



The Northern  
Powerhouse in Health  
Research – A Science  
and Innovation Audit

Submitted by the Northern  
Health Science Alliance Ltd

Appendices  
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## 2 Policy Context

### Introduction

2.1 This Chapter provides the national and local policy context within which the NPiHR operates. It reviews:

- The Industrial Strategy;
- The Life Sciences Industrial Strategy;
- The Life Sciences Sector Deal;
- NHS Five-year Forward View;
- The Review of Data Security, Consent and Opt-Outs and Your Data: Better Security, Better Choice, Better Care;
- Twelve actions to support and apply research in the NHS;
- Relevant SIAs;
- The Northern Powerhouse Independent Economic Review; and
- The alignment between Northern Local Enterprise Partnerships and this SIA's two themes: Data for Better Health **and** **Wealth** and **Precision Medicine**.

### Industrial Strategy, Life Sciences Industrial Strategy, and Life Sciences Sector Deal

2.2 The Industrial Strategy: Building a Britain for the future<sup>1</sup>, Life Sciences Industrial Strategy<sup>2</sup> and the subsequent Life Sciences Sector Deal<sup>3</sup> provide the business and economic policy framework for the UK Life Science sector.

2.3 The *Industrial Strategy* identifies five foundations of productivity:

- **Ideas** – so that the UK becomes the world's most innovative economy;
- **People** – to generate good jobs and greater earning power;
- **Infrastructure** – a major upgrade of the UK's infrastructure;
- **Business environment** – the best place to start and grow a business; and

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1

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/664572/industrial-strategy-white-paper-print-ready-version.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664572/industrial-strategy-white-paper-print-ready-version.pdf)

2

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/650447/LifeSciencesIndustrialStrategy\\_acc2.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/650447/LifeSciencesIndustrialStrategy_acc2.pdf)

<sup>3</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/665479/life-sciences-sector-deal-print-ready-version.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/665479/life-sciences-sector-deal-print-ready-version.pdf)



- **Places** – prosperous communities across the UK.

2.4 It also identifies four Grand Challenges to ensure that the UK is at the forefront of the ‘industries of the future’, namely:

- **Artificial Intelligence & Data Economy** – to exploit the AI and data revolution;
- **Ageing Society** – to innovate to meet the needs of an ageing society;
- **Clean Growth** – to maximise the advantages of the shift to clean growth; and
- **Future Mobility** – to lead the world in the movement of people, goods and services.

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The scope of this SIA is directly related to the Grand Challenges AI & Data and Ageing Society, with indirect links to Clean Growth and Mobility, given their impact on health outcomes.

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2.5 **Table 2.1** outlines the core recommendations of the Life Sciences Industrial Strategy with a commentary on where and how the NPiHR might contribute, led by NHTA. **Table 2.2** summarises actions in the Life Sciences Sector Deal and indicates where and how the NPiHR might make a positive contribution to the delivery of the agreed Northern Life Science Sector Deal.

2.6 The NHTA is currently negotiating a Northern Sector Deal with HM Government to help develop the Health and Life sciences sector, following the publication of the Life Sciences Industrial Strategy last year<sup>4</sup>. The NHTA has identified a strong commercial pipeline of investment for further waves of the Sector Deal.

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‘Further regional approaches, including in the north of England via the Northern Health Science Alliance, are expected for further phases of the deal’- UK Industrial Strategy White Paper – p. 197

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‘We anticipate that the next phase of the Sector Deal will be an opportunity to further identify and develop regional approaches to implementing the Life Sciences Industrial Strategy, working closely with Life Sciences clusters and the devolved administrations. For example, we will work across the north of England in partnership with the Northern Health Science Alliance, (NHTA), along with the local and global businesses, to support the growth of the North’s Life Sciences and health innovation economy’. UK Industrial Strategy Life Sciences Sector Deal – p. 36

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<sup>4</sup> <http://www.thenhsa.co.uk/2017/12/nhsa-named-north-partner-lsis-sector-deal-1bn-investment-identified/>

**Table 2.1: Delivering the Life Sciences Industrial Strategy across the North**

Section	Recommendation for NHS and NPIHR
Health Advanced Research Programme (HARP)	The North can provide the clinical research environment to support the pan-Northern implementation of genomics in medicine, developing effective diagnostics for early, asymptomatic chronic disease, digitalisation and AI to transform pathology and imaging. This includes utilising Newcastle’s National Institute of Ageing and the North’s four Active and Healthy Ageing Reference Sites to support projects around healthy ageing.
Reinforce the UK Science Offer	<p>Translational Science:</p> <ul style="list-style-type: none"> <li>The NHS can further develop its pan-Northern Memorandum of Understanding between the northern National Institute of Health Research (NIHR) Clinical Research Networks (CRNs) to support the NIHR CRNs to increase capacity and delivery through pan-regional collaboration.</li> <li>Working with NWeHealth Ltd, the only organisation to have delivered a real-world clinical trial, the NHS is well placed to support the roll-out of the Salford Lung Study infrastructure across the North of England.</li> </ul>
Growth & Infrastructure	<p>Clusters and ‘place’, support the growth of Life Sciences clusters:</p> <ul style="list-style-type: none"> <li>The NHS will continue to promote the UK and the North internationally with maintained support from Department for International Trade to the international pharma, medtech and digital health industries. This SIA is also a clear recognition of the North of England’s potential in health research and its ability to grow the health and wealth of the region.</li> <li>The NHS is a founding member of a self-assembled alliance of UK Clusters including NHS Research Scotland, MedCity, Life Science Hub Wales, Northern Ireland and the South West GW4 Alliance. With the Academy of Medical Sciences, this group can work with Government to promote a ‘single front door’ to the UK for research collaboration, partnership and investment as well as cross-cluster collaboration.</li> </ul> <p>Manufacturing, attract substantial investment to manufacture and export high-value Life Science products of the future:</p> <ul style="list-style-type: none"> <li>The North of England is home to the manufacturing clusters in Speke and in the North East. In the North East, the overall direct, indirect and induced GVA contribution to the UK by the regional cluster is estimated at over £1bn, Speke biomanufacturing is reported in the order of £2bn and Seqirus is £1bn. The North can work with Government to attract substantial investment to manufacture and export high-value Life Sciences products of the future.</li> </ul>
NHS collaboration	<p>Supporting the delivery of fifty collaborative programmes in late-stage clinical trials, Real-World data collection, or in the evaluation of diagnostics or devices:</p> <ul style="list-style-type: none"> <li>The NHS unites eight NHS Teaching Trusts, eight top universities and four Academic Health Science Networks. The NHS can ensure that health research projects work in partnership through a collaborative model with the potential to be rolled out across the North’s four AHSNs and the UK to underpin the research in the NHS and drive investment and health outcomes throughout the country.</li> <li>Medtech Centres of Excellence:</li> <li>The NHS through centres in Leeds, Sheffield, Newcastle and Manchester and recent designation of five NIHR Medtech and In vitro diagnostic Co-operatives (MICs), as well as the Leeds City Region Science Innovation Audit for MedTech, strongly position the North to deliver on the creation of Medtech Centres of Excellence.</li> </ul>
Data	<p>Establish two to five regional innovation hubs providing data across regions of three to five million people:</p> <ul style="list-style-type: none"> <li>The NHS’s central project, Health North: Connected Health Cities (CHC), harnesses patient data at scale to diagnose and treat patients quickly and deliver services more effectively and efficiently. CHC is a prime example of an innovative data ecosystem across multiple geographies of 3-5m populations enabling easy linkage and comparison of data, facilitating forecasting, joined-up care and real-world outcomes-based evaluation. The NHS commits to developing a subset of the data innovation hubs in line with the CHC programme to support the ambitions and recommendations set out in the Life Sciences Industrial Strategy.</li> </ul>

Section	Recommendation for NHSa and NPiHR
Skills	<p>Developing and building our skill base:</p> <ul style="list-style-type: none"> <li>Through our direct work with leading Universities, teaching hospitals, NIHR BRCs and global industry in the region, the North can establish and build on existing training programmes to ensure the skills necessary to deliver the fourth industrial revolution are available across the UK.</li> </ul>
Manufacturing	The North of England is home to Life Science manufacturing clusters in Speke, Cheshire, and in the North East. The North will work with Government to attract substantial investment to manufacture and export high-value life sciences products of the future.

Source: NHSa

**Table 2.2: Life Sciences Sector Deal**

Foundations	Actions	NPiHR SIA
Ideas	<p><b>Government</b></p> <ul style="list-style-type: none"> <li>Raise the intensity of research and development in the UK;</li> <li>Establish the Health Advanced Research Programme; and</li> <li>Strengthen the environment for clinical trials.</li> </ul> <p><b>Sector</b></p> <ul style="list-style-type: none"> <li>Life Sciences companies will make increasing commitment to investing in the UK;</li> <li>Collaborations between companies and academia, developing innovative clinical trials; and</li> <li>A diverse range of Life Sciences organisations will collaborate with government on advanced health research projects.</li> </ul>	<ul style="list-style-type: none"> <li>Respond to the call to establish Local Integrated Care Record exemplars, with a view to these becoming Digital Innovation Hubs, as part of a national approach to rapidly and effectively establish studies for the generation of real-world data and full-population studies, which can be appropriately accessed by researchers; including the capability to streamline and accelerate Clinical Trial Authorisation and Health Research Authority approvals;</li> <li>Rollout e-prescribing in hospitals in the North;</li> <li>Work with NHS Digital and NHS England to set out clear and consistent nationwide approaches to data and interoperability standards and requirements for data access agreements;</li> <li>Streamline legal and ethical approvals for access to datasets; and</li> <li>Act as a coordinator of data in the North to work with academia, charities and industry to engage with all health data programmes.</li> </ul>
People	<p><b>Government</b></p> <ul style="list-style-type: none"> <li>Work with the sector to ensure highly-skilled workforce by reinforcing the skills base across the UK and enabling high-skilled immigration.</li> </ul> <p><b>Sector</b></p> <ul style="list-style-type: none"> <li>Trailblazer apprenticeship standards to meet skills gaps, e.g. in bioinformatics, regulatory trials, and clinical trials specialists.</li> </ul>	<ul style="list-style-type: none"> <li>Establish an Applied Precision Medicine Academy to provide cutting-edge educational programmes, training and career development in Precision Medicine for a range of healthcare professionals, patients and the public, to facilitate interaction between industry, clinicians, commissioners, Academic Health Science Networks.</li> </ul>

