impact on beneficiary businesses and there is ongoing demand for the HPC Wales service. That the successor project appears focused on SO 1.1 and is driven by enhanced Research Capacity rather than business engagement is inconsistent with these findings.
15. **HPC Refresh.** Investment in the ownership of a HPC facility is high, and a refresh is continually required, with evidence suggesting that hardware should be refreshed every three-years. This is mainly due to the hardware aging, paralleled with constant technical developments that create more sophisticated and lower-costing facilities. Using a HPC facility does not necessarily require owning HPC hardware outright. There are many instances (particularly with large organisations) where they have a core hardware capability, and then use additional external resources when required e.g., Rolls Royce. HPC Wales has consistently evaluated the TCO and advantages of sourcing additional core hours from HPC academic led initiatives, e.g., at STFC Daresbury Laboratory, Edinburgh University or alternatively by core hours in the open market from Cloud providers such as Amazon and Google. While these analyses consistently point to the current ownership model being the most cost effective (particularly after the investments in infrastructure made by HPC Wales), it is true that the perception exists within some senior management in the Stakeholder institutions and WEFO/WG, incorrectly in our view, that expenditure on HPC technology is not cost-effective vis-à-vis the outsourced rental model.



Signed: David Elcock- Acting Chief Executive

Date: 31 August 2015

11. Appendix III: Thematic Case Studies

1. Cardiff Catalysis Institute

Overview of the Cardiff Catalysis Institute

The Cardiff Catalysis Institute is a Cardiff University research centre of excellence based in the School of Chemistry. Established in 2011, the Institute builds on the University's strengths in heterogeneous catalysis, homogeneous catalysis and bio-catalysis, providing a focal point to interdisciplinary interactions. The Institute is funded by the University, with other sources from commercial and research council funding. It currently has 12 members of staff, plus a number of research students.

The Institute's main connection to HPC Wales is through the work of its Computational Chemistry research group. This group is concerned with the use of computer simulation to understand materials with a particular focus on catalysis and related areas. Led by Dr David Willock the team includes a number of post-graduates and post-doc researchers, one of whom is funded by a HPC Wales funded Studentship (PhD).

High performance computing and links to HPC Wales

The Computational Chemistry research group has been a long-time user of high performance computing systems, including Cardiff University's own Raven Supercomputer (managed by the University's ARCCA – Advance Research Computing @ Cardiff – who also host a HPC Wales hub), and key UK resources such as HECToR/ARCHER.

The group first became aware of HPC Wales through its close links to ARCCA. This subsequently led to the group contributing to the development of the HPC Wales system, 'acting as a test driver of the system'. It was subsequently able (as noted above) to secure funding for a research studentship from HPC Wales. This research is being undertaken in collaboration with a specialist polymer and recycling company based in North Wales – NexTek Ltd. This company has strong expertise in designing and building plants for recycling of post-consumer plastic wastes into applications such as food grade PET bottles and HDPE milk bottles. Its focus in making plastics from biological sources also requires significant computational modelling input, and its need for specialist expertise.

The HPC Wales studentship (candidate - Liam Thomas) is using computer simulation to design and improve catalytic materials for the production of green chemical feedstock materials derived from agricultural waste. In particular, the project is investigating the mechanism for the oxidation of Hydroxymethylfurfural (HMF) using supported nanoparticles (see figure for an example of early HMF Adsorption profile results).

The research group has also worked alongside HPC Wales in its two day conference in Swansea Liberty Stadium (2013). This included providing a presentation, and allowed discussion with potential students. Relatively few SMEs, however, were said to be present at the meeting.

Satisfaction

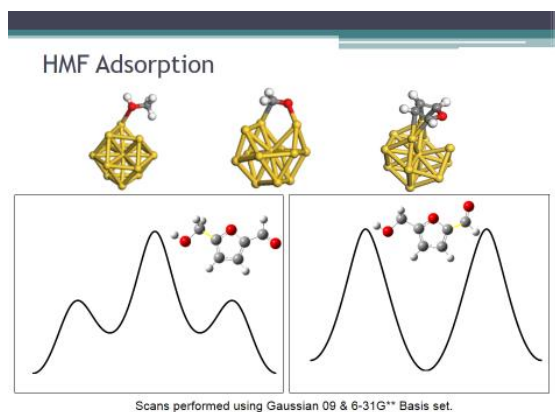
The research group are highly satisfied with the offer of HPC Wales, and believe that it provides a secure and reliable system, alongside a wide range of chemistry software packages. The system is said to be over and above that which is available locally, and has a flexible offer. This provides the research group with greater time access to the system and 'a greater number of CPU cycles'.

Unlike HECToR/ARCHER it is felt to be relatively straightforward to discuss requirements for memory and software with HPC Wales staff. This makes reconfiguration relatively straightforward (without completion a new grant application), and enables bigger projects to be undertaken, with greater 'confidence' in results possible.

Initial impacts

To date, research undertaken using the HPC Wales system has resulted in two new peer-reviewed publications. A further five publications are in preparation, all referencing the support of HPC Wales.

While the research is at a relatively early stage (second year of the studentship), the research studentship findings have the potential to make a positive impact on the sustainable chemicals industry in Wales and further afield, through the efficient use of catalysts to reduce energy requirements and increase yields. This ultimately may lead to smaller chemical plant sizes and lower levels of environmental impact.



Wider benefits from the partnership with NexTek have been achieved from the regular interaction and exchange of information during the research studentship period. This has enabled the research group to develop experience of industry needs, and conducting computational catalysis research alongside a leading edge commercial environment.

Additionality

Without HPC Wales' system the research group are clear that they would have to use either local resources, or UK systems such as HECToR/ARCHER. This, however, would impact on the quality (reliability) of research results.

In relation to the research studentship and collaboration with NexTek the research group are clear that this would not have gone ahead without HPC Wales funding.

Challenges and areas for development

The key challenge for the research group is identifying projects, which have the potential to benefit the Convergence area of Wales. To date, this has been addressed by working with partners such as NexTek in Bangor. The research group has also found it difficult to host HPC Wales training events due to the location of its students (primarily Cardiff based).

