Sci-Tech Daresbury Campus Impact Study

A Final Report to the Science and Technology Facilities Council

23 March 2017

SQW

Contents

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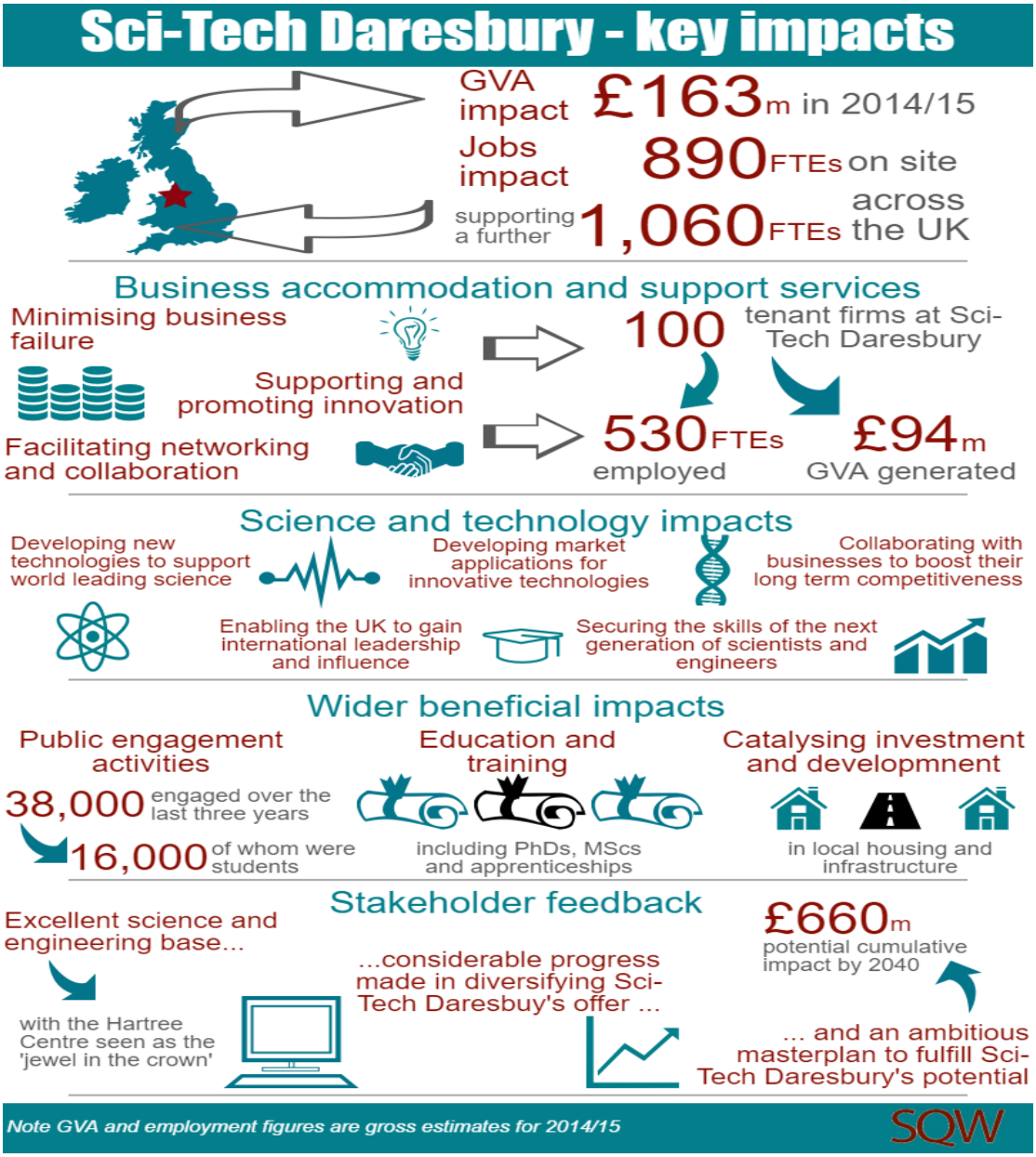
Executive Summary

1. This report presents the findings from a study of the economic and wider impacts generated by those activities conducted at Sci-Tech Daresbury (the Campus) in the financial year 2014/15. A broad range of impacts are included in the assessment. Key science and technology impacts are considered, such as developing new technologies to support world-leading science and developing market applications for innovative technologies, alongside impacts on the performance of tenant firms and other firms collaborating with organisations on site, as well as wider beneficial impacts in areas such as public engagement and skills development.

2. The infographic below presents a summary of Sci-Tech Daresbury's key impacts in 2014/15, including those arising from the work of the research and engineering staff on site, and the 100 tenant firms.



3. Sci-Tech Daresbury is one of the UK's leading science and innovation campuses. It is run by a Joint Venture comprising the Science and Technology Facilities Council (STFC), Halton Borough Council and Langtree, a property development and management company. The Campus hosts nationally and internationally significant assets for big science as well as the supporting scientific, engineering and wider technical capabilities. Alongside these, Sci-Tech Daresbury is also home to a thriving community of around 100 businesses with a combined annual turnover of £56m. In total, almost 1,000 people work on the Campus.

4. To better understand and contextualise the impacts of Sci-Tech Daresbury, it is helpful to unpack the Campus in to its core component activities. However, it is important to note that in reality, many aspects of the Campus are delivered in a highly integrated fashion. These are summarised below and explored in greater detail in the main body of the report.

Table 1: Overview of the core component activities at Sci-Tech Daresbury

The **Joint Venture** is responsible for running Sci-Tech Daresbury (the three JV partners are STFC, Halton Borough Council and Langtree, a property development and management company)	
Scientific Computing: the Scientific Computing Department, Hartree Centre and Virtual Engineering Centre (VEC) support the UK's ability to address global challenges, deliver scientific breakthroughs and increase productivity	**Accelerator Science and Technology Centre** specialises in particle accelerators, ranging from large scale international and national research facilities through to specialised industrial and medical applications
STFC's Technology Department supports a wide range of advanced engineering, technology, instrumentation, specialist facilities and high-level skills	**The Cockcroft Institute**: A collaboration between academia, STFC and industry, it designs, constructs and uses innovative instruments such as particle accelerators and leads the UK's participation in flagship international experiments
EPSRC electron microscope SuperSTEM supports multi-disciplinary research by providing access to cutting-edge instrumentation and expertise and training in electron microscopy	**Business accommodation and specialist support** for the c.100 tenant firms on Campus who are located in either STFC or Joint Venture managed properties
STFC's Business and Innovations staff provide support to tenant firms and to other businesses looking to access the scientific knowledge and equipment on Campus	**STFC's corporate services, finance and strategy staff** provide the supporting services necessary for the scientists and engineers to undertake their work.

Source: SQW

5. Sci-Tech Daresbury is now entering a new and exciting phase in its development with additional grow-on space coming on stream, whilst the longer term masterplan for the site envisages more than 1m sq ft of business accommodation, housing up to 10,000 jobs.

Sci-Tech Daresbury is a major generator of both GVA and high-quality employment within the Northern Powerhouse

6. The ***gross*** **GVA contribution of the operations at Sci-Tech Daresbury to the UK economy is estimated at £163m** for the financial year 2014/15. This includes GVA generated directly through employment and turnover, indirect GVA from the purchase of bought in goods and services, and induced GVA from household spending. Sci-Tech Daresbury also makes a significant contribution to the Atlantic Gateway economy, generating an estimated ***gross*** **GVA impact of £135m in 2014/15 across the Liverpool City Region, Cheshire and Warrington, and Greater Manchester sub-regions in 2014/15**.

7. In addition, there are almost 900 FTEs employed on-site at Sci-Tech Daresbury, many of whom are highly skilled and work in high value roles. A further 1,000 jobs are estimated to

be indirectly supported by activities conducted at the Campus; whether through impacts on supply chains or employee spending in the wider economy. Therefore, overall, **the Campus supports, directly and indirectly, almost 2,000 jobs across the UK**.

8. The **£163m annual operational economic impact of the Campus** compares to the **average annual £42.5m input costs of running the STFC operations on Campus over the 2012/13 to 2014/15 period**.

Sci-Tech Daresbury's estimated impact on the UK economy in 2014/15

	GVA impact	Employment impact
Gross impact	£163m	1,950 FTEs
Net impact	£70m	840 FTEs

9. These *gross* economic effects must be reduced to take account of impacts that would have occurred anyway, in the absence of the Campus – the counterfactual. For example, as a thought experiment, if Sci-Tech Daresbury did not exist, what proportion of the highly skilled and expert STFC staff currently employed on site would be working elsewhere in the UK in similar roles, in similar industries, generating similar salary levels (and economic impacts) as they do currently? In addition, how many of the businesses on Campus would be trading and generating very similar amounts of turnover from alternative locations? By triangulating multiple strands of evidence, the study team has sought to assess what proportion of the GVA impacts arising from both of these activities would have occurred anyway. The resulting analyses estimate that **the *net* GVA impact of Sci-Tech Daresbury on the UK economy was £70m in 2014/15**.

10. Due to the complex challenges associated with monetising the totality of the economic impacts generated by the activities undertaken on the Campus, these operational impact figures under-estimate the true scale of economic impact. However, Sci-Tech Daresbury is not unique in facing significant challenges in impact evaluation and a headline review of impact studies reveals that STFC is leading the way in commissioning such a complex and comprehensive impact study for all components of a large science and innovation campus.

The Campus is home to an expanding community of innovative science and technology-rich high growth firms…

11. **A growing cohort of successful science and technology driven firms are based on Campus**. They have been attracted by Sci-Tech Daresbury's integrated, high quality flexible accommodation, tailored business support services, and access to nationally and internationally significant scientific research, kit, and supporting capabilities.

12. There are currently **100 firms located on the Campus. They generated an estimated *gross* GVA impact of £94m and employed just under 530 FTEs in 2014/15.**

13. Sci-Tech Daresbury has helped these firms to prosper by **minimising business failure, supporting and promoting innovation, and facilitating networking and collaboration**.

For example, the three year business survival rate of companies located on the Campus is in excess of 90%, and tenant firms are more likely to invest in all forms of innovation than the national average of firms operating within the UK's two most innovative sectors. Thirteen of the 60 tenants surveyed by the study team started on site and key sectors for all tenant firms have been identified by the Sci-Tech Daresbury Strategy as: digital/ICT; advanced engineering and materials; and biomedical and healthcare.

14. The diversification of the Sci-Tech Daresbury offer into a fully integrated science and innovation Campus will continue over the coming years with the **implementation of the long-term Campus masterplan**. This envisages additional business accommodation, which would help to increase the economic impact of the Campus substantially. If fully implemented, this could add a **cumulative £660m (of discounted GVA) to Sci-Tech Daresbury's *gross* impact by 2040**.

… and delivers a broad range of scientific and technology impacts

15. The three science focused case studies presented in the main report focus on different technology areas and their wider applications. Across the three areas, five broad categories of science and technology impacts can be evidenced, as summarised below:

- **Supporting high quality scientific research and developing the technology to support fundamental research and large scale scientific facilities elsewhere** is a key part of Daresbury Laboratory activity. This includes, but is not limited to, developing and building new technologies to be used in cutting-edge scientific research, providing enabling computing infrastructures to the scientific community, enhancing knowledge of energy efficient computing, developing capabilities in accelerator science and playing a key co-ordinating role for the UK nuclear physics community.

- The high quality of scientists and engineers working on the Campus allows the **UK to gain international leadership and influence** by coordinating major international accelerator science projects and designing/developing the advanced equipment necessary for experiments at high profile international facilities. Providing this specialised technology allows UK scientists to access these world leading facilities.

- Whether through direct project assignments with businesses at Hartree or the VEC, the industrial engagement activities of the Detector Systems Group, or ASTeC's work to help business innovation, **direct engagement with businesses is a key focus for the Campus and is boosting the competitiveness of beneficiary firms**.

- Sometimes arising from fundamental research, a range of **practical market applications for technologies have been developed** including the prototype ProSPECTus medical imager. Other technologies developed at Daresbury are being used within healthcare to improve patient outcomes.

- Daresbury Laboratory has helped to build a skills base in accelerators, scientific computing and advanced engineering over the decades since it was founded. This legacy is being strengthened as the Campus is continuing to help **develop the skills of the next generation of scientists and engineers for the UK.** Examples include

the Hartree Centre's skills development programme, and post-graduate training at both the Cockcroft Institute and the Medical Training and Research Laboratory.

Table 2: Company case study headlines

Unilever
• The Hartree Centre is part of Unilever's 'Science Grid' - preferred academic partners who are world-leading in science and complementary to Unilever's own science and technology skills. • Annual spend with Hartree is typically £150k. Nineteen distinct projects with the Scientific Computing Department/Hartree have been undertaken since 2010, as part of long term programme of using Daresbury to enable the move to 'in-silico' R&D activity. • It was reported that one project which used the Hartree Centre's capabilities to simulate liquid pouring had potential benefits, if/when fully implemented globally, of up to £20 million (gross) of annualised incremental turnover generated by faster time-to-market. • The company views the Hartree Centre as a vital strategic partner ('Hartree is a key consideration for Unilever remaining at Port Sunlight') and expects to be working with Hartree for at least five years to progress its 'in silico' agenda.
Rolls-Royce
• Rolls-Royce has participated on four linked projects with Hartree over the last four years, for which Hartree has received revenues of around £600k, with a general emphasis on large scale modelling (e.g. highly detailed combustion chemistry and airflow through jet engines). These provide much deeper insights into the physical and chemical performance of the firm's technologies, providing vital research findings which can feed into the wider design and development process. • Significant operational gains for Rolls-Royce include the ability to run more complex models, identify latent weaknesses in their current codes, and reduce the time of a model cycle (in some cases to a tenth of former times).
Victrex
• Victrex is an advanced materials manufacturer that employs 750 people worldwide in the R&D and manufacture of high performance plastics and composites for the Oil, Gas, and Aerospace sectors. • Victrex has long-standing links with STFC's Scientific Computing Department and collaborated on a £45k assignment with Hartree, buying 16 weeks of researcher time in the latter half of 2014. • Victrex wanted to build their own capacity in computational models and simulation methods as tools for its sector; and to secure evidence on the lifetime performance of one of its higher-value products. • Assisted by the project, and what the firm learnt from it, Victrex is now seen as a key opinion leader on the lifetime performance of materials across its sector.

Source: SQW

Stakeholder feedback

16. The **quality of the science and engineering base at Sci-Tech Daresbury was seen as being excellent,** with a clear focus on supporting discovery research and a growing emphasis on commercialisation. There was a strong consensus amongst stakeholder consultees and researcher survey respondents in relation to the quality of the scientific capabilities and supporting assets at Sci-Tech Daresbury. The **Hartree Centre was recognised consistently as being the key asset** in terms of securing the Campus' future success and is seen increasingly as being of international significance. At a national level, **consultees also identified the influence that researchers at the Campus have on public policy**. For example, the Nuclear Physics Group members have provided high level advice to government departments and agencies on the detection of illicit nuclear materials.

17. Stakeholders were in agreement that the **considerable progress achieved by Sci-Tech Daresbury over the last decade or so should not be underestimated or taken for granted**. The threat to Daresbury's long-term survival was real following the decommissioning of the Synchrotron Radiation Source (SRS). The ability of the Campus to **successfully reinvent and reposition itself is a major success story for the North** and provides a strong platform for the future.

18. The **consultation evidence is unambiguous in relation to the scale of the future potential at Sci-Tech Daresbury**. Stakeholders reported consistently that the co-location of the STFC with academic staff and research capabilities, specialist equipment, flexible property solutions and tailored business support on a single large site with good access to transport networks makes the Campus proposition highly attractive. There is scope for **attracting significantly more business activity on-site**, as reflected in the site's ambitious masterplan, which would increase the impact of the Campus.

19. Two thirds of the respondents to the researcher e-survey reported that the core features and benefits of the Campus could not be secured at other locations or in other ways, demonstrating that there is a **relatively high level of additionality for the research conducted at the Campus**. Indeed, more than a third of the survey respondents felt that their research activity at Daresbury had enabled them to: access more and higher quality collaboration partners; compete more successfully for more and higher quality grant funding; and attract and retain more and higher quality researchers within their team.

20. Looking more broadly, stakeholders also valued the wider social impacts generated by the Campus, particularly the **public engagement work** with local schools. Over the last three years, public engagement activities have reached almost 38,000 people, including nearly 16,000 students through school-based activities, stimulating the interest of young people and the wider public in science and associated career paths.

Recommendations

21. Five recommendations are presented for discussion. The first focuses specifically on monitoring and evaluation activity at Sci-Tech Daresbury and the other four cover wider issues in relation to increasing the long-term economic impact of the Campus. The recommendations are summarised below:

- Recommendation 1: A more systematic and consistent approach to capturing input, activity and output data should be embedded across the totality of the Campus.
- Recommendation 2: The leadership team at the Campus should be tasked with implementing a strategy to quickly scale up business employment levels and achieve a critical mass and density of businesses on-site. A key element of this will involve the translation of the current Sci-Tech Daresbury Strategy into a detailed programme of complementary investments, which would form the basis of a long-term integrated development plan for the Campus.
- Recommendation 3: Develop a cluster of data intensive businesses built around the world-class capabilities of the Hartree Centre.
- Recommendation 4: Senior managers at Daresbury should work in collaboration with competitor sites and key relevant organisations such as the local universities and Northern cities in order to bring forward complementary developments and to maximise the overall growth of the Northern Powerhouse and wider UK economies.
- Recommendation 5: Consideration should be given to establishing a dedicated and focused senior-level resource to champion and market the Campus offer to external partners and potential investors, both nationally and internationally.

1. Introduction

1.1 Sci-Tech Daresbury (the Campus) is one of the UK's leading science and innovation campuses. It is run by a Joint Venture (JV) comprising the Science and Technology Facilities Council (STFC), Halton Borough Council and Langtree, a property development and management company.

1.2 Sci-Tech Daresbury is home to nationally and internationally significant assets for big science (and supporting scientific, engineering and wider technical capabilities) including the Hartree Centre, the ALICE and VELA particle accelerators, and the EPSRC funded electron microscopes of SuperSTEM. In addition, the Campus is home to research staff from the Universities of Liverpool, Manchester and Lancaster at the Cockcroft Institute. University of Liverpool staff also deliver applied services to businesses through the Virtual Engineering Centre. The Campus is also home to a thriving community of around 100 businesses with a combined annual turnover of £56m. In total, almost 1,000 people work on the Campus.

1.3 Sci-Tech Daresbury is now entering a new and exciting phase in its development. A long-term masterplan for the site has been agreed and additional grow-on space (in the form of the two Techspace buildings) is currently being constructed. This will support the continued expansion of the high quality business accommodation and tailored support offer available at the site. Similarly, a new Campus Technology Hub engineering facility opened last year and major investments at the Hartree Centre totalling £313m have been announced by the UK Government and private sector partners.

Study Objectives

1.4 Informed by this context, the Government's wider impact agenda and continued pressures on public sector funding, STFC sought to establish a robust methodology to assess the economic and wider impacts of the Campus. Accordingly, STFC commissioned SQW Ltd (SQW) in 2015 to undertake the impact assessment.

Table 1-1: Study objectives

- Provide a description of the Campus and its core funding arrangements
- Present a framework describing the different impacts of the Campus
- Characterise and describe, including through the use of focused case study research, the qualitative and quantitative impacts of the Campus, including direct, indirect and induced impacts
- Quantify these impacts using one or several different methodologies
- Produce a set of metrics to measure the current and future impact of the Campus, and an associated template[1].

1.5 The requirement of the impact assessment, as established in the original invitation to tender, was to explore the impact that Sci-Tech Daresbury has had over its lifetime. However, due to a lack of historical data, it was agreed at the inception meeting that the study team would

[1] A list of high-level performance metrics for the Campus was developed by the study team and shared with STFC.

quantify the economic impacts using a 'snap-shot' of the current position and would instead capture historical impacts in the form of a broader supporting qualitative narrative.

Study Approach

1.6 Using a mixed methods approach consistent with these objectives, this report provides a quantitative and qualitative assessment of the impact of Sci-Tech Daresbury in the UK.

Key challenges in developing a robust impact assessment framework

1.7 The study presented a range of complex methodological problems, related to both the mix of activities conducted on the Campus and the resulting outputs and outcomes, as summarised in Table 1-2 below. This is because of Sci-Tech Daresbury's combination of: significant assets focused on different branches of science; specialised scientific kit, engineering capabilities and activities that are used to support the development of future scientific instruments and experiments, which in turn contribute towards discovery research and innovation; and high quality accommodation and support for businesses who can access the scientific facilities and expertise across the site (as can non-tenants).

Table 1-2: Headline depiction of challenges to assessing impact

Activities	Outputs and outcomes
Very wide range of activities – spanning business mentoring and support, to supporting scientific research, to skills development	**Broad nature of outputs and outcomes** – from advancing human knowledge to speeding up business R&D and commercialisation
Diverse 'target' group – tenant firms and non-tenant firms in different sectors and at different sizes and/or stages of development, scientific institutes, Higher Education Institutes (HEIs), etc. Consequently, **different engagement strategies** are used for each group	**Causality and attribution** – there are often several inputs into the research process, including multiple partners each receiving funding from many different sources
Evolving nature of activities as capabilities of, and activities at, Sci-Tech Daresbury change over time – some activities have taken place over decades, others have only just started	**Different time-paths to outcome** – from business support to new start-ups (relatively fast), to undertaking/supporting research at the lower end of the technology readiness level (TRL) scale (much longer)
Because STFC's raison d'être and strategic rationale is research focused, its **goals and activities are often not primarily commercial in nature**[2]	**Outcomes that are difficult to trace/quantify** – e.g. enhancing the UK's scientific reputation, and its level of international leadership and influence.

Source: SQW 2016

1.8 Taking accelerator science as an example illustrates the challenges of valuing the impact of just one specified activity. The principal economic and social impacts of accelerator science arise indirectly through scientific outputs. Activities on the Campus contribute to the development of scientific instruments and methods, which have direct technical impacts for scientists and some companies, and in turn facilitate scientific discoveries. The nature of these discoveries, and even more so their commercial applications, cannot be valued in advance. Furthermore, disentangling the relative contribution of Sci-Tech Daresbury from that of others involved in facilitating, undertaking and commercialising previous research is non-trivial. Finally, given the international nature of large-scale accelerator facilities, whilst the Campus' contribution will positively influence the standing of the UK accelerator science

[2] http://www.stfc.ac.uk/about-us/our-purpose-and-priorities/corporate-strategy

community, the eventual economic and social impacts arising from the research are just as likely to be captured abroad as in the UK.

1.9 This study is the first of its kind commissioned by STFC and part of its rationale was to understand how to improve future impact assessments, including what data to collect. In this context a final challenge for the study team was the lack of robust and comprehensive historical data for impact evaluation purposes currently held by STFC. Consequently, it has not been possible to systematically compute the value of Daresbury's work with *all* businesses, because much of the underpinning data are not currently being collected or are withheld due to contractual non-disclosure agreements. Whilst the exact nature of the support that the Campus provides in leading-edge R&D is always likely to be confidential, a standardised data set recording headline information on business interactions (date, duration, contract value, summary, nature and scale of potential benefits, etc.) would provide a useful baseline to demonstrate potential impacts, even if it they could not be fully measured.

1.10 In summary, the full benefits derived from present activities at Daresbury are not currently able to be monetised and thus the operational GVA figures presented in Section 3 of this report almost certainly under-estimate the real scale of economic impact. These impacts must therefore be considered alongside the wider qualitative impacts depicted through the case study research and the stakeholder evidence. This theme is returned to below.