Foundations	Actions	NPIHR SIA
Business environment	<p><b>Government</b></p> <ul style="list-style-type: none"> <li>Support the growth of medicines manufacturing;</li> <li>Improve the UK environment for business with the potential to scale-up;</li> <li>Implement the Accelerated Access Review;</li> <li>Support development of measures to improve the UK's health data infrastructure; and</li> <li>Deliver actions to support and apply research in the NHS<sup>5</sup>.</li> </ul>	<ul style="list-style-type: none"> <li>The North will work with Government to attract substantial investment to manufacture and export high-value life sciences products of the future.</li> <li>Through our direct work with leading Universities, teaching hospitals, NIHR BRCs and global industry in the region, the North can establish and build on existing training programmes to ensure the skills necessary to deliver the fourth industrial revolution are available across the UK.</li> <li>NHSA working with industry and government to support the growth of the North's Life Science and Health Innovation economy; and</li> <li>Respond to the call to establish Local Integrated Care Record exemplars, with a view to these becoming Digital Innovation Hubs, as part of a national approach to rapidly and effectively establish studies for the generation of real-world data and full-population studies, which can be appropriately accessed by researchers; including the capability to streamline and accelerate Clinical Trial Authorisation and Health Research Authority approvals;</li> </ul>
Places	<p><b>Government</b></p> <ul style="list-style-type: none"> <li>Implement a regional approach to the Life Sciences Sector Deal by working closely with clusters and the devolved administrations.</li> </ul> <p><b>Sector</b></p> <ul style="list-style-type: none"> <li>Investment.</li> </ul>	<ul style="list-style-type: none"> <li>Work with Leeds City Region in the delivery of £350m investment programme in the Med-tech hub;</li> <li>Work with colleagues in Sheffield to deliver the Orthopaedic and Rehabilitation Research and Innovation Centre and Centre of Child Health and Technology (this is not yet funded);</li> <li>NHSA working with industry and government to support the growth of the North's Life Science and Health Innovation economy; and</li> <li>QIAGEN – a world leader in molecular testing partnering with Health Innovation Manchester to develop a genomics and diagnostics campus.</li> <li>SEQIRUS – second largest influenza vaccine company in the world developing Liverpool site with a new fill-and-finish facility for an adjuvanted influenza vaccine designed for people aged 65+ that will bring nearly a hundred new high-tech jobs to the region and help develop the North West's biomanufacturing cluster.</li> <li>Work with devolved NHS arrangements in Greater Manchester to explore the possibilities for testing and adopting innovation in <b>Precision Medicine</b>.</li> </ul>

Source: SDG-ED drawing on the *Life Sciences Sector Deal*

<sup>5</sup> <https://www.england.nhs.uk/wp-content/uploads/2017/11/08-pb-30-11-2017-supporting-and-applying-research.pdf>

## NHS Five-year Forward View<sup>6</sup>

2.7 In terms of national health policy, the NHS Five-year Forward View sets out five priorities for service delivery:

- Upgrading prevention and public health activity;
- Patients gaining far greater control of their own care;
- Taking steps to break down the barriers between family doctors and hospitals in how care is provided;
- Ensuring meaningful local flexibilities, based on choices from a range of radical local delivery models; and
- Improving the NHS’s ability to undertake research and apply innovation – including by developing new ‘test bed’ sites for worldwide innovators, and new ‘green field’ sites where completely new NHS services may be designed from scratch.

## Review of Data Security, Consent and Opt-Outs and Your Data: Better Security, Better Choice, Better Care

2.8 The *Review of Data Security, Consent and Opt-Outs*<sup>7</sup> and the Government’s response, *Your Data; Better Security, Better Choice, Better Care*<sup>8</sup> provide the policy framework within which stakeholders should operate with regard to patient data. They cover: data security, data security standards, the embedding of data security standards in every-day practice, consent and opt-outs and balance public and professional views of the main issues. The National Data Guardian has established 10 Data Security Standards for leaders (Table 2.3)

Table 2.3: Data Security Standards

Data Security Standard	Definition
Data Security Standard 1:	All staff ensure that personal confidential data is handled, stored and transmitted securely, whether in electronic or paper form. Personal confidential data is shared for only lawful and appropriate purposes.
Data Security Standard 2:	All staff understand their responsibilities under the National Data Guardian’s data security standards, including their obligation to handle information responsibly and their personal accountability for deliberate or avoidable breaches.
Data Security Standard 3:	All staff complete appropriate annual data security training and pass a mandatory test, provided through the redesigned Information Governance Toolkit.
Data Security Standard 4:	Personal confidential data is only accessible to staff who need it for their current role and access is removed as soon as it is no longer required. All instances of access to personal confidential data on IT systems can be attributed to individuals.
Data Security Standard 5:	Processes are reviewed at least annually to identify and improve any which have caused breaches or near misses, or which force staff to use workarounds which compromise data security.
Data Security Standard 6:	Cyber-attacks against services are identified and resisted and CareCERT security advice is responded to. Action is taken as soon as possible following a data breach or near miss, with a report made to senior management within 12 hours of detection. Significant cyber-attacks are to be reported to CareCERT immediately following detection.

<sup>6</sup> <https://www.england.nhs.uk/five-year-forward-view/>

<sup>7</sup> <https://www.gov.uk/government/publications/review-of-data-security-consent-and-opt-outs>

<sup>8</sup> <https://www.gov.uk/government/consultations/new-data-security-standards-for-health-and-social-care>

<b>Data Security Standard 7:</b>	A continuity plan is in place to respond to threats to data security, including significant data breaches or near misses, and it is tested once a year as a minimum, with a report to senior management.
<b>Data Security Standard 8:</b>	No unsupported operating systems, software or internet browsers are used within the IT estate.
<b>Data Security Standard 9:</b>	A strategy is in place for protecting IT systems from cyber threats, based on a proven cyber security framework such as Cyber Essentials. This is reviewed at least annually.
<b>Data Security Standard 10:</b>	IT suppliers are held accountable via contracts for protecting the personal confidential data they process and for meeting the National Data Guardian’s data security standards.

Source: HMG, Your Data: Better Security, Better Choice, Better Care, 2017

## Twelve actions to support and apply research in the NHS

2.9 NHS England Board and National Institute for Health Research produced 12 actions to support and apply research in the NHS, for the twin ends of stimulating economic growth, and accelerating and shaping an NHS pipeline of high value, affordable innovations (Table 2.4).

**Table 2.4: Twelve actions to support and apply research in the NHS**

Simplify NHS research processes	Articulate the NHS’s own research priorities better	Enhance our data infrastructure	Support advanced research into leading-edge technologies	Improve and simplify our adoption ecosystem
1. Manage excess treatment costs better. 2. Eliminate delays in confirming multi-site trials.	3. Set out research priorities for national NHS programmes. 4. Increase research focus and capability on value and cost. 5. Set out local NHS research and innovation priorities of Academic Health Science Networks and Sustainability and Transformation Partnerships.	6. Increase GP practice participation in the Clinical Practice Research Datalink. 7. Back 3-5 local NHS systems as they create interoperable local care records that are also research-ready.	8. Develop the NHS genomic medicine service. 9. Develop the application of artificial intelligence in pathology and radiology at scale.	10. Use NHS England’s specialised commissioning and commercial medicines clout, combined with NICE appraisals, to drive faster uptake of affordable, high impact innovation. 11. Back AHSNs to become the main local NHS delivery vehicle for spreading innovations. 12. Review and simplify the number of different national innovation projects and programmes.

Source: NHS England in partnership with The National Institute for Health Research, *Twelve actions to support and apply research in the NHS*, November 2017

## Related Science and Innovation Audits

2.10 **Table 2.5** provides a summary of the main activities and areas of commonality with earlier Wave 1 and 2 SIAs, to identify areas of potential collaboration and where the NPiHR can add value to extant thinking. The NPiHR is committed to leveraging existing SIAs – Northern and elsewhere in the UK – and thereby supporting the development of the nation’s health innovation economies. We have also already engaged, through a day-long workshop, with the Wave 3 **Precision Medicine** SIA for Scotland to discuss points of potential collaboration and complementarity, and we anticipate ongoing collaboration in the coming months once the respective SIAs have defined next steps and lead programmes. There will also undoubtedly be scope for collaboration with other Wave 3 SIAs including Applied Digital Technologies and the Northern Powerhouse in Chemicals and Process.

- 2.11 Other opportunities also exist for establishing links to the Bio-economy across Yorkshire and working to drive forward the Health and Social Care freedoms that devolution in one of the North's major agglomerations is testing. Equally importantly, we see this SIA as playing a key role in helping to progress the Life Science Industrial Strategy Sector Deal, and how this presents in different areas across the North. We want this SIA to be seen as extending, enhancing, and fully enabling of these initiatives, with their own performance being used as metrics/key performance indicators in our success on equal measure.

### The Northern Powerhouse Independent Economic Review

- 2.12 The Northern Powerhouse Independent Economic Review<sup>9</sup> identified four 'Prime Capabilities' at the level of the North:
- Advanced Manufacturing, with a particular focus on materials and processes;
  - Energy, in particular, expertise around generation, storage, and low carbon technologies and processes;
  - Health Innovation based on the North's long-established strengths in Life Sciences, Medical Technologies and Devices, and a growing competence in new and efficient service delivery models brought about by e-health and the growing devolution of responsibilities for Health and Social Care; and
  - Digital, focusing on high-performance computing, cognitive computation, data analytics, simulation/modelling, and machine learning.
- 2.13 Our SIA sits firmly with the latter two priorities and will link with the emphasis given to Advanced Manufacturing and Materials.

### Alignment with Northern Local Enterprise Partnerships

- 2.14 If partners in the North are to maximise the economic benefits of **Data for Better Health and Wealth** and **Precision Medicine**, Local Enterprise Partnerships will need to be ready to undertake supportive activity to attract and support the associated businesses and supply chain of companies that support 21st-century healthcare. Table 2.6 sets out the alignment between the NPiHR SIA themes and the seven Northern LEPs which have prioritised the Life Sciences in their Strategic Economic Plans – the other four LEPs in the North have not prioritised Life Sciences, but, as noted above, their geographies are covered by the four Northern AHSNs. The NPiHR will work with AHSNs and LEP partners to engage those LEPs which currently don't prioritise Life Sciences.