The research group feel that HPC Wales' offer could be strengthened by opening up its system to researchers on an 'all Wales' basis. This could be managed carefully to ensure that projects meeting the eligibility criteria are given preference. By broadening out its offer, geographically HPC Wales would have potential to maximise its use, and subsequent impacts.

2. thinkplay.tv

Using Supercomputing to Create Animation thinkplay.TV based in Ceredigion creates virtual sets, interactive games, animation and motion graphics. Set up in 2006 its work has featured on S4C, Channel 4, Five, Discovery, myTV (India), Telefonica5 (Spain), Playstation, Wii and Xbox.

The MD Aled Lloyd found out about HPC Wales through a contact on Linked-in. Following several skype meetings with the technical team they were rendering within two days. "Working with HPC Wales has been absolutely brilliant right from the start – they are very good at working out how much help you need. They diagnosed our needs quite well and understood the market... some of the staff members were even prepared to work late in the evening and at weekends".

Aled describes how the company's carries out its work. "Firstly, you need to produce the scene (factoring in lighting, shading, textures, and so on), and then you need to process or 'render' that scene. Prior to working with HPC Wales, we could do the core of the work, the production stage, but we didn't have the computing power to go on and do the processing (rendering) stage."

thinkplay.tv now use HPC Wales' supercomputing facilities to render their animations much faster than was previously possible in-house. It started with a rendering job for a large media organisation. Aled claimed "[this process] would have taken a month and using HPC we turned it around in a day and half. Some jobs you can't do without render power, it allows you to increase quality and therefore price and scale – its puts you in a better position to bid that work".

On jobs with a deadline the company does not have the time to carry out the sequence of steps required. Working with HPC Wales can save 20% or more on a project and on certain assignments "you just can't do without it [HPC Wales supercomputing power] for instance if you are doing more high-end effects for TV". Aled claimed "on another recent project that would normally have taken 4 days to render, we had it finished in 4 hours on the HPC Wales system".

With access to only two desktop computers, the duo could only generate limited amounts of animation and were unable to work on anything else when their desktops occupied rendering. "We're more productive as a company... we do not have to wait for the rendering to finish. We couldn't show off our skills and our creativity was being limited by our rendering capabilities. Instead of spending my time thinking about what we can't do, I can now...look at what we can do".

Previously the team used to run computers over-night which was both risky and expensive. With access to more rendering power they are able to start later and work on generating more or better scenes or footage or doing other work. "What was holding us back was the rendering, now we can improve quality and lighting. We can also fix issues with renders post production or re-render at no cost on the HPC Wales system".

The Company also worked with a client to develop an app for iPad and Android computers that promotes basic life skills to all young children, focusing on those with Autism Spectrum Disorders. It used the HPC Wales' system to render digital characters resulting in a much faster turnaround time. thinkplay.tv has also made use of HPC Wales' range of open source and commercial software licenses for rendering and modelling. "We can now do film level effects, full HD with no problem. We have the capacity to increase the size of a job at short notice when a client asks for more frames. We can also pass any savings on to a client!"

Aled claims that HPC Wales' facilities are ideal for people in remote locations and likes the fact that both businesses as well as universities can now use the facilities. "Being in mid-Wales, HPC Wales' web based portal is perfect for us. We can access the technology 24 hours a day, from anywhere. HPC Wales assign you 20-30 computer chips [worth of

computing power] which is fantastic as we only have five. They have the largest chip array in Wales – that's immense power".

The firm is able to compete for larger, more complex projects for prestigious organisations improving their credibility within their target market avoiding expensive commercial render farms. "It exposed me to file rendering and the issues involved, I would not have had that unless I had access to HPC supercomputing facilities" maintains Aled. "When I first used HPC facilities I was breaking new ground ... testing it...the process has helped me from a technical point of view to understand how we work".

Whilst the company has now shifted its market focus from TV to publishing Aled believes the experience with HPC Wales has given the firm new capabilities. In the future Aled would like to see more sophisticated on-line team management tools to enable like-minded companies to collaborate more easily. An example would be the provision of small repositories or cloud storage with tailored support that can handle 3D and allow teams to drop files and access appropriate software. Aled thinks there is scope for better standardisation of the effects pipeline. This might foster better collaboration across studios pitching for larger contracts.

Aled believes HPC Wales should continue to specialise, ensure its software and hardware easy to use and provide a package of personal support and dedicated client management. This would make HPC continue to stand out from the commercial render houses that just operate via a web interface. He also likes the fact that training and CDP is offered by HPC Wales and is interested in learning Programming in C++.

3. i-Create

i-Create is UK leading dynamic team of architectural visualisers and 3D architectural renderers based in Swansea with virtual offices in London and the USA. The company produces high quality 'fly throughs', interior renderings and develops Computer Generated Images (CGI) for the international property sector. With a team of eight they have been established for over ten years working mainly for architects and developers. The MD Jake Major described what they do as "breathing life into architectural plans". The firm also creates interactive 3D apps and multi-media 3D graphics for websites and presentations for instance.

The team in Swansea help clients to present new developments in their best possible light before they're built, helping them to secure planning permission, sell property 'off plan', and engage communities in regeneration and town planning. The process involves the conversion of 2D Computer Aided Design (CAD) drawings into 3D which is quite a time consuming process. The MD claims "there is not as much programming and code as people might think, it's a very hands on process for our digital artists". Once we have created a project we then need to create the animation which at 25 frames per second takes a lot of computing power".

Someone mentioned the HPC team and equipment to the MD when they were moving to premises nearby. He subsequently made contact with the team at HPC Wales and have been working with them for about a year on three separate occasions.



The first project was for an international developer in Miami who had created an exclusive \$22 million house on an island (see image). Whilst it was under construction the client asked iCreate to create a visualisation of the house and a fly around with the aim of selling it prior to its completion. HPC supercomputing power was used to help generate the separate frames to produce an animation of some 8000 frames.

The client also asked for it to be in High Definition which required even more computing power. "We could not have done it without HPC Wales, it would have taken couple of months compared to a couple of weeks saving the firm around £5-6000. Their facilities gave us access to a vast amount of computer power".