Learning from and informed by impact assessment elsewhere

1.11 Sci-Tech Daresbury is not unique in facing significant challenges in assessing impact, see for example SQW's recent work to develop evaluation frameworks for the High Value Manufacturing and Satellite Applications Catapults. A headline review of impact studies of similar sites in the UK is presented in Annex B. The key findings are that:

- STFC is leading the way in commissioning an impact study for a *whole* science and innovation campus, rather than at Research Council or Research Institute level. For example, a study on the Roslin Institute does not include the whole of the wider Easter Bush Research Consortium, whilst the Babraham Institute study does not include the impact of the tenant companies located on site
- At the level of individual research institutes, a variety of methodologies have been used to monetise research impacts. However, these methodologies are either not appropriate for Sci-Tech Daresbury (e.g. research at comparator sites is 'nearer to market' and/or with clearer commercial applications) or judged by the study team as not being robust enough
- Two recently published impact studies (for the N8 Research Partnership and Keele University) are based on *gross* operational impacts of the universities and also monetise the impact of the student population. However, they only describe the academic research undertaken in qualitative terms
- Internationally, the GIANT Innovation Campus, Berlin Adlershof Science and Technology Park and UA Tech Park have published impact studies. However, these

only include *gross* operational impacts, and do not quantify research impacts in monetary terms or describe the research conducted on site

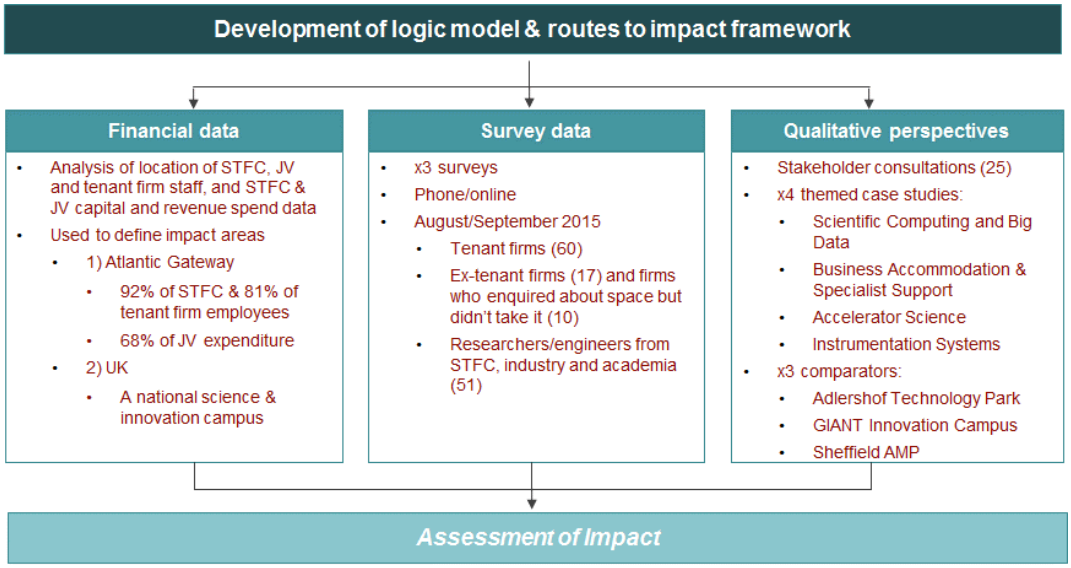
- A recent meta-evaluation found that previous studies of similar sites were beset by "*the perennial challenge…of attribution and additionality. Counterfactual analysis is nowhere in sight.*"[3]

1.12 The study's responses to these challenges and lessons from elsewhere are presented overleaf.

Campus Impact Study methodology

1.13 The overall approach taken by the study is shown in Figure 1-1 below, with the logic model presented in Annex A.

Figure 1-1:Overview of study approach



Source: SQW 2016

1.14 An additional diagram showing the precise routes to impact identified by the study team and the study's Project Board is at Figure 1-2.[4] As previously discussed, some of the outcomes shown are relatively intangible and difficult to quantify in monetary terms, such as the quality of research undertaken (those on the right of the graphic), whilst others are easier to quantify, for example the GVA impact of changes in business performance (on the left). Both quantitative and qualitative impacts are important and the study therefore adopted a mixed methods approach which covers the whole of the Campus and includes operating, research and wider impacts.

1.15 Table 1-3 provides a headline summary of the method for assessing impact for each component part of the Campus and, in the final column, a red, amber, green assessment of whether this methodology captured and monetised the full impact of each component part.

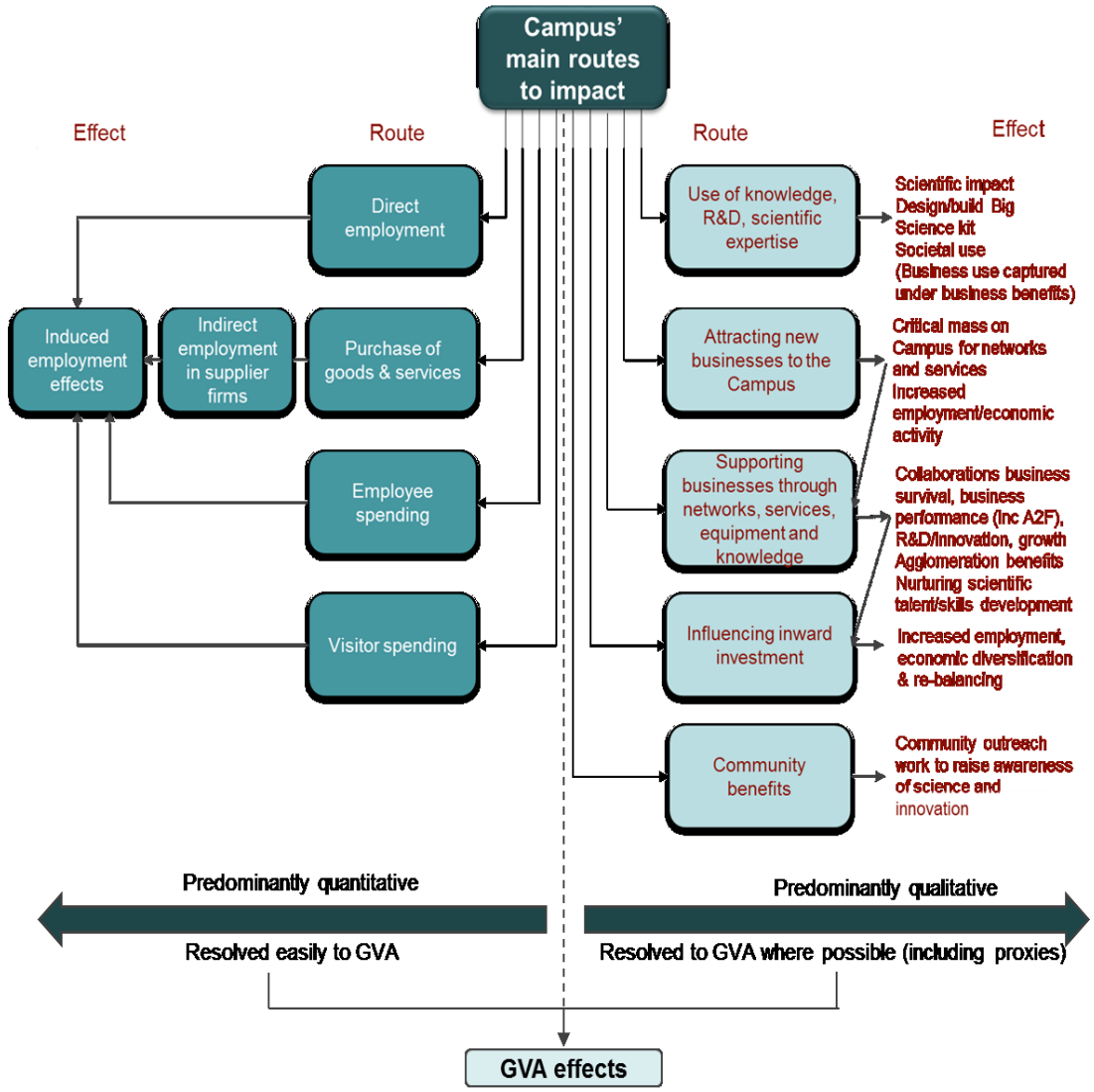
[3] Big Science and innovation, Technopolis, 2013, page 39
[4] Project Board members: STFC - Claire Dougan, Head of Impact Evaluation; Gillian Collins, Impact Evaluation Programme Manager; Katharine Robertson, Head of Campus Development; and Sci-Tech Daresbury - John Leake, Business Development Manager.

1.16 Informed by a review of previous impact studies, this study considers the counterfactual as both *gross* and *net* figures are presented for the monetised impacts. The STFC Executive Board, Project Board and other senior stakeholders were tasked with generating a series of additionality estimates for each component part of the Campus. These were supplemented by the self-reported additionality of tenant firms and researchers active on Campus, and the views of former tenants of the Campus and firms who enquired about taking space but never did so. The collated evidence, in the form of additionality coefficients, was used to estimate what proportion of the *gross* economic impact would have occurred anyway, in the absence of the Campus. These coefficients were fed into the SQW impact model and used to calculate the net economic impact of Sci-Tech Daresbury.

1.17 Only SuperSTEM was assessed as being completely non-additional (i.e. all economic impacts arising from SuperSTEM activity would have happened anyway in the absence of Daresbury, as it was assumed by senior managers that the facility would be located elsewhere in the UK were it not housed on the Campus). Conversely, the Scientific Computing Department including the Hartree Centre was assessed as being fully additional.

1.18 Where it has not been possible to monetise impacts, a wider and richer qualitative perspective is presented which illustrates both the breadth of impact and, where possible, gives an indication of the potential scale of these impacts.

Figure 1-2: Routes to impact



Source: SQW 2017

Table 1-3: Overview of the methodology used during the Campus Impact Study

Component part of Campus	Methodology for assessing impact	Red / Amber / Green assessment[5]
Tenant Firms	Operational impact (gross and net) – monetised	
Joint Venture	Operational impact (gross and net) – monetised Wider impact (gross and net) - quantitative impact on tenant businesses	
STFC's Business and Innovations department	Operational impact (gross and net) – monetised Wider impact (gross and net) – quantitative impact on tenant businesses	
STFC corporate services, finance and strategy functions	Operational impact (gross and net) – monetised Wider impact (gross) – skills/training delivered and public outreach activities both quantified	
Scientific Computing (including the Hartree Centre)	Operational impact (gross and net) – monetised Research impact (gross) – qualitative depiction through in-depth case study work	

[5] This relates to the robustness and coverage of the methodology used to assess the impact of each component of the Campus e.g. a green assessment indicates a robust methodology was used, with monetised operational and wider impacts

Component part of Campus	Methodology for assessing impact	Red / Amber / Green assessment[5]
STFC's Technology Department	Operational impact (gross and net) – monetised Research impact (gross) – qualitative depiction through in-depth case study work	
Accelerator Science and Technology Centre (ASTeC)	Operational impact (gross and net) – monetised Research impact (gross) – qualitative depiction through in-depth case study work	
Cockcroft Institute	Operational impact (gross and net) – monetised Research impact (gross) – qualitative depiction through in-depth case study work	
SuperSTEM	Operational impact (gross and net) – monetised Research impact (gross) – qualitative depiction	

Source: SQW

Structure

1.19 The remainder of this report is structured as follows:

- Section 2 sets the scene in which Sci-Tech Daresbury operates and the impact study was conducted
- Section 3 reports the direct, indirect and induced impacts of the Campus
- Section 4 presents evidence on the business accommodation elements of the Campus
- Section 4 presents summary evidence from the case study work on research conducted on the Campus
- Section 5 contains evidence of the wider qualitative impacts of the Campus
- Section 6 reports on the qualitative feedback from stakeholders and wider impacts
- Section 7 sets out lessons from similar science and innovation campuses elsewhere
- Section 8 contains the study conclusions and recommendations.

1.20 In addition, a series of supporting annexes are presented

2. Setting the scene

2.1 This Section explores the historical evolution of the Campus including an overview of its current scientific strengths and innovation 'offer' to tenant firms, and ambitious expansion plans for the future. This provides the backdrop against which the impacts generated can be understood and assessed in the round.

Key findings

- Sci-Tech Daresbury is **one of the UK's leading science and innovation campuses**.
- The Campus is located in the Liverpool City Region. It forms a **key part of the science and innovation ecosystem(s) in the Northern Powerhouse** as well as having links to other parts of the UK.
- Since its opening in the 1960s, the Campus has developed **world-class strengths in scientific computing** (the Scientific Computing Department, the Hartree Centre, and the Virtual Engineering Centre), **accelerator science and technology** (ASTeC and the Cockcroft Institute) and **nuclear physics**. The Hartree Centre in particular is increasingly seen as being the jewel in Daresbury's crown and is expected to play a crucial role in the continued growth and development of the site of the coming years.
- Tenant firms on the Campus cover a wide range of sectors, including **digital and ICT, healthcare and life sciences, advanced engineering and materials, and energy and environmental technologies**. These firms benefit from access to modern flexible office, lab and workshop space, including the recently opened Campus Technology Hub, as well as tailored business support provided by the Sci-Tech Daresbury team.
- The **diversification of the Campus** following the decommissioning of the Synchrotron Radiation Source facility in 2008 into an **open innovation environment**, with high quality business accommodation and support services is a real success story.
- There are **ambitious further expansion plans for the Campus**. Over the longer-term (30 years), the masterplan for the site envisages the creation of a 'Technology Village', with more than **1m sq ft of accommodation, housing up to 10,000 jobs**.

The historical development of Daresbury

2.2 Since the Daresbury Laboratory was given the go-ahead by the UK Government in 1962, it has been a site of internationally recognised scientific facilities and research. Originally established to maintain the UK's position at the leading edge of nuclear physics,[6] Daresbury was officially opened in 1967 with the NINA accelerator, which was in use for a decade. It was replaced by the world's first second generation synchrotron, the Synchrotron Radiation Source (SRS), in 1980, which remained operational until it was decommissioned in 2008. In 1981, another key asset, the Nuclear Structure Facility, was commissioned.

2.3 Daresbury has also been at the forefront of computer science in the UK. IBM first installed high performance computers on the site in the 1960s and the UK's first Cray-1 Supercomputer arrived in 1978. More recently, in 2012, Daresbury's Hartree Centre became host to two supercomputers based on IBM's Blue Gene technology platform.

2.4 Faced with an uncertain future as the SRS was decommissioned in August 2008 and replaced by the Diamond Light Source at Harwell, a partnership was set up between the then North West Regional Development Agency (NWDA), the Council for the Central Laboratory of the

[6] http://www.robinmarshall.eu/papers/DL50Long.pdf

Research Councils (CCLRC[7]) [a predecessor to STFC[8]], Halton Borough Council and the Universities of Lancaster, Liverpool and Manchester. The main purpose of the partnership was to focus on the longer-term development of the site. Two new buildings were developed, the Innovation Centre (2005) and Cockcroft Institute (2006). In 2010, a new joint-venture company was created with STFC, Halton Borough Council and Langtree, a property developer and investor, as partners, and the site was renamed Sci-Tech Daresbury in July 2012.

2.5 Over the last decade or so, significant investment totalling approximately £90m has been made through the Joint Venture (JV) to reposition the Campus (around £65m from the North West Development Agency and nearly £25m from the Sci-Tech Daresbury Joint Venture). New accommodation for tenant firms, support services and enabling infrastructures have been established to form a highly supportive environment for early stage SMEs and more mature and larger sized technology rich companies.

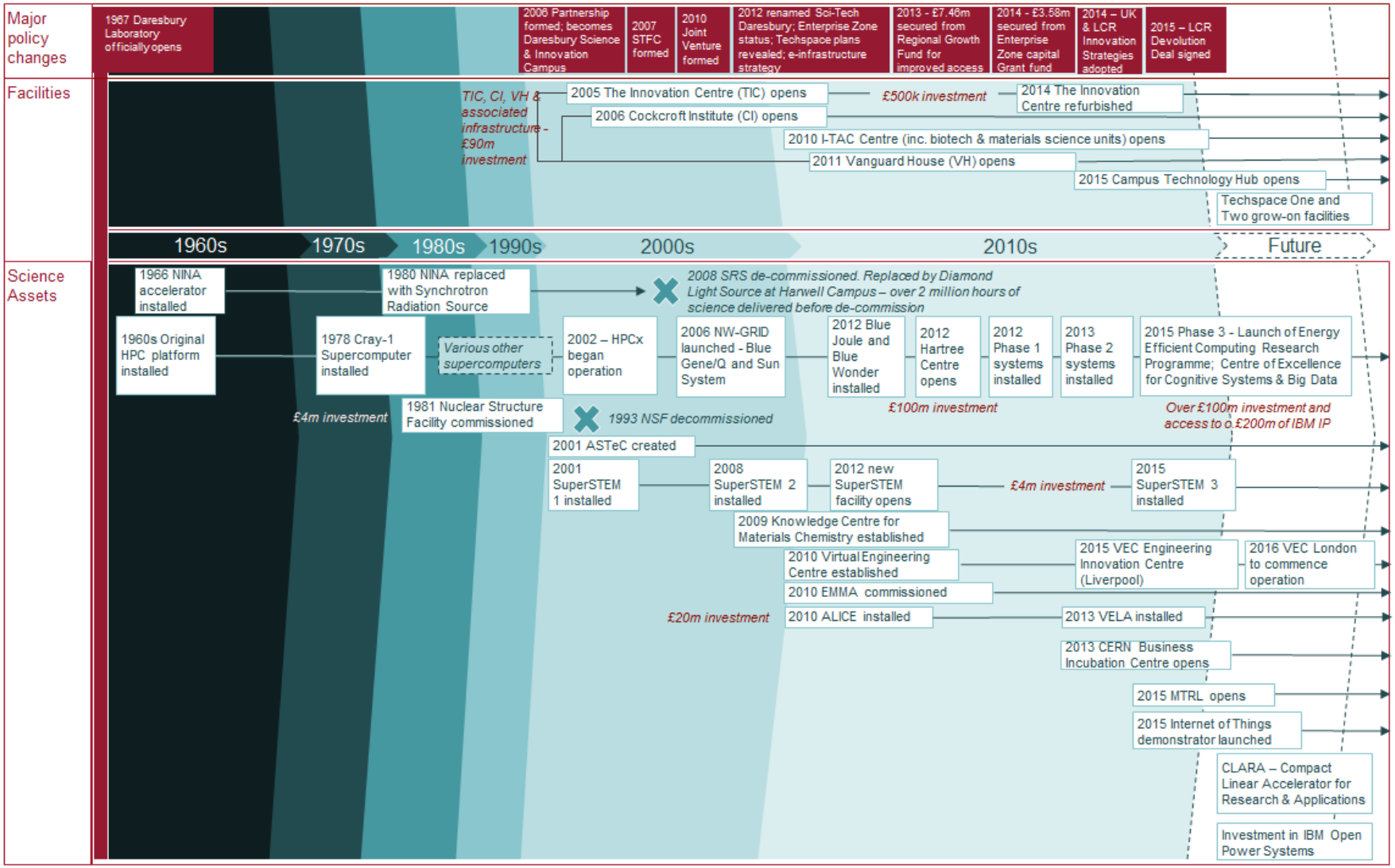
2.6 More recently, the Government has made significant investments in research at Sci-Tech Daresbury including £37.5m to create the Hartree Centre in 2012, and subsequent investments of £30m in 2013 and £115.5m announced in the 2014 Autumn Statement.[9,10] In 2015, IBM agreed "a package with STFC to provide access to IBM's world-class 'Watson' cognitive computing platform of technology and expertise of IBM on-site researchers worth up to £200 million."[11] [12] Other activity on the Campus is also receiving public sector investment; the £3.7m SuperSTEM III microscope was unveiled in 2015 by the Engineering and Physical Sciences Research Council (EPSRC).[13]

2.7 Investment in facilities for tenant firms is continuing through the recently opened Campus Technology Hub (which is also available to non-tenant firms) and, at a combined cost of £20m, the development of the Techspace One and Two facilities. When completed in late 2016, the Techspace buildings will provide further grow-on space for tenant firms and state of the art lab/workshop and office space, with the potential to house an additional 350 jobs. In order to support the continued growth and development of existing tenants, half of the space in each facility will be reserved for firms currently based on the Campus or members of the wider Daresbury network, which includes more than 4,000 people (see the case study research presented in Section 4 for more details).

2.8 The development of the Campus over time is illustrated in Figure 2-1.

[7] http://www.scienceinparliament.org.uk/wp-content/uploads/2013/09/sip63-2-7.pdf
[8] The Science and Technology Facilities Council (STFC) was created from a merger of the CCLRC and Particle Physics and Astronomy Research Council (PPARC) in 2007.
[9] http://community.hartree.stfc.ac.uk/access/content/group/admin/The%20Hartree%20Centre/CLC03007GBEN.PDF
[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/382327/44695_Accessible.pdf
[11] https://www-03.ibm.com/press/us/en/pressrelease/47056.wss
[12] http://www.stfc.ac.uk/news/313-million-boost-for-uk-big-data-research/
[13] https://www.epsrc.ac.uk/newsevents/news/superstemmicroscope/

Figure 2-1: Chronological development of Sci-Tech Daresbury's development



Source: SQW

The current situation

2.9 Over many decades, Sci-Tech Daresbury has built and maintained internationally significant research and engineering capabilities alongside an impressive portfolio of assets. To better understand and contextualise the impacts of Sci-Tech Daresbury, it is helpful to unpack the Campus in to its core component activities. This depiction is also used in the operational impact model. However, it is important to note that in reality, many aspects of the Campus are delivered in a more integrated and connected fashion. These are summarised below and explored in greater detail later in the report.

Table 2-1: Overview of the core component activities at Sci-Tech Daresbury

The **Joint Venture** is responsible for running Sci-Tech Daresbury (the three JV partners are STFC, Halton Borough Council and Langtree, a property development and management company)	
Scientific Computing: the Scientific Computing Department, Hartree Centre and Virtual Engineering Centre support the UK's ability to address global challenges, deliver scientific breakthroughs and increase productivity	**Accelerator Science and Technology Centre** specialises in particle accelerators, ranging from large scale international and national research facilities to specialised industrial and medical applications
STFC's Technology Department supports a wide range of advanced engineering, technology, instrumentation, specialist facilities and high-level skills	**The Cockcroft Institute**: A collaboration between academia, STFC and industry, it designs, constructs and uses innovative instruments such as particle accelerators and leads the UK's participation in flagship international experiments
EPSRC electron microscope SuperSTEM supports multi-disciplinary research by providing access to cutting-edge instrumentation and expertise and training in electron microscopy	**Business accommodation and specialist support** for the c.100 tenant firms on Campus who are located in either STFC or Joint Venture managed properties
STFC's Business and Innovations staff provide support to tenant firms and to other businesses looking to access the scientific knowledge and equipment on Campus	**STFC's corporate services, finance and strategy staff** provide the supporting services necessary for the scientists and engineers to undertake their work.

Future expansion plans

2.10 In addition to prompting the development of Techspace One and Two, the success of the existing business accommodation facilities has led to the development of a long term masterplan for the Campus. This envisages the Campus becoming "a home for life" to technology and science focused firms by providing additional high quality space and support, designed to meet the changing needs of tenants. The philosophy underpinning the Campus expansion plans is that firms can start-up in the on-site business incubation centres (I-TAC [Innovations Technology Access Centre] or the Innovation Centre), progress through Vanguard House and/or one of the Techspace buildings, before potentially moving into bigger premises as they mature, grow and develop.

2.11 Over the longer-term (30 years), the masterplan for the entire Daresbury site envisages the creation of a 'Technology Village', with more than 1m sq ft of accommodation, housing up to 10,000 jobs. This would include development activity on land on the other side of the canal to the current campus. Such a development would move Sci-Tech Daresbury into the 'premier league' of UK science and innovation campuses in terms of scale and critical mass, and would align Daresbury more closely with the comparator science and innovation sites at Adlershof and Grenoble, as detailed in Section 7 and Annex D.

3. Operational impacts of the Campus

3.1 This Section considers the operational impacts of Sci-Tech Daresbury on the UK economy in 2014/15. These monetised impacts are presented in terms of Gross Value Added (GVA), which is a key measure of wealth in an economy. The defined impact area for these calculations is taken as the UK and both *gross* and *net* figures are presented at this geography. Additionally, based on the spatial distribution of employees, *gross* impact figures are presented at the level of the Atlantic Gateway (LEPs of Liverpool City Region, Greater Manchester, and Cheshire and Warrington), so local partners can understand the beneficial impacts derived from campus.

- Sci-Tech Daresbury is a **major generator of both GVA and high-quality employment within the Northern Powerhouse**.
- The *gross* GVA contribution of the operations at Sci-Tech Daresbury to the UK economy is estimated at **£163m in 2014/15**. This includes GVA generated directly through employment and turnover, indirect GVA from the purchase of bought in goods and services, and induced GVA from household spending. In addition, the Campus supports, directly and indirectly, almost **2,000 jobs** across the UK.
- The £163m operational impact of the Campus compares to the average **annual £42.5m input costs of running the STFC operations on Campus** over the period 2012/13 to 2014/15.
- These *gross* effects must be reduced to take account of impacts that would have occurred anyway, in the absence of the Campus (the counterfactual). So for example, as a thought experiment, if Sci-Tech Daresbury did not exist, what proportion of the highly skilled and expert STFC staff currently employed on site would be working elsewhere in the UK in similar roles, in similar industries, generating similar salary levels (and economic impacts) as they do currently? In addition, how many of the businesses on Campus would be trading and generating very similar amounts of turnover from alternative locations? By triangulating multiple strands of evidence, the study team has sought to assess what proportion of the GVA impacts arising from both of these activities would have occurred anyway. The resulting analyses estimate that the ***net* GVA impact of Sci-Tech Daresbury on the UK economy was £70m in 2014/15**.
- **Sci-Tech Daresbury also makes a significant contribution to the Atlantic Gateway economy**, generating an estimated ***gross* GVA impact of £135m in 2014/15** across the Liverpool City Region, Cheshire and Warrington, and Greater Manchester sub-regions in 2014/15.