**Table 2.5: Links between other Science and Innovation Audits and the NPiHR Audit**

Science & Innovation Audit	Key areas covered	Links to NPiHR
<b>Wave One</b>		
Edinburgh and South East Scotland	<ul style="list-style-type: none"> <li>Data-driven innovation</li> </ul>	<ul style="list-style-type: none"> <li>A history of strength within Data-driven innovation has helped assure NPiHR’s strength in <b>Data for Better Health and Wealth</b> as well as being Edinburgh and South-East Scotland’s regional strength.</li> </ul>
Greater Manchester and Cheshire East	<ul style="list-style-type: none"> <li>Core Strengths: Health Innovation and Advanced Manufacturing</li> <li>Fast-growing opportunities: Digital, Energy and Industrial Biotechnology</li> </ul>	<ul style="list-style-type: none"> <li>With a geographical and subject overlap with the NPiHR overlap, many of Greater Manchester and Cheshire East’s key regional strengths that are highlighted in this SIA, are also relevant to our SIA, including: (1) global excellence in health, including in clinical trials; (2) growing strengths in the synergies between digital as a cross-cutting enabling sector with a focus on the health sector, including in the delivery of Precision Medicine; (3) a network of key enabling assets including Alderley Park and Science corridors; and (4) unique opportunities from ‘DevoManc’ with Health Innovation Manchester, which is focused on building data capabilities and health informatics into clinical trials and Precision Medicine.</li> </ul>
Midlands Engine SIA	<ul style="list-style-type: none"> <li>Transport Technologies</li> <li>Agri-food and drink manufacturing and production</li> <li>Advanced Manufacturing and Engineering</li> <li><b>Healthcare, life sciences and translational medicine</b></li> <li>Energy &amp; Low carbon Technologies</li> <li>Creative, Digital and Design Sector</li> </ul>	<ul style="list-style-type: none"> <li>The SIA identifies medical tech and pharmaceuticals identified as a market driver.</li> <li>The region has a wealth of healthcare and life science assets including six biomedical research centres’ the UK Research Council – Regenerative Medicine, Cancer Research UK – UK Clinical Trials Unit, Birmingham, UK’s largest NIHR/Wellcome Trust Clinical Research Facility and the Leicester <b>Precision Medicine</b> Institute (LPMI).</li> <li>There are long-term plans from Birmingham Health Partners for a Life Sciences Campus to capitalise on strengths clinical and innovation strengths</li> <li>The SIA puts forward a proposal for Life Science Opportunity Zone status for the former AstraZeneca site at Charnwood</li> </ul>
Sheffield City Region and Lancashire County	<ul style="list-style-type: none"> <li>Advanced Manufacturing and <b>Materials</b></li> </ul>	<ul style="list-style-type: none"> <li>The importance of (1) data and the Digital sector as a cross-cutting enabling theme; (2) international demand for Medical Equipment and Technologies (e.g. China); and (3) Health Innovation Campus under development at Lancaster. MedTech touched as part of SIA’s core emphasis on Industry 4.0.</li> </ul>
<b>Wave Two</b>		
East of England	<ul style="list-style-type: none"> <li>Life Sciences</li> <li>Agri-tech</li> <li><b>Advanced Materials</b> and Manufacturing (AM&amp;M)</li> <li>ICT</li> </ul>	<ul style="list-style-type: none"> <li>An established strength in Life Sciences, although the East of England’s core specialism is in ‘core biopharma’, it is strong across the entirety of the sector; and</li> <li>A focus on the importance of data to help support further growth for the region so it remains world-leading.</li> <li>The NHTA has already secured conversations with the University of Cambridge Academic Health Partnership to progress collaborations between the North and Cambridge in this domain.</li> </ul>



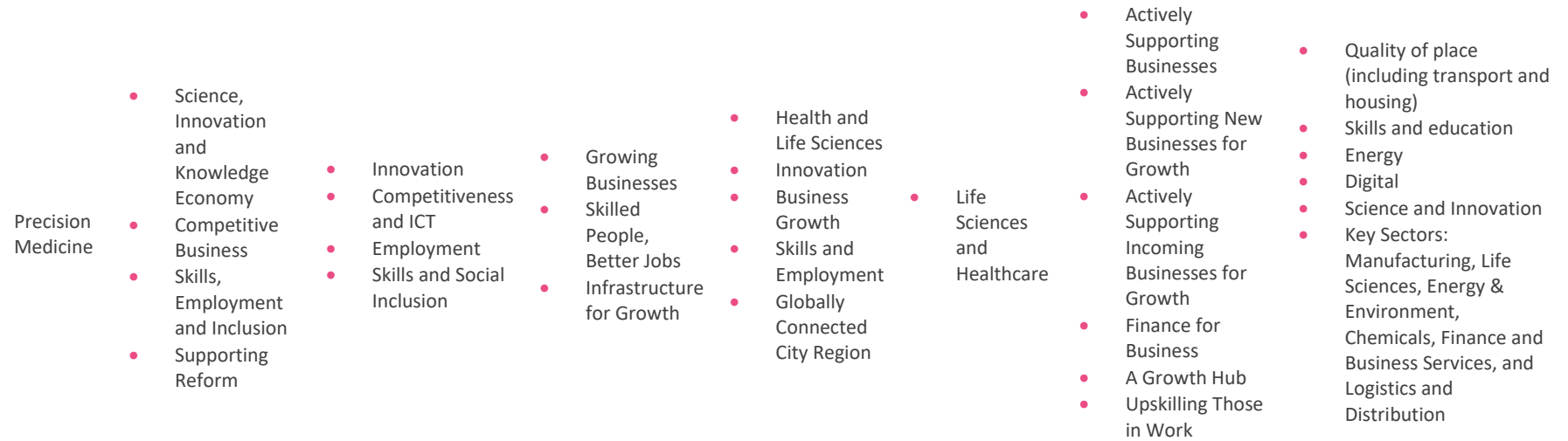
Science & Innovation Audit	Key areas covered	Links to NPiHR
Innovation South	<ul style="list-style-type: none"> <li>Digital Enabling Technologies</li> </ul>	<ul style="list-style-type: none"> <li>Digital Enabling Technologies are a key enabler for Bioscience and are impacting upon the development of medical data, devices and pharmaceuticals amongst others;</li> <li>The South has research strengths in human and animal health and key corporate presence including Syngenta and Bayer upon which to build. They also have significant research organisations including Pirbright Institute and Leatherhead Food Research;</li> <li>The University Hospital Southampton (UHS) achieved national recognition as an IT Centre of Excellence and Global Exemplar for Clinical Informatics development; and</li> <li>The Southampton Trust is also one of 11 NHS Genomic Medicine Centres, and in 2016, launched a project to process the genomic data of cancer patients to help clinicians deliver personalised treatment.</li> </ul>
Leeds City Region Med-Tech	<ul style="list-style-type: none"> <li>Medical Technologies</li> </ul>	<ul style="list-style-type: none"> <li>Leeds City Region is home to four out of five NHS headquarters, 22% of UK digital health technology jobs, received 8% of all EPSRC medtech funding and 8.9% of patents by UK inventors, but finds graduate retention a challenge;</li> <li>The growth of medtech is driven by: (1) ageing population; (2) changing lifestyle factors e.g. diabetes, cancer; and (3) demand from emerging economies;</li> <li>The SIA links the development and launch of medical devices to reduced healthcare costs and improved patient outcomes; and</li> <li>Universities are well connected internationally but the wider medtech sector is poorly networked with 'limited clustering behaviour and pre-competitive collaboration'.</li> </ul>
Liverpool City Region+	<ul style="list-style-type: none"> <li>Infection</li> <li>Materials Chemistry</li> <li>High Performance &amp; Cognitive Computing</li> </ul>	<ul style="list-style-type: none"> <li>Infection accounts for seven of the top 20 causes of mortality globally;</li> <li>LSTM and UoL are the largest concentration of expertise in translational-focused research, development and innovation in infectious disease in the UK;</li> <li>Anti-Microbial Resistance is significant, and the market drivers include growth in medical devices, construction sector regulation and food and beverage regulation;</li> <li>The SIA argues that by linking and enhancing the City Region's world-leading knowledge, research and facilities in Infection can, with wider collaboration, catalyse an internationally significant cluster of companies that will generate economic productivity and growth for the LCR, Northern Powerhouse and the UK.</li> <li>The High Performance and Cognitive Computing Capacity at the Hartree Centre provides the ability to: (1) model and simulate in greater detail; (2) integrate and analyse larger data sets; (3) deal with sensor data in real time; and (4) to use cognitive computing techniques to enable faster decision-making processes.</li> </ul>
North of England	<ul style="list-style-type: none"> <li>Bio-economy</li> </ul>	<ul style="list-style-type: none"> <li>Covers the same geographic area as this SIA but healthcare and therapeutic applications are beyond the scope of the audit.</li> </ul>

Science & Innovation Audit	Key areas covered	Links to NPiHR
Oxfordshire Transformative Technologies Alliance	<ul style="list-style-type: none"> <li>• Connected and autonomous vehicles</li> <li>• <b>Digital health</b></li> <li>• Space-led data applications</li> <li>• Technologies underpinning quantum computing</li> </ul>	<ul style="list-style-type: none"> <li>• Digital health is one of the four identified transformative technologies in the Oxfordshire markets and is at an advanced stage of commercial maturity.</li> <li>• The SIA area has over 160 digital health companies and 430 stakeholders across industrial, academic, NHS and third sector with projected 33,000 further jobs by 2030 and £1.8bn/year in savings to the NHS through continued development in end-to-end patient pathway and test-bed system.</li> <li>• Digital health is identified as critical in the transformation of healthcare systems from supply-driven to patient-centered and outcome-driven health care systems.</li> <li>• The SIA identifies the Key stages for digital health integration as (i) Clinical Pathway Mapping (ii) Development/Clinical Trials (iii) Evaluation/Real World Evidence (iv) Health Economics/Pricing and (v) Commercial/Financial Model.</li> <li>• The SIA puts forward two proposals to deal with current issues in digital health:             <ul style="list-style-type: none"> <li>• Data-enabled ecosystem for innovations: (1) a single data lake that sits on top of existing platforms for health economics – across provider trusts, primary care and social care so that the patient pathway is a closed loop for analysis. (2) Links between the city and the rural regions – making the region work better together.</li> <li>• Support for companies across the development pathway: Providing access to an end-to-end treatment pathway test-bed pilot where new Digital Health technologies can be tested to generate the necessary data for CE marking or gathering RWE.</li> </ul> </li> </ul>
Scotland’s Central Belt	<ul style="list-style-type: none"> <li>• Enabling Technologies</li> </ul>	<ul style="list-style-type: none"> <li>• Enabling technologies are a key component for healthcare and the region is home to key assets including Stratified Medicine Scotland, Digital Health and Care Institute, University of Edinburgh’s School of Informatics.</li> </ul>