The second project was for a smaller fly through movie for a Welsh development – a housing project on the Gower requiring an exterior fly around of about five minutes long. Jake claims "this didn't need as much processing power but it ended up being some ten times quicker on the HPC equipment, taking two days as opposed to twenty". The third project was a commercial assignment for leisure centre for a developer who again wanted a fly around of the exterior to show what it might look like once constructed. The facilities included a gym, swimming pool and changing rooms. There were some technical challenges that needed to be resolved on this project (with some of the 'assets' missing following the rendering process).

In terms of the outcomes for the company following their engagement with HPC Wales the Miami project helped iCreate generate an HD flythrough that they would not otherwise have had. The MD claimed "this does show us off better and we have had more enquires and hopefully sales. It has improved our prospects of winning high end luxury projects".

When asked about HPC Wales, Jake the MD claimed "they are very nice people, very friendly and accommodating and have tried in every way to make it as simple and easy as possible. They could do with more personnel to help programme the web interface that we access. This would match the expenditure on equipment. By matching the HPC capabilities with staff I believe they could get up and running quicker and make it an even smoother process for clients".

In terms of the future Jakes claims they might create a job as a result of working with HPC Wales. HPC power has extended and sped iCreate's capabilities. "HPC Wales will come in especially useful when we have got a really tight deadline - in that scenario we would be able to meet the deadline and win a job that might otherwise not have been able to". "They [HPC Wales] have had a massive positive impact on our business but we are not there yet in terms of ironing out all the glitches on this new technology". Overall it's been very positive, Jake claims and his advice for the future would be to balance the number of staff with HPC power to make sure HPC equipment and capabilities are fully exploited.

12. Appendix IV: HPC Product Offering

HPC Wales Portal

HPC Wales allows researchers and businesses dealing with large volumes of data and complex analytical problems to access HPC as and when they require via HPC Wales' easy-to-use portal or, for those more experienced HPC users, direct access through HPC Wales' secure shell interface.

HPC Wales' portal will include access to thematic gateways, providing collaborative access to software, easy to tailor workflows, a user community, discussion forum, user guides and support services to make it even easier to access HPC Wales' facilities.

Key benefits:

- Productivity at first login through different access routes for both novice and expert users
- The ability to submit data from any location to HPC Wales' network
- Expert support and training to maximise your use of HPC
- Cost-effective access to HPC (*European funding available for compliant projects)
- A secure, lower-risk HPC solution, private network and daily data back-up
- Better research results, faster

Data Curation

HPC Wales' data curating services enable researchers and businesses with large data sets to deposit and retrieve relevant data, produce more accurate reports, add value to data (for example, through indexing), maintain the quality of their data, and ensure that data can be re-used over time.

Key features:

- Specialist technical team to assist beneficiaries
- Specifically geared to HPC data
- Local access to your data reports

Data Repository

For large datasets HPC Wales' Data Repository service can help. In order to maintain datasets securely, HPC Wales guarantees the optimal timing and tier of storage, whilst ensuring the process is conducted in the most cost-efficient way possible. HPC Wales provides secure and easy access storage for HPC data.

Key features

- Specialist HPC data storage
- Ability to store data for future re-use
- Optimum security for your datasets (daily data back-up)
- Easy access to archived data
- Access to large storage capacity

Simulation and Modelling

HPC Wales' computational simulation and modelling services enable researchers and

businesses to study complex problems and explore numerous scenarios more quickly and cost-effectively than with theory or experiments - for example, in optimal manufacturing design or screening of potential drug molecules.

The rapid integration of mathematical modelling, computing technology and real-life applications have made simulation and modelling powerful and indispensable tools in the study of complex phenomena.

HPC Wales offers a suite of community and commercial simulation codes and provides advice on cost-effective capacity computing and novel architecture solutions. Beneficiaries can:

- Customise their own code: HPC Wales can help make it run in parallel and optimise the performance and scalability of the code
- Access commercial and/or community codes
- Access codes produced and developed by Welsh academic sources
- HPC Wales may also be able to offer computer room accommodation to facilitate and manage beneficiary systems.

Key features

- Cost effective and secure access
- World-class computing capability for demanding research simulations
- The expertise of computational scientists across Welsh universities
- Large scale computing capacity for high-throughput
- Secure and safe facilities

Security Assurance

HPC Wales' supercomputing services are split into three broad areas:

- Technology and applications: Access to HPC Wales' integrated facilities and resources with a wide range of data and computational applications and software
- Consultancy and support: Help in understanding how HPC may be relevant to the beneficiary, how to exploit the solution that's most efficient and cost-effective, and access to a brokerage service to provide additional support where relevant
- Skills and training: A programme of specialised courses and workshops tailored to beneficiary needs

SME Offering

HPC Wales works closely with SMEs to define specific requirements and clearly identify the high performance computing benefits.

Key steps

1. HPC Wales consults with the SMEs on project requirements - diagnostics
2. HPC Wales identifies how to maximise benefits
3. Where relevant, HPC Wales helps identify options for research collaborations and training
4. HPC Wales agrees with the SMEs the scope of HPC Wales services
5. SMEs have access to workshops/training to improve their understanding of HPC and HPC Wales

6. The research project is ready to run; support is provided through HPC Wales' Outreach and Technical teams

Software

HPC Wales offers a range of open-source and commercial applications. Some are available for use by all HPC Wales' users; others have specific license conditions. HPC Wales regularly reviews the software available to HPC Wales' users. If HPC Wales is not able to provide access to the software that a beneficiary requires, the Project may be able to host a beneficiary's own version of the software on HPC Wales' systems.

HPC Wales has recently introduced a range of "market-leading" software packages which will particularly appeal to those working in the manufacturing and engineering, life sciences and creative industries. Examples of key target markets can be seen in the table below:

Market-leading software packages

Multi-sector	Manufacturing / Engineering	Life Sciences	Creative industries
<ul style="list-style-type: none"> • Gaussian 09 • Matlab • Molpro • VASP 	<ul style="list-style-type: none"> ▪ ANSYS ▪ Geometry interface for Solidworks ▪ Design Modeller ▪ Extended Meshing ▪ CFD ▪ HPC Pack ▪ Academic research CFD 	<ul style="list-style-type: none"> ▪ CLC Genomics 	<ul style="list-style-type: none"> ▪ Mental Ray ▪ Arnold ▪ Cinema 4D ▪ V-Ray

Consultancy & Support

Recent purchases of software, aligned with the change in focus throughout HPC Wales, have allowed the Project to get closer to key industry sectors. The Project provides facilitation between a beneficiary and potential collaborators, whether they are researchers, businesses, suppliers or funders, to development projects. HPC Wales also provides advice and on-going support through HPC Wales' experienced technical and outreach teams to assist beneficiaries.