As noted in Section 1, these figures do not include the scientific impacts generated by activities on the Campus or the commercial benefits flowing from the work of the Hartree Centre; these are captured qualitatively later in the report.

Sci-Tech Daresbury's estimated impact on the UK economy in 2014/15

	GVA impact	Employment impact
Gross impact	£163m	1,950 FTEs
Net impact	£70m	840 FTEs

Impacts on the UK economy

3.2 The study has modelled three types of operational economic impact:

- **Direct impacts** arise from the payment of salaries or the generation of turnover

- **Indirect impacts** triggered by operations at Sci-Tech Daresbury which generate additional economic value/GVA in the supply chain through the purchase of goods and services. This includes: **revenue expenditure** on utilities, general and specialist maintenance, catering and other support services etc.; and **capital expenditure** on scientific equipment and on-site construction work etc.

- **Induced impacts** result from employees spending their incomes in the economy, thereby helping to create further economic activity (and employment) in un-related industries.

Findings

3.3 Aggregating the direct, indirect and induced operational impact figures indicates an **estimated overall *gross* GVA contribution from activities at Sci-Tech Daresbury of £162.5m in 2014/15.** It should be noted that as this is a snapshot for the 2014/15 financial year, the economic impacts arising from investments on the Campus made before or after this date have not been modelled.[14] However, informed by the latest evidence available, the study team is confident that this level of annual economic impact is likely to persist into the future. Furthermore, as the supply of business accommodation on the Campus increases and occupancy levels build, the *gross* GVA impact figure will rise. However, if business occupancy levels drop and/or there is a reduction in capital or revenue expenditure on-site by STFC, the scale of the economic impact would reduce. However, the study team is confident that these figures represent a 'typical year' at Daresbury.

3.4 Based on the indirect and induced GVA contribution of the site, it is also possible to estimate the additional employment generated over and above Daresbury's direct employment contribution. The estimated £59m of *gross* indirect (£45.6m) and *gross* induced (£13.4m) GVA supported implies **an estimated additional 1,060 jobs in 2014/15. This gives an overall estimated total of 1,950 jobs which are either located at Sci-Tech Daresbury or supported indirectly by activities conducted at the Campus.**

Figure 3-1: Campus impacts on the UK economy

Sci-Tech Daresbury's estimated *gross* impact on the UK economy in 2014/15

	GVA impact	Employment impact
Direct impact	£103.5m	890 FTEs
Indirect impact	£45.6m	1,060 FTEs
Induced impact	£13.4m	
Total impact	**£162.5m**	1,950 FTEs

Source: SQW 2017

[14] Apart from the indirect impact of the Daresbury Laboratory which uses an 'average year' figure for the period 2012/13 to 2014/15 to capture significant investments in these years.

The Net Position in the UK

3.5 It is important to consider the *net* impact of the Campus, because some of the *gross* impacts estimated above would have occurred even if Sci-Tech Daresbury had never existed. However, determining the counterfactual, that is what would have happened if Sci-Tech Daresbury did not exist, is especially difficult because the Campus has been operational since the 1960s.

3.6 Overall, the study team has estimated (by triangulating a wide range of evidence, see paragraph 1.16) that there is a significant level of additionality associated with the component parts of the Daresbury Laboratory. However, self-reported evidence from the tenant firms suggests that the additionality of the business support and accommodation offer is lower – see paragraph 4.14 for details. It should be noted that within the scope of this research assignment, the study team has been unable to verify the accuracy of these responses so they should be treated with caution.[15]

3.7 The **estimated total *net* GVA impact of the Campus as a whole of £70.3m in 2014/15** is considerably smaller than the estimated *gross* impact figure (£162.5m). Likewise, the **estimated total *net* direct employment figure of 370 FTEs in 2014/15,** is again below the *gross* impact estimate for the same year (890 FTEs).

Figure 3-2: Net impact on the UK economy summary graphic

Sci-Tech Daresbury's estimated *net* impact on the UK economy in 2014/15

	GVA impact	Employment impact
Direct impact	£44m	370 FTEs
Indirect impact	£21.7m	470 FTEs
Induced impact	£4.7m	
Total impact	**£70.3m**	840 FTEs

Source: SQW 2017

Impact on the Atlantic Gateway economy

3.8 The study team has also calculated Sci-Tech Daresbury's impact on the sub-regional economy of the surrounding Atlantic Gateway geography, which covers the three LEP areas of the Liverpool City Region, Cheshire and Warrington, and Greater Manchester. [16] The Campus sits at the heart of this area with 93% of Daresbury Laboratory employees and 81% of tenant firm employees living within it.[17] The direct impact is the same at the level of the UK and the Atlantic Gateway because the impact occurs at Sci-Tech Daresbury (as the Campus is the site of employment and turnover generation) which sits within both geographies. Overall however, *gross* impacts are smaller at the level of the Atlantic Gateway because: the scale of **indirect impacts** is lower at the level of the Atlantic Gateway (some

[15] Self-reported data may be inaccurate if respondents have difficulty recalling the information, if they are overly optimistic or pessimistic about how an intervention benefitted them, or if they misunderstand the question.
[16] See the Atlantic Gateway Partnership website for further details: http://www.atlanticgateway.co.uk/
[17] Source: STFC data and study survey of tenant firms

suppliers to the Daresbury Laboratory and tenant firms are located outside of the Atlantic Gateway area); and **induced impacts** are smaller at the level of the Atlantic Gateway as staff who live elsewhere spend the majority of their salary outside the area. In addition, staff who live within the Atlantic Gateway also spend a proportion of their salary outside the area.

3.9 Overall, Sci-Tech Daresbury makes a considerable contribution to the Atlantic Gateway economy; **estimated at a *gross* GVA figure of £135m in 2014/15 with over 1,500 jobs supported both directly and indirectly**.

Figure 3-3: Gross impact on the Atlantic Gateway economy summary graphic

Sci-Tech Daresbury's estimated *gross* impact on the Atlantic Gateway economy in 2014/15

	GVA impact	Employment impact
Direct impact	£103.5m	890 FTEs
Indirect impact	£23.5m	640 FTEs
Induced impact	£8.4m	
Total impact	**£135.4m**	1,540 FTEs

Source: SQW 2017

4. Impact on tenant firms

4.1 This Section presents a summary of the findings from case study research on the business accommodation and tailored support service offer available at the Campus.

- Sci-Tech Daresbury's integrated, high quality flexible accommodation, tailored business support services and access to nationally and internationally significant scientific research, kit, and supporting capabilities have helped to **attract *a cohort of successful science and technology driven firms* to the Campus**
- There are currently **100 firms on Campus** and they generated an estimated ***gross* GVA impact of £94m in 2014/15**
- Sci-Tech Daresbury has helped these firms to prosper by **minimising business failure, supporting and promoting innovation, and facilitating networking and collaboration**. For example, the three year business survival rate of companies located on the Campus is in excess of 90%, and tenant firms are more likely to invest in all forms of innovation than the national average of firms operating within the UK's two most innovative sectors
- The diversification of the Sci-Tech Daresbury offer into a fully integrated science and innovation Campus will continue over the coming years with the **implementation of the Campus masterplan**. This envisages additional business accommodation, which would help to increase the economic impact of the Campus. If fully implemented this could add a **cumulative £660m (discounted GVA) to Sci-Tech Daresbury's gross impact by 2040.**

Business Accommodation and Support Services

4.2 Since the opening of the Innovation Centre in 2005, a range of specialist business accommodation for science and technology-rich firms has been developed at Sci-Tech Daresbury. There are now around 100 tenant firms with operations on the Campus, with an estimated combined turnover of £56m and employment of 528 FTEs. This summary case study examines the property offer and business support that tenants benefit from, and the key impacts this gives rise to.

Overview of the Daresbury offer to tenants

4.3 The supply of flexible business accommodation at Daresbury is a relatively recent development. Over recent years, significant investment totalling approximately £90m has been made through the Joint Venture (the I-TAC facilities are managed by STFC outside of the Joint Venture) to grow and reposition the Campus as shown in Table 4-1 below.

Table 4-1: Existing accommodation and facilities available to tenant firms

Facility	Date opened	Description
Innovation Centre	2005	Aimed at companies with a small team of employees, it has 60 office units and four lab/workshops, as well as hot desk facilities
I-TAC (Materials and Bio)	2010	Wet chemistry, materials and biology labs available on month notice or 'hot labs' terms, allowing early stage businesses to minimise their costs and risks
Vanguard House	2011	For larger companies (up to 50 employees) who can sign longer term leases (3-5 years). If offers 20 offices and five lab/workshops
STFC CERN Business Incubation Centre	2013	Incubatees benefit from £40k grant funding, up to 40 hours' free access to STFC and CERN scientists, and access to CERN IP at favourable terms
Campus Technology	2016	A high quality and flexible environment in which to bring together

Facility	Date opened	Description
Hub		business R&D teams, STFC researchers and academics so they can collaborate on specific R&D projects. The CTH offers access to state of the art 3D printing machines and other kit.

Source: SQW 2016

4.4 Sci-Tech Daresbury also provides tailored business support designed to enable firms to fulfil their full growth potential. This focuses on tackling four 'killer issues' (access to market, funding, skills and technology/technical facilities), which tenant firms face if they are to succeed in increasingly competitive UK and international markets. This specialist business and innovation support was highlighted as being of great importance to a third of all Campus Impact Study business survey respondents, whilst the networking support was felt to have had the most significant impact by a third of the survey respondents.

4.5 A formal occupation policy is in place to ensure that the Campus remains associated with innovative science and technology focused firms, as it continues to expand its offer. The Sci-Tech Daresbury Strategy for Science Innovation and Growth identifies three key sectors for tenant firms: digital/ICT; advanced engineering and materials; and biomedical and healthcare.[18]

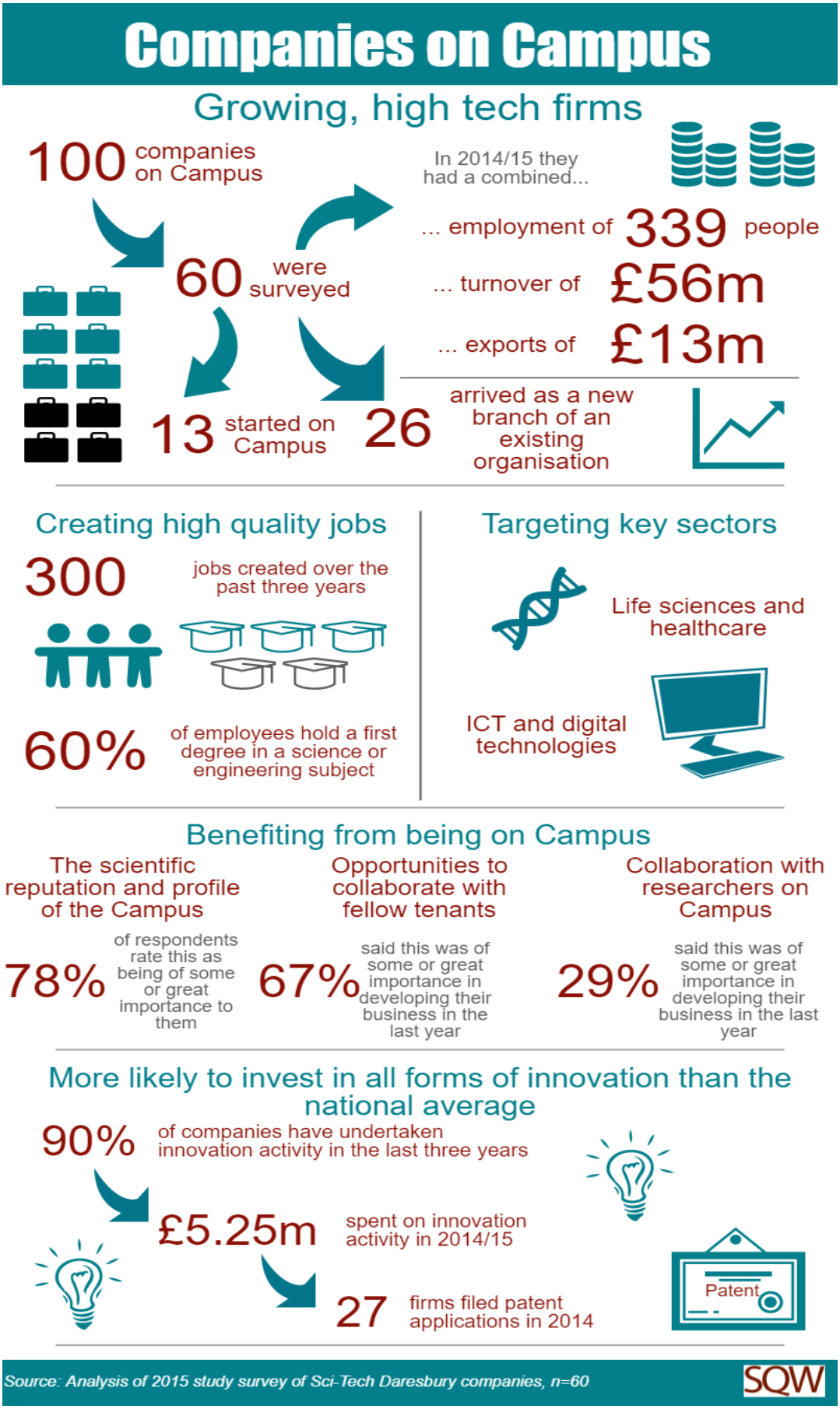
4.6 The Techspace One and Two facilities are the two most recent developments on the Campus and will open in late 2016. As set out earlier, over the longer-term (30 years), the masterplan for the whole site envisages the creation of a 'Technology Village', with more than 1m sq ft of accommodation, housing up to 10,000 jobs.

Key Impacts

4.7 Background information on the companies located at Sci-Tech Daresbury is provided inFigure 4-1: A snap-shot of 60 surveyed tenant firms . This infographic only refers to the responses provided by the 60 firms who were surveyed as part of the Campus Impact Study, and has intentionally not been scaled up to represent all tenant firms on site. In order to keep a consistent source, and refer to a consistent base of firms, the graphic does not present data from the separate in-house Sci-Tech Daresbury Annual Campus Survey or the Sci-Tech Daresbury Strategy.

[18] http://www.sci-techdaresbury.com/uploads/Sci_Tech_Brochure_final%20version.pdf

Figure 4-1: A snap-shot of 60 surveyed tenant firms at Sci-Tech Daresbury in 2015



Achievements of the Campus

4.8 The survey evidence demonstrates that Sci-Tech Daresbury is both providing a home to start-up companies and to new branches of existing firms.

4.9 Of the 60 tenants surveyed, 13 were started on the Campus. These 13 tenants currently have 98 FTEs and a combined annual turnover of £11.6m and operate in sectors including life sciences, ICT and energy.

4.10 A further 26 tenants were created on the Campus as a new branch or subsidiary of an existing organisation. This includes five international companies, which together have a combined annual turnover of £9.6m for their Campus-based operations.[19] These five foreign-owned tenants are:

- **Coservit** – a software organisation that focuses on systems management, monitoring sales and sales automation
- **COPA-DATA** – a leader for industrial automation software
- **Mellanox Technologies** – providers of networking and interconnection of data for supercomputers
- **RPost** - a leader in secure and certified electronic communications
- **Synchrogenix** – a medical writing consultancy.

4.11 The key ways in which the Campus impacts positively on the performance of its tenant firms are summarised below in **Error! Reference source not found.**, using a red, amber, green ating system to provide a high level indicative assessment of the performance of the Campus.[20]

Table 4-2: Key business support achievements of the Campus

Achievements	Details at Daresbury	Comparator benchmarks
Minimising business failure	Only 13 business failures in over 11 years; 3 year business survival rate in excess of 90%	3 year business survival rate in the North West is 60%
Accelerating business growth	Without Daresbury, 35% of tenants would be smaller in turnover terms and 20% would be smaller in employment terms Average sales growth of 30% per annum	Without an Oxford Innovation (OI) Innovation Centre, 30% of OI tenants recognised that their business would not be growing as fast[21] NI Science Park reported in 2015 that it had delivered a tenant growth rate of 30% per annum on average[22]
Attracting investment	Firms have secured £82m of all forms investment since formation, £15m in 2015. 50% of companies raised funds in 2015[23]	0.28 NW companies per 1,000 received private equity or venture capital investment in 2014. Approximately 10% of investment

[19] Note, two companies did not provide turnover data for their operations on the Campus
[20] A green assessment indicates that the Campus is outperforming competitor sites and/or the national average, whilst a red assessment would indicate relative underperformance
[21] Business Survival and Growth within Oxford Innovation's Centres, 2014, Oxford Innovation
[22] Delivering innovation through partnership, NI Science Park and the NW Regional Science Park, UKSPA presentation, June 2015
[23] Note that in 2014 Campus companies had secured £109m in investment. Three key companies have since left the Campus causing the drop to £82m

Achievements	Details at Daresbury	Comparator benchmarks
		(£448m) in 2014 was captured by NW firms[24]
Creating highly skilled and high value jobs	300 jobs created over the past three years Survey evidence suggests average growth of 1 FTE job per annum per firm on campus (Vanguard House has a higher annual growth rate at 3.1 FTEs) A third of employees of tenant firms earn £40-59k per year with a small number earning over £100k	Comparator growth rates per firm p.a.: OI tenants 1.1 FTE 2014 mean annual salary in Halton £26.6k, and the North West £24.6k[25]
Promoting innovation	75% of firms who responded to the SQW survey have introduced new or significantly improved goods and/or services in the last three years 22% of companies have taken out patents	Comparator product innovator rates: 18.9% of North West firms, 39.8% UK engineering based manufacturing firms, and 28.7% UK knowledge intensive services firms Comparator patents: 1.7% of North West firms, 8.6% UK engineering based manufacturing firms, and 2.6% UK knowledge intensive services firms
Collaboration	51% of tenants collaborate with STFC, 67% collaborate with a University and 74% collaborate with either STFC or a University[26]	76% of Babraham Research Campus companies have interactions with the Babraham Institute[27]

Source: 2015 Annual Campus Survey data, 2015 study team Campus survey data

Company case study: Arcis:Altos Group

Arcis Biotechnology moved to Sci-Tech Daresbury in 2010 and expanded from The Innovation Centre into Vanguard House in 2011. Arcis bought California-based Altos Medical in a £3.7m deal in 2012 and now has ten employees at the Campus.

Arcis:Altos uses a fully equipped, Class 2 certified micro-laboratory in ITAC and shared facilities for larger costlier items such as autoclaves and spectrophotometers. ITAC has also provided a space for collaboration – Arics:Altos worked with Perfectus Biomed on a solution for a global organisation, which will benefit both companies.

Arics:Altos also values the networking benefits that being located at Sci-Tech Daresbury provides "*one of the key benefits which we enjoy is taking part in the director's forum…this provides a platform to discuss best practice …[be] kept up to date on new funding opportunities, and benefit from presentations on patent box, UKTI and R&D tax relief.*"[28]

Monetising the business impacts

4.12 In addition to the current 100 tenants, over the past decade, around 250 other firms have been located on Campus. Although these firms are no longer tenants at Daresbury, the Campus has supported their growth and development, thus illustrating the wider beneficial impacts generated by the site. Note that the GVA figures presented below do not include any economic impacts from these former tenants.

4.13 Based on responses to the study survey, it is estimated that all 100 companies at Sci-Tech Daresbury were responsible for **a total *gross* direct employment impact of 528 FTEs and a *gross* combined GVA impact of £94.1m in 2014/15**.

[24] British Private Equity and Venture Capital Association, Private Equity and Venture Capital Report on Investment Activity in 2014 (Autumn 2015)
[25] ONS, Annual Survey of Hours and Earnings. Median annual salaries were £22.7k and £20.7k respectively
[26] Additional survey data (study team in August 2015) indicate lower levels of collaboration: 37% of respondents report formal collaboration and 53% report informal collaboration with Daresbury Laboratory researchers or academic researchers active at the campus
[27] Capturing the Economic Impact of the Babraham Institute, Alacrita, 2013, page 40. These interactions include scientific Services followed by CASE awards, consultancy, antibody sales, IP licences and collaborative research.
[28] http://www.sci-techdaresbury.com/sectors/studies/7/

4.14 Tenant firms responding to the study survey were specifically asked what would have happened to their employment and turnover if they were not located at the Campus and were instead based somewhere else; a measure of self-reported additionality. Respondents indicated that roughly 10% of their current turnover and 10% of their current employment are due to their location at Daresbury. Furthermore, 97% of respondents stated that their business would have located elsewhere, if Sci-Tech Daresbury did not exist. These figures are surprising given the highly differentiated nature of the offer at Daresbury (compared to standard managed property solutions available at business parks), but may in part reflect that a critical mass of on-site business activity has not yet been reached.

4.15 It has not been possible for the study team to benchmark Daresbury's net impact performance against comparators, as such developments have generally avoided the issue, meaning that there are few robust net economic impact figures to draw on. Anecdotal evidence suggests that business support services are very useful, but that typically, relatively few firms make full use of these in the UK. For those firms that do access the tailored support, it is very difficult to quantify or monetise the benefits, which are mainly associated with image (affecting both staff and perceptions). Thus the 'true' additionality of Sci-Tech Daresbury may be higher than that reported by the survey respondents. The study team has therefore revised the additionality estimate upwards to 15% because of wider evidence including: the low business failure rates on Campus; the value placed on both specialist business and innovation support, and networking support provided by the Campus; and the importance of the Campus in facilitating networking and collaboration activity between tenants.

4.16 After allowing for these additionality considerations, **the estimated *net* economic impact is 79 FTEs and a net GVA impact of £14.1m.**

Table 4-3: Gross and net impacts of Sci-Tech Daresbury's tenant firms on the UK economy

	FTEs on site	GVA impact
Gross impact in 2014/15	528	£94.1m
Net impact in 2014/15	79	£14.1m

Source: SQW calculations based on survey responses

Company case study: Perceptive Engineering

Software and consultancy business Perceptive Engineering Ltd (PEL) was founded in 2003. It re-located to the Innovation Centre at Daresbury in 2005 and moved to Vanguard House in March 2012.

Since PEL moved to Sci-Tech Daresbury, its turnover has increased from £450k to almost £2m and staff numbers have increased from seven to 24. The business has also expanded its reach with the creation of an office in Singapore, partly through a connection formed through the Campus network. PEL's supply chain also includes other Campus companies.

PEL is involved in many collaborations, including with Campus gold partners Inventya, and off site organisations such as the Universities of Manchester and Lancaster, and Unilever and United Utilities. PEL has also received advice from UKTI representatives on international collaboration opportunities and has recently commenced a joint project with STFC and major pharmaceutical partners (Pfizer, GSK, AstraZeneca and Bristol-Myers Squibb); the £20.4m ADDoPT (Advanced Digital Design of Pharmaceutical Therapeutics) project addresses the challenge of getting new innovative medicines to market in the quickest and most cost-effective way possible.[29]

4.17 The Campus masterplan envisages the creation of approximately 1m sq ft of additional lettable space over the next 25 years. Were this to be realised, it is **estimated by the study**

[29] http://www.psenterprise.com/news/press_releases/160128_addopt/index.html

team that almost 10,000 gross additional jobs could be created on the Campus, which would have a cumulative gross *direct* GVA impact of £660m (in 2014 prices) by 2040. These impacts would be in addition to the impacts generated by firms currently on site, some 95% of whom expect their turnover to increase over the next two years.

Table 4-4: Potential future gross impacts by 2040[30]

	2040
Cumulative *gross* total jobs (2016-2040)	9,889
Cumulative *gross* direct GVA (undiscounted) (2016-2040)	£1,107m
Cumulative *gross* direct GVA (discounted) (2016-2040)	£660m
Annual discounted *gross* direct GVA per annum (2040)	£22m

Source: SQW calculations based on Sci-Tech Daresbury estimates

Company case study: XCellR8

XCellR8 was founded in 2008 to provide cruelty-free testing solutions for the cosmetics industry. Since relocating to Sci-Tech Daresbury in 2013, the business has quadrupled its turnover to £500k and significantly expanded its employment.

In 2013 XCellR8 gained GLP (Good Laboratory Practice) accreditation and also won the Lush Training Prize, enabling it to develop a key strategic partnership with Lush.

XCellR8 recently secured a £180k research grant from Innovate UK to develop a new ethical test for human acute toxicity, in combination with partners Inventya (also based at Sci-Tech Daresbury), Lush and FRAME (Fund for the Replacement of Animals in Medical Experiments).