Source: SDG-ED via analysis of evidence in the public domain

**Table 2.6: Alignment of NPiHR SIA Themes and Northern Local Enterprise Partnership priorities**

	Greater Manchester LEP	Lancashire LEP	Leeds City Region LEP	Liverpool City Region LEP	North East LEP	Sheffield City Region LEP	Cheshire and Warrington
Data for Better Health and Wealth	<ul style="list-style-type: none"> <li>Competitive Places</li> <li>Science, Innovation and Knowledge Economy</li> <li>Competitive Business</li> <li>Skills, Employment and Inclusion</li> <li>Supporting Reform</li> </ul>	<ul style="list-style-type: none"> <li>Innovation</li> <li>ICT</li> <li>Employment</li> <li>Skills and Social Inclusion</li> </ul>	<ul style="list-style-type: none"> <li>Growing Businesses</li> <li>Skilled People, Better Jobs</li> <li>Infrastructure for Growth</li> </ul>	<ul style="list-style-type: none"> <li>Digital and Creative</li> <li>Innovation</li> <li>Business Growth</li> <li>Skills and Employment</li> <li>Globally Connected City Region</li> </ul>	<ul style="list-style-type: none"> <li>Creative, Digital, Software and Technology Based Services</li> </ul>	<ul style="list-style-type: none"> <li>Actively Supporting Businesses</li> <li>Actively Supporting New Businesses for Growth</li> <li>Actively Supporting Incoming Businesses for Growth</li> <li>Finance for Business</li> <li>A Growth Hub</li> <li>Upskilling Those in Work</li> </ul>	<ul style="list-style-type: none"> <li>Quality of place (including transport and housing)</li> <li>Skills and education</li> <li>Energy</li> <li>Digital</li> <li>Science and Innovation</li> <li>Key Sectors: Manufacturing, Life Sciences, Energy &amp; Environment, Chemicals, Finance and Business Services, and Logistics and Distribution</li> </ul>



Source: NHSA analysis

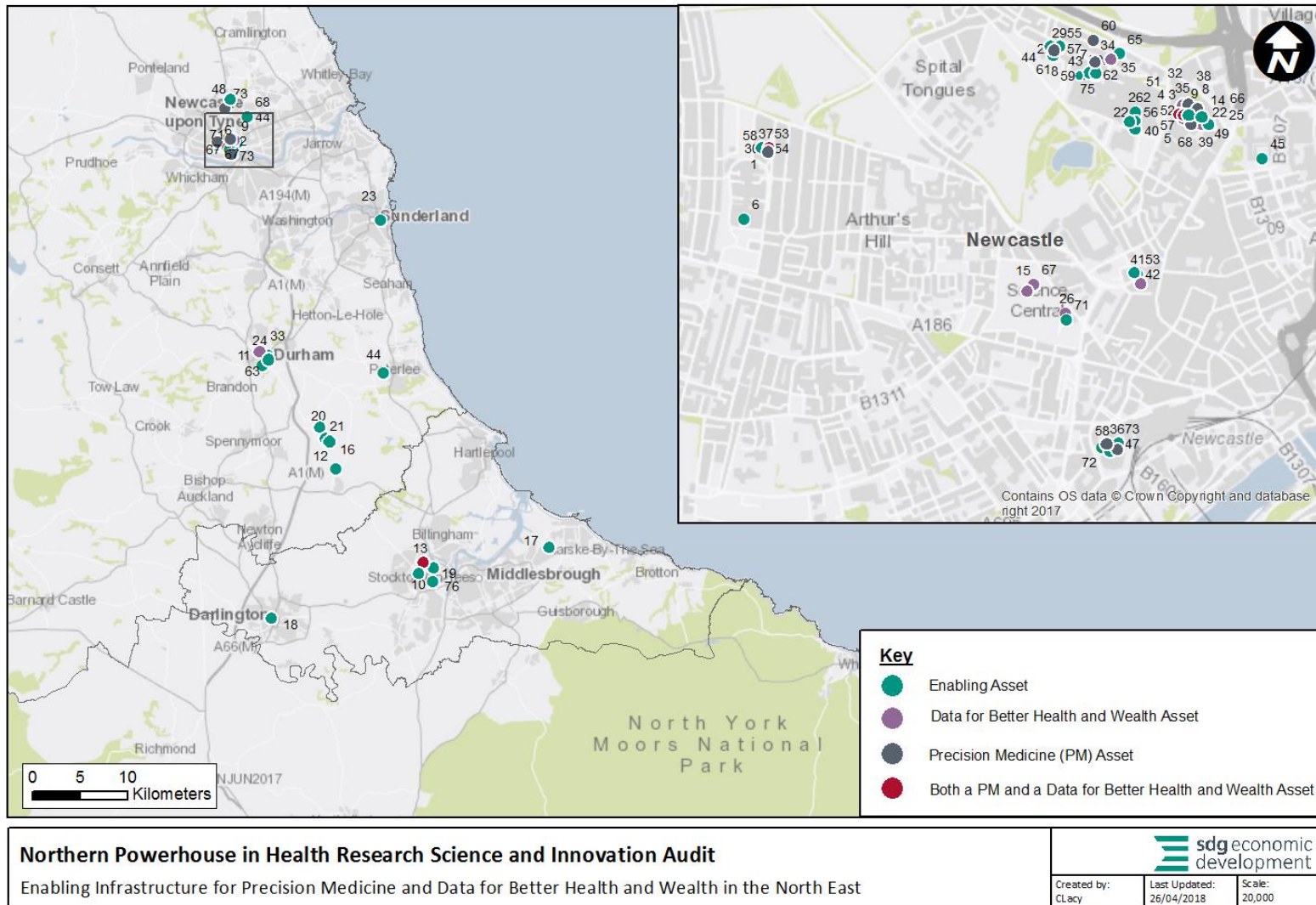
## Conclusions

- 2.15 This chapter has provided an overview of relevant national and local public strategies within which the NPiHR operates. Our themes, **Precision Medicine** and **Data for Better Health and Wealth**:
- Address key elements of the Life Sciences Industrial Strategy and Sector Deal, in particular;
    - A platform for developing effective diagnostics;
    - Digitalisation and AI;
    - Improving the speed and efficiency of UK clinical trial capabilities;
    - Collaboration between the NHS and industry for the benefit of UK patients;
    - Adoption, Access and Diffusion, and
    - Data.
  - Support the main themes of the NHS Five-year Forward View, in particular, patient control of care and improve the NHS's ability to undertake research and apply innovation; informed by the 12 actions to support research identified by the NHS England Board and National Institute for Health Research, in the context of the requirements of the National Data Guardian;
  - Complement previous SIAs and peer Wave Three SIAs; and
  - Form essential parts of LEP strategies in the North, particularly, Innovation, Life Science and Health Care, Skills and Upskilling.

## 3 Chapter Two Appendix - Strengths in Science and Innovation

- 3.1 This appendix covers all the appended material from Chapter Two, looking at the Science and Innovation strengths across our SIA area.
- 3.2 Figure 3-1, Figure 3-2 and [Figure 3-3](#) provide maps of significant infrastructure in the North East, North West and Yorkshire and Humber respectively. The maps show Enabling Infrastructure, for example, adjacent technologies that support work in Data for Better Health and Wealth and Precision Medicine, plus infrastructure that is either specific to one of the two themes or shared between them. [Table 3.1](#), [Table 3.2](#) and [Table 3.3](#) list the sites in each of the maps.
- 3.3 A list of Northern NHS Foundation Trusts, relevant incubators and science parks across the SIA area, and businesses that work across our two themes and are situated in the North can be found in [Table 3.4](#), [Table 3.5](#), [Table 3.6](#) and [Table 3.7](#) respectively.
- [Table 3.8](#),
- 3.4 [Table 3.9](#), [Table 3.10](#) and [Table 3.11](#) provide summaries of recent and pipeline investments.

Figure 3-1: Asset Map for the North East



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**Table 3.1: List of Assets: The North East**

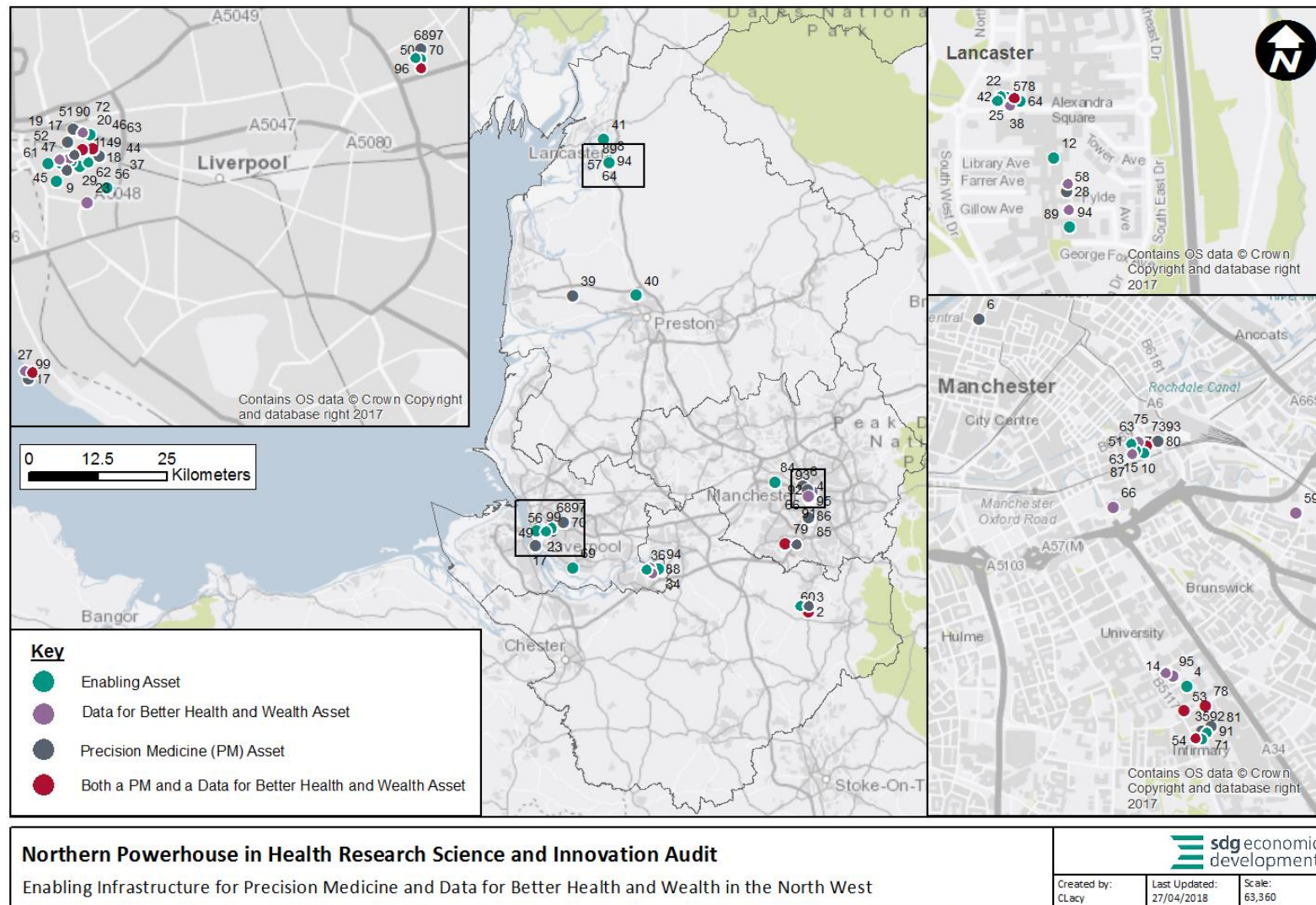
No.	Name	Asset Type
1	Academic Health Science Network for North East and North Cumbria	Enabling
2	aHUS (atypical Haemolytic Uraemic Syndrome) National Centre of Excellence	Enabling
3	Arthritis Research UK Rheumatoid Arthritis pathogenesis Centre of Excellence (Universities of Glasgow, Birmingham and Newcastle)	Enabling
4	Arthritis Research UK Tissue Engineering Centre (Cambridge, Aberdeen, Newcastle, York, Keele and Oswestry)	Enabling
5	Biopharmaceutical Bioprocessing Technology Centre (Newcastle University)	Enabling
6	Campus for Ageing and Vitality, (Newcastle Hospitals, Newcastle University)	Enabling
7	Centre for Bacterial Cell Biology (Newcastle University)	PM
8	Centre for Cardiovascular Research (Newcastle University)	Both
9	Centre for Health and Bioinformatics (Newcastle University)	Data
10	Centre for Integrated Health Care Research (Durham University)	Both
11	Centre for Medical Humanities (Durham University)	Enabling
12	Centre for Process Innovation (CPI) Head Office	Enabling
13	Centre for Public Policy & Health (School of Medicine, Pharmacy & Health, Durham University/ Newcastle University)	Enabling
14	Centre for Synthetic Biology and Bioexploitation (Newcastle University)	Enabling
15	Centre of Excellence for Cyber Security Research (Newcastle University)	Data
16	CPI's Healthcare Futures Centre	Enabling
17	CPI's National Industrial Biotechnology Facilities	Enabling
18	CPI's National Biologics Manufacturing Centre	Enabling
19	CPI's National Centre for Healthcare Photonics	Enabling
20	CPI's National Formulation Centre	Enabling
21	CPI's National Printable Electronics Centre	Enabling
22	Dementia Translational Research Collaboration (Newcastle University)	Both
23	Digital Catapult Centre North East & Tees Valley	Enabling
24	Durham Centre for Ethics and Law in the Life Sciences (CELLS) (Durham University)	Enabling
25	EPSRC Centre for Doctoral Training (CDT) in Cloud Computing for Big Data	Data
26	EPSRC Centre for Doctoral Training (CDT) in Digital Civics (Newcastle University)	Data
27	Experimental Cancer Medicine Centres (Great North Children's Hospital)	Enabling
28	Experimental Cancer Medicine Centres (Northern Institute for Cancer Research)	Enabling
29	Fuse: UKCRC Centre for Translational Research in Public Health – (Newcastle University, Durham University, Northumbria University, University of Sunderland and Teesside University)	Enabling
30	Human Nutrition Research Centre (Newcastle University)	Enabling
31	Infectious Diseases Unit (Royal Victoria Infirmary (RVI))	Enabling
32	Institute for Ageing (Newcastle University)	Enabling
33	Institute of Advanced Research Computing (Durham University)	Data
34	Institute of Health & Society (Newcastle University)	Enabling
35	Institute of Neurosciences (Newcastle University)	Enabling
36	John Walton Muscular Dystrophy Centre (Newcastle University)	PM