Key benefits

- Local access to a member of HPC Wales' expert technical team
- Assistance with installation and initial use
- Access to HPC Wales' national network of expertise
- The ability to connect with like-minded user communities through HPC Wales' specialist scientific gateways
- Funding for research support
- Industrial placements

Resource brokerage

HPC Wales works with businesses to find a solution to address identified needs, utilising complementary supplier services where beneficial, to deliver an end-to-end solution that gives enterprises and researchers flexible access to HPC resources.

Application advice and deployment

HPC Wales provide a range of on-site consultancy services on software, applications and advice on how to get the most out of high performance computing. HPC Wales' expert team can help "translate" a beneficiary's computational problem into a working solution through the following:

Supporting/Scoping software: HPC Wales can provide advice on requirements and the most appropriate and cost effective programmes. HPC Wales can also help with software migration. Code validation: In line with HPC Wales' computational services, HPC Wales can also help validate and port your codes as follows:

Workflow construction: HPC Wales can manage the complexity of applications by describing, managing, and conducting the associated scientific analysis through optimising build scripts for your portal workflows.

Key features

- Local access to a member of HPC Wales' expert technical team
- Assistance with installation and initial use
- Access to a national database of expertise
- The ability to connect with like-minded user communities through HPC Wales' specialist scientific gateways.

Funding and placements

HPC Wales provides indirect financial assistance through PhD studentships, bursaries and industrial placements, to help fund research or both researchers and businesses.

HPC Wales Bursaries: HPC Wales offer a contributory bursary to students on participating NVQ level 4+ courses (such as BSc, MSc or MPhys), where they are living within the Convergence areas of West Wales and the Valleys.

Skills and Training

HPC Wales' Skills Academy provides a variety of courses and workshops aimed at building skills in HPC. HPC Wales' courses are appropriate for academic, professional or organisational development, and HPC Wales' training programmes can be tailored to your needs to ensure you get the most benefit out of them.

Typical courses include:

- Introduction to HPC
- How do I get started with High Performance Computing?
- Applications with HPC
- Computational Science Workshops
- Applications for Research Workshops

In addition, HPC Wales contributes to a wide number of University Degree and Masters programmes across Wales, (see below).

Key benefits

- Enhanced skills and understanding of research computing techniques

- Increased opportunity for business profitability
- Accelerated results for research and development
- Methods and skills to address complex and non-routine problems
- Ability to plan your own personal development
- Understand the steps you need to take to start reaping the benefits of HPC

Introduction to HPC

This course will provide an introduction to HPC and an overview of the services on offer from HPC Wales. It will provide an introduction to HPC or 'research computing' and give a general overview of the services on offer from HPC Wales.

Course delivery: face-to-face and delivered over 2 to 4 hours.

Outcomes

- Find out why HPC is becoming indispensable for researchers and development managers.
- See the benefits of HPC through real-life application and case studies.
- Discover how HPC can increase business profitability and commercial success and accelerate research results.
- Explore the most commonly used software by sector.
- Find out what thematic, scientific gateways do, why they exist and how to use them for maximum benefit.
- Find out what support is available and how to access the benefits of HPC

How do I get started with HPC?

This course provides a 'Quick Start Guide' on how to use HPC Wales' systems.

Course delivery: This is a face-to-face course delivered over 1 to 2 hours by members of HPC Wales' experienced Outreach and Technical teams. It is Researchers and Business users of the HPC Wales services

Outcomes

- Find out how the HPC Wales systems are set up
- Learn how to access HPC Wales with minimal support
- Beneficiaries can benefit from one-to-one guided support from HPC Wales' experienced Outreach and Technical teams
- Access HPC Wales' support network once up and running

Introduction to the Applications that can be used with HPC

This course will provide an overview of what Open Source and ISV standard applications can be used with HPC

Course delivery: This course will be delivered over 3 to 4 hours by members of HPC Wales' Outreach and Technical teams and experienced HPC users. Beneficiaries can choose from one of HPC Wales' workshops or request bespoke one-to-one tuition.

Outcomes

- Learn how to use standard packages to enhance innovation capabilities.

- Obtain skills to use established packages to undertake modelling, simulation and data analysis. You will also learn some advanced uses of these tools.
- Gain an understanding of a range of applications and eliminate the need for investment in feasibility or wasted licensing costs
- See real-life examples of HPC applications in practice
- Explore possibilities for open source software options and cost cutting

Computational Science Workshops

These customised workshops aim to provide higher computational skills to enable beneficiaries to make the most of HPC.

These customised workshops will be for intermediate to advanced level users of HPC and aim to provide higher computational skills to enable beneficiaries to make the most of HPC and move them through higher levels of progression in areas such as code and performance optimisation.

Modules delivered include:

1. Debugging Serial and Parallel Codes
2. Introduction to Multicore Performance
3. Introduction to Performance Tools
4. Parallel Programming Concepts and High-Performance Computing
5. Python on HPC Wales
6. Balancing Scripts and Compiled Code in Scientific Applications
7. MATLAB Programming
8. Parallel Numerical Libraries
9. Performance Tuning for Clusters
10. Introduction to MPI
11. Intermediate MPI
12. Introduction to OpenMP
13. Using Databases

Course delivery: This course will be delivered through workshops and e-Learning modules over 3 to 4 hours by members of HPC Wales' Outreach and Technical teams and experienced HPC users.

Outcomes

- Enhance skills to move beneficiaries towards a higher level
- Develop strategies and tools to exploit HPC for maximum benefit
- For language and library specific tuition
- Benefit from the course's integration with courses at other leading institutions and research learning providers
- Gain access to a wide variety of topics over time
- Accredited training to Level 4+
- The opportunity to progress to expert level at the beneficiary's own pace
- Benefit from HPC Wales' networking opportunities

Applications for Research Workshops

HPC Wales' research workshops provides customised training for intermediate to advanced level HPC users to help with the set up and running of specific application/s.