Conclusions

4.18 Over the last decade, the Joint Venture and STFC have launched multiple business facilities and attracted an impressive cohort of science focused and/or technology rich companies. The majority of these have been start-ups, early stage firms or SMEs. However, the Daresbury 'story' has also been shaped by investment from some major international corporations including Lockheed Martin, Mellanox Technologies and IBM.

4.19 The co-location of the science, research, specialist equipment/kit, flexible modern property solutions and tailored business support differentiates the Campus offer from some competitor developments. This impressive ecosystem has also enabled some traditional barriers to innovation, collaboration and business growth to be removed. **Current tenants had an estimated *gross* GVA impact of £94m in 2014/15, employed 528 FTEs and had created around 300 jobs over the past three years.**

4.20 Looking forward, a long-term aim of the Campus is to stimulate business growth and contribute towards the development of an internationally competitive and innovative Northern Powerhouse. It is delivering against this objective by attracting firms to invest in Daresbury and create high quality jobs.

[30] The study team note that the estimates presented here are based on Sci-Tech Daresbury job density estimates which are more optimistic than best practice guidance from the HCA. The assumptions used are one job per 90sq ft of lettable office space (HCA: 108-140sq ft) and one job per 200sq ft of lab/workshop space (HCA: 161-431 sq ft lettable maker spaces or 431-646 sq ft lettable R&D space). For more details, see HCA's Employment Density Guide

5. Science and technology impacts

5.1 This Section presents a summary of the findings from three case studies on the scientific and engineering offer at Sci-Tech Daresbury. Within the scope of the case study research and because of the challenges discussed at paragraph 1.7, it has not been possible to value or monetise impacts across all three case studies. This section therefore presents a qualitative depiction of impacts with illustrative examples also provided.

The three science focused case studies presented in the main report focus on different technology areas and their broader applications. Across the three areas, five broad categories of science and technology impacts can be evidenced. These are illustrated below with further examples given in the case study summaries that follow.

- **Supporting high quality scientific research and developing the technology to support fundamental research and large scale scientific facilities elsewhere** is a key part of Daresbury Laboratory activity. This includes, but is not limited to, developing and building new technologies to be used in cutting-edge scientific research, providing enabling computing infrastructures to the scientific community, enhancing knowledge of energy efficient computing, developing capabilities in accelerator science and playing a key co-ordinating role for the UK nuclear physics community.
- The high quality of scientists and engineers working on the Campus allows the **UK to gain international leadership and influence** by coordinating major international accelerator science projects and designing/developing the advanced equipment necessary for experiments at high profile international facilities. Providing this specialised technology allows UK scientists to access these world leading facilities.
- Whether through direct project assignments with businesses at Hartree or the VEC, the industrial engagement activities of the Detector Systems Group, or ASTeC's work to help business innovation, **direct engagement with businesses is becoming more important for the Campus and is boosting the competitiveness of beneficiary firms**.
- Sometimes arising from fundamental research, a range of **practical market applications for technologies have been developed** including the prototype ProSPECTus medical imager. Other technologies developed at Daresbury are being used within healthcare to improve patient outcomes.
- The Hartree Centre's skills development programme, and post-graduate training at both the Cockcroft Institute and the MTRL are all helping to **develop the skills of the next generation of scientists and engineers for the UK,** building on the skills developed over the last 50 years.

Scientific Computing and Big Data

5.2 This case study summary reviews 'Scientific Computing and Big Data' at Daresbury, specifically the Scientific Computing Department, The Hartree Centre, and The Virtual Engineering Centre (VEC).

Overview of the Daresbury offer

1. Scientific Computing Department

5.3 Scientific computing is used to understand and solve complex problems through advanced computing capabilities such as numerical analysis and detailed simulation and modelling. It is one of Daresbury's longest-standing activities, dating to the 1960s when High Performance Computing ('HPC') resources were needed both to help control the process of particle acceleration and analyse the data generated. Significant milestones included the installation of the UK's first Cray-1 Supercomputer in 1978, and Daresbury's successful bid

in 2001, with the Edinburgh Parallel Computing Centre, to operate the UK's National Supercomputer service (HPCx), the first Terascale computer in the UK.

5.4 In 2005, Daresbury secured investment from the then North West Development Agency (NWDA) for HPC infrastructure and fibre links (to Lancaster, Liverpool and Manchester) Universities) to form the North West Grid, offering industrial users the flexibility to buy 'mainframe time' to support their R&D needs. Similarly, in 2009, Daresbury together with the Universities of Bolton, Liverpool, and Manchester, secured funds, again from the NWDA, to set up the Knowledge Centre for Materials Chemistry (KCMC), intended to coordinate, develop and exploit cutting-edge research in materials chemistry.

5.5 With around 160 staff, roughly half of which are based at Daresbury, the Scientific Computing Department (SCD) has a strong focus on the development and optimisation of large-scale scientific applications across a wide range of science areas supported by R&D activities.

2. The Hartree Centre

5.6 Formally opened in 2012, the Hartree Centre provides "collaborative research, innovation and development services that accelerate the application of high performance computing, big data analytics and cognitive computing technologies."[31]

5.7 Funding for, and the establishment of, the Hartree Centre was announced in 2011 – £7.5 million in August and £30 million (as part of £145 million for national e-Infrastructure) in October 2011. In 2013, a further £19 million of capital investment, was secured by Hartree, followed by £115.5 million (over five years) in June 2015 to establish Hartree as the UK centre of excellence in Cognitive Systems and Big Data. Through industrial engagement, Hartree is intended to transform the competitiveness of UK industry by accelerating the adoption of data-centric computing, big data and cognitive technologies.

5.8 Investment announced in 2015 will provide Hartree with access to intellectual property held by IBM and has also seeded the establishment of IBM Research's first ever UK presence, with around 30 IBM staff (building over five years) to be co-located alongside Hartree. The value of the total package of "access to IBM's world-class 'Watson' cognitive computing platform…and expertise of IBM on-site researchers" is worth up to £200 million to STFC.[32],[33]

3. The Virtual Engineering Centre (VEC)

5.9 Led by the University of Liverpool, and brought to bear in 2010 with NWDA and ERDF resources[34], the VEC works with the Automotive, Aerospace, Oil/Gas, Rail, Nuclear and adjacent sectors to support R&D activities in firms. Although not part of Hartree, or indeed STFC, the VEC at Daresbury has a close working relationship with both. Whilst the core capability of the VEC is around advanced engineering technologies, its relationship with Hartree ensures there is a strong and integrated HPC component to its offering. Currently,

[31] http://www.hartree.stfc.ac.uk/hartree/
[32] https://www-03.ibm.com/press/us/en/pressrelease/47056.wss
[33] http://www.stfc.ac.uk/news/313-million-boost-for-uk-big-data-research/
[34] North West Development Agency (NWDA) and the European Regional Development Fund (ERFD)

the VEC employs around 20 high-quality engineering specialists, three of whom are funded by Hartree, helping to ensure linkages with Hartree's HPC expertise.

Key Impacts

Supporting scientific research

5.10 In a UK context, Daresbury has been at the forefront of scientific computing efforts for almost 60 years. **Examples of SCD's foundational impacts** include:

- The operation of HPCx, the National Supercomputer, between 2002 and 2009. The £52m facility enabled UK researchers to progress a wide range of hitherto computationally intractable problems in areas such as Materials Research and Environmental/Climate Modelling.
- Collaborative Computational Projects ('CCPs') bring together key university groups to share code and computational methods, with support from Daresbury in code development, optimisation, maintenance, support, and training. They are a cornerstone of STFC's support for UK computational science.
  - For example, CCP4 grew out of the operation of Daresbury's Synchrotron Radiation Source and is used by academics and specialist researchers worldwide in a wide range of biomedical projects. It is also licensed to over 100 companies in the Pharmaceutical, Biotech and Agri-Tech sectors, providing an income stream three-to-four times the core grant funding.
- CASTEP, a code for calculating the properties of materials including atomic structure and electronic response. CASTEP was developed by the Rutherford Appleton Laboratory with key supporting inputs from Daresbury, reflecting strong linkages across STFC's two core sites. It is now marketed and sold by a commercial firm, with aggregate sales exceeding US$30m.
- Project GungHo, a collaborative project involving Daresbury, the Met Office, and NERC, is developing a new model of atmospheric dynamics for weather prediction and climate simulations. SCD/Hartree are developing the computational framework to support the efficient operation of the new model on the latest HPC architectures. The Business Case to Government for the new £100m HPC facility at the Met Office states *'the supercomputer's sophisticated forecasts are anticipated to deliver £2 billion of social benefits to the UK by enabling better advance preparation and contingency plans to protect peoples' homes and businesses'.*

5.11 In its relatively short period of operation to date, the **Hartree Centre has also carried out a wide range of projects to support scientific research**. These include:

- Collaboration with Erasmus MC to develop detailed, real-time brain models and simulations. Faster and more energy efficient than before, the new models can provide valuable insights without having to perform real-life experiments[35]

[35] http://www.stfc.ac.uk/files/using-supercomputers-to-simulate-brain-activity1/

- Work with researchers from the Universities of Warwick and Aston to use Hartree's computing power to test simulation software that could improve fibre optic cable performance. This software is a faster, more affordable alternative to physical experiments, so cuts costs and time-to-market for both designers of fibre optic networks and component manufacturers of transmission system equipment.[36]

5.12 Hartree (with major SCD support) is also leading an **Energy Efficiency Computing Research Programme** to understand how efficiency gains can deliver high-performance/low-power computing capability. This is needed because larger computers will be so power hungry as to be economically unviable and/or unable to be supported by the current electricity provisioning, so work on energy efficiency is essential for the next generation of computers.

- As part of this, and building on Project GungHo, the GOcean project between Hartree and the National Oceanography Centre is investigating options for ocean modelling on new supercomputers. This could lead to faster, more energy efficient models and more accurate ocean simulations and predictions.[37]

5.13 More broadly, the Programme is intended to give the UK a leadership position in HPC software efficiency, optimisation and fault tolerance, and assist the development of scalable low-energy HPC systems and software. It is too early to quantify formal economic impacts, but based on initial tests, Hartree's view is that the Programme's methods and technologies, including the adoption of Energy Aware Scheduling (EAS) and using low power states, could deliver an approximate 20 per cent energy saving based on current levels of HPC use.

Direct engagement with businesses

Company case study: Unilever

- Unilever is a multinational company employing 172,000 people worldwide in the R&D, manufacture, and supply of fast-moving consumer goods, including Foods, Beverages, Home, and Personal Care Products
- There is a commitment in the company's Global Strategy to move to a 'Digital First' approach in all of its activities. At Port Sunlight in the Liverpool City Region, one of two UK R&D centres for the firm, this is driving all R&D being undertaken 'in silico' (i.e. digital space), offering the potential for major reductions in R&D processes and the opportunity to do things 'right first time'.
- Hartree is part of Unilever's 'Science Grid' - preferred academic partners who are world-leading in science and complementary to Unilever's own science and technology skills. Other partners in the Science Grid are the Universities of Liverpool (Materials Chemistry) and Manchester (Materials Processing and Bioscience).
- Unilever has a long-standing relationship with the Scientific Computing Department and, more recently, Hartree. Annual spend (now with Hartree) is typically £150k per annum. Nineteen distinct projects with SCD/Hartree have been undertaken since 2010, as part of long term programme of using Daresbury to enable the move to 'in-silico' R&D activity
- Three recent projects include:
  - **Virtual Pouring** (2015): using Hartree's expertise to simulate liquid pouring, as part of bottle design for new products. The input cost to Unilever was about £10k and the potential benefits were reported as being up to £20 million (gross) of annualised incremental turnover generated by faster time-to-market, if/when fully implemented globally.
  - **Manufacturing Production Optimisation** (2015): using Hartree's expertise to identify bottlenecks in one factory's filling line, with the goal of reducing unwanted down-time and increasing productivity. The input cost to Unilever was about £60k; on operational implementation of the project, it was reported that there is potential for around a 10 per cent improvement in line productivity, equivalent to 3.6 million more bottles/year, with potential increased sales on implementation of around £37 million/year (gross).
  - **Computer Aided Formulation** (ongoing): A collaboration developing computer simulation tools to predict how ingredients come together to form the liquid structures underpinning many of Unilever's

[36] http://www.stfc.ac.uk/files/making-light-work-of-fibre-optic-optimisation/
[37] http://www.stfc.ac.uk/stfc/includes/themes/MuraSTFC/assets/legacy/3554_res_1.pdf

typical products (e.g. shampoo, liquid detergents, etc.). The input cost to Unilever thus far is about £80k. Key business impacts will be improved product quality and faster product development, with an estimated 80 per cent reduction in development time on the critical path to launch. No hard data are available yet on gross effects on turnover or cost base. Similar tools have been deployed already within Unilever across more than 150 users, with 1,000s of formulations simulated annually. (Such tools are estimated to have saved more than 5,000 years on microbiological challenge studies).

- The company views Hartree as a vital strategic partner **('Hartree is a key consideration for Unilever remaining at Port Sunlight'**) and expects fully to be working with Hartree for at least five years to progress its '*in silico'* agenda. The firm sees Hartree's expertise as being able to add very significant value to Unilever's R&D processes for the future.

5.14 Compared to the activities of SCD, those of Hartree and the VEC were reported by consultees as being 'nearer to market' and most usually with, and for, businesses. They are about providing specific solutions to particular R&D challenges that firms are facing. Indicators of impact include the following:

- Evaluation work for the US Government suggests that each dollar of HPC investment returns in the long run between 317-515 times in terms of revenue effects, and 39-42 times in terms of profit/cost savings. The study states that these figures are 366.5 and 26.7 respectively for the UK, with the returns starting to emerge 1.6 years after the end of HPC investment.[38] This is unlikely to be the situation yet at Hartree, given its capacity and competence are still building, but does set a useful longer-term, benchmark.

- Of around 90 project assignments undertaken by Hartree and/or the VEC between 2012 and April 2015, 50 or so are judged to have had, or will have, a 'material economic impact' on the organisation concerned.

  - Clients include major multinationals (e.g. GSK, Mellanox Technologies and Unilever at Hartree; BAE Systems, Bentley Motors, and Jaguar Land Rover at the VEC – see Table 5-1), universities (e.g. Edinburgh, Leeds, Manchester, Warwick) and SMEs (e.g. Democrata).[39]

  - Hartree and the VEC have typically assisted at the feasibility, prototyping, and/or product development and testing stages, with the Hartree Centre in particular focusing primarily on activities at TRLs 4, 5 and 6. Given this, there will be time lags before economic impacts are realised

  - The most common main impact is timing additionality - bringing forward development and innovation more quickly than would otherwise have happened, in some cases by as much as six years. This offers the potential for major savings in firms' R&D and production cycles

  - Additional impacts include positive effects on firms' understanding of, and thought leadership in, HPC issues for their sectors, and major enhancements in modelling the physical and chemical performance of firms' technologies.

[38] Creating Economic Models Showing the Relationship Between Investments in HPC and the Resulting Financial ROI and Innovation, IDC, 2013
[39] Case studies and testimonials can be found online at http://www.stfc.ac.uk/about-us/our-impacts-achievements/case-studies/hartree-centre-case-studies/

- As a key component of their recent investment package, IBM has decided to site its first-ever UK research presence with Hartree at Daresbury. Whilst SCD has a long-standing relationship with IBM, the co-location means that Hartree, Daresbury and by extension the UK benefit from day-to-day access to the world-leader in cognitive computation and supercomputing architecture design. The partnership **will leverage £200m of value from IBM** through Hartree to the UK, of which the largest part is access to IBM's substantial portfolio of world-leading intellectual property.

Table 5-1: Virtual Engineering Centre case studies

Challenge	Solution	Benefits
BAE Systems - developing evidence for certification for autonomous systems		
Due to UK airspace regulations, it is difficult to test Autonomous Remotely Piloted Aircraft Systems in the environment where they will ultimately be used	The VEC has developed tools to allow industry to test virtual prototypes with a view to being able to demonstrate compliance with the relevant airworthiness codes as early as possible in the design cycle	Virtual prototypes developed at the VEC that conform to industry standards can be linked with HPC capability at Hartree to generate supporting evidence for compliance and safety certification
Bentley Motors - supporting new product development		
Bentley wanted to assess the value of integrating virtual reality and high fidelity simulation into their product development process	Working with the VEC and technology partner Optis, studies demonstrated that utilising the expertise and technology available provided a platform for robust decision making and supported improvements for design	Development is now faster due to better understanding of design data at early stages, a reduction in the number of physical prototypes required, and an elimination of the need for late stage modification
Jaguar Land Rover - accelerating product design and development		
JLR seeks opportunities in technological developments to continually improve their development process and product performance	The VEC developed Computer-Aided-Engineering process templates and optimisation methods to support future designs for JLR	The time taken for these processes has reduced from several weeks to several days

Source: SQW analysis of VEC case studies[40]

[40] http://www.virtualengineeringcentre.com/showcase/case-studies

Company case study: Rolls-Royce

- Rolls-Royce is a multinational public company involved in the design, manufacture, and supply of power systems for aviation and other industries. The firm has an annual turnover globally of £13.4 billion, with 24,500 UK employees.
- The company's markets are very highly competitive globally, with innovation, speed-to-market, and compliance (e.g. around safety, and emissions) constant pressures. Hence, there is a relentless need for the business to shorten its R&D and production cycles, at the same time as becoming ever more expert in understanding the performance and predictability of its products, both current and proposed for the future.
- Rolls-Royce has a long-standing relationship with the UK's HPC infrastructure. It knows Scientific Computing staff at Daresbury well, has been a major user of ARCHER at Edinburgh, and over the last four years has developed an increasingly close relationship with Hartree. The firm has participated on four linked projects with Hartree over the last four years, for which Hartree has received revenues of around £600k.
- The general emphasis of the firm's collaboration projects with Hartree has been on optimising and further developing codes for large scale modelling (e.g. highly detailed combustion chemistry and airflow through jet engines) using today's high end (>100k core) HPC platforms, which the company expects will be affordable to firms such as itself in two-to-three years' time. In addition to this 'preparatory intent', large scale models are showing the ability to provide much deeper insights into the physical and chemical performance of the firm's technologies, providing vital here-and-now research findings which can feed into the wider design and development process.
- It is exceptionally difficult to follow-through inputs by Rolls-Royce/Hartree on to outcomes for the company and the wider economy. At this stage, it was reported that the cost benefit return on the £600k spent so far is, at best, probably neutral, but the case study interviewee expects this to improve rapidly over the next two or three years as recent findings are driven into Rolls-Royce's design and development processes. The ability to model chemical species in combustion (from four species, pre-Hartree, to 50 now), to identify latent weaknesses in Rolls-Royce's current codes (only exposed by running in >100k core environments), and the reduction of modelling cycles (in some cases to a tenth of former times) were all highlighted by the interviewee as significant present operational gains (and thereby cash savings).
- The company comments explicitly and positively on the calibre and expertise of Hartree staff.

Developing the skills of the next generation of scientific and engineers

5.15 With supercomputing having been an important activity at Daresbury for over 50 years, the SCD and its predecessor departments have helped to develop a considerable skills base in this area for the local economy. More recently, Hartree has built on this capacity and is further developing individual researcher and overall scientific community capacity in its expertise areas, and to this end, runs a number of training and skills courses for staff, academia, and industry throughout the year[41]. It also runs week-long Summer Schools annually, with internationally renowned academics and industrial organisations delivering lectures and think pieces. Since 2013, some 170 attendees from around the world have participated in the Summer Schools. Consultees reported that courses at Hartree had 1,000 attendees in 2015, equating to over 67,000 training days delivered. These activities, underpinned with personal relationships, are vital in keeping SCD, Hartree and VEC at the centre of international HPC thinking and networks. For UK attendees in particular, they are also important in helping to address gaps in HPC skills and knowledge.

Company case study: Victrex

- Victrex is an advanced materials manufacturer that employs 750 people worldwide in the R&D and manufacture of high performance plastics and composites for the Oil, Gas, and Aerospace sectors
- The firm has long-standing links with Daresbury's Scientific Computing Department, with Victrex personnel involved in the leadership of the Knowledge Centre for Materials Chemistry, which operates from Daresbury
- The firm has collaborated on a single £45k assignment with Hartree, buying 16 weeks of researcher time in the latter half of 2014
- Two drivers for the project with Hartree were highlighted: (i) to build Victrex's own capacity in, and understanding of, computational models and simulation methods as tools for its sector; (ii) to secure empirical evidence at the atomic level of the performance of one of its higher-value products, so helping to predict performance-over-lifetime as product operating environments become more hostile

[41] http://www.stfc.ac.uk/stfc/cache/file/539D82A2-E9D5-48AD-9BAFD04A9B908D08.pdf

- No traceable economic benefits were reported as such. However, the consultee stated that there had been highly valued qualitative effects in terms of building the firm's expertise, thought-leadership, and profile in issues relating to the lifetime performance of materials. Assisted by the project, and what the firm learnt from it, Victrex is now seen as a key opinion leader on these issues across its sector
- The firm is highly satisfied technically and interpersonally with how the project was delivered and according to the consultee, the project offered good (although intangible) Value for Money and Victrex would reuse Hartree were suitable further projects to arise, and they would recommend the Centre to others

Conclusions

5.16 The last 15 years have seen a major reorientation in the rationale for, and focus of, High Performance Computing at Daresbury, away from supporting primarily on-site research activity to driving external engagement, especially with UK industry. The last four years in particular have seen major investment to establish a comprehensive and integrated platform where world-class High Performance Computing and data analytic competencies can be built and developed.

5.17 Key impacts arise through the following:

- **Supporting research** through the National Supercomputer and Collaborative Computational Projects, as well as carrying out research into energy efficient computing.
- **Direct engagement with businesses** to bring forward innovation more quickly than would otherwise have happened, offering the potential for major savings in R&D and production cycles. In addition, IBM's decision to site it's first-ever UK research presence with Hartree is an impressive commitment by a global player and the access to IBM's intellectual property that this brings is a major resource to exploit for the benefit of the UK.
- With supercomputing having been an important activity at Daresbury for over 50 years, the SCD and its predecessor departments have helped to develop a considerable skills base in this area for the local economy. This is built on through Daresbury's Summer Schools which help to **develop the skills of the next generation** and address UK gaps in HPC skills.

Accelerator Science

5.18 The purpose of this case study is to illustrate the ways in which accelerator science is generating impacts and complementarities between the Daresbury Laboratory activities.

5.19 Particle accelerators are at the heart of numerous frontier projects in science and technology, including large-scale international research facilities for particle and nuclear physics. As well as fundamental research, accelerator technology benefits many aspects of our everyday lives by allowing us to investigate the structure of materials, as well as having applications in areas such as cancer treatment, security scanning, and clean energy. STFC supports several key accelerator projects both within its own laboratories and in the wider science community. As a result, UK accelerator science has a strong and diverse programme encompassing world-leading research.

> *Accelerator science is a core component of the STFC programme underpinning much of what the organisation does. Accelerators have played a central role in many of the major discoveries made in particle and nuclear physics over the past century, and continue to provide the bedrock on which these fields rest. At the same time accelerators have developed into essential tools for discovery throughout science and engineering[42].*

Overview of the Daresbury offer

5.20 Daresbury has a long history in accelerator science and engineering dating back to the 1960s, strengthened by the operation of the Synchrotron Radiation Source (SRS) from 1980. The two important accelerator science capabilities at Daresbury are the **Accelerator Science and Technology Centre** (ASTeC) and the **Cockcroft Institute**. ASTeC was created in 2001. It is core funded by STFC and supported by additional project grants. The Cockcroft Institute began operations in 2007, and is a joint venture between STFC and the Universities of Lancaster, Liverpool, Manchester and Strathclyde (who joined in 2016[43]).

5.21 ASTeC and the Cockcroft Institute collaborate on individual projects, longer running research and postgraduate education, whilst ASTeC is also working with the Hartree Centre. The Engineering Technology Centre (ETC), part of STFC's Technology Department, has long experience of the specialist engineering activities associated with accelerators. Both ASTeC and the Cockcroft Institute consider this a critical component of the Campus.

5.22 Around half of the ETC's work is with ASTeC at Daresbury, including contributions to recent accelerator systems such as ALICE, EMMA and VELA. ETC engineers are responsible for the design and assembly of devices ranging from nanometre scale through to giant detector systems for experiments at CERN, GSI and J-Parc[44], which allow scientists to explore fundamental physics. Projects for ISIS, Diamond, nuclear physics (e.g. AGATA) and particle physics (e.g. T2K) have been assembled, integrated and tested in the ETC. It therefore supports both accelerator science and instrumentation systems.

Key impacts

Supporting fundamental scientific research

5.23 Particle accelerators are at the heart of numerous frontier projects in science and technology, including large-scale international research facilities for particle and nuclear physics. In addition, accelerators have been used in a wide range of manufacturing and service industries including materials, health and medicine, energy and security scanning (amongst others).