37	MRC Arthritis UK Research Centre for Integrated Research into Musculoskeletal Ageing (CIMA) (University of Newcastle)	Both
38	MRC Muscle Performance and Exercise Training Laboratory (University of Newcastle)	Enabling
39	MRC Newcastle University Single Cell Unit	PM
40	Musculoskeletal Research Group, (Newcastle University, the Freeman Hospital)	PM
41	National Innovation Centre for Ageing (NICA)	Enabling
42	National Innovation Centre for Data (NICD)	Data
43	Newcastle Bioinformatics Support Unit (Newcastle University)	Data
44	Newcastle Cancer Centre at the Northern Institute for Cancer Research	Enabling
45	Newcastle Science Central LLP	Enabling
46	Newcastle Surgical Training Centre (NSTC) (Freeman Hospital)	Enabling
47	Newcastle University Single Cell Functional Genomics Unit (NUSCU) (Institute of Human Genetics, Newcastle University)	PM
48	NHS Health Call	Enabling
49	NIHR Blood and Transplant Research Unit (BTRU): Organ Donation and Transplantation (Newcastle University)	PM
50	NIHR Clinical Research Network North East North Cumbria	Enabling
51	NIHR Health and Protection Research Unit (HPRU) in Chemical and Radiation Threats and Hazards (Newcastle University)	Enabling
52	NIHR HPRU in Emergency Preparedness and Response (Newcastle University)	Enabling
53	NIHR Innovation Observatory (Newcastle University, Newcastle upon Tyne Hospitals NHS Foundation Trust)	Enabling
54	NIHR Newcastle Biomedical Research Centre (Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle University)	Enabling
55	NIHR Newcastle Clinical Research Facility (Clinical Ageing Research Unit)	Enabling
56	NIHR Newcastle Clinical Research Facility (Dental Clinical Research Facility)	PM
57	NIHR Newcastle Clinical Research Facility (RVI Clinical Research Facility)	Enabling
58	NIHR Newcastle In Vitro Diagnostics Co-operative (Newcastle University, Newcastle upon Tyne Hospitals NHS Foundation Trust)	PM
59	NIHR Research Design Service North East (Durham University, Newcastle University)	Enabling
60	NIHR School for Primary Care Research (Newcastle University)	Enabling
61	NIHR School for Public Health Research (Newcastle University)	Enabling
62	North East Stem Cell Institute (NESCI) (Centre of Life)	Enabling
63	North East Stem Cell Institute (NESCI) (Durham University)	Enabling
64	North East Stem Cell Institute (NESCI) (Newcastle University)	Enabling
65	Northern Institute for Cancer Research (NICR) (Newcastle University)	PM
66	Policy, Ethics and Life Sciences Research Centre (Newcastle University)	Enabling
67	School of Computing Science (Newcastle University)	Data
68	School of Mathematics, Statistics & Physics (Newcastle University)	Data
69	School of Medicine, Pharmacy and Health (Durham/ Newcastle University)	Enabling
70	Sir Bobby Robson Cancer Research Trials Unit (Northern Centre for Cancer Care)	Enabling
71	The Core at Newcastle Science Central	Enabling
72	The Institute of Genetic Medicine	PM
73	The John Walton Muscular Dystrophy Centre	PM

74	The Newcastle Proximity Laboratory (Newcastle University)	PM
75	Wellcome Trust Centre for Mitochondrial Disease (Newcastle University)	PM
76	Wolfson Research Institute for Health and Wellbeing (Durham University)	Enabling

Figure 3-2: Asset Map for NPiHR: The North West



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**Table 3.2: List of Assets: The North West**

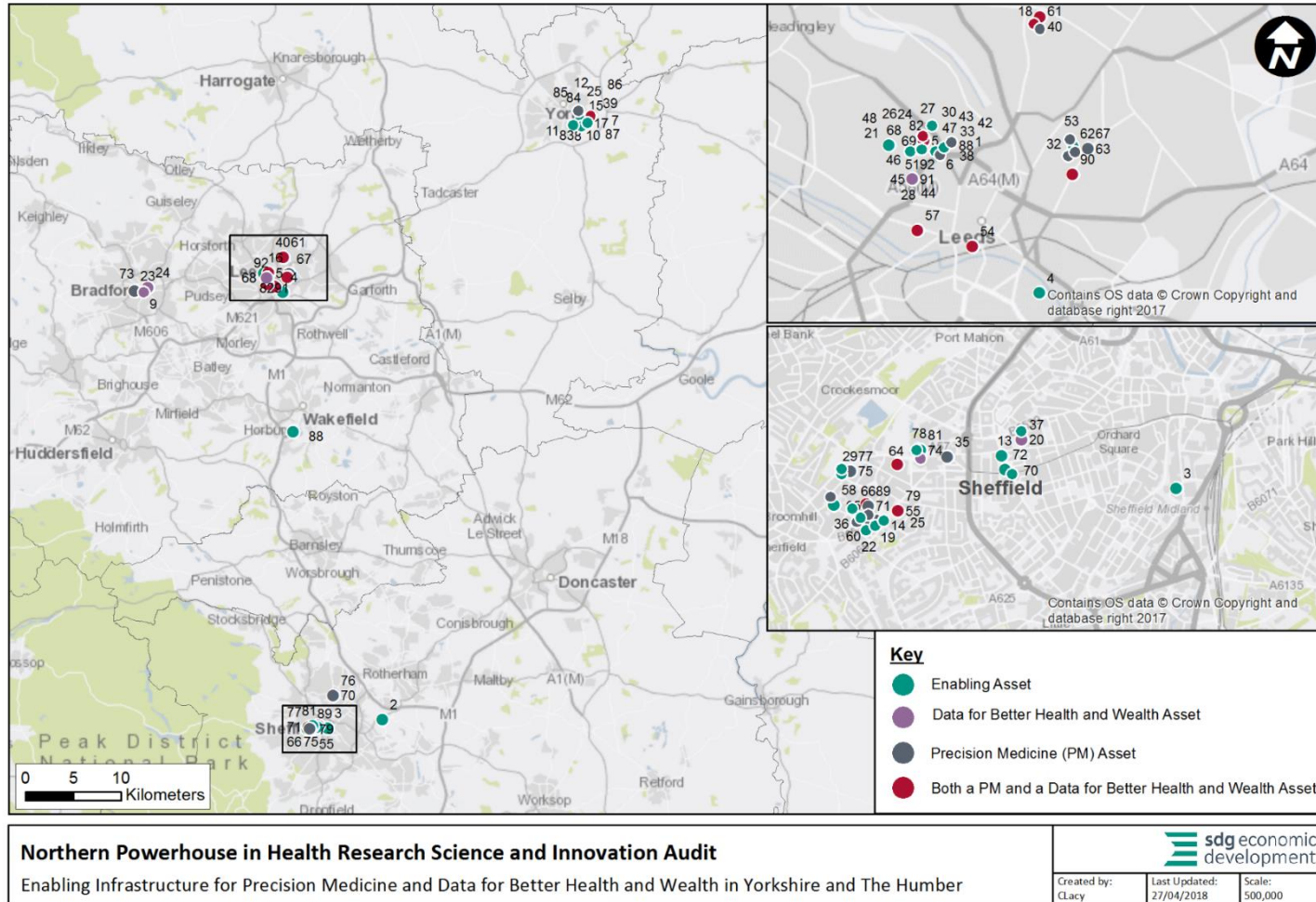
No.	Name	Asset Type
1	Academic Centre of Excellence in Cyber Security Research (Lancaster University)	Data
2	Alderley Park	Enabling
3	Antimicrobial Resistance Centre (Alderley Park)	PM
4	Arthritis UK Centre of Excellence (Manchester)	Enabling
5	Cancer Research UK Liverpool Cancer Trials Unit	PM
6	Cancer Research UK Manchester Institute	PM
7	Cardiovascular Health and Care Interest Group (Liverpool John Moores University)	PM
8	Centre for Ageing Research (Lancaster University)	Both
9	Centre for Better Births (University of Liverpool)	Enabling
10	Centre for Biostatistics (University of Manchester)	Data
11	Centre for Genomic Research (Institute of Integrative Biology, University of Liverpool)	PM
12	Centre for Health and Inequalities Research (Lancaster University)	Enabling
13	Manchester Centre for Health Economics (University of Manchester)	Enabling
14	Centre for Health Informatics (University of Manchester)	Data
15	Centre for Musculoskeletal Research, The University of Manchester	PM
16	Centre for Nanomedicine (University of Liverpool)	PM
17	Centre for Preclinical Imaging (Institute of Translational Medicine, University of Liverpool)	Both
18	Centre for Proteome Research (Institute of Integrative Biology, University of Liverpool)	PM
19	Centre of Excellence in Infectious Disease Research (CEIDR) (Liverpool School of Tropical Medicine and University of Liverpool)	Both
20	Clinical Research Unit (Royal Liverpool Hospital)	Enabling
21	Clinical Trials Research Centre (University of Liverpool)	Enabling
22	Combining Health Information, Computation and Statistics (CHICAS) (Lancaster Medical School, Lancaster University)	Data
23	Consumer Data Research Centre (CDRC)	Data
24	CRUK Lung Cancer Centre of Excellence (University of Manchester)	Both
25	Data Science Institute (Lancaster University)	Data
26	Department of Biostatistics (University of Liverpool)	Data
27	Department of Computer Science (University of Liverpool)	Data
28	Department of Mathematics and Statistics (Lancaster University)	Data
29	Department of Musculoskeletal Biology (Institute of Ageing and Chronic Disease, University of Liverpool)	Enabling
30	EPSRC Liverpool Centre for Maths in Healthcare	Data
31	Experimental Cancer Medicine Centres (Alder Hey Children's Hospital)	Enabling
32	Experimental Cancer Medicine Centres (Christie Hospital NHS Foundation Trust)	Enabling
33	Experimental Cancer Medicine Centres (Liverpool Experimental Cancer Medicine Centre)	Enabling
34	Hartree Centre	Data
35	Health Innovation Manchester (HinM)	Enabling
36	Innovation Agency (NWC AHSN)	Enabling
37	Institute of Infection and Global Health (University of Liverpool)	Both
38	Institute of Social Futures (Lancaster University)	Enabling