These thematic workshops focus on applications being used for short-term research and/or development projects in research groups or companies.

Course delivery: This course will be delivered through workshops and e-Learning modules by members of HPC Wales' Outreach and Technical teams and experienced HPC users. It is for intermediate to advanced HPC users and research groups

Outcomes

- Opportunities to develop and explore new research opportunities
- Gain access to HPC Wales' powerful HPC infrastructure
- Link with researchers and SMEs to enhance your project
- Receive support for your project through final year university or postgraduate student industrial placements

University courses supported

HPC Wales contribute to a wide number of University Degree and Masters programmes across Wales.

Student Bursaries

HPC Wales offers contributory bursaries to students on a number of BSc, MSc or MPhil courses across Wales. HPC Wales are providing valuable input on HPC to a number of degree and postgraduate courses in universities across Wales.

HPC is able to offer a contributory bursary to students on participating level 4+ courses (such as BSc, MSc or MPhys), where they are living within the Convergence areas of West Wales and the Valleys.

Students who do not already receive bursary contributions from other ESF projects and are eligible to work in Wales upon completion of their studies can apply.

The contributory bursary is currently £300 for degree level qualifications (such as BSc), £500 for Masters degree level qualifications (such as MSc), and £2,000 for PhD level qualifications, and is payable by the University upon attainment of the qualification.

Courses provided by HPC Wales partner Universities with HPC contribution:

Aberystwyth University

- Institute of Geography and Earth Sciences (IGES)
 - MSc in Glaciology
 - MSc in Remote Sensing and Geography
 - MSc in Remote Sensing and Geographical Information Systems
 - MSc in Remote Sensing and the Living Environment
 - MSc in Remote Sensing and Planetary Science
 - MSc in Remote Sensing and Computer Science
- Institute of Mathematics and Physics (IMAPS)

- Physics - MPhys (F303), BSc (F300)
- Physics with Planetary and Space Physics - MPhys (F366), BSc (F364)
- Astrophysics - MPhys (F511), BSc (F510)

Bangor University

- School of Ocean Sciences
 - MSc in Physical Oceanography
 - MSc in Applied Marine Geoscience
- School of Computer Science
 - BSc Computer Science
 - BSc Computer Science for Business
 - BENG / MENG Computer Systems Engineering
 - BENG / MENG Electronic Engineering
- School of Chemistry
 - MSc in Computational Chemistry

Cardiff University

- Cardiff School of Physics and Astronomy
 - MPhys
- Cardiff School of Computer Science & Informatics (CM0323)
 - BSc Computer Science
 - BSc Computer Science with Computer Vision & Computer Graphics
 - BSc Computer Science with Distributed and Mobile Systems
 - BSc Computer Science with Knowledge and Information Systems
 - BSc Joint Honours Computing & Mathematics

Cardiff Metropolitan University

- School of Management
 - BSc Computer Science
- Glyndwr University
- Computing
 - MSc High Performance Computing

Swansea University

- Department of Computer Science
 - MSc/BSc Computer Science
 - BSc Computer Science with Foundation Year
 - BSc Software Engineering

- College of Engineering
 - MSc in Civil Engineering & MSc in Computer Modelling in Engineering
- College of Science
 - MSc in High Performance Computing

Swansea Metropolitan University

- Faculty of Applied Design & Engineering
 - BSc\HN Computing and Games Development Portfolios
 - BEng Motorsport Engineering and Design / BEng Motorcycle Engineering