5.24 The work undertaken at Daresbury has strengthened the UK's skills base and led to the development of leading edge instrumentation, some of which has, and will, generate direct economic and social benefits. Major developments include:

[42] STFC Accelerator Review Report 2014
[43] http://www.stfc.ac.uk/news/uni-of-strathclyde-joins-cockcroft/
[44] GSI is a large-scale accelerator facility in Germany; J-Parc is the Japan Proton Accelerator Research Complex.

- Designed and built at Daresbury, **ALICE (Accelerators and Lasers in Combined Experiments)** is a major facility for cutting-edge research in accelerator science and its applications. Many of its capabilities were new to the UK, it is still the only case of energy recovery demonstration in Europe, and one of a handful of beam quality enhancing electron sources worldwide.

- **EMMA (Electron Model for Many Applications)** was the first non-scaling Fixed Field Alternating Gradient (ns-FFAG) proof of principle accelerator in the world.

- **VELA (Versatile Electron Linear Accelerator)** became operational in 2013. Rapiscan are a key partner and have been working with ASTeC using VELA to develop an advanced 3D imaging process for more comprehensive cargo screening.

- Recognised as a potentially unique resource for the Free Electron Laser (FEL) community, work on the first phase of **CLARA (Compact Linear Accelerator for Research and Applications)** has been completed.

Allowing the UK to gain international leadership and influence

5.25 STFC's accelerator science programme has supported the UK community in gaining international leadership, both in terms of scientific excellence, and coordination of major projects. For example, UK-based Free Electron Laser (FEL) physicists are highly regarded internationally, and have published in high impact journals such as Nature Photonics and Physical Review Letters. Furthermore, global recognition in ns-FFAG technology (a type of particle accelerator)[45] offers great potential for the UK to assume a significant role, both technologically and commercially, in this key area of accelerator science.

5.26 Daresbury staff hold many international leadership roles in accelerator science and are invited speakers at international conferences which, together with academic publications, enables it to maintain contact with, and to some extent influence, global developments.

5.27 Daresbury's high international standing is illustrated by its **contribution to important global scientific facilities** at CERN, PSI (Zurich) and the ESS.[46] For example, Daresbury will provide over £60 million of the UK's £165 million investment in-kind contribution to the ESS, including the £10.5 million beam transport module. This work both enhances the standing of the UK scientific community and also helps to promote the development of new technologies.

Direct engagement with businesses

5.28 ASTeC engages with companies in knowledge transfer, training and educating their core team on accelerator and engineering design, generating almost £0.75m from working with businesses in 2014/15. Key beneficiary firms include:

- **Tech-X**, a company based on campus, has been working with ASTeC and the Hartree Centre to advance accelerator design tools for high performance modelling of particle accelerators. This project could eventually facilitate the development of

[45] Non scaling Fixed Field Alternating Gradient Accelerator – a type of particle accelerator
[46] The European Spallation Source (ESS) is a leading neutron science facility https://europeanspallationsource.se

next-generation 'table-top' accelerators, in turn enabling the development of portable medical imaging capabilities to provide cheaper treatments with better outcomes.

- **Rapiscan** is working with ASTeC and using VELA to develop methods of generating three-dimensional x-ray images for more comprehensive cargo screening.
- **Shakespeare Engineering** is working with ASTeC to enter the global superconducting radio frequency accelerator market. This is estimated to be £2bn over the next 12 years, and includes the medical, security and energy sectors
- **Waters** have a Knowledge Transfer Associate from ASTeC working with them to support their research activities in mass spectrometry. This will direct their design, development and manufacturing activities.
- As a global centre of excellence for accelerator design, ASTeC was chosen as a collaborative partner by a **leading global player in silicon device manufacture** for a project to increase the number of transistors on silicon wafers, which could lead to more powerful processors and smaller computers. This could be done by using a Free Electron Laser to provide the high power EUV light source for the next generation of semiconductor fabrication plants. They have also trained the company's internal staff.

Developing practical market applications for technologies

5.29 One key area of applied accelerator science at Daresbury is in medical imaging and diagnosis:

- Cockcroft Institute researchers are part of a major collaborative project to develop more powerful proton imaging technology that could provide more accurate cancer treatments. Collaborating with clinicians at the Christie NHS Foundation Trust (Manchester) and CERN, Cockcroft Institute researchers are developing an imaging prototype with greater treatment accuracy, enabling the most accurate pre-treatment images of patients in the world. This builds on earlier work between the Cockcroft Institute and the forthcoming proton beam therapy centre at the Christie.
- The ALICE accelerator supports the EPSRC-funded photon exploitation programme to advance the understanding, diagnosis, and treatment of cervical, oesophageal, and prostate cancers. New techniques are being developed to monitor interactions between pathogens, pharmaceuticals and healthy and diseased cells or tissue, which in the longer term could lead to much cheaper and more efficient diagnoses.

Developing the skills of the next generation of scientists and engineers

5.30 The Cockcroft Institute has around 50 PhD students who have access to the Daresbury particle accelerators. The 'hands-on' experience provides highly valuable training for the future generation of accelerator scientists and engineers, whether they go on to a career in business or academia. The STFC Accelerator Review Report from 2014 states:

> *Of the 70 where destinations are known 23 students have found work in industry or other private sector employment in the UK, and a further 14 outside the UK. It is clear that there is a significant flow of highly skilled people enriching UK and worldwide industry as a result of STFC funding of the accelerator programme.*

5.31 The Cockcroft Institute runs a two-year post-graduate education programme in accelerator science and technology for both its own PhD students and students at other universities. A small number of internships are also available for undergraduates to work on accelerator science and technology projects at one of the partner universities or with ASTeC itself.

Conclusions

5.32 Sci-Tech Daresbury has a long history in accelerator science and the underpinning engineering technology dating back to the 1960s, strengthened by the operation of the SRS from 1980. The breadth and strength of STFC's accelerator science programme which has developed over many years is extremely impressive. Strategic investment coupled with significant support from the wider science community has created a strong and diverse world-leading research programme.

5.33 The key impacts arise through:

- **Developing accelerator science capabilities in the UK**. The work undertaken at Daresbury has strengthened the UK's skills base and led to the development of leading edge instrumentation, some of which has, and will, generate direct economic and social benefits.
- **Developing accelerator science capabilities internationally.** Daresbury contributes to the development of large-scale international facilities, such as CERN and the ESS, which enhances the standing of the UK scientific community and helps to promote the development of new technologies.
- **Applying accelerator science in health and medicine**, including work to develop more powerful proton imaging technology that would enable the most accurate pre-treatment images of patients in the world. Other work could lead to cheaper and more efficient diagnoses cervical, oesophageal, and prostate cancers.
- **Working with business to deliver market applications**. Daresbury is working with a number of companies to develop new types of free electron lasers or new applications of existing accelerators (e.g. Rapiscan and Shakespeare Engineering), which have, or are expected to, generate significant increases in competiveness. The work with one collaborator is potentially highly significant as it may lead to more compact and powerful computer processors in the future.
- **High level skills and international influence**. STFC's accelerator science programme supports the UK's international leadership, both in terms of scientific excellence, and the coordination of major projects. A unique and valued form of post-graduate training is provided by the Cockcroft Institute, and together with ASTeC staff training companies' own staff, the work undertaken at Daresbury has strengthened, and is helping to secure, the UK's skills base in accelerator engineering and design.

Instrumentation Systems

5.34 STFC's Technology Department exists to provide advanced technology and engineering in support of both STFC programmes and other high profile international projects. It has 350 scientists and engineers across three STFC sites, 90 of which are based at Sci-Tech Daresbury.

Overview of the Daresbury offer

5.35 The Technology Department at Daresbury comprises three main areas:

- The **Nuclear Physics Group** is funded by STFC to support and contribute to the UK's Nuclear Structure research programme through: design and installation of equipment in facilities around the world; supporting the UK nuclear physics community; and in carrying out their own research programmes, at international facilities and often in collaboration with other groups.
- The **Detector Systems Group** provides instrumentation and detector systems in support of the STFC programme. Many of these are developed for use on major scientific facilities such as accelerators e.g. Diamond Light Source and the European Synchrotron Radiation Facility. The Group also provides an electronics workshop for campus companies, as well as supporting applied nuclear science e.g. specialist medical imaging.
- The **Engineering Technology Centre** whose capabilities underpin the instrumentation work of the Nuclear Physics and Detector Systems Groups, as discussed at paragraph 5.22.

Key Impacts

5.36 The major impacts from both the Nuclear Physics Group and Detector Systems Group are mainly qualitative in nature, long-term, and relate to work at the frontiers of basic research, and to a lesser extent direct short-term economic impacts from industrial engagement.

Supporting fundamental scientific research

5.37 A key impact of the Nuclear Physics Group at Daresbury has been in enabling the relatively small community of nuclear physicists in the UK to deliver powerful research outputs of world-class standing. In 2013, the number of publications produced by the UK nuclear physics research community ranked seventh in the world, but was first in the world for citation impact and second for normalised citation impact.

Allowing the UK to gain international leadership and influence

5.38 Development of advanced scientific detectors at Daresbury, required for experiments at the frontiers of science, has enabled the UK to participate in major international facilities. This acts as the UK's 'entry ticket', enabling UK researchers to undertake projects at a particular scientific facility.

5.39 In addition, the UK is able to influence the scientific and technical direction of overseas research programmes. This is primarily through the leading role of NPG scientists on

international scientific committees and projects led by Daresbury scientists and engineers, such as the development of specialist detectors e.g. AGATA (see below). This is particularly important because, since 1993, the UK has had no national nuclear physics facilities to undertake research into the most fundamental nature of matter.

5.40 The benefits of this are an enhanced standing of both the UK engineers who enable the research and the UK scientists who help set the research agenda and also undertake it, and in the longer term, promotion of the development of new technologies which can bring economic benefits to the UK and worldwide.

5.41 For example, the expertise of the Nuclear Physics Group in the development of very efficient detector systems for gamma rays enabled their participation in Advanced Gamma Tracking Array (AGATA)[47]. AGATA represents a breakthrough in gamma ray spectroscopy and will allow the pursuit of a broad scientific programme. It is also beneficial to applications where efficient and accurate radiation detection is important such as medical imaging, border security and nuclear decommissioning (see below for more information on this). Staff at Daresbury have also contributed to the European Synchrotron Radiation Facility (ESRF) in Grenoble and the new FAIR accelerator facility in Germany.[48]

Direct engagement with businesses

5.42 The Detector Systems Group's IP portfolio supports high-performance designs and innovation in large area sensors and "*has been translated into sensors which are now used by research groups in leading edge experiments as well as in commercial products*."[49] It was reported by STFC staff that technology transfer has taken place to some 40 firms. Additionally, staff at Daresbury provide training to companies such as **Norcott Technologies**, a high tech electronic design and manufacturing firm based in the Liverpool City Region. This training focused on supporting Norcott's technicians to test and commission bespoke products they develop for their clients. STFC staff also train end-users in how to exploit these new technologies so as to ensure that they add most value to beneficiaries.

5.43 A good example of technology transfer is the work of the Detector Systems Group on CMOS image sensors[50] which have applications across virtually all types of imaging, including earth observation, medical x-rays and industrial analysis. The Detector Systems Group has extensive experience and expertise in developing readout and control systems for these sensors and has developed specialist systems for **BAE Systems**, successfully producing a number of milestone demonstrators over a three-year period. CMOS sensors are also supplied to the commercial market by **VIVAMOS**, a spin-out company from STFC's Rutherford Appleton Lab, who have benefitted from the CMOS sensor knowledge and skills of a Detector Systems Group engineer from Daresbury, who has moved to VIVAMOS for a two-year period.

[47] https://www-win.gsi.de/agata/overview.htm
[48] http://www.esrf.eu/ and http://www.fair-center.eu/
[49] http://www.technologysi.stfc.ac.uk/Technology/44172.aspx
[50] Complementary Metal-Oxide Semiconductor (CMOS) image sensors are used in electronic imaging devices including digital cameras, medical imaging equipment and night vision devices.

5.44 Specialised X-ray detectors have also been sold to a wide range of clients including the Diamond Light Source and the ESRF in France. Examples developed by the DSG include:

- **Xpress** – digital signal processing systems which allow much faster data collection. The original Xpress system was developed for the SRS at Daresbury. Xpress3 is licensed to Quantum Detectors for sale[51], and further versions are in development, including for use with the Diamond Light Source.[52]

- **RAPID** – a high speed readout system for x-ray detection that reads at least ten times faster than conventional readouts. It was developed for the SRS at Daresbury and a copy sold to Spring8 in Japan.[53]

5.45 **Quantum Detectors** is a spin-out from STFC's Rutherford Appleton Lab based at Harwell and with a presence in Sci-Tech Daresbury's recently opened Campus Technology Hub. It supplies high speed detector technologies - many employ proprietary technology previously unavailable to commercial firms - to global research institutions. In its first year of business, 2007, Quantum Detectors worked with staff from the Technology Department at Daresbury who provided expertise to enable the building of initial test models. The company now employs six full time staff and two non-executive Directors, and had an annual turnover of £1 million in 2015. On average, the company has exported two thirds of its products to countries including China, the USA, Japan, Germany and France. With an estimated market size of £400 million per annum, there is a considerable export market opportunity in this space[54].

Developing practical market applications for technologies

5.46 From the extensive knowledge gained in developing detectors such as AGATA, a wide range of technology applications have been developed for areas such as security scanning, nuclear industry decommissioning and medical imaging.

5.47 Detection of illicit materials at airports and public buildings is becoming increasingly important. The Portable Gamma Ray detector 'PorGamRays', developed using technologies made possible through AGATA, is one example of STFC's positive impact in this area. The global market for gamma-ray spectrometers was estimated to be worth $700m in 2012 and a route into this market is licencing the PorGamRays technology to industrial partners.

5.48 Daresbury, Liverpool University, the National Nuclear Laboratory and manufacturer Canberra are developing imaging technology based on gamma rays for sites such as Sellafield. This technology is useful where there are problems related to the detection and characterisation of nuclear waste stored for many years in containment ponds, and in the remote sensing of buildings where there are requirements for decommissioning nuclear facilities.

5.49 In the field of medical imaging, the prototype ProSPECTus imager developed by STFC at Daresbury and the University of Liverpool is a novel technology designed to allow

[51] http://quantumdetectors.com/xspress3
[52] http://www.diamond.ac.uk/Science/Research/Detector/Xspress4.html
[53] http://www.spring8.or.jp/pdf/en/res_fro/05/175.pdf
[54] This estimated was provided by Roger Goldsbrough, CEO of Quantum Detectors, based on 20 synchrotrons worldwide each with 20 beamlines. It was reported that they spend c. £1m per year on instrumentation on average.

simultaneous functional and anatomic imaging, thus reducing patient exposure to radiation. It provides a better diagnostic tool, which is expected to lead to earlier detection and treatment of brain tumours and other cancers, thus improving patient outcomes.

Developing the skills of the next generation of scientists and engineers

5.50 The Medical Teaching Research Laboratory (MTRL), also operated by the Technology Department, is specifically designed to provide advanced training and research into new medical scanning technologies. The purpose built facility at Daresbury[55] enables researchers and medical staff to provide training for medical staff through an MSc in Clinical Science and continuing professional development. The MTRL also provides unique opportunities for enhancing understanding of new techniques in medical physics, particularly in comparing the capabilities of new and established technologies.

5.51 With the recognition of the need for high-level training for PhD students covering a broad range of nuclear physics areas, the UK nuclear physics community, has developed and operated a UK Nuclear Physics Graduate School since 2013. Up to 200 MSc students per year are involved in this, with a further 50-60 industrial staff benefitting from CPD.[56] Masterclasses for GCSE and A-level students help enthuse young people to pursue a career in physics and nationally reach over 1,500 students per annum.

Conclusions

5.52 The Nuclear Physics Group and Detector Systems Group teams operate in highly advanced and specialised areas of science and technology and their key impacts need to be considered in this context. Much of the Technology Department's work is focused on supporting and enabling fundamental 'discovery research' through the development of specialist instruments and detectors which form part of key scientific equipment.

5.53 The key impacts can be summarised as follows:

- Major impacts in scientific terms in **enabling a relatively small UK nuclear physics community to achieve international scientific impact and recognition** as evidenced by numbers of publications (ranked 7th in the world) and citation impact (1st in the world).[57]
- Advanced research on nuclear structures using highly specialised equipment such as the AGATA instrument and Compton Camera technologies, has also **supported the development of innovative applied technologies with major implications for improved health, security, environmental monitoring, the nuclear industry** and other areas. The expertise developed at Daresbury also facilitates vital advice to government agencies in homeland security related issues.
- Development of **advanced scientific detectors, such as those used for measuring outputs of gamma rays in experiments at the frontiers of science, have enabled**

[55] A joint initiative between the University of Liverpool, the Royal Liverpool and Broadgreen University NHS Hospitals Trust and STFC
[56] The Physics of Nuclei, Nuclear Matter and Nucleosynthesis, Report of the Nuclear Physics Advisory Panel, 2016
[57] https://www.stfc.ac.uk/files/impact-report-2015/

the UK to participate in major international nuclear physics facilities in Europe and elsewhere; an impact which is particularly important because the UK has no major nuclear physics facilities of its own.

- Technology transfer of specialised technologies including imaging and specialist high speed detectors **enable companies to develop new detection equipment and exploit new technology driven markets.**
- A relatively new departure for the Technology Department has been in the **provision of a suite of advanced facilities (MTRL) for research and training in healthcare imaging**, which is likely to grow in importance and lead to further opportunities in driving healthcare improvements and nuclear medicine.
- With the recognition of the need for **high-level training for PhD students** covering a broad range of nuclear-physics areas, the UK nuclear-physics community has developed and operated a UK Nuclear Physics Graduate School since 2013.

SuperSTEM

5.54 This section presents a short summary of the key impacts of SuperSTEM which was founded in 2001 and is run by academic consortium led by the University of Leeds.[58]

Overview of the Daresbury offer

5.55 SuperSTEM is the EPSRC National Facility for Aberration-Corrected Scanning Transmission Electron Microscopy. Aberration corrected microscopes produce a sharper image than conventional microscopes. A specially built facility at Sci-Tech Daresbury houses three such instruments, the latest of which, installed in 2015 at a cost of £3.7m, is one of only three in the world.[59]

Key impacts

Supporting scientific research

5.56 The microscopes at Sci-Tech Daresbury allow imaging of unprecedented resolution of objects a million times smaller than a human hair. This means that researchers can both clearly identify atoms and observe the strength of the bonds between them, thus improving understanding of their properties and potential performance. This is important because developments in sophisticated new materials such as graphene demand greater precision in analysis. Over the three years to 2015, SuperSTEM delivered 130 projects for 81 user groups, resulting in 102 scientific publications.[60] Three specific examples are summarised below.

Breakthrough in batteries.

- Using microscopes at SuperSTEM and Berkeley Laboratory, USA, researchers identified the

[58] http://www.superstem.com/
[59] https://www.epsrc.ac.uk/newsevents/news/superstemmicroscope/
[60] SuperSTEM: World Leading Electron Microscopy Facility, ESPRC, 2015

structure of lithium-and manganese-rich transition metal oxides. These materials can potentially be used to make batteries with capacities double that of the most commonly used Lithium-ion batteries; a discovery with the potential to transform the market for electric vehicles, and also mobile phones and laptops.[61]

From SuperSTEM to the clinic

- Iron is a 'trace' dietary element necessary for life. However, current forms of oral iron supplements are toxic and/or expensive. Researchers at the University of Leeds, King's College London and the MRC at Cambridge first used SuperSTEM to provide insight into how iron is stored in the body and second, to guide and confirm the development of a new oral iron supplement. This is "based upon understanding how dietary iron digestion works and all the evidence is that it is safe, side effect-free, well absorbed and cheap to manufacture."[62]

Engineering the Structures of Thermoelectric Oxides for Power Generation

- Thermoelectric materials generate power from waste heat. Although used in space missions for years, and increasingly in automotive and industrial areas, they are not environmentally sustainable. New materials (oxide thermoelectrics) offer a solution if their thermoelectric performance can be improved. University of Manchester researchers used SuperSTEM to gain detailed atomic level insights which allowed them to design methods to enhance the new materials' thermoelectric properties.

Source: SQW analysis

Direct engagement with businesses

5.57 In addition to working with the worldwide scientific community, SuperSTEM is also used for industrial and proprietary research. A good example of this is a joint project with **Haldor Topsøe**, which has used SuperSTEM to look at a catalyst used in oil refineries to remove harmful sulphur impurities from fossil fuels. SuperSTEM imaged its constituent atoms to gain a detailed understanding of its structure, allowing Haldor Topsøe to see how additives such as cobalt alter this structure and effect its properties.

Developing the skills of the next generation of scientists and engineers

5.58 Additional impacts from SuperSTEM come through the skills development that it has offered through workshops and Summer Schools since 2004. For example, 31 participants from 11 countries attended the 2014 SuperSTEM Summer School on Electron Microscopy where "lectures by world-leading experts were complemented by extensive practical sessions over the four days of the school."[63] SuperSTEM also hosts a small number of PhD students from the collaborating universities, and De Beers have supported the work of three students.[64]

[61] https://newscenter.lbl.gov/2015/10/29/battery-mystery-solved-atomic-resolution-microscopy-answers-longstanding-questions-about-lithium-rich-cathode-material/
[62] SuperSTEM: World Leading Electron Microscopy Facility, ESPRC, 2015
[63] http://www.superstem.org/events
[64] http://www.superstem.org/people

6. Wider beneficial impacts of the Campus

6.1 This Section summarises the wider beneficial impacts of Sci-Tech Daresbury, drawing on quantitative data, qualitative feedback and a review of relevant documentation.

- The world-leading research programmes at Sci-Tech Daresbury **provide material for public engagement, which stimulates the interest of young people and the wider public in science and associated career paths**.
- Over the last three years**, public engagement activities have reached almost 38,000 people, including nearly 16,000 students through school-based activities**.
- Further and Higher Education courses delivered at Sci-Tech Daresbury include **PhD programmes at the Cockcroft Institute, the MSc course in Clinical Science (Medical Physics) at the MTRL, the University of Liverpool MSc Data Science, and the Daresbury Laboratory Apprenticeship Scheme.**
- Investment at Daresbury and the attractive employment opportunities this is giving rise to, is having a **positive catalytic impact on local housing development and wider infrastructure investment.**

Public engagement

6.2 The involvement of Daresbury Laboratory scientists in world-leading research programmes provides material for public engagement activities that is likely to stimulate young people as well as the wider public. In this context, stakeholders highlighted the work of three STFC staff specifically employed in community engagement roles and the support they receive from other STFC staff. From 2012-2014, they have engaged almost 38,000 people, including nearly 16,000 students through school activities. In addition, students have been engaged as part of a wider programme of activities aimed at the general public, such as building a large model of a DNA molecule at a regional shopping centre. These outreach activities are helping to make science more exciting and accessible.

Table 6-1: Activities of the Daresbury Laboratory public engagement (PE) team (2012-2014)

	On site visits to PE team	Off site visits made by PE team	Number of schools engaged	Young people engaged (KS1-5)	Teachers and officials engaged	General public engaged
2012	58	59	157	5,507	794	5,807
2013	73	58	102	5,352	474	6,035
2014	53	52	117	4,986	338	8,354
Total	**184**	**169**	**376**	**15,845**	**1,606**	**20,196**

Source: SQW analysis of STFC data

6.3 Highlights of events covered in the general public section include:

- The 3,200 who attended the Lancashire Science Festival in 2012
- Stargazing Live at Tatton Park in 2013, which attracted a crowd of 3,000 people
- 2014's skills fair and The Big Bang Near Me which attracted 5,000 people in total[65].

[65] https://nearme.thebigbangfair.co.uk/

6.4 More recently, the Daresbury Open Week in July 2016 included events focussed on families, schools and businesses. Some 7,500 people visited Sci-Tech Daresbury for the main event, with a further 1,100 school students of all ages, from across the region taking part in inspirational talks, tours and interactive workshops, covering areas from supercomputing and coding, to lasers and telescopes. In addition, around 150 delegates attended the Corporate Open Day where businesses could learn about STFC's research, how emerging technologies could impact their business, and about opportunities to locate their business at the Campus.[66]

6.5 The Public Engagement team also routinely organises school visits, open days and master classes. There have been eight master classes delivered over the past three years.

6.6 As well as the Public Engagement team, a range of other scientific and engineering experts at Daresbury contribute to the activities listed above and also to additional events such as Liverpool Café Scientifique[67], North West Institute of Physics meetings[68] and public lectures.[69] Consultees praised these activities, which they felt had helped to raise the profile of the Campus specifically, and science more broadly, across the region.

Skills

6.7 Consultations with stakeholders revealed important wider social impacts of the Campus, primarily around training and skills development. Stakeholders felt that, by providing training and skills development at all levels from work experience through to post-doctoral research assistants, Daresbury had contributed to building and sustaining the scientific and technology knowledge base in the Atlantic Gateway.