39	Lancashire and Cumbria Innovation Alliance (LCIA) NHS England Test Bed	PM
40	Lancashire Clinical Research Facility	Enabling
41	Lancaster Health Hub (Lancaster University)	Enabling
42	Lancaster Health Innovation Campus (Lancaster University)	Enabling
43	Liverpool and Lancaster Universities Collaboration for Public Health Research (LiLaC) (Lancaster University)	Enabling
44	Liverpool and Lancaster Universities Collaboration for Public Health Research (LiLaC) (University of Liverpool)	Enabling
45	Liverpool Bio-Innovation Hub (LBIH) Biobank (University of Liverpool)	Enabling
46	Liverpool Clinical Laboratories	Enabling
47	Liverpool Health Inequalities Research Institute (LivHIR)	Enabling
48	Liverpool Health Partners	Enabling
49	Liverpool Neuroscience Group (University of Liverpool)	PM
50	Liverpool NIHR Medicines for Children Research Network (Faculty of Health and Life Sciences, University of Liverpool and Liverpool PCT)	Both
51	Liverpool Regenerative Medicine Network (University of Liverpool)	PM
52	Liverpool School of Tropical Medicine	PM
53	Manchester Academic Health Science Centre Technology Hub: Clinical Proteomics Centre for Stratified Medicine	Both
54	Manchester Centre for Genomic Medicine	Both
55	Manchester Molecular Pathology Innovation Centre (MMPaThIC) (University of Manchester)	PM
56	Materials Innovation Factory (University of Liverpool)	Enabling
57	Materials Science Institute (Lancaster University)	Enabling
58	Medical and Pharmaceutical Statistics (MPS) Research Unit (Lancaster University, MRC North West Hub)	PM
59	Medical Data Solutions and Services (MDSAS)	Data
60	Medicines Discovery Catapult (Alderley Park)	Both
61	MRC Arthritis UK Research Centre for Integrated Research into Musculoskeletal Ageing (CIMA) (University of Liverpool)	Both
62	MRC Centre for Drug Safety Science (University of Liverpool)	Both
63	MRC North West Hub for Trial Methodology Research (University of Liverpool)	Enabling
64	MRC North West Hub for Trials Methodology Research (Lancaster University)	Enabling
65	MRC North West Hub for Trials Methodology Research (University of Manchester)	Enabling
66	National Centre for Text Mining (NaCTeM) (University of Manchester)	Data
67	National Graphene Institute	Enabling
68	National Headquarters for Children's Research (Alder Hey Hospital)	Enabling
69	NHS Blood and Transport Tissue Banking Facility	Enabling
70	NIHR Alder Hey Clinical Research Facility (CRF)	PM
71	NIHR Clinical Research Network Greater Manchester	Enabling
72	NIHR Clinical Research Network North West Coast	Enabling
73	NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC - Manchester)	Enabling
74	NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC - North West Coast)	Enabling

75	NIHR Greater Manchester Patient Safety Translational Research Centre (Greater Manchester PSTRC)	Enabling
76	NIHR Health Protection Research Unit in Emerging and Zoonotic Infections (University of Liverpool, LSTM)	PM
77	NIHR Health Protection Research Unit in GI Infections (University of Liverpool)	Both
78	NIHR Manchester Biomedical Research Centre	Both
79	NIHR Manchester Respiratory & Allergy Clinical Research Facility	Both
80	NIHR Patient Safety Translational Research Centre	Both
81	NIHR/Wellcome Trust Manchester Clinical Research Facility	Enabling
82	North West Cancer Research UK Centre (University of Liverpool)	PM
83	North West England Medical Research Council Clinical Research Training Fellowship in Clinical Pharmacology and Therapeutics (University of Liverpool)	Enabling
84	North West England Medical Research Council Clinical Research Training Fellowship in Clinical Pharmacology and Therapeutics (University of Manchester)	Enabling
85	Prostate Cancer UK Centre of Excellence (Christie NHS Foundation Trust)	PM
86	Proton Beam Therapy Centre (Christie NHS Foundation Trust)	PM
87	School of Computer Science (University of Manchester)	Data
88	Sci-Tech Daresbury	Data
89	Security Lancaster (Lancaster University)	Data
90	Sensor City (University of Liverpool & LJMU)	Enabling
91	Stoller Biomarker Discovery Centre (SBDC) (Central Manchester University Hospitals NHS Foundation Trust)	PM
92	Stoller Biomarker Discovery Centre (SBDC) (CityLabs Manchester)	PM
93	Stoller Biomarker Discovery Centre (SBDC) (University of Manchester)	PM
94	STOR-i Centre for Doctoral Training (Departments of Mathematics and Statistics and Department of Management Science, Lancaster University)	Enabling
95	The Health eResearch Centre (Farr Institute of Health Informatics Research)	Data
96	UK Centre of Excellence for Childhood Lupus (Alder Hey)	PM
97	UK Experimental Arthritis Treatment Centre for Children (University of Liverpool)	PM
98	Virtual Engineering Centre	Enabling
99	Wolfson Centre for Personalised Medicine	PM



Figure 3-3: Asset Map for NPiHR: Yorkshire and the Humber



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**Table 3.3: List of Assets: Yorkshire and The Humber**

No.	Name	Asset Type
1	Advanced Imaging Centre (Leeds Institute of Cardiovascular and Metabolic Medicine, Faculty of Medicine and Health, University of Leeds)	Both
2	Advanced Manufacturing Research Centre (AMRC) (University of Sheffield)	Enabling
3	Advanced Wellbeing Research Centre	Enabling
4	Assisted Living Leeds	Enabling
5	Astbury Centre for Structural Molecular Biology	Data
6	Bio-imaging Facility (Faculty of Biological Sciences, University of Leeds)	PM
7	Biological Physical Sciences Institute (University of York)	Enabling
8	Bioscience Technology Facility (University of York)	Enabling
9	Born in Bradford (BiB)	Data
10	Born and Bred in Yorkshire (BaBY)	Data
11	Cancer Research Unit (University of York)	PM
12	Centre for Health Economics (University of York)	Enabling
13	Centre for Assistive Technology and Connected Healthcare (CATCH) (University of Sheffield)	Enabling
14	Centre for Genome Translation (University of Sheffield)	Both
15	Centre for Hyperpolarisation in Magnetic Resonance (CHyM) (University of York)	Enabling
16	Centre for Immunology and Infection, (University of York)	Both
17	Centre for Reviews and Dissemination (University of York)	Enabling
18	Centre of Excellence in Rheumatology (Leeds Institute of Rheumatic and Musculoskeletal Medicine University of Leeds)	PM
19	Centre of Excellence in Rheumatology (Sheffield Teaching Hospitals NHS Foundation Trust)	PM
20	Chemical Engineering at the Life Science Interface (ChELSI) (University of Sheffield)	Enabling
21	Clothworkers' centre for textile materials innovation for healthcare (University of Leeds)	Enabling
22	Devices for Dignity (D4) (NIHR Medtech and In vitro diagnostics Co-operative (MIC), Hosted by Sheffield Teaching Hospitals NHS Foundation Trust)	Enabling
23	DHEZ Academic	Data
24	Digital Catapult Centre Yorkshire	Data
25	Donald Heath Sheffield – pulmonary hypertension research (Sheffield Teaching Hospitals NHS Foundation Trust and University of Sheffield)	Both
26	EPSRC Centre for Doctoral Training in Tissue Engineering and Regenerative Medicine (University of Leeds)	Enabling
27	EPSRC Centre for Innovative Manufacturing in Medical Devices	Enabling
28	ESPRC Consumer Data Research Centre (LIDA, University of Leeds)	Data
29	Experimental Cancer Medicine Centres (Cancer Clinical Trials Centre)	Enabling
30	Flow Cytometry and Cell Sorting Facility (Faculty of Biological Sciences, University of Leeds)	PM
31	Genomics Central Laboratory Hub (GCLH)	PM
32	Haematological Malignancy Diagnostic Service	PM
33	Haematological Malignancy Research Network (HMRN) (University of York)	PM
34	Hull York Medical School	Enabling
35	Imagine: Imaging Life (University of Sheffield)	PM
36	Infectious Disease Unit (Sheffield Teaching Hospitals NHS Trust)	PM