University of South Wales

- Faculty of Health, Sport and Science (HESAS)
 - BSc Chemistry

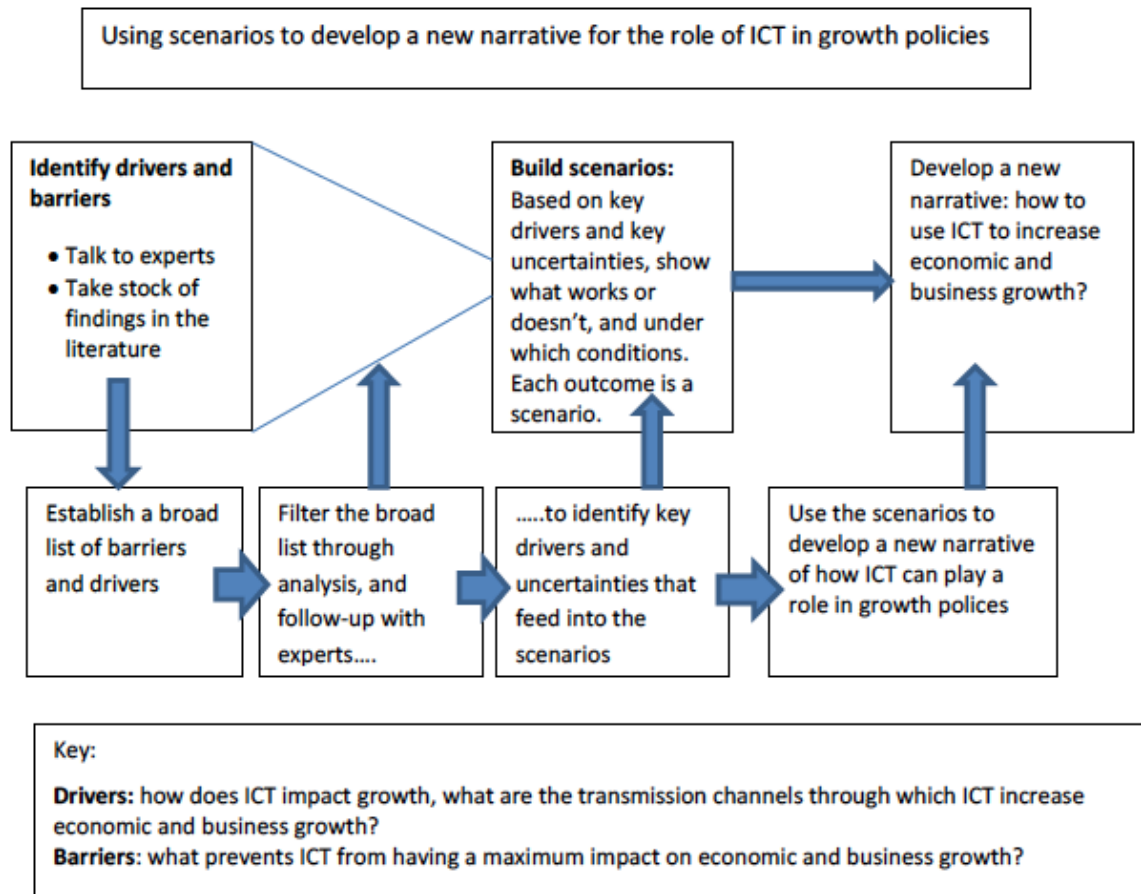
Summary of the study approach

The Conference Board was commissioned by DG Connect to “use scenario analysis to build a new narrative for the role of ICT for growth in Europe. The study should bring together existing knowledge about ICT and growth to build scenarios, assessing which environments are most conducive to growth benefits induced by ICT”, and for ICT policy in growth policy, to be used as an input into the development of a new policy agenda. Knowledge and research gaps were also to be identified, making suggestions for areas where more research is needed to help shape the next research agenda.

Mapping out ICT’s impact on the future economy and the business environment is an inherently uncertain exercise, especially given the rapid pace of continuous technological change and increasing technological convergence. Therefore, rather than starting from a static outlook for ICT trends or economic growth dynamics, the approach of this study was to develop multiple scenarios on how ICT developments and economic growth may relate to one another for the remainder of this decade. In addition to a review of the available empirical evidence, insights from experts were used to develop the key drivers, uncertainties and barriers that determine how ICTs shape economic and business performance. The scenarios were developed using different combinations of those factors, and were used to articulate a “high level narrative” that describes the several, most compelling different roles ICTs can play in growth, and, in particular, in stimulating a slow growth environment. The purpose of the narrative is to help policymakers frame the growth and ICT development agenda for Europe, help the communication around the role of ICT in growth, and relate it to the Digital Agenda and Europe 2020.

The study approach is depicted in the diagram below. Much emphasis was put on the engagement with experts from the business, policy and academic communities through individual interviews, a video panel discussion, an in-person scenario brainstorming meeting, and several follow-up discussions with individual experts. In addition, we also talked to a group of young professionals and technology enthusiasts, and a round table was set up to gather the input from a group of digital web entrepreneurs.

Summary of the Study Methodology



We conducted 41 phone call interviews with experts from the business, policy, and academic communities. The following questions were used to guide the interview conversations, and they were shared with the interviewees in advance of the call:

- How does ICT—its development, production, and/or usage—most impact economic growth?
- What ICT trends will, could, or should have the biggest impact on economic growth in the period up to 2017?
- What looming or foreseeable new technologies, product, or services related to ICT could have the biggest impact on economic growth in the future?
- How are countries and governments succeeding or failing to leverage ICT to its fullest potential in driving economic growth?
- What role, if any, can government policy play in maximizing the potential for ICT to drive economic growth?
- In a context of austerity and competing policy and fiscal objectives, how can one convince those who are sceptical about the role government can play in ICT?

We summarised the information from the interviews and drew up a broad list of drivers and barriers, of which we asked the experts to rank their top five. These rankings were discussed at a panel video conference with the experts and were used to draw up an initial set of

scenarios that was discussed during an in-person brainstorming scenario session in Brussels. The discussions and feedback from that meeting, as well as subsequent follow-up discussions with various experts, were used to build the scenarios presented in this report. See Appendix 1 and II of the Background Companion Report for more details on the study approach and the list of experts we engaged with for this study.

13. Appendix V: Key Aspects of the Net Impact Methodology

Aspect	Approach
Employment Impacts	The figures for gross jobs were taken from the WEFO Dashboard where there was completed evidence.
Deadweight	This refers to outputs that would have occurred without the intervention. Survey respondents were asked about the degree to which the impact would have happened anyway. From these answers the consultant team were able to assess the indicative level and type of additionality from pure additionality (where none of the impacts would have occurred) to scale and time additionality (they would have occurred at a smaller scale or later date) or instances where no impacts would have occurred at all. The answers were converted to an appropriate additionality factor and applied to each company/respondent. Deadweight was generally found to be low for jobs created and relatively high for training.
Leakage	Leakage refers to the proportion of outputs that benefit those outside the ERDF target area. ERDF eligibility rules minimize leakage therefore this was assumed to be very low.
Displacement	This refers to the perceived degree to which other firms or demand might be affected elsewhere in Wales. Using the HCA Guidance the displacement effects were assumed to be low.
Substitution	This effect arises where a firm substitutes one activity for a similar one to take advantage of public sector assistance. We found no evidence of substitution so this was assumed to be very low.
Persistence	The suggested benchmark for skills and employment projects from the HCA Additionality Guide (2014, P51) is three years. This was the figure that was used.
Multiplier	Again using HCA Guidance we calculated a supply chain multiplier using a ready reckoner (see page 36, sub-regional composite multiplier). Given the specialist nature of the sector this was assumed to be low (1.25). Whilst other adjustments are taken away from the gross estimates multipliers are the only adjustments generating additional impacts.
Return on Investment	The RoI calculated are expressed as a ratio against each £1 of public (or ERDF) funding spent to date. To calculate GVA per head deriving from employment benefits we have used data from the Office of National Statistics (total employment from the Business Register and Employment Survey (BRES) and the Regional Gross Value Added NUTS 1 tables. An inflationary factor was also applied. For training impacts we used an average annual NPV per unit informed by BIS estimates for the benefits of a higher level training qualification.