6.8 The case study summaries in Section 4 provide more detailed information about the impact of the Campus on skills. More specifically however, stakeholders cited PhD students at the Cockcroft Institute, students undertaking the MSc course in Clinical Science (Medical Physics) at the MTRL, the University of Liverpool MSc data science course and those on the Daresbury Laboratory Apprenticeship Scheme as among those benefitting the most.

Table 6-2: Examples of skills and training activities linked to the Campus

Daresbury Laboratory apprenticeship scheme	The scheme re-commenced in 2012 with an intake of two. After receiving on- and off-site training, the two apprentices are expected to graduate with an HND/Foundation Degree in August 2016. There are seven other apprentices currently enrolled on the scheme, with plans in place to double this by 2018.
Hartree – addressing the skills gap in HPC	The Hartree Centre is working with the University of Liverpool to implement a new MSc in Big Data and it also runs week-long Summer Schools with some 170 attendees since 2013, to address the skills gap in HPC Consultees reported that Hartree ran 23 courses with a total of over 1,000 attendees in 2015, giving a total of 67,000 training days delivered
Advanced Computing for Accelerators workshop	Organised jointly by the Hartree Centre, ASTeC, Cockcroft Institute and the University of Huddersfield in 2013, it attracted 70 delegates. It aimed to increase the use of high performance computing in addressing research challenges in particle accelerators[70]
Medical physics training	The MTRL houses a unique purpose built facility with a medical imaging scanner dedicated to research and teaching. It is used for the MSc Clinical Science (Medical

[66] http://www.stfc.ac.uk/public-engagement/see-the-science/daresbury-open-week/
[67] http://liverpoolcafescientifique.org/
[68] http://www.iop.org/activity/branches/north_west/index.html
[69] http://www.stfc.ac.uk/public-engagement/see-the-science/talking-science-at-daresbury-laboratory/
[70] https://www.cockcroft.ac.uk/archives/1086

	Physics) course and 35 students attended the facility as part of the NHS-STP MSc training provision during the first six months of operation in 2015.
Science and engineering work placements	There have been 105 placements over the last three years. They can be used as a 'talent pipeline' for permanent positions

Source: SQW analysis

Supporting local housing development and wider infrastructure investment

6.9 Sci-Tech Daresbury is identified as one of two employment areas of regional significance (the other being Daresbury Park) in the Halton Core Strategy.[71] The Campus has benefitted from an additional 26 ha of land being designated as suitable for employment use to aid implementation of the Campus masterplan. Approximately 1,400 new homes are to be delivered on three sites surrounding the Campus by 2028 and consultations with stakeholders have revealed plans for further development of 'executive homes' to the west of the Campus. At the time of writing, one of the local land owners, Redrow, has submitted a planning application to build 850 new homes. The proposed scheme will be a mix of residential and commercial space, comprising two, three and four-bedroom homes, along with office and research accommodation to complement the neighbouring Sci-Tech Daresbury campus.

6.10 In combination with the earlier removal of greenbelt status for the area surrounding the site, this illustrates the catalytic impact Sci-Tech Daresbury is having on local housing development and wider infrastructure investment.

[71] Halton Core Strategy Local Plan, April 2013, Halton Borough Council

7. Stakeholder feedback on Campus impacts

7.1 This Section turns to the wider qualitative feedback on the Campus and the broader impacts which it is giving rise to. The material draws on three main sources of evidence:

- Information provided to the SQW study team by STFC and the Joint Venture on the scope and nature of their wider activities at Sci-Tech Daresbury.
- Feedback from consultations with senior representatives from national and local stakeholder organisations, which have played a role directly or indirectly in the development of the Campus and the surrounding innovation landscape over recent years.
- Responses to an e-survey of researchers and engineers who are active at Sci-Tech Daresbury, either by being based there or by using the facilities there on a regular basis. Some 51 responses were received in September 2015.

- The **quality of the science and engineering base at Sci-Tech Daresbury is seen as being excellent,** with a clear focus on supporting discovery research and a growing emphasis on commercialisation.
- Stakeholders were in agreement that **the considerable progress achieved by Sci-Tech Daresbury over the last decade or so should not be underestimated or taken for granted**. The threat to Daresbury's long-term survival was real following the decommissioning of the SRS. The ability of the Campus to **successfully reinvent and reposition itself is a major success story for the North** and provides a strong platform for the future.
- There is scope for **attracting significantly more business activity on-site**, as reflected in the site's ambitious masterplan, which would increase the impact of the Campus.

Key messages from the e-survey and stakeholder consultations

The quality of the science base at Sci-Tech Daresbury is seen as being excellent. . .

7.2 There was a strong consensus amongst consultees in relation to the quality of the scientific capabilities and supporting assets/kit present at Sci-Tech Daresbury. This was echoed by the respondents to the e-survey of researchers and engineers, **59% of whom stated that Daresbury's facilities are highly regarded internationally**. In addition, **almost all respondents reported that the quality of on-site researchers and their expertise is very important** to them, with more than three quarters saying the same of technical support and the quality of the specialist scientific facilities and equipment.

7.3 The Hartree Centre, underpinned by a strong and effective Scientific Computing Department, was recognised by the majority of consultees as being the key asset in terms of securing the Campus' long-term future success. The investment from Government and commitment of IBM to the facility were seen as being very significant, and it was felt that **Hartree was now a resource of national significance** for the UK. Part of the positive story was how the Scientific Computing Department, including through the birth of the Hartree Centre, has been able to move progressively towards more commercial activities, working collaboratively to support, accelerate and reduce the cost of innovation, whilst maintaining a

strong competence in fundamental computation activity. This move was partly in response to the recognition that UK business performance will increasingly be driven by the need for more powerful systems and analysis of Big Data as agendas such as Industry 4.0 become more pervasive. Hartree, both in terms of the platform and its relationship with technology partners such as IBM, Intel, and NVIDIA, is helping to drive this.

7.4 The **Virtual Engineering Centre (VEC) at the Campus was also commented on positively**, often in the context of the Scientific Computing Department and the Hartree Centre, with stakeholders impressed with how the assets were working in tandem effectively. Learning was helpfully bi-directional: for example, client relationship management and consortium building from the VEC; and technical creativity and innovation from the Scientific Computing Department and the Hartree Centre.

7.5 Stakeholders felt that **the Technology Department[72], the Scientific Computing Department, the Cockcroft Institute and ASTeC in particular all play key supporting roles at the Campus.** Within the Atlantic Gateway, consultees reported that the image, profile and prestige of the Daresbury Laboratory attracts world-leading scientists to the area and helps to develop the next generation of them through education, training and community engagement work.

7.6 The **Cockcroft Institute was highlighted as having a number of significant research strengths around particle accelerator science and technology**. On this point, one consultee claimed that "*the Cockcroft Institute has enabled the UK community to obtain international leadership*" in this area. It was recognised that a new Director had been appointed in 2015 with a remit to boost the Institute's wider impacts in terms of economic growth and tackling global challenges e.g. around healthcare and security.

7.7 **Consultees spoke highly of the scientific capabilities of ASTeC and the engineering expertise at the Engineering Technology Centre**. However, they observed that both of these and the Cockcroft Institute could do more in terms of projecting to a non-scientific audience what it is that they do. This point appeared to be reinforced by the fact that amongst the non-academic consultees, stakeholders had limited knowledge about the Cockcroft Institute and ASTeC. The Engineering Technology Centre was seen as being a critical, supporting part of the Campus.

7.8 Consultees also reported that **the cutting-edge and highly specialised nature of the activities at Sci-Tech Daresbury has allowed the UK to obtain a position of international leadership and influence**. Daresbury Laboratory staff having high profile roles on international projects such as AGATA, for example, provides the UK with tangible advantages in steering the scientific direction of major international programmes.

7.9 At a national level, consultees also identified the **influence that researchers at the Campus have on public policy**. For example, the Nuclear Physics Group members have provided high level advice to government departments and agencies on the detection of illicit nuclear materials.

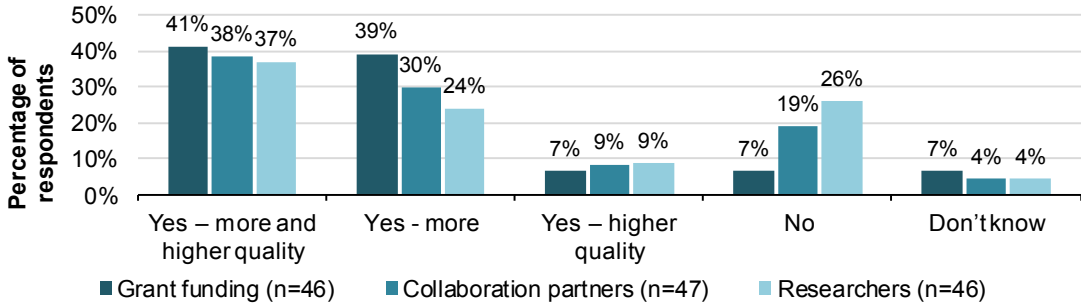
[72] Consultations primarily focussed on the Nuclear Physics Group and the Detector Systems Group although the impact of the Technology Department is wider than this.

…leading to benefits that could not be achieved elsewhere…

7.10 **Two thirds of the researcher e-survey respondents reported that the features and benefits of the Campus could not be secured at other locations or in other ways**. The reported reasons for this included that it is "*difficult to see another organisation taking on the high level of technology provision in a non-partisan way for the benefit of the UK research community*" and because "*no other campus (certainly in the North) has equivalent benefits or facilities*."

7.11 Encouragingly, more than a third of the survey respondents felt that their research activity at Daresbury had enabled them to: access more and higher quality collaboration partners; compete more successfully for more and higher quality grant funding; and attract and retain more and higher quality researchers within their team.

Figure 7-1: Has Daresbury enabled staff to access additional grant funding, collaboration partners and/or researchers than would have been the case otherwise?



Source: SQW analysis

. . . with a clear focus on supporting 'discovery research' and a growing emphasis on commercialisation

7.12 As alluded to above, the transition over recent years towards a more applied and higher TRL programme of activity, including the Hartree Centre, has been recognised widely and received positively by consultees. When the study team probed on this further with stakeholders, a consistent theme emerged.

7.13 Whilst the role of the Campus in supporting discovery research was acknowledged, consultees were generally of the opinion that a greater emphasis should be placed on delivering research orientated towards more market-facing agendas. However, most stakeholders recognised that this may not be universally popular at the Campus or even feasible given the remit of STFC's research agenda.

7.14 Similarly, some consultees felt that part of the challenge was that Sci-Tech Daresbury had to get better at evidencing the scale and nature of the impact it was having on the UK economy and its business base. The helpful work of the Joint Venture through the annual campus survey was highlighted and it was suggested that this approach could be expanded over time to cover the totality of commercial activities on the Campus.

Daresbury researchers reported effective links with industry

7.15 It is understood that many of the STFC and academic staff active at the Campus are conducting applied research to give scientists the tools for advancing more fundamental

discovery research. However, this does not always lend itself to collaborations with businesses either on or off site. Stakeholders have advised the study team that low rates of collaboration are therefore to be expected in some areas, as the primary outputs from research at the Campus are academically rather than commercially focused. As one researcher commented "*research papers and trained personnel are the primary outputs of my collaboration with Daresbury*."

7.16 In this context, it is encouraging that a third of non-business respondents to the e-survey (16) stated that they had developed contractual and non-contractual links with businesses as a result of their work at Daresbury. A further 15% had developed purely non-contractual links. The links are mainly in the form of collaborative research and research consultancy.

7.17 In total, the **survey respondents indicated that they had been in regular contact with at least 125 businesses, of which 12 were based at Daresbury**. On average, each researcher has regular contact with four businesses, of which one is based at Daresbury. This removes two outlier respondents although consultees suggested that it was not uncommon for a few individuals to be very active in relation to business interactions.[73]

7.18 Where stated by respondents (11)[74], the total value of the formal contractual links made by researchers with industry over the past twelve months was £3.4m, an average of £198k per researcher reporting a value. Removing the same two outliers, the total value is £2.8m or £184k per researcher. This is much higher than the English average of £17k per academic staff member at HEIs in 2014./15.[75]

The diversification story at Daresbury is a positive one. . .

7.19 Stakeholders were in agreement that **the progress achieved by Sci-Tech Daresbury over the last decade or so should not be underestimated or taken for granted**. The threat to Daresbury's long-term survival was real following the decommissioning of the SRS. The ability of the Campus to successfully reinvent and reposition itself is a major success story for the North and provides a strong platform for the future.

7.20 There was considerable support across the consultee group for the development of the business premises and associated support services at the Campus, with the consistency and constancy of the support from Halton Borough Council highlighted.

. . . and there is scope for attracting significantly more business activity on-site

7.21 The **consultation evidence is unambiguous in relation to the scale of the future potential at Sci-Tech Daresbury**. Stakeholders reported consistently that the co-location of the STFC with academic and scientific research capabilities, specialist equipment, flexible property solutions and tailored business support on a single large site with good access to transport networks makes the Campus proposition a highly attractive one.

[73] Removing two outlier respondents – one respondent reported being in contact with 20 businesses and another reported contact with 30.
[74] Five respondents did not provide a value
[75] Derived from HEFCE data on academic staff employed at English HEIs and Higher Education – Business and Community Interaction survey data on value of collaborative research, contract research and consultancy income at English HEIs.

7.22 Many consultees were of the view that if these strengths could be fully integrated and perhaps better 'packaged' for firms, the Campus would be able to attract more occupiers and larger private sector investment projects. Consultees indicated that they are highly supportive of the ambitious expansion plans at the Campus and they want to see further development over the coming years as the site cements its position as a key innovation ecosystem, not just for the Liverpool City Region or Atlantic Gateway, but for the Northern Powerhouse more generally and indeed the wider UK.

7.23 **It was felt that Sci-Tech Daresbury had a unique offer that is highly differentiated from competitor sites elsewhere**. With continued investment and strong leadership, stakeholders were confident that the site's growth targets set out in the masterplan could be delivered. Amongst some consultees, there were calls for a more rapid phase of expansion of the business premises in order to increase the scale of high quality employment in the short-term. There was a strong sense that the current phase of development (Techspace and the recently completed Campus Technology Hub) could and should act as a powerful catalyst for building greater momentum over the coming years. This would enable the Joint Venture to develop a critical mass of business activity on site, thus realising the full innovation and economic impact potential of Sci-Tech Daresbury though more substantial collaboration, cluster development and agglomeration benefits.

Looking to the future

7.24 Consultees expected that the increasingly large-scale and capital intensive nature of major publicly funded scientific facilities would lead to further international collaborations. They felt that Daresbury remains an attractive proposition for additional investment, but noted that competition from other sites in the UK and Europe will be fierce. Therefore, consultees felt that the key imperative for Sci-Tech Daresbury is to ensure that it continues to play a significant role in the specification, design, planning, implementation, extension and upgrade of these large-scale scientific facilities.

7.25 It was reported that a second potentially significant area of change for the Campus will be in relation to further strengthening industry, academia and STFC collaborations in order to drive innovation and economic growth. The Hartree Centre in particular is likely to play a major role in this over the coming years, as big data analytics, modelling, visualisation and simulation all become more 'centre stage' in manufacturing, service and public sector activities.

7.26 The Joint Venture Board and STFC are currently contending with the challenges of developing a critical mass of innovative firms on the Campus and moving towards a culture of more open innovation. In this context, the wider programme of change underway in Summer 2016 to remodel some of the outdoor shared spaces of the Campus and facilitate increased networking and collaboration between the tenant firms and STFC staff is a welcome development.

8. Lessons from elsewhere

8.1 As part of the study process, research was undertaken on three comparator science campuses at home and abroad. This Section presents the key findings from the comparator research in summary form, with fuller explanations provided in Annex D.

- Comparator research was conducted for three science and innovation campuses: **Grenoble and the GIANT Innovation Campus**; **Berlin Adlershof Science and Technology Park**; and the **Advanced Manufacturing Park** (AMP) in Sheffield-Rotherham.
- **Grenoble and Adlershof are both significantly larger and at a more advanced stage of development than the AMP and Sci-Tech Daresbury**. They have both benefitted from a sustained period of **large-scale public investment** of a different order of magnitude to Sci-Tech Daresbury. They also have a **critical mass of businesses co-located with scientific researchers, again on a different scale to Daresbury**. Finally, these employment opportunities are increasingly being supported by housing and leisure developments, **turning these areas into 'innovation districts'** where young highly skilled people are attracted by live, work and play offers.
- The AMP is much smaller than the other two sites, but shares many of the same success factors, including the **ambition and drive to realise a nationally significant site**. With plans in place to build housing adjacent to the AMP, there is potential for the creation of an innovation district here.
- Key learning points for Sci-Tech Daresbury are that:
  - **Scale and critical mass matters**, as does maintaining a **clear sector/technology focus**
  - **Hosting national and international class facilities helps attract/retain the best researchers and businesses users**, especially when supported by high quality housing/leisure developments
  - **Sustained funding and partnership working between public, private, research and education actors is key** to driving long term development
  - It is important to **develop a clear image and profile** that transcends sub-regional or regional administrative boundaries.

Headlines from the comparator research

8.2 Table 8-1 below provides background information[76] on each of the three comparator sites and Sci-Tech Daresbury. It shows that both the GIANT Innovation Campus and Adlershof Science and Technology Park are much larger than Sci-Tech Daresbury and have benefitted from significantly higher levels of public sector financial support and sustained investment.

[76] Please note that due to the fact that the provenance of the data varies, there is a need for considerable care in interpretation. Explanations of the sources used are provided in the full versions of the comparator case studies.

Table 8-1: Headline overview of the comparator sites

Name	GIANT Innovation Campus	Adlershof Science and Technology Park	Advanced Manufacturing Park	Sci-Tech Daresbury Campus
Location	Grenoble, France	Berlin, Germany	Sheffield-Rotherham, UK	Daresbury, UK
Indicative size	250 hectares	420 hectares	40 hectares	30 hectares
Scale of capital investment	€1.3bn from 2010-2015	€1.3bn public funds from 1991 to 2011.[77]	£280m	£314m investment since 2006[78]
Firms and employees	5,000 jobs across 40. Major employers: STMicroelectronics, Siemens and Schneider Electric (2,000, 900 and 850 employees respectively)[79]	11,500 jobs across 1,000 companies, including over 100 start-ups	Over 700 jobs, including Rolls Royce, Boeing and Sandvig	Over 550 jobs (528 FTEs) across 100 tenant firms SMEs?
HEIs and students	5,000 students. Three founding members of GIANT (Grenoble Ecole de Management, Grenoble Institute of Technology and Joseph Fourier University) and one partner: Grenoble University	8,000 students and 1,000 staff. 6 scientific institutes of the Humboldt-Universität zu Berlin: Chemistry, Geography, Computer Science, Mathematics, Physics and Psychology	35 University of Sheffield staff. The University of Sheffield's AMRC with Boeing includes: AMRC with Boeing – Rolls-Royce Factory of the Future, AMRC Composites Centre, National Metals Technology Centre (Namtec), Nuclear AMRC, Medical AMRC	c.40 students at the Cockcroft Institute and c.40 staff from the Universities of Lancaster, Liverpool and Manchester. University of Liverpool involvement with the VEC.
Researchers and facilities	6,000 researchers. **Key facilities:** European Synchrotron Facility, the European Molecular Biology Laboratory, Institut Laue Langevin (ILL, a neutron source) **Key groups:** CEA (French Atomic Energy and Alternative Energies Commission) and CNRS (National Centre for Scientific Research)	1,600 researchers. **Multiple research institutes**. Eight on photonics/optics and seven on energy (including the electron storage ring BESSY)	335 University of Sheffield Researchers. In addition to above, other facilities include: Castings Technology International (CTi), The Welding Institute (TWI)	358 FTEs at STFC's Daresbury Laboratory, SuperSTEM and the Cockcroft Institute. **Key facilities**: Hartree Centre, VEC, ALICE, EMMA, MTRL, Campus Technology Hub and SuperSTEM. **Key groups**: Scientific Computing, Technology, Accelerator Science, Cockcroft Institute.
Focus areas	Nanotechnology; Biotechnology for Healthcare; New Energy	Photonics and optics; Renewable energies and photovoltaics; Microsystems and materials; IT and media; Biotechnology and environment.	Advanced manufacturing	Research: Scientific Computing, Technology, Accelerator Science. Tenant firms: Advanced Engineering and Materials; Biomedical and Healthcare; Digital/ICT; Energy and Environmental Technologies

[77] From 1991-2005, private sector investment was 14% of total investment, increased to 68% from 2006-2010
[78] See figure 2-1
[79] http://www.giant-grenoble.org/en/chiffres-cles-2/44-presentation/99-key-figures

Source: SQW analysis

Key lessons and implications for Sci-Tech Daresbury

8.3 Although each of the comparators appear very different, they share some common success factors – some of which may help to inform the long-term plans for Sci-Tech Daresbury.

Table 8-2: Key lessons and implications for Daresbury

- **Scale and critical mass matters**. Adlershof and Grenoble have both reached an advanced stage of development allowing them to have a critical mass of businesses co-located with scientific researchers. Sci-Tech Daresbury has a similar occupancy mix, but this is currently on a much smaller scale, so there are limits to the level of networking, clustering and innovation activity. Similarly, the scale of economic impact at Adlershof and Grenoble is of a different order of magnitude to that at Daresbury. However, these comparators do highlight the potential at Daresbury for the future, assuming the full masterplan is implemented successfully.
- **Sector and technology focus.** The AMP occupies a relatively small site (compared to the other two comparators) and has maintained a clear focus on advanced manufacturing, helping to ensure that its 'brand' is not diluted. However, as both Adlershof and Grenoble cover much larger areas they have been able to accommodate a broader range of sectors and capabilities. Sci-Tech Daresbury currently sits between these strategies with its smaller site, but wide ranging sectoral focus. Going forward, clarity is needed around the long-term focus of the Campus in terms of target market(s), technology areas and even a potential cluster strategy. Thought will need to be given to ensure that the strategy is complementary to other significant science and technology park developments within the Atlantic Gateway area.
- The importance of hosting **national and international class facilities** that attract/retain the best researchers and businesses users. Adlershof and Grenoble both host European facilities, whilst the AMP's development has been supported by AMRC, Nuclear AMRC and Medical AMRC. This demonstrates the importance of Sci-Tech Daresbury maintaining and building on its current high quality assets. Daresbury should promote itself more actively and make the case for nationally significant science and innovation investments to be located on Campus. Employment opportunities at all three sites are supported -- or are planned to be - by **housing and leisure developments**, turning these areas into 'innovation districts' where young highly skilled people are attracted by the combined live, work and play offer.[80] Sci-Tech Daresbury's masterplan helpfully moves the Campus in this direction.
- **Financial support.** Grenoble and Adlershof have both benefitted from a sustained period of large-scale public investment – of a different order of magnitude to that seen to date at Sci-Tech Daresbury. All three comparators have strong and effective partnerships between public, private, research and education actors to drive their development. The Joint Venture plays a similar role for Sci-Tech Daresbury, and one that is crucial in promoting the future of the Campus, but the full potential of Daresbury is unlikely to be realised without continued public sector investment and support. As demonstrated by the recent Independent Economic Review of the Northern Powerhouse[81], Daresbury could and should play a leading role in helping the North of England to close its economic performance gap with the rest of the UK.
- **Location and connectivity** are also important success factors, although not ones that Sci-Tech Daresbury can influence directly. Adlershof and Grenoble are explicitly urban, whilst the AMP sits on the edge of Sheffield and very close to Rotherham. By contrast, Sci-Tech Daresbury has a more rural location. Whilst Daresbury benefits from relatively good strategic transport links, action will be needed to ensure that this connectivity is maintained and enhanced e.g. links to HS2 via Runcorn and improvements to the M56 motorway.
- **Image, profile and positioning.** All three comparators have invested a significant amount of time and effort in promoting their offers and marketing their capabilities widely. They are recognised and branded as nationally significant assets. They have positioned themselves as part of the mainstream science, technology and economic growth partnership structures and their activities have a sphere of influence that transcends sub-regional or regional administrative boundaries. They are confident and outward-facing developments that have recognised the importance of building networks and relationships. Daresbury has made encouraging progress in these areas over the last ten years and is well positioned to build on this in the future.

Source: SQW

[80] The Rise of Innovation Districts, Katz, B. and Wagner, J., Metropolitan Program at Brookings, May 2014
[81] http://www.sqw.co.uk/insights-and-publications/northern-powerhouse-independent-economic-review/

9. Conclusions and recommendations

9.1 This Section contains a synthesis of the key findings from the Campus Impact Study and presents a suite of recommendations designed to support the continued development and positioning of Sci-Tech Daresbury as a significant science and technology asset for the UK.