37	INSIGNEO Institute for in silico medicine (University of Sheffield)	Data
38	Institute of Medical and Biological Engineering (University of Leeds)	Both
39	Jack Birch Centre for Molecular Carcinogenesis, University of York	PM
40	Leeds Biomedical Research Centre	Both
41	Leeds Cancer Centre	PM
42	Leeds Centre for Personalised Medicine and Health (Leeds Academic Health Partnership)	PM
43	Leeds Electron Microscopy and Spectroscopy Centre (University of Leeds)	Enabling
44	Leeds Institute for Data Analytics (LIDA) (University of Leeds)	Data
45	Leeds Institute of Biomedical & Clinical Sciences (School of Medicine, University of Leeds)	Both
46	Leeds Institute of Clinical Trials Research	Both
47	Leeds Institute of Cancer and Pathology (University of Leeds)	PM
48	Leeds Omics (University of Leeds)	PM
49	Medical Technologies Innovation and Knowledge Centre (University of Leeds)	Enabling
50	MRC Arthritis UK Research Centre for Integrated Research into Musculoskeletal Ageing (CIMA) (University of Sheffield)	Both
51	MRC Medical Bioinformatics Centre (MBC) (LIDA, University of Leeds)	Data
52	National Audit of Cardiac Rehabilitation (NACR)	Data
53	Next Generation Sequencing Facility (University of Leeds)	PM
54	NHS Digital	Both
55	NIHR Biomedical Research Centre (Sheffield Teaching Hospitals NHS Foundation Trust, University of Sheffield)	Both
56	NIHR Children's and Young People Med-tech co-operative (Sheffield Children's NHS Foundation Trust)	Both
57	NIHR Clinical Research Network National Coordinating Centre (CRNCC)	Both
58	NIHR Clinical Research Network Yorkshire & Humber	Enabling
59	NIHR Clinical Trials Research Unit (University of Sheffield)	Enabling
60	NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC - Yorkshire & Humber)	Enabling
61	NIHR Leeds Biomedical Research Centre (Leeds Teaching Hospitals NHS Trust and the University of Leeds)	Both
62	NIHR Leeds Clinical Research Facility	Enabling
63	NIHR Leeds In Vitro Diagnostic Co-operative	PM
64	NIHR MedTech and Invitro Diagnostic Cooperative (MIC) for Children and Young People (Sheffield Children's NHS Foundation Trust)	Both
65	NIHR Sheffield Biomedical Research Centre (Sheffield Teaching Hospitals NHS Foundation Trust and the University of Sheffield)	PM
66	NIHR Sheffield Clinical Research Facility (Sheffield Teaching Hospitals NHS Foundation Trust)	Enabling
67	NIHR Surgical MedTech Co-operative	PM
68	NIHR Trainees National Coordinating Centre (Leeds Innovation Centre)	Enabling
69	NIHR Yorkshire and Humber Patient Safety Translational Research Centre	Enabling
70	Northern General Hospital Clinical Research Facility	Enabling
71	POLARIS (Pulmonary, Lung and Respiratory Imaging Sheffield, University of Sheffield)	PM
72	School of Health and Related Research (SchARR) (University of Sheffield)	Enabling
73	School of Pharmacy and Medical Sciences (University of Bradford)	PM

74	Sheffield Bioinformatics Hub (University of Sheffield)	Data
75	Sheffield Cancer Clinical Trials Centre	Enabling
76	Sheffield Diagnostic Genetics Service	PM
77	Sheffield Experimental Cancer Medicine Centre (Sheffield Teaching Hospitals NHS Foundation Trust, University of Sheffield)	PM
78	Sheffield Healthcare Gateway (University of Sheffield)	Enabling
79	Sheffield Institute for Translational Neuroscience (SITraN) (University of Sheffield)	Both
80	Sheffield NIHR Research Design Services	Enabling
81	The Florey Institute (University of Sheffield)	Enabling
82	Wellcome Trust/EPSRC Centre of Excellence in Medical Engineering (University of Leeds)	Both
83	York Centre for Cross-disciplinary Systems Analysis (University of York)	Data
84	York Health Economics Consortium (University of York)	Enabling
85	York Neuroimaging Centre (University of York)	Enabling
86	York Structural Biology Laboratory (University of York)	Enabling
87	York Trials Unit	
88	Yorkshire and Humber Academic Health Science Network	Enabling
89	Yorkshire and Humber Genomic Medicine Centre	PM
90	Yorkshire Cancer Centre	Both
91	Yorkshire Cancer Research Centre for Early Phase Clinical Trials/ Leeds Institute of Clinical Trials Research (University of Leeds)	Both
92	Yorkshire Centre for Health Informatics	Data

**Table 3.4: List of Assets: NHS Foundation Trusts in the North**

Aintree University Hospital NHS Foundation Trust
Airedale NHS Foundation Trust
Alder Hey Children's NHS Foundation Trust
Barnsley Hospital NHS Foundation Trust
Blackpool Teaching Hospitals NHS Foundation Trust
Bolton NHS Foundation Trust
Bradford District Care NHS Foundation Trust
Bradford Teaching Hospitals NHS Foundation Trust
Bridgewater Community Healthcare NHS Foundation Trust
Burton Hospitals NHS Foundation Trust
Calderdale and Huddersfield NHS Foundation Trust
Cheshire and Wirral Partnership NHS Foundation Trust
The Christie NHS Foundation Trust
City Hospitals Sunderland NHS Foundation Trust
The Clatterbridge Cancer Centre NHS Foundation Trust
Countess of Chester Hospital NHS Foundation Trust
County Durham and Darlington NHS Foundation Trust
Cumbria Partnership NHS Foundation Trust
Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust
Gateshead Health NHS Foundation Trust

Greater Manchester Mental Health NHS Foundation Trust
Harrogate and District NHS Foundation Trust
Humber NHS Foundation Trust
Lancashire Care NHS Foundation Trust
Lancashire Teaching Hospitals NHS Foundation Trust
Leeds and York Partnership NHS Foundation Trust
Liverpool Heart and Chest Hospital NHS Foundation Trust
Liverpool Women’s NHS Foundation Trust (Lead for the NHS North West Coast NHS Genomic Medicine Centre)
Manchester University NHS Foundation Trust (Lead for the NHS Greater Manchester NHS Genomic Medicine Centre and member of the Shelford Group)
Mersey Care NHS Foundation Trust
Mid Cheshire Hospitals NHS Foundation Trust
The Newcastle upon Tyne Hospitals NHS Foundation Trust (Lead for the NHS North East and North Cumbria NHS Genomic Medicine Centre and member of the Shelford Group)
North East Ambulance Service NHS Foundation Trust
North Tees and Hartlepool NHS Foundation Trust
North West Anglia NHS Foundation Trust
North West Boroughs Healthcare NHS Foundation Trust
Northumberland, Tyne and Wear NHS Foundation Trust
Northumbria Healthcare NHS Foundation Trust
Pennine Care NHS Foundation Trust
Rotherham Doncaster and South Humber NHS Foundation Trust
The Rotherham NHS Foundation Trust
Salford Royal NHS Foundation Trust
Sheffield Children’s NHS Foundation Trust
Sheffield Health & Social Care NHS Foundation Trust
Sheffield Teaching Hospitals NHS Foundation Trust (Lead for the NHS Yorkshire and Humber NHS Genomic Medicine Centre and member of the Shelford Group)
South Tees Hospitals NHS Foundation Trust
South Tyneside NHS Foundation Trust
South West Yorkshire Partnership NHS Foundation Trust
Stockport NHS Foundation Trust
Tameside and Glossop Integrated Care NHS Foundation Trust
Tees, Esk and Wear Valleys NHS Foundation Trust
University Hospitals of Morecambe Bay NHS Foundation Trust
The Walton Centre NHS Foundation Trust
Warrington and Halton Hospitals NHS Foundation Trust
Wirral Community NHS Foundation Trust
Wirral University Teaching Hospital NHS Foundation Trust
Wrightington, Wigan and Leigh NHS Foundation Trust
York Teaching Hospital NHS Foundation Trust

Source: NHS Foundation Trust Directory

**Table 3.5: List of Northern Science Parks, Incubators and Accelerators**

Name	Area	Type of Asset	Sector
3M Buckley Innovation Centre (3MBIC)	Huddersfield	Incubator	Life Sciences / Other Deep-tech / Other Digital technology
Advanced Manufacturing Park	Rotherham	Science Park	No particular sectoral focus
Advanced Manufacturing Research Centre (AMRC) Group	Sheffield	Science Park	No particular sectoral focus
Alderley Park (including BioHub)	Cheshire	Science Park	No particular sectoral focus
Ambleside Rural Growth Hub	Cumbria	Coworking space plus	No particular sectoral focus
Ashton Old Baths Innovation Centre	Tameside	Incubator	Creative Industries and Design
Atlantic Business Centre, Altrincham	Altrincham	Coworking space	No particular sectoral focus
Beautiful Ideas (Liverpool)	Liverpool	Accelerator	Social Enterprise
Beautiful Ideas (Salford)	Salford	Accelerator	Social Enterprise
Bioscience Incubator	Bradford	Incubator	Life sciences
Business Growth Hub	Manchester	Other	No particular sectoral focus
Business Sparks	Newcastle	Other	No particular sectoral focus
C4DI – Centre for Digital Innovation	Hull	Incubator	Leisure / Health and Wellbeing / Engineering and Manufacturing
Carlisle Business Interaction Centre	Carlisle	Other	No particular sectoral focus
Cloud Innovation Centre	Newcastle	Incubator	Other Digital Technology
Community Enterprise Centre	Blyth	Coworking space	No particular sectoral focus
CSIT Labs	Carcroft	Accelerator	Cyber security
Daresbury Science and Innovation Campus	Daresbury	Science Park	No particular sectoral focus
Digital Exchange	Bradford	Incubator (University Enterprise Zone)	Health and wellbeing
Dotforge Impact (Leeds)	Leeds	Accelerator	Social Enterprise
Dotforge Impact (Manchester)	Manchester	Accelerator	Social Enterprise
Dotforge Impact (Sheffield)	Sheffield	Accelerator	Social Enterprise
Enterprise and Innovation Hub	Leeds	Incubator	No particular sectoral focus
Enterprise Place	Sunderland	Incubator	Creative Industries and Design / Other Digital Technology
Excelerate Labs	Manchester	Accelerator	B2B
Excelerate Labs	Liverpool	Accelerator	B2B
Genesis	Cudworth	Incubator	No particular sectoral focus
Genesis	Cudworth	Incubator	No particular sectoral focus
Glue Accelerator	Sunderland	Accelerator	Smart cities
High Growth Centre	Chester	Incubator	Engineering and Manufacturing / Transport / Energy and the Environment
Ignite Accelerator (Manchester)	Manchester	Accelerator	Other Digital Technology