14. Appendix VI: Glossary, Acronyms and Abbreviations used in this Review

ARC	Advanced Research Computing – is the use of computing and data resources for research, which are beyond the capabilities of the average desktop or laptop computer (see HEC).
ARCCA	<i>Advanced Research Computing at Cardiff</i> . A division within Cardiff University that provides, co-ordinates, supports and develops advanced research computing services for researchers at Cardiff University. http://www.cardiff.ac.uk/arcca/index.html
ARCHER	UK's National Supercomputer Facility [Cray XC30 at Edinburgh Parallel Computer Centre – EPCC – University of Edinburgh].
ASTUTE	A five year (2007-2013) EU Funded Project, ASTUTE (Advanced Sustainable Manufacturing Technologies) is part-funded by ERDF through the Welsh Government. ASTUTE has supported the stimulation of ideas in the Welsh manufacturing sector through provision of resources, facilities, advice and guidance exploiting the wealth of research in Welsh Universities in close research collaborations with industry.
Big data	Big data is a broad term for data sets so large or complex that traditional data processing applications are inadequate.
Blended Learning	Blended learning (also called hybrid learning) is the term used to describe learning or training events or activities where e-learning, in its various forms, is combined with more traditional forms of training such as "class room" training.
BPE	'Business Population Estimates' for the UK and Regions' (BPE) provides the only official estimate of the total number of private sector businesses in the UK at the start of each year, with their associated employment and turnover.
BRES	The Business Register and Employment Survey
CDEC Catapult	The Connected Digital Economy Catapult (CDEC) is an organisation established to work with a wide range of partners to build platforms and capabilities that help innovators across the breadth of the UK digital economy innovate and turn great ideas into new business.
CFD	Computational fluid dynamics (CFD) is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the millions of calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions.
CEMAS	The Centre of Excellence in Mobile Applications and Services (at the University of South Wales was partly funded by ERDF. The CEMAS Support Programme came to its planned end on the 30th of June 2015.
Cloud computing	A style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet . In theory users need not have knowledge of, expertise in, or control over the technology infrastructure in the "cloud" that supports them. Possible area of future development concerns over data security.
Cluster	A widely-used term meaning independent computers combined into a unified system through software and networking.
Competitive	Competitive dialogue is a public-sector tendering option that allows for

dialogue	bidders to develop alternative proposals in response to a client's outline requirements. Only when their proposals are developed to sufficient detail are tenderers invited to submit competitive bids.
Core	One or more cores contained within a processor package.
CPU	Central Processing Unit or processor.
CRM	Customer relationship management (CRM) is an approach to managing a company's interaction with current and future customers. CRM software enables the management of sales, marketing, customer support, and inventory in a single system.
CSE	Computational science and engineering.
Data Curation	Data curation is the management of data throughout its lifecycle, from creation and initial storage to the time when it is archived for posterity or becomes obsolete and is deleted. The main purpose of data curation is to ensure that data is reliably retrievable for future research purposes or reuse.
Distributed computing	A distributed computing system consists of multiple autonomous computers that communicate through a computer network . The computers interact with each other in order to achieve a common goal.
EFAT	European Funds Audit Team.
EINFRA	Horizon 2020 Research Infrastructures Work Programme.
ELC	The E-infrastructure Leadership Council (ELC) advises government on all aspects of e-infrastructure including networks, data stores, computers, software and skills.
Emacs	GNU Emacs is an extensible, customizable text editor.
EPCC	Edinburgh Parallel Computing Centre, https://www.epcc.ed.ac.uk/
EPSRC	Engineering and Physical Sciences Research Council.
ERDF	European Regional Development Fund.
ESF	European Social Fund.
ESIF	European Structural and Investment Fund
ETP4HPC	ETP4HPC as an industry-led think tank and advisory group of companies and research centres involved in HPC technology research in Europe. http://www.etp4hpc.eu/
first amongst equals	A member of a group who is officially on the same level as other members but who in fact has slightly more responsibility and power.
FLE	Fujitsu Laboratories of Europe. Key activities include Future Networking & Wireless Standards, Big Data Processing & Linked Open Data, Social Innovations and Supercomputer Applications.
FP7	FP7 is the short name for the Seventh Framework Programme for Research and Technological Development. This was the EU's main instrument for funding research in Europe and it ran from 2007-2013
G-Cloud	The UK Government G-Cloud is an initiative targeted at easing procurement by public-sector bodies in departments of the United Kingdom Government of commodity information technology services that use cloud computing.[1]
GPU	Graphical Processing Units (also GP-GPU – General Purpose Graphical

	Processing Unit).
GVA	Gross Value Added, the measure of the value of goods and services produced in an area, industry or sector of an economy.
GW4	An alliance which combines the intellectual capacity and physical resources of the four leading research-intensive universities in the South West of England and Wales: Bath, Bristol, Cardiff and Exeter.
H2020	Horizon 2020 is the EU funding programme for research and innovation running from 2014 to 2020 with a €80 billion budget. H2020 supports SMEs with a new instrument that runs throughout various funded research and innovation fields, enhances EU international research and Third Country participation, attaches high importance to integrate social sciences and humanities, encouraging the development of a gender dimension in projects.
HEC	High-End Computing – captures the use of leading-edge IT resources and tools to pursue research; including computer simulation and modelling, manipulating and storing large amounts of data, and many other methods to solve research problems that would otherwise be impossible.
HECToR	UK's National Supercomputer Facility [Cray XT4 at Edinburgh Parallel Computer Centre (EPCC) University of Edinburgh].
HEFCW	The Higher Education Funding Council for Wales.
HPC	High Performance Computing. The use of (parallel) supercomputers and computer clusters, computing systems made of multiple (usually mass-produced) processors linked together in a single system with commercially available interconnects.
“Hub and Spoke” and distributed infrastructure	A distribution paradigm (or model or network) is a system of connections arranged like a chariot wheel, in which all traffic moves along spokes connected to the Hub at the centre. The model is commonly used in distributed computing . In a spoke-hub network the hub is likely to be a single point of failure , one of the reasons for favouring a dual-Hub approach within HPC Wales.
HVM Catapult	The High Value Manufacturing (HVM) Catapult is the catalyst for the future growth and success of advanced manufacturing in the UK. 7 Technology and Innovation centres work with companies of all sizes to bridge the gap in – and accelerate the activity between – technology concept and commercialisation.
ICT	Information and communications technology - a “diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information.”
Innovate UK / TSB	Innovate UK is the operating name of the Technology Strategy Board, the UK's innovation agency. It is a UK non-departmental public body operating at arm's length from the Government reporting to the Department for Business, Innovation and Skills (BIS).
ISC	The International Supercomputing Conference is a yearly conference on supercomputing which has been held in Europe since 1986. http://www.isc-hpc.com/
ISO 9001	A certified quality management system (QMS) for organisations who want to prove their ability to consistently provide products and services that meet the needs of their customers and other relevant stakeholders.