Sci-Tech Daresbury is a major generator of both GVA and high-quality employment within the Northern Powerhouse

- The *gross* operational GVA contribution of the Campus to the UK economy is estimated at £163m in 2014/15, whilst almost 900 FTEs were employed on site. In total, the study estimates that directly and indirectly, Sci-Tech Daresbury supports almost 2,000 jobs across the UK. The *net* GVA and employment impacts are estimated to £70m and 840 jobs respectively in 2014/15. **This should be seen in light of the average annual £42.5m input costs of running the STFC operations on Campus over the period 2012/13 to 2014/15.**
- Looking to the future, both the *gross* and *net* GVA impacts can be expected to increase as the long term Campus masterplan begins to be realised. If fully implemented this could add a cumulative £660m (discounted GVA) to Sci-Tech Daresbury's gross impact by 2040.

The Campus is home to a community of innovative and high growth firms…

- The integrated offer of flexible accommodation, tailored business and innovation support services, as well as access to nationally and in some areas, internationally significant scientific research and kit, have helped to attract a cohort of successful science and technology driven firms to the Campus. Sci-Tech Daresbury is home to a community of 100 innovative and high growth firms who generated an estimated *gross* GVA impact of £94m in 2014/15, out of the total gross Campus impact of £163m.
- Sci-Tech Daresbury has helped these firms to prosper by:
  - minimising business failure
  - supporting and promoting innovation
  - facilitating networking and collaboration.

… and delivers a broad range of scientific impacts

- The operational economic impacts must be considered alongside wider findings. Qualitative evidence shows that the Campus generates impact by:
  - supporting fundamental scientific research and developing technologies to support fundamental research facilities
  - allowing the UK to gain international leadership and influence
  - developing practical market applications for new technologies
  - direct engagement with businesses
  - helping to develop the skills of the next generation of scientists and engineers.
- There was a strong consensus amongst stakeholder consultees and researcher survey respondents in relation to the high quality of the scientific capabilities and supporting assets at Sci-Tech Daresbury. Looking more broadly, they also valued the wider social impacts generated by the Campus, particularly the skills development programmes and community outreach work.
- Three quarters of respondents to the study's researcher survey stated that their activities at Daresbury were highly important to their published research outputs.

Sci-Tech Daresbury is a major generator of both GVA and high-quality employment within the Northern Powerhouse

9.2 The *gross* GVA contribution of the operations on the Campus to the UK economy is estimated at £163m in 2014/15. This includes GVA generated directly through employment and turnover, indirect GVA from the purchase of bought in goods and services, and induced GVA from household spending.

9.3 There are almost 900 FTEs employed across the component parts of Sci-Tech Daresbury, many of whom are highly skilled and work in well paid roles. In addition to this, a further 1,000 jobs are estimated to be indirectly supported by activities conducted at the Campus; whether this is through impacts on supply chains or employee spending in the wider economy. Directly and indirectly, Sci-Tech Daresbury therefore supports almost 2,000 jobs across the UK.

9.4 The *net* GVA and employment impacts are estimated to be lower than the *gross* impacts. This is because, whilst senior consultees indicated that there is a high level of additionality associated with the STFC presence on Campus, self-reported evidence from the study survey of tenant firms suggests that while the tenant firms are growing and highly innovative, many of them would be trading and generating similar amounts of turnover from alternative locations if Sci-Tech Daresbury did not exist. Consequently, the study estimates that the *net* GVA impact of Sci-Tech Daresbury was £70m and 840 jobs in 2014/15.

9.5 Looking to the future, both the *gross* and *net* GVA impacts can be expected to increase in the future as the long term Campus masterplan begins to be realised. If fully implemented this could add a cumulative £660m (of discounted GVA) to Sci-Tech Daresbury's gross impact by 2040.

9.6 Due to the complex challenges associated with monetising the totality of the economic impacts generated by the activities undertaken on the Campus (see paragraph 1.7), the operational impact figures under-estimate the real scale of economic impact. However, Sci-Tech Daresbury is not unique in facing significant challenges in impact evaluation and a headline review of impact studies reveals that STFC is leading the way in commissioning an impact study for a *whole* science and innovation campus. Recommendations to build on this over the coming years are presented below.

The Campus is home to an expanding community of innovative, science and technology-rich high growth firms…

9.7 The supply of flexible business accommodation at Daresbury is a relatively recent development and the Campus has made considerable progress in this area over the past decade in response to the closure of the SRS. Over recent years, significant investment totalling approximately £90m has been made through the Joint Venture to reposition the Campus.

9.8 The integrated offer of flexible accommodation, tailored business and innovation support services, as well as access to nationally and in some areas, internationally significant research and kit, have helped to attract a cohort of successful science and technology driven firms to the Campus. High profile multi-national companies located on site include IBM, Lockheed Martin and Mellanox Technologies. More broadly, the Sci-Tech Daresbury Strategy for Science Innovation and Growth identifies key sectors as digital/ICT; advanced engineering and materials; and biomedical and healthcare.

9.9 Evidence collected through surveys of tenant firms at Sci-Tech Daresbury reveals that the Campus is:

- **Delivering economic impact** - the *gross* economic impact of the 100 tenant firms at Sci-Tech Daresbury is estimated as being equivalent to an annual GVA figure of £94m in 2014/15, out of the total Campus impact of £163m
- **Generating high quality employment opportunities and supporting economic rebalancing** - around 300 jobs have been created over the past three years alone
- **Minimising business failure** - there have been only 13 business failures in over 11 years at the Campus, suggesting a three year business survival rate in excess of 90% (compared to 60% in the North West)
- **Accelerating business growth** - without Sci-Tech Daresbury, 35% of tenants would be smaller in turnover terms and 20% would employ fewer people. Tenant firms have achieved average sales growth of 30% per annum
- **Supporting enterprise development and new business formation** – 13 of the current tenants started on Campus. They currently have 98 FTEs and a combined annual turnover of £11.6m
- **Attracting investment** - tenant firms have secured £82m of all forms of investment since formation, £15m in 2015.[82] The Campus also attracts international investment, hosting five branch offices of major international companies
- **Supporting and promoting innovation -** firms responding to the study survey were more likely to invest in all forms of innovation than the national average of firms in the UK's two most innovative sectors. A third of survey respondents reported that the specialist business and innovation support provided at the Campus had been of great importance in developing their business over the previous twelve months
- **Facilitating networking and collaboration** - the majority of respondents reported that networking and/or collaboration with other firms on the Campus had been of some or great importance to the development of their business over the last year
- **Meeting the property, support and other needs of occupiers** - almost half of respondents did not feel any improvements were needed with the specialist services, facilities or specialist equipment available.

9.10 At Sci-Tech Daresbury, tenant firms benefit from being located on a Campus that has a number of distinctive characteristics. These strengths of the site should be exploited fully over the coming years as the ambitious and high quality long-term masterplan is delivered.

9.11 Good progress has been made since the launch of the business accommodation elements of the Campus in improving access to STFC researchers, engineers and scientific equipment. STFC's investment in the I-TAC and Campus Technology Hub facilities, and the CERN BIC programme are good examples of this. One tenant firm reported to the study team that "*the collaboration between academic and enterprise culture has been particularly good here*."

[82] Note that in 2014 Campus companies had secured £109m in investment. Three key companies have since left the Campus causing the drop to £82m

9.12 In the longer term, successful implementation of the Campus masterplan will see more than 1m sq ft of business accommodation developed. This would take the Campus to the next level, boosting economic impact as networking, collaboration and cluster development benefits are scaled-up significantly. As set out in the Sci-Tech Daresbury Strategy, the attraction of more mid-sized companies as well as larger blue-chip investors should remain as key imperatives in order to increase the scale and density of business activity on-site. However, in an increasingly competitive and uncertain marketplace, this will not be straightforward.

… and delivers a broad range of scientific and technology impacts

9.13 The scientific impacts of Sci-Tech Daresbury can be summarised as falling into five broad categories:

- **Supporting high quality scientific research and developing the technologies to support fundamental research and large scale scientific facilities elsewhere** is a key part of the Daresbury Laboratory. This includes, but is not limited to, providing enabling computing infrastructures to the scientific community, enhancing knowledge of energy efficient computing, developing capabilities in accelerator science and playing a key co-ordinating role for the UK nuclear physics community.
- The high quality of scientists and engineers working on the Campus allows the **UK to gain international leadership and influence** by coordinating major international accelerator science projects and designing/developing the advanced equipment necessary for experiments at high profile international facilities. Providing this specialised technology allows UK scientists to access these world leading facilities.
- Sometimes arising from fundamental research, a range of **practical market applications for technologies have been developed** including the prototype ProSPECTus medical imager. Other technologies, for example the ALICE accelerator, are being used within healthcare to improve patient outcomes.
- Whether through direct project assignments with businesses at the Hartree Centre or the VEC, the industrial engagement activities of the Detector Systems Group, or ASTeC's work to help business innovation, **engagement with businesses** is becoming more important to the scientific organisations at Sci-Tech Daresbury and is boosting the competitiveness of beneficiary firms such as Unilever, Rolls-Royce, BAE Systems and the Waters Corporation.
- Building on the skills base in accelerators and scientific computing developed over the decades since the founding of the Daresbury Laboratory, the Hartree Centre's skills development programme, and post-graduate training at both the Cockcroft Institute and the MTRL are all helping to **develop the skills** of the next generation of scientists and engineers for the UK.

Stakeholder feedback

9.14 There was a strong consensus amongst stakeholder consultees and researcher survey respondents in relation to the **quality of the scientific capabilities and supporting assets**

at Sci-Tech Daresbury. The key messages from the qualitative evidence are summarised below:

- The **Hartree Centre was recognised consistently and clearly as being the key asset** in terms of securing the Campus' future success and is seen increasingly as being of national and international significance.
- Stakeholders felt that the **Technology Department[83], the Scientific Computing Department, the Virtual Engineering Centre, Cockcroft Institute and the ASTeC had all played key supporting roles** at the Campus. There was also praise for the engineering expertise of the Engineering Technology Centre.
- Overall, the survey evidence suggests a relatively high level of additionality for the research conducted at the Campus. **Two thirds of the researcher e-survey respondents reported that the core features and benefits of the Campus could not be secured at other locations** or in other ways.
- It was also noted that whilst **current activity is focused on activities to support discovery research, there was a growing emphasis on commercialisation and connecting to commercial issues which was welcomed**. Consultees indicated that there was further scope to build on existing business accommodation successes to attract significantly more business activity and private sector investment on-site.
- Looking more broadly, **stakeholders also valued the wider social impacts generated by the Campus**, particularly through the skills development programmes and community outreach work with local schools and community groups.
- Whilst the feedback on the Campus from stakeholders was generally very positive, one key area for improvement was identified. There was a consistent theme running through the majority of the stakeholder consultations in relation to the **visibility, profile and positioning of the Campus**. Specifically, it was claimed that on occasions in the past, Daresbury had undersold itself and that **it should seek to articulate its offer in the round more clearly** – particularly to a non-scientific audience.

Recommendations

9.15 Five recommendations are presented for discussion. The first focuses specifically on monitoring and evaluation activity at Sci Tech Daresbury and the other four cover wider issues in relation to increasing the long-term economic impact of the Campus.

- This Campus Impact Study process has highlighted the difficulty in monetising many of the impacts generated by Sci-Tech Daresbury. The Campus is not alone in this. Indeed, a review of the literature reveals that STFC and the Joint Venture are "ahead of the pack" in seeking to undertake a robust and comprehensive assessment of the totality of the Campus. In order to maintain the momentum generated through this

[83] Consultations primarily focussed on the Nuclear Physics Group and the Detector Systems Group although the impact of the Technology Department is wider than this.

process, further resource should be invested to build capacity and strengthen monitoring and evaluation activity. This study has revealed that the Campus is delivering a significant annual economic impact, but the modelled figures underestimate the true scale of the GVA and employment impacts.

Recommendation 1: Whilst it will never be possible to monetise with any degree of certainty all of the scientific impacts generated by activities conducted on site, improvements can be made to current monitoring processes. Specifically, a more systematic and consistent approach to capturing input, activity and output data should be embedded across the totality of the Campus. This will require changes to data collection and management systems to seek permission from beneficiary firms early on in their engagement with the Campus to share project level data and financial (recognising commercial sensitivities) impact information. Given the potential scale of the economic impacts generated by the Hartree Centre, this should be the first priority. However, other significant components of the Campus could over time, be tasked with developing proportionate monitoring and evaluation frameworks. This work should draw on the latest good practice and guidance[84] and the frameworks should be developed in a consistent manner. With more comprehensive and robust monitoring data, the Campus will be in a stronger position to identify, articulate and champion its true economic impact.

- Over the last decade, the Joint Venture and STFC have successfully launched multiple business-facing facilities and attracted a cohort of impressive science focused and/or technology rich companies. The majority of these tenant firms have been start-ups, early stage firms or SMEs. However, the Campus story has also been shaped by investment from some major international corporations including Lockheed Martin (through their acquisition of the Amor Group) and IBM (through its links to the Hartree Centre).

- ***Recommendation 2: The high quality business accommodation and tailored support services offer at Sci-Tech Daresbury is now entering an exciting and critical phase of development. As highlighted by some of the comparator research presented in this report, achieving a critical mass and density of businesses located on-site matters. Therefore, the leadership team at the Campus should be tasked with implementing a strategy to quickly scale-up the on-site business employment levels, recognising that demand will need to be identified/cultivated, whilst at the same time ensuring financial prudence and protecting the entry policy criteria and the quality of the employment opportunities. A key element of this will involve the translation of the current Sci-Tech Daresbury Strategy into a detailed programme of complementary investments, which would form the basis of a long-term integrated development plan for the Campus.***

[84] See for example, HM Treasury's Magenta book (https://www.gov.uk/government/publications/the-magenta-book) and BEIS' Evaluation Strategy 2015-16 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387507/bis-14-1295-evaluation-strategy-2015-16-accountability-and-learning-at-the-heart-of-bis.pdf)

- The combination of STFC's Scientific Computing Department, the Hartree Centre and the Virtual Engineering Centre together provide a very powerful offer that is fully aligned with key market and technology drivers of change e.g. the emergence of Industry 4.0 thinking.[85] STFC and partners should ensure that the quality of these assets are maintained and that existing links to IBM, Intel, Nvidia, Lenovo and others are leveraged fully, leading to more commercialisation, innovation, local cluster development on site and productivity growth for UK plc.

  Recommendation 3: To deliver on the ambition presented in the Sci-Tech Daresbury Strategy to "develop a cluster of data intensive businesses built around the world-class capabilities of the Hartree Centre", the Joint Venture and the Hartree Centre should work closely together to produce a detailed Big Data cluster development plan for the Campus. This would seize the exciting opportunity to exploit the developing Hartree offer to develop a local cluster which can help to drive national economic growth and productivity gains – all in response to the increasingly pervasive Industry 4.0, Big Data and associated agendas.

- Within the Atlantic Gateway there is a large and growing concentration of science and technology hubs. Whilst the Sci-Tech Daresbury offer is different to that of these other sites, there will undoubtedly be some competition between them from time to time.

  Recommendation 4: Senior managers at Daresbury should work in collaboration with these competitor sites and key relevant organisations such as the local universities and Northern cities in order to bring forward complementary developments and to maximise the overall growth of the Northern Powerhouse and wider UK economies.

- The policy and operating context for the Campus has changed significantly over recent years. With the emergence of the Northern Powerhouse concept and an increasingly singular focus on driving productivity growth, the expectations for Daresbury are also changing, resulting in new challenge areas and opportunities. Additionally, Sci-Tech Daresbury is a complex and multi-faceted site, with many different component parts and inter-relationships, whilst much of the underpinning science conducted on-site is also very complicated.

  Recommendation 5: Consideration should be given to establishing a dedicated and focused senior-level resource to champion and market the Campus offer to external partners and potential investors, both nationally and internationally. Linked to this, as the Campus strategy and masterplan are refined over time, there needs to be concise, understandable and easily communicable key messages on what the unique Daresbury offer is, what impact it delivers, and how this is differentiated from competitor sites.

[85] Industry 4.0 refers to the trend of automation and data exchange in manufacturing, including the Internet of things and cloud computing.

Annex A: Sci-Tech Daresbury logic model

A.1 This Annex presents the logic model used to frame the study.

Figure A-1: Logic model for Sci-Tech Daresbury

Objectives	Inputs & activities	Immediate outputs	Short-term outcomes	Longer-term outcomes
Campus vision - the campus continues to develop as a national centre for large-scale science investments & is a place where science innovation & entrepreneurship deliver business growth & high quality jobs, regionally in North West England & nationally across the UK Objectives relating to: - Driving excellent in science and technology - Business growth through innovation - Developing a world-class science campus - Attracting and developing the very best talent - Powering productivity through partnerships	JV between STFC, Halton BC & Langtree *International-class science* -Scientific computing (Hartree Centre and SCD), Accelerator science & technology (ASTeC, Cockcroft Institute), Nuclear physics *'Mid-range' science* - Virtual Engineering Centre, SuperSTEM, MedTEC, Knowledge Centre for Materials Chemistry, Detector Systems Group *Tenant facilities & accommodation* - Innovation Centre , Vanguard House, I-TAC, Campus Technology Hub, single occupier buildings, Techspace One and Two Current £ - EZ status, as well as STFC/BIS £, plus leverage of EU £	Business tenants in accommodation (& associated employment) Businesses (on & off site) engaged through: - use of equipment, facilities & expertise - networking with other businesses - other services offered by the Campus - services offered by Strategic, Gold & Silver partners Researcher-business collaborations (both formal & informal) Skills development	Changes in **business behaviour** & short-term performance (e.g. investing in innovation / R&D activities, developing products / services, attracting finance / investment, filing for patents) Local/national inward investment Initial scientific discoveries Changes in **researcher behaviour** (e.g. placements in companies, collaborations, licensing, spin-outs, research projects with industry focus)	Longer-term effects relating to **business performance** through cost savings, turnover benefits, new employment creation, & graduation of companies off the Campus. Monetised in terms of GVA. **Research impacts**, e.g. quality of research Wider **societal benefits**, e.g. through the development and/or commercialisation of research leading to, for example, health-related benefits Wider **agglomeration effects** in local economy through labour markets, capital markets etc. Developing, attracting and retaining the **very best talent**

Drivers and assumptions: businesses attracted by the highly differentiated offer & integrated ecosystem, enhanced by Enterprise Zone status; proximity and/or networking activities lead to informal & formal collaboration, & use of specialist facilities, as well as access to expertise; critical mass attracts partners/others to site, leading to further networks, access to finance / investment, clustering effects; activities attract specialised labour; collaborations with researchers lead to accelerated/more/higher quality innovations, leading to growth & development of companies; research has a range of applications leading to societal effects (where relevant); activity also supports the nurturing of scientific talent & skills development; additionality due to specialist nature of offer not available elsewhere, & due to provision of support to help enable networks/collaboration to happen more readily.

Source: SQW

Annex B: Headline review of previous impact studies

B.1 This Annex presents a headline summary of previous impact studies of research institutes and campuses in Table B-1. Following this, a review of the policy context which Sci-Tech Daresbury operates in is presented. They reveal that STFC is leading the way in commissioning an impact study for a *whole* science and innovation campus, rather than at Research Council or Research Institute level. For example, a study on the Roslin Institute does not include the whole of the wider Easter Bush Research Consortium, whilst the Babraham Institute study does not value the impact of the tenant companies located on site.

B.2 A variety of methodologies have previously been used to monetise research impacts. However, these methodologies are either not appropriate for Sci-Tech Daresbury (e.g. research at comparator sites is 'nearer to market' and/or with clearer commercial applications) or are judged by the study team as not being robust enough.

Table B-1: Headline review of previous impact studies of research institutes/campuses

Campus/Site	Study	Methodology overview	Learning for Sci-Tech Daresbury/comments
Adlershof Science and Technology Park	The Economic Significance of Adlershof, DIW econ GmbH, 2011	Operating impact quantified Research impact not captured quantitatively or qualitatively	-
Advanced Manufacturing Park	No study published	-	-
Babraham Institute (part of Babraham Research Campus)	Capturing the Economic Impact of the Babraham Institute, Alacrita, 2013	Operating impact quantified Research impacts described qualitatively with a series of case studies but not monetised	Highlights the challenges of time lags, non-linear innovation making outcomes unpredictable, difficulties in disaggregation, and the need to risk-adjust the values of current projects due to the risk that they will not be successful
GIANT Innovation Campus	GIANT, 2016, GIANT Review,	Methodology unclear	-
Institute for Food Research (IFR) (part of the Norwich Research Park)	Impact of the Institute of Food Research, Brookdale Consulting, 2013	Operating impact presented Eleven examples of research impact quantified for both gross annual benefits and 10 year Net Present Value	Attribution on the basis of either proportion of project costs borne by IFR or the proportion of the work undertaken at IFR Research is closer to market and with clearer economic impacts than that carried out at Sci-Tech Daresbury
John Innes Centre (JIC) (part of the Norwich Research Park)	Impact of the John Innes Centre, Brookdale Consulting, 2013 Economic impact of the John Innes	2013 report uses methodology and assumptions from earlier 2008 report Operating impact quantified Research impact quantified	Assumptions on attribution of research impacts are clear but there is ambiguity as to how they have been arrived at – "If we assume that half a tonne of wheat yield increase over the period is due to JIC work, we can calculate a market impact" and "If JIC is responsible for a sixteenth of this market value, its contribution to

Campus/Site	Study	Methodology overview	Learning for Sci-Tech Daresbury/comments
	Centre, DTZ, 2008	Future impacts projected	world wheat is £3.4 billion."
Keele University	The Economic Impact of Keele University, Regeneris, 2016	Operating impact quantified (including student spending) Future potential (operating) impact of proposed future investments quantified Research impacts described qualitatively	Quantification of future operating impacts based on planned growth of student numbers, expected growth in business engagement, etc.
N8 Research Partnership of Universities	The Power of 8, N8 Research Partnership, 2016	Operating impact quantified (including student spending) Research impacts described qualitatively	Methodology to quantify operating impacts is unclear as figures presented do not appear to sum to the stated total impact
Roslin Institute (RI) (Part of the Easter Bush Research Consortium)	Economic Impact Of The Roslin Institute, Biggar Economics, 2013	Quantifies net impacts for: GVA from spinouts, turnover of tenant firms and operational impacts. Quantifies gross impacts for: marginal and cumulative research impacts and skills	Assumptions on attribution of research impacts are clear but the robustness of the approach can be questioned. For example, based on consultations on the importance of RI's poultry genetics research, it is assumed that 10% of the marginal increase in *all* livestock productivity in the UK in 2011 is due to RI. No list of consultees is given so there is no transparent justification for this assumptions. Does not value the impact of the wider Easter Bush Research Consortium
Rothamsted Research (Rothamsted Centre for Research and Enterprise)	Rothamsted Research and the Value of Excellence: A Synthesis of Available Evidence, Séan Rickard Ltd, 2015	Assesses how much lower UK agriculture's productivity would be in the absence of Rothamsted Research's cumulative research output and consequently how much higher the prices of agricultural products would be	Assumptions on attribution of research impacts are clear but the robustness of the approach can be questioned. – "On the basis of the cumulative impact of Rothamsted's published research in the area of agronomical management…it would not be unreasonable to argue that the underlying average levels of crop yields in the UK…are around 5 to 10 per cent higher than they otherwise would be." No explicit justification is given for assuming 5-10% compared to, say, 10-15%. Pathways to economic impact of the research at Rothamsted is clearer than for activities at Sci-Tech Daresbury
Synchrotron Radiation Source (at Daresbury)	New Light on Science: The Social & Economic Impact of the Daresbury Synchrotron Radiation Source, (1981 - 2008), STFC	Impacts presented in four categories: Long term, global impacts; Medium to long term UK impacts; Short term direct local impacts; Future impacts	Highlights methodological challenges around time lags to impact, attribution and data (e.g. availability, confidentiality)
University of Arizona Tech park	Economic Impacts of the UA Tech Park, VP Research & Consulting, 2015	Operational impact quantified Research impact not captured quantitatively or qualitatively	-

Source: SQW analysis

Annex C: Policy context

C.1 On-going developments at Sci-Tech Daresbury are supported by a favourable policy context at the European, national and sub-national levels.

European level initiatives

C.2 Until the UK formally leaves the European Union (EU), the European Commission's policy priorities and commitments in relation to science, research and innovation are likely to remain important for the Campus.