Linux	Linux is a Unix-like computer operating system (OS) assembled under the model of free and open-source software development and distribution.
MATLAB	A numerical computing environment and fourth generation programming language. Maintained by The MathWorks, MATLAB allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages.
Modelling and Simulation	Modelling and Simulation is a discipline for developing a level of understanding of the interaction of the parts of a system, and of the system as a whole.
Monte Carlo methods	A class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used when simulating physical and mathematical systems. Markov chain Monte Carlo (MCMC) methods (which include random walk Monte Carlo methods), are a class of algorithms for sampling from probability distributions based on constructing a Markov chain that has the desired distribution as its equilibrium distribution.
MPI	Message Parsing Interface is a programming technique which uses software libraries to turn serial applications into parallel ones which can run on distributed memory systems. This is now the one of the standard paradigms for parallel programming in both C, C++ and Fortran languages.
MRC Farr Institute	The Farr Institute of Health Informatics Research comprises four nodes distributed across the UK and led from the University College London (Farr Institute @ London) , University of Manchester (Farr Institute @ HeRC N8) , Swansea University (Farr Institute @ CIPHER) , and the University of Dundee (Farr Institute @ Scotland) .
NAG	The Numerical Algorithms Group (NAG) provides expertise in numerical engineering, by delivering high-quality computational software, consulting services and high performance computing services. http://www.nag.co.uk/
NERC	Natural Environment Research Council.
NGS	Next-generation sequencing, also known as high-throughput sequencing, is the catch-all term used to describe a number of different modern sequencing technologies, including Illumina (Solexa) sequencing, Roche 454 sequencing, Ion torrent: Proton / PGM sequencing and SOLiD sequencing.
NVIDIA CUDA	Compute Unified Device Architecture is a compiler and set of development tools that enable programmers to use a variation of C to code for execution on a Graphical Processing Unit (GPU).
NPV	Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows.
NVQ level 4+	National Vocational Qualifications (NVQs) such as BSc, MSc or MPhys etc.
OLT	Operational Logic Tables. Part of the application process for prospective applicants to the 2014-2020 European Structural Funds programmes to proceed through the pre-planning stage. Following the initial contact, the suitability of a proposed operation for EU funding is tested through the completion of an operation logic table.

	http://www.wvec.org.uk/Pages/default.aspx
OpenMP	Open Multi-Processing is an application programming interface that supports multiplatform shared memory multiprocessing (SMP) programming in C, C++ and Fortran.
WEFO PDM / PDO	WEFO Project Development Manager and Project Development Officer.
PIVT	Project Inspection and Verification Team.
P/P/S	An ERDF indicator – “New or improved products, processes or services”
PRACE	Partnership for Advanced Computing in Europe.
PUE	Power Usage Effectiveness, the ratio of total amount of energy used by a computer data centre facility to the energy delivered to computing equipment. PUE was developed by a consortium called The Green Grid. PUE is the inverse of data centre infrastructure efficiency (DCIE).
Sandy Bridge	Sandy Bridge is the codename for Intel's second-generation Intel Core processor family. Sandy Bridge processors are distinguished from previous-generation Intel processors by featuring all cores – including graphics – on a single chip, being manufactured using Intel 32nm (nanometer) die shrink fabrication process technology.
SBRI	The Small Business Research Initiative (SBRI) is a well-established process to connect public sector challenges with innovative ideas from industry, supporting companies to generate economic growth and enabling improvement in achieving government objectives. https://sbri.innovateuk.org/
Thematic Gateway	A domain-specific computing environment, typically accessed via the Web, which provides a scientific community with end-to-end support for a particular scientific workflow.
SESAME Net	SESAME Net is a network project funded under Horizon 2020 to set up a network of HPC competency centres focused on industry, particularly SMEs.
SIF	The UK Strategic Investment Fund
SME	Small and Medium Enterprise whose personnel numbers fall below certain limits.
SMP	Symmetric Multiprocessors: a computer hardware architecture which distributes the computing load over a small number of identical processors, which share memory.
SPV	Special Purpose Vehicle - A subsidiary of a company that attempts to isolate risk from the parent company by maintaining its assets and liabilities on a completely separate balance sheet.
STFC	Science and Technology Facilities Council. The main UK government agency for funding research and training in astronomy, particle physics, space science and nuclear physics. http://www.scitech.ac.uk/
Supercomputer	A computer that is considered, or was considered at the time of its introduction, to be at the forefront in terms of processing capacity, particularly speed of calculation.
TCO	Total cost of ownership (TCO) is a financial estimate intended to help buyers and owners determine the direct and indirect costs of a product or system.

TechHub	A unique environment where technology startups can start up faster. https://www.techhub.com/
Tier-0, Tier-1, Tier-2	Denotes the various levels of a conceptual pyramid of HPC systems. In the present context, the dual-Hub systems would constitute tier-0, the spokes at Bangor, Aberystwyth and Glamorgan would constitute tier-1 while the 20 "clusters-in-a-box" would constitute tier-2.
TOM	HPC Wales Training and Outreach Mentor.
UK BIS	The Department for Business, Innovation & Skills (BIS) is the department for economic growth. The department invests in skills and education to promote trade, boost innovation and help people to start and grow a business. BIS also protects consumers and reduces the impact of regulation.
Visualization	The process of converting large amounts of complex, multi-dimensional data into images so people can more quickly and easily see patterns and anomalies in the data. Visualization technologies are widely used within the HPC community to enable better understanding of the ever larger data sets that computer simulations and sensor networks are creating.
Visual computing research	Research into the analysis, enhancement and display of visual information to create life-like, real-time experiences and more natural ways for people to interact with computers and other devices.
WEFO	The Welsh European Funding Office.
Welsh Wound Innovation Centre	A centre of excellence focused on the prevention and treatment of both chronic and acute wounds. http://www.wwic.wales/
"wrap-around" support	A support framework that combines the interpretation of requirements driving the use of optimised software, firmware and hardware.