C.3 The EU considers science, research and innovation to be key to driving economic growth and creating jobs. **Europe 2020,** the EU's ten year growth strategy, aims to create the conditions for "*smart, sustainable and inclusive growth.*[86]" As one of the flagship initiatives under this, the **Innovation Union** aims to: make Europe a world-class science performer; remove obstacles to innovation; and revolutionise the way public and private sectors work together.[87]

C.4 **Horizon 2020**, the €80bn EU Research and Innovation programme for 2014-2020, has an emphasis on excellent science, industrial leadership and tackling societal challenges with the goal of ensuring "*Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.*"[88]

C.5 Aligned with Horizon 2020, the focus of the current **European Structural and Investment Funds** (ESIF) programme period, 2014-2020, is on supporting SMEs to commercialise research and bring new products to market. The actions to be supported will be framed by smart specialisation strategies and thus limited to specific aspects of each Industrial Sector Strategy (see below). Local Enterprise Partnerships would bid for money to support Sci-Tech Daresbury under this framework.

C.6 Horizon 2020 also provides support to the **Enterprise Europe Network** (EEN), which aims to improve SME access to funding opportunities. Led by Innovate UK in England, Wales and Northern Ireland, EEN offers a broad range of innovation and internationalisation support services. The North-West EEN branch works closely with staff at Daresbury to help SMEs based at the Campus to develop international partnerships and learn about funding opportunities.

The national picture

C.7 The UK Government has committed to '*fund and support innovation in science, technology and engineering to help the UK's high-tech industries to thrive*.'[89] As detailed in the **Innovation and Research Strategy for Growth**[90], this covers both fundamental and

[86] http://ec.europa.eu/europe2020/index_en.htm
[87] http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=intro
[88] http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020
[89] https://www.gov.uk/government/topics/science-and-innovation
[90] Innovation and Research Strategy for Growth, BIS, 2011 https://www.gov.uk/government/publications/government-innovation-and-research-strategy

applied research. This includes the October 2011 Government announcement of £145 million of capital investment in e-infrastructure (High Performance Computing, software, networks, data storage, security, people and skills); £30 million of which was earmarked for super-computing research at a new facility that became known as the Hartree Centre at Sci-Tech Daresbury.

C.8 The Strategy notes that the UK's knowledge base is the most productive in the G8[91], but that it faces challenges with regard to translating discoveries into commercial successes and the rising cost of cutting-edge research. It also recognises that enhanced links between universities and business will be required in order to drive greater commercialisation.

C.9 The **UK Government 'Our Plan for Growth: science and innovation'[92]** again recognises the key role that the commercialisation of science plays in driving economic growth and underscores the Government's commitment to supporting science; amounting to £5.9 billion of capital investment up to 2021. It also lays out support for the Eight Great Technologies[93] whilst the **Emerging Technologies and Industries Strategy** identifies seven high-potential technologies of strategic national importance which have received investment.[94]

C.10 **Industrial Strategies** for eleven sectors, chosen because of their current strength and/or potential future contribution to the UK economy, were developed by the UK government.[95] An **update to the Industrial Strategy** showing short-term progress against long term objectives was published in 2014[96]. Many of these strategies are directly relevant to the scientific research, engineering and business activities conducted at Sci-Tech Daresbury.

C.11 The theme of 'smart specialisation' runs through these policy documents and was formally defined by Government in **Smart Specialisation in England** as "*an approach to investment in innovation which: provides a long term strategic tool to identify opportunities to inform and design emerging and future policies for innovation;…is applied in all places taking into account the specific circumstances of each place;…and provides for better strategic alignment of relevant public funding support for innovation from both national and EU sources*."[97]

C.12 Following this, **Science and Innovation Audits** (SIAs) were launched as a process for consortia of universities, public authorities, LEPs and businesses to map strengths and identify potential areas of strategic focus for their region. Greater Manchester and East Cheshire, and the Liverpool City Region submitted two separate applications for an SIA, with Sci-Tech Daresbury identified as a core member of both, in January 2016. Greater

[91] Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
[92] UK Government Science and Innovation Strategy, 'Our Plan for Growth: science and innovation', BIS, December 2014. https://www.gov.uk/government/publications/our-plan-for-growth-science-and-innovation
[93] Big data, satellites, robotics and autonomous systems, synthetic biology, regenerative medicine, agri-science, advanced materials and nanotechnology, energy and storage.
[94] They are: synthetic biology, energy efficient computing, energy harvesting, non-animal technologies, emerging imaging technologies, graphene and quantum technologies. Emerging Technologies and Industries Strategy 2014-2018, Innovate UK, 2014, See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370017/Emerging_technologies_-strategy_2014-2018.pdf
[95] These eleven sectors are: Aerospace; Nuclear; Oil & Gas; Information Economy; Construction; Automotive; Professional Business Services; Offshore Wind; Agri-tech; Education; and Life Sciences.
[96] The Industrial Strategy: One year on, BIS, April 2014, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf
[97] https://www.gov.uk/government/publications/smart-specialisation-in-england p4

Manchester and East Cheshire was selected as part of the first wave of five areas to undertake full SIAs[98].

C.13 Our review of the national policy documentation reveals that the funding landscape for large-scale scientific facilities in the UK (and elsewhere) is changing dramatically. A key driver is the high cost of developing cutting-edge scientific kit and supporting research processes, which is often too large for single countries and almost certainly so for individual research institutions and companies.[99] Therefore, "*scientific progress has become increasingly reliant on large-scale collaborative efforts that involve shared facilities and other resources, a form of scientific endeavour popularly known as Big Science.*"[100]

C.14 Sci-Tech Daresbury is an example of this and, as one of the UK's leading science and innovation campuses, its critical role is defined as providing:

> *"thriving environments for businesses, industry, universities and researchers, enabling innovation and delivering impact from research investment…. They provide access to advanced world-leading facilities; scientific services; a unique training environment and world-leading expertise. They foster a culture of collaboration and innovation to support the creation and growth of new and existing business. UK facilities act as magnets for domestic and overseas investment by high-tech companies, and they give UK researchers sought after expertise in international collaborations. This allows the UK to participate in major international research infrastructure projects that are too expensive and complex for any one country to develop in isolation"*[101]

The Northern Powerhouse

C.15 In June 2014, the Chancellor of the Exchequer delivered a speech setting out the need for a Northern Powerhouse. Subsequently, an **Independent Economic Review** was commissioned by the newly created Transport for the North, and progressed by SQW between November 2015 and March 2016. The review identified four Prime capabilities and three Enabling capabilities at the level of the North.[102]

C.16 Sci-Tech Daresbury, through the Scientific Computing Department and the Hartree Centre, is strongly linked to the digital capability, whilst the other prime capabilities identified (Advanced Manufacturing, Energy, and Health Innovation) are all pertinent to capabilities of the Virtual Engineering Centre and Campus Technology Hub, as well as the high-tech companies based on the Campus.

[98] Other successful SIA first wave areas include: Edinburgh and the Lothians City Region; South West England and South East Wales; Sheffield City Region and Lancashire; and The Midlands Engine.
[99] Innovation and Research Strategy for Growth, BIS, 2011 https://www.gov.uk/government/publications/government-innovation-and-research-strategy
[100] Innovation from Big Science: Enhancing the Big Science Impact Agenda, Autio, E. (Imperial College Business School) for BIS, (March 2014), page 11
[101] Innovation and Research Strategy for Growth, BIS, 2011 p50.
[102] Reports from across all five Northern Powerhouse IER workstreams can be accessed from the SQW website here: http://www.sqw.co.uk/insights-and-publications/northern-powerhouse-independent-economic-review/

Regional developments

C.17 Over recent years, STFC and the Joint Venture partners have worked hard to strengthen links between the science and research conducted at the Campus and the wider North West economy. "*This ecosystem approach connects the UK and North West's science community with the economy and ensures the effective delivery of real business growth, innovation, the creation of high value employment and thriving science based businesses*."[103]

C.18 A good example of this wider positioning and partnership working can be seen through the work of the Sci- Tech Daresbury Joint Venture in supporting the **North West Business Leadership Team** (NWBLT); an independent group of business leaders. The NWBLT has published various reports highlighting the importance of continued investment in science, technology and innovation activity across the North West and developed a **prospectus to promote the region's ecosystems** (including Sci-Tech Daresbury) as attractive locations for science, technology and innovation foreign direct investment.[104]

C.19 Other regional policy agendas relevant to Sci-Tech Daresbury include the work of the **Atlantic Gateway Partnership**[105], which has recently led a study into science and innovation opportunities across the Liverpool City Region, Cheshire and Warrington, and Greater Manchester LEP areas. The study identified four main areas of strength across the three LEP geographies: advanced manufacturing and materials; energy and associated engineering; life sciences and health innovation; plus, big data and high performance computing. These areas – particularly the last two – are very well aligned with the Sci-Tech Daresbury offer.

Local Enterprise Partnerships level

C.20 There are differing geographies of innovation and the Smart Specialisation approach grants the Local Enterprise Partnerships (LEPs) a significant role in identifying their own local priorities. Government requested that all LEPs produce a Strategic Economic Plan (SEP) promoting their strengths, demonstrating how their aspirations and proposed actions are aligned with national priorities and how they would use ESIF money to achieve these. The contained evidence indicating the location of niche or specialist areas of expertise with genuine importance and future relevance for LEPs to draw on as well helping them to identify opportunities for collaboration with other parts of England with similar specialisms.

C.21 LEPs thus have an important role to play in stimulating involvement and participation from local firms as well as leading on other elements of Smart Specialisation that can best be delivered at the local level including:

- strengthening of local innovation 'ecosystem(s)' and building local capabilities;
- supporting local supply chains to invest and collaborate;
- catalysing and leveraging the differing opportunities of social innovation; and

[103] Liverpool City Region Growth Prospectus, Liverpool City Region LEP, p22 http://www.liverpoollep.org/economic-strategy/growth-deal/
[104] For example the NWBLT's Productivity Report, Unlocking our Potential, June 2016, available at: http://www.nwblt.com/download/nwblt-productivity-report-unlocking-our-potential/
[105] See the Atlantic Gateway Partnership website for details: http://www.atlanticgateway.co.uk/

- branding and positioning places as credible centres of smart specialisation.[106]

The Liverpool City Region LEP

C.22 Sci-Tech Daresbury is located within the Liverpool City Region (LCR) and forms a central element of the LCR's strategic approach to building long-term competitiveness through the exploitation of science and research. A smart specialisation process was undertaken by partners across the City Region, which resulted in a detailed **Innovation Plan** for the period 2014-20[107]. The Plan identifies LCR's innovation ecosystem (focusing primarily on the Liverpool Knowledge Quarter and Sci-Tech Daresbury) and four market-facing priority areas:

- Health and Well-Being;
- Advanced Manufacturing;
- Solutions for Sustainable Growth;
- Creative Content/Digital Capabilities.

C.23 More recently, the Campus has been identified by the **LCR Growth Strategy** as both an asset to exploit and an important opportunity to build on.[108]

Cheshire and Warrington LEP

C.24 The Cheshire and Warrington LEP has not undertaken a formal smart specialisation analysis, but through the development of its **Strategic Economic Plan**[109], has identified four key sectors with potential to 'grow further, faster'[110]. These are:

- Advanced Engineering;
- Financial and Professional Services;
- Life Sciences and Chemicals;
- Energy and Environment.

C.25 Since the Strategic Economic Plan was first developed, work has been undertaken by partners to develop the concept of the **Cheshire Science Corridor**[111]. This has resulted in the identification of six key scientific assets including Sci-Tech Daresbury, as well as Capenhurst Technology Park, Thornton Science Park, Birchwood Park's Nuclear and Forensics Clusters, Alderley Park (Life Sciences), Jodrell Bank and the Square Kilometre

[106] https://www.gov.uk/government/publications/smart-specialisation-in-england p5
[107] Liverpool City Region Innovation Plan 2014-2020, Liverpool City Region LEP, available at: https://www.liverpoollep.org/wp-content/uploads/2015/06/wpid-lcr-innovation-plan-draft2014.pdf
[108] Building Our Future: Liverpool City Region Growth Strategy, LCR LEP and LCR Combined Authority, 2016, https://www.liverpoollep.org/wp-content/uploads/2016/06/SGS-Final-main-lowres.compressed.pdf?platform=hootsuite
[109] For details see: http://www.871candwep.co.uk/resources/strategic-economic-plan-and-growth-plan-for-cheshire-and-warrington/
[110] A Strategic Economic Plan for Cheshire and Warrington, C&W LEP, 2014 available at: http://www.871candwep.co.uk/content/uploads/2015/05/Strategic-and-Economic-Plan-and-Growth-Plan-for-Cheshire-and-Warrington.pdf
[111] For details see: http://www.871candwep.co.uk/strategic-priorities/science-corridor/

Array (SKA). The SKA development in particular is potentially significant for Daresbury, given the need for large-scale data analytics capabilities and STFC's lead in managing the UK's role, which is supported by £197m of UK Government investment.

Greater Manchester LEP

C.26 Policy around science and innovation is at an advanced stage in Greater Manchester. The LEP-led **Science Review** of 2012[112] established the vision that *'by 2020 Greater Manchester will be renowned as a successful commercial science city.'* This goal was built on in 2013 by the **Greater Manchester Strategy and a Smart Specialisation Strategy**, which has received endorsement from the European Commission[113]. The strategy identified strengths in:

- Health Innovation;
- Advanced Materials;
- Biotechnology;
- Energy;
- Chip Design/High Performance Computing;
- the Built Environment;
- Interactive Technologies/Robotics;
- Acoustic Technologies.

C.27 Greater Manchester also values Sci-Tech Daresbury, and the **Plan for Growth and Reform** aims to ensure that the Campus "*receives the required levels of investment and [that] benefits are maximised*."[114] Building on Manchester's smart specialisation work, the on-going Wave 1 Science and Innovation Audit includes Sci-Tech Daresbury as a core member.

[112] For details see: http://neweconomymanchester.com/publications/manchester-science-review
[113] http://www.manchester.gov.uk/download/meetings/id/20285/5_science_and_health_innovation
[114] A Plan for Growth and Reform in Greater Manchester, 2014, GM LEP, GM Combined Authority and Association of GM Authorities

Annex D: Summary comparators

Grenoble and the GIANT Innovation Campus

D.1 Since the establishment of a branch of the CEA (now French Atomic Energy and Alternative Energies Commission) in Grenoble in 1956, other major scientific facilities and laboratories have moved to the area. They are complemented by six Higher Education Institutes (HEI), representing 65,000 students, who have come together to form the Université Grenoble Alpes. Over the last 60 years there has been increasing collaboration between the science base and industry in the area and increasing investment in scientific facilities, laboratories and HE.

D.2 The latest, and most far reaching development, was the establishment of the GIANT Innovation Campus in 2009, which aims to build on previous successes in developing clusters in the area. The Campus covers 250 hectares and encompasses many existing scientific facilities. It is a partnership of European/University/public research institutes, local government, public transport, major companies, cluster organisations and local agencies. More than €1.3bn of investment was planned for the period 2010-2015: €700m on research and €600m on transport, accommodation and quality of life. The Campus currently has: 6,000 researchers, 5,000 industrial jobs, 5,000 students, and 300 residents, with an annual direct and indirect economic impact of €4.1bn.[115]

Factors for success

D.3 Factors which have been key to the success of Grenoble and, more recently, the GIANT Campus are:

- History. Knowledge-based industries have developed in the city, and region, over a very long period and the basic building blocks for an effective cluster were in place before public intervention
- Very high levels of science-focused public investment, from a range of sources, have been sustained over many years. This includes major facilities (ILL and ESRF), public laboratories, and higher education. Public funding has also supported projects and programmes and the more recent GIANT initiatives
- Funding for growth more broadly. Local authorities are actively engaged in providing financial support but they are also committed to the GIANT urban development plan, which could take Grenoble to the next level
- Scale. There are a very large number of researchers, facilities, graduates and knowledge-based businesses in a comparatively small urban area, giving the Campus a critical mass of activity. The current and proposed size of the GIANT innovation campus is of a different order of magnitude to that of Sci-Tech Daresbury (250 hectares at GIANT compared to 30 hectares at Daresbury)

[115] http://www.giant-grenoble.org/wp-content/uploads/2016/06/GIANT-Review-Spring-2016.pdf The methodology is unclear but this seems to be a *gross* impact

- Environment and quality of life. With its excellent access to the Alps and mix of traditional and modern architecture, Grenoble is an attractive and vibrant location for skilled people of all ages, and their families, to live and work in. This helps to both attract and retain talent in the area.

- The HEIs seem committed to promoting technology-based development and work closely with each other, tailoring their educational programmes to business needs as well as entering research collaborations.

- The core capability of GIANT is the development of technology platforms which bring together researchers from HE, major laboratories and industry. There are currently 12 platforms which cover nanotechnology, biotechnology, and new energy technologies. They are an effective means of transferring technology from the science base and attracting inward investment.

Berlin Adlershof Science and Technology Park

D.4 The Berlin Adlershof Science and Technology Park was set up in 1991. Adlershof had been an airport and aeronautics centre and after the Second World War became the location of the East Germany Academy of Science; the largest science and innovation institution in the GDR.

D.5 The Science and Technology Park is at the heart of Adlershof Science City, which hosts around 1,000 companies and 12 non-university research institutes. A wide range of sectors are present with a focus on: photonics and optics; renewable energies and photovoltaics; microsystems and materials; IT and media; biotechnology and environment; and analytics. In addition, the Humboldt-Universität zu Berlin has established six scientific institutes on the Park. The Park also hosts "Media City" which, with almost 140 businesses and film studios, claims to be Germany's premier media centre.

D.6 Some 380 private houses and a landscaped park have been developed on an area of 66ha in the immediate vicinity of the park with further short-term plans for 1,400 housing units ("Living on Campus") for about 2,500 people.

D.7 In 2010, the OECD rated Adlershof as one of the 15 largest science parks globally and considered it to be one of the best high-tech locations in Germany. There are around 1,000 companies on the park with total employment of 11,500. A further 2,600 people are employed in the research institutes and university centres and there are almost 8,000 students studying on site. It has an annual direct and indirect economic impact of €1.74bn.[116]

Factors for success

D.8 Factors which have been key to the success of Adlershof are:

- The historical situation with the availability of premises already hosting research institutes and the later decision of Humboldt to relocate departments to the Park

[116] The Economic Significance of Adlershof, DIW econ GmbH, 2011. The €1.74bn seems to be *gross* operational impacts, and does not include the value of the research conducted at Adlershof.

- Stable, long-term and effective management with the Berlin State playing a key planning and supporting role
- Synergies between renowned scientific institutes, high-tech companies and universities providing education as well as research. However, some commentators have identified a reluctance of some university researchers to undertake applied research with companies and believe that Adlershof could have done more to build networks
- The entrepreneurial life cycle approach with advice and premises for new company generation, incubation, growth and expansion
- Proximity between businesses and researchers
- The importance of networks and networking behaviours. Adlershof is a key member of various sector networks, which facilitates access by businesses
- Cluster development and supply chains with research capability, suppliers and users on the Park
- Excellent infrastructure reflecting premises, transport networks and the developing residential accommodation and facilities.

Advanced Manufacturing Park Sheffield-Rotherham

D.9 The Advanced Manufacturing Park (AMP) was conceived in 2000 to provide a visible focus for, and a means of building further upon, South Yorkshire's expertise in metal-based technologies, materials, related process industries and structures. The aim from the outset was to create development on a scale which could directly change, and then facilitate further change in, the South Yorkshire economy. The AMP occupies a 100 acre site at Waverley between Rotherham and Sheffield.

D.10 The University of Sheffield Advanced Manufacturing Research Centre (AMRC) is one of the key facilities on site and, amongst others, includes the Boeing – Rolls-Royce Factory of the Future, AMRC Composites Centre, Nuclear AMRC and the Medical AMRC. Other facilities on site which firms can access include the TWI Yorkshire Technology Centre, AMP Technology Centre and Evolution @ the AMP. Outline plans have been approved for a second advanced manufacturing and research space (AMRC2) on an adjacent site.

Factors for success

D.11 The AMP can be summarised as 'the right idea, with the right people, at the right time'. It was realised on a professional basis, with the necessary contracts governing commercial agreements and confidentiality, but also with a minimum of formal liaison agreements. The plans for AMRC2 and the Innovation District show that there is ambition to take this forward into a significant new stage. Key learning points are set out below:

- The ambition and drive to realise a nationally significant development, identifying at the outset a distinctive capability, then creating and following through the opportunity

- Clear strategic direction, set and maintained from the outset, focusing exclusively on operations within, or in support of, advanced engineering, material, manufacturing and environmental energy
- The early provision of a high profile facility, the AMRC, with a global industrial partner involved at the outset and others attracted by the technology offer
- The capacity to scale up and expand to meet emerging new opportunities, and the skills base, and credibility to widen into new sectors
- The presence of a Technology Centre (earlier the ITC) which provides flexible business space, meeting rooms, café facilities and a range of support services for small firms and businesses already established at the AMP
- A shared long term commitment and ambition at senior level by the key institutions, namely the University of Sheffield, Rotherham MBC, Sheffield City Council and earlier Yorkshire Forward. This partnership gave priority to the initiative in dedicating resources, identified and utilised external funding, and engaged successive governments
- A partnership which was sufficiently embedded and flexible to adapt to changing, sometimes adverse situations – notably the reduced availability of public funding with the loss of Objective 1 status, and later the demise of Yorkshire Forward. UK Coal became Harworth Estates, and under this new name, the landowner is also overseeing development of the adjacent new community of 4,000 homes, shops, restaurants, schools, leisure & community facilities and parks
- Finally, and not least, the continuity of key personnel at AMP, which has provided profile and credibility to business and public sector partners: in particular, Professor Keith Ridgway, CBE; Adrian Allen, OBE; and John Baragwanath, OBE.

Annex E: List of consultees

E.1 This annex presents a list of consultees who were interviewed as part of the study.

Table E-1: List of consultees

Contact Name	Organisation
Alan Welby	Liverpool City Region LEP
Andrew Taylor	STFC
Anthony Gleeson	STFC, ASTeC
Clive Drinkwater	UKTI
Colin Bailey	University of Manchester
David Bogg	STFC – Campus Technology Hub
David Parr	Halton Borough Council
Debbie Buckley-Golder	Innovate UK
Dominic Rice	BIS (now BEIS)
Gillian Murray	Virtual Engineering Centre
Graeme Burt	Cockcroft Institute
Ian Green	IBM
Ian Lazarus	STFC
Jonathan Hague	Unilever
John Leake	Sci-Tech Daresbury Joint Venture
John Lewis	The Heath
John Simpson	STFC
Leigh Lapworth	Rolls-Royce
Luke Georghiou	MIoIR/ Greater Manchester LEP
Mark Affonso	STFC
Martin Ridge	BIS (now BEIS)
Mary Richardson	DCLG
Michael Norris	STFC
Neil Morgan	STFC
Paul Treloar	Sci-Tech Daresbury Joint Venture
Paul Vernon	Thornton Science Park
Peter McIntosh	ASTeC
Phil Atkinson	STFC
Philip Cox	Cheshire and Warrington LEP
Peter Ratoff	Cockcroft Institute
Richard Ainsworth	Victrex

Contact Name	Organisation
Richard Farrow	STFC
Sarah Jackson	University of Liverpool
Susan Smith	ASTeC Director and Head of Daresbury Laboratory
Tim Bestwick	STFC
Tim Wheeler	Cheshire and Warrington LEP

Source: SQW analysis

Annex F: References

F.1 The reports, data sets and online data sources used in the preparation of this report are set out below.

Reports

- Accelerators: Powering Cutting Edge Research, STFC, 2014
- Annual Business Survey: Glossary of Terms, ONS
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- Smart Specialisation in England, BIS, April 2015, https://www.gov.uk/government/publications/smart-specialisation-in-england
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- The Economic Significance of Adlershof, DIW econ GmbH, 2011
- The Green Book, HM Treasury, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf
- The Industrial Strategy: One year on, BIS, April 2014
- The Power of 8, N8 Research Partnership, 2016
- UK Government Science and Innovation Strategy, 'Our Plan for Growth: science and innovation', BIS, December 2014. https://www.gov.uk/government/publications/our-plan-for-growth-science-and-innovation

Data sources

- Annual Business Survey, ONS, release date July 2014
- Family Spending 2014 Edition, ONS, release date December 2014

- Regional Gross Value Added (Income Approach), release date December 2014
- UK Innovation Survey, 2013, BIS and ONS, release date October 2014

Organisation web links

- Aberystwyth Innovation and Enterprise Campus, http://www.aber.ac.uk/en/news/archive/2014/12/title-161032-en.html
- Babraham Research Campus, http://www.babraham.co.uk/about/about.html
- Biotechnology and Biological Sciences Research Council, http://www.bbsrc.ac.uk/about/research-innovation-campuses/
- Easter Bush Campus, http://www.easterbush.mvm.ed.ac.uk/
- Enterprise Europe Network, http://een.ec.europa.eu/, http://www.enterprise-europe.co.uk
- Fera, http://fera.co.uk/
- Horizon 2020, http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020
- Norwich Research Park, http://www.norwichresearchpark.com/home
- Rothamsted Centre for Research and Enterprise, http://www.rocre-rothamsted.com/the-campus
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