Name	Area	Type of Asset	Sector
Ignite Accelerator (Newcastle)	Newcastle	Accelerator	Other Digital Technology
Ignite Pre-accelerator (Manchester)	Manchester	Pre-accelerator	Other Digital Technology
Ignite Pre-accelerator (Newcastle)	Newcastle	Pre-accelerator	Other Digital Technology
Industry 4.0 Accelerator	Teeside	Unknown	Other Digital Technology
Innospace	Manchester	Incubator	No particular sectoral focus
Innovation Accelerator	Teesside	Coworking space	Life sciences / Other Deep-tech
Innovation Programme	Sunderland	Incubator	No particular sectoral focus
InTechnology Enterprise incubator	Leeds	Incubator	No particular sectoral focus
I-TAC Labs	Warrington	Incubator	Life Sciences / Energy and the Environment / Space and Satellite technology / Other Deep-tech
JD Works 2017	Manchester	Accelerator	B2B / Other Digital Technology
Kroto Innovation Centre	Sheffield	Incubator	Engineering and Manufacturing / Other Deep-tech
Lancaster Science Park	Lancaster	Science Park	No particular sectoral focus
Launch22 (Liverpool)	Liverpool	Incubator	No particular sectoral focus
Leeds Hatchery	Leeds	Accelerator	No particular sectoral focus
Leeds Innovation Centre	Leeds	Science Park	No particular sectoral focus
Listerhills Science Park	Bradford	Science Park	No particular sectoral focus
Liverpool Innovation Park	Liverpool	Science Park	No particular sectoral focus
Liverpool Life Sciences Accelerator	Liverpool	Incubator	Life sciences / Health and wellbeing
Liverpool Science Park	Liverpool	Science Park	No particular sectoral focus
MadLab Arts & Tech Accelerator	Manchester	Accelerator	Creative Industries and Design
Manchester Hatchery	Manchester	Accelerator	No particular sectoral focus
Manchester Incubator Building	Manchester	Incubator	Life Sciences
Manchester Science Park	Manchester	Science Park	No particular sectoral focus
MedTech Incubator	Manchester	Incubator	Health and wellbeing
MerseyBio	Liverpool	Science Park	No particular sectoral focus
MerseyBIO Business Incubator	Liverpool	Incubator	Life Sciences
Newcastle Bio Incubator	Newcastle	Incubator	Life sciences
Newcastle Hatchery	Newcastle	Accelerator	No particular sectoral focus
Newlands Science Park	Hull	Science Park	No particular sectoral focus
North East Space Incubation Programme - by Business Durham	Sedgefield	Incubator	Space and Satellite technology
North East Technology Park/ NETPark	Durham	Science Park	No particular sectoral focus
North East Workspace	Newcastle	Coworking space plus	No particular sectoral focus

Name	Area	Type of Asset	Sector
North of England Life Science Accelerator	Cheshire	Accelerator	Life sciences / Health and wellbeing
NoWFOOD Centre	Chester	Incubator	Food
ODI Startup Accelerator (Leeds)	Leeds	Accelerator	Other Digital Technology
ODI Startup Accelerator (Leeds)	Leeds	Accelerator	No particular sectoral focus
Open Future_ North	Oldham	Accelerator	Other Digital Technology
Origin	Salford	Incubator	No particular sectoral focus
Pioneer 10	Stockport	Accelerator	No particular sectoral focus
Riverside Innovation Centre	Chester	Incubator	No particular sectoral focus
Sci-Tech Daresbury	Warrington	Science Park	No particular sectoral focus
Sci-Tech Daresbury	Warrington	Incubator	Other Digital Technology / Engineering and Manufacturing / Life Sciences / Health and Wellbeing / Energy and the Environment
Searchcamp	Middlesbrough	Accelerator	Other Digital Technology
Sheffield Technology Park	Sheffield	Science Park	No particular sectoral focus
SLP Manchester	Manchester	Other	No particular sectoral focus
Social Impact Accelerator	Lancashire	Other	Social Enterprise
SparkUp	Liverpool	Incubator	No particular sectoral focus
St Peter's Gate Science Park	Newcastle	Science Park	No particular sectoral focus
Start-up Hatchery	Newcastle	Coworking space plus	No particular sectoral focus
Startup Launchpad Programme	Rotherham	Other	No particular sectoral focus
STEP Space Business Incubation	Warrington	Incubator	Space and Satellite technology
STFC CERN Business Incubation Centre	Warrington	Incubator	Other Deep-tech
Stockport Business & Innovation Centre	Stockport	Incubator	No particular sectoral focus
Studio: 505	Sheffield	Coworking space plus	Creative Industries and Design
Sunderland Science Park	Sunderland	Science Park	No particular sectoral focus
Sunderland Software City/Digital Catapult	Sunderland	Other	Transport / Other Digital Technology
Teesside LaunchPad	Teesside	Accelerator	No particular sectoral focus
The Enterprise Team - The Duke of York Young Entrepreneur Centre	Huddersfield	Incubator	No particular sectoral focus
The Hatchery	Sheffield	Coworking space plus	No particular sectoral focus
The Heath Business and Technical Park	Runcorn	Science Park	No particular sectoral focus
The Leeds Accelerator	Leeds	Accelerator	Health and wellbeing / Social Enterprise
The Northern Lights Business Incubation Unit	Lancashire	Incubator	No particular sectoral focus

Name	Area	Type of Asset	Sector
The Phoenix Centre	York	Other	No particular sectoral focus
The Sheffield Bioincubator	Sheffield	Science Park	No particular sectoral focus
UBC Creative Fashion and Textile Hub	Leeds	Incubator	Creative Industries and Design
UBC Halifax	Halifax	Incubator	No particular sectorial focus
UBC Leeds Digital Hub	Leeds	Incubator	Other Digital Technology
UKSE Y Accelerator	Sheffield	Accelerator	Engineering and Manufacturing
University of York Enterprise Support	York	Incubator	No particular sectoral focus
Up Accelerator	Manchester	Active seed / VC	Other Digital Technology / B2B
WB100	Sheffield	Incubator	No particular sectoral focus
Westlakes Science Park	Cumbria	Science Park	No particular sectoral focus
Women's International Centre for Economic Development (WICED) / 54 St James Street	Liverpool	Incubator	No particular sectoral focus
York Science Park	York	Science Park	No particular sectoral focus
Young Founders (Newcastle)	Newcastle	Pre-accelerator	No particular sectoral focus

Source: SDG-ED, NHSA and Business incubators and accelerators UK director

**Table 3.6: Life Science and Health Data Businesses in the North, non-exhaustive**

Advanced Digital Innovation Ltd
AIMES Grid Services Ltd
Alcyomics
Allscripts
Aridhia
Arquerdiagnostics
Biosignatures
Changing Health
Cisco Systems
Citrus Suite
CSC
Damibu
Datatrial Ltd
EMIS Health Ltd
Gendius
Glythera
Hitachi EU
IBEX
InHealthcare
Intel
InterSystems

Kromek
Medical Data Solutions and Services (MDSAS)
Microsoft
Msoft
New Cells Biotech
Nonlinear Dynamics
NorthWest EHealth (NWEH)
Orcha
PC-MIS
Polyphotonix
Quantum DX
Quaenam
RedNinja Studios
Reprocell
Rescon Technologies
Sciformix Europe
Sensapharm
Telefonica
Totallab
TPP Ltd
Tunstall Healthcare (UK) Ltd
UKFast
UK Cloud
X-Lab Limited

Source: NHSA

**Table 3.7: Precision Medicine Businesses in the North, non-exhaustive**

Abtek Biologicals Ltd
Advanced Medical Solutions
Agenda 1 analytical Services Ltd
Alere Limited
Associates of Cape Cod International Inc.
Astec Ltd
Avacta Ltd
Baxter Healthcare
Bio Alternative Medical Devices
Bioanalytical Technologies Ltd
Biofortuna Ltd
Biomer Ltd
BiOracle



BioSignatures Ltd  
Butters Innovation Ltd  
Byotrol Ltd  
Collect Biotech Ltd  
Chiesi Ltd  
Credent Medical  
Cytos Ltd  
Delta Diagnostics/Elucigene  
Dialog Devices  
Drew Scientific Co Limited  
Eden Biodesign Ltd  
Elanco Ltd (Lilly)  
Eli Lilly  
Elucigene Diagnostics  
Epistem Ltd  
Euprotech Ltd  
Frazer Nash Consultancy  
GE Healthcare  
Gentronix Ltd  
Global Biodiagnostics Ltd  
Glythera  
Hart Biologics Ltd  
Hologic / Tepnel Pharma Services  
Hydra Polymers  
IF Sensing  
Imagen Biotech Ltd  
Intercytex Ltd  
Invitrogen  
Kanichi Research Ltd  
Kershaw Technology Services  
Lab M  
Mast Group Ltd  
Medalytix (Group) Ltd  
Medimmune Ltd  
Microvisk Technologies  
MIDS Medical  
NewGene Limited  
PalindromX Ltd  
Peakdale Molecular Ltd  
Pharmapac  
Precision Medicines

Premaita Health Ltd
Pro-Lab Diagnostics Ltd
Promega Health Ltd
Qiagen
QuantuMDx Group Ltd
Reacta Biotech
RedX Pharma
Sensam
Sigma-Aldrich
Spectromics
Spheritech Ltd
Watson Pharmaceuticals
Wheatsheef Investments
Zilico

**Table 3.8: Recent major tech-intensive business investments relevant to Data for Better Health and Wealth and Precision Medicine**

LEP	Title	Description	Date
North East	Kromek	Manufacturer of radiation detection devices for use in various sectors using CZT. Moved out of NETPark Incubator to its own premises in 2010. Kromek was a spin out of Durham University and not an II	2010
North East	New Cells	Experts in the production of induced pluripotent stem cells (iPSCs) to provide customers engaged in drug discovery, pre-clinical development and disease mechanism investigation, with the best quality cells and services. Total value: £1.5m	2018
North East	Alcyomics	unique non-artificial human in vitro skin tests predicting hypersensitivity responses to pharmaceuticals, chemicals and cosmetics.	
North East	Polyphotonix	Polyphotonix designs and markets the Noctura 400 sleep mask to prevent and treat macular degeneration caused by diabetes. Until it becomes profitable it continues to invest in R&D and commercialising its innovations which began with its incorporation in 2008.	
North East	Arquerdiagnostics	development and commercialisation of highly accurate minichromosome maintenance (MCM) protein based non-invasive tests for cancer diagnosis and monitoring. Total value £2.1m	2017
North East	Glythera	Glythera, an emerging biopharmaceutical company specialising in protein/peptide functionalisation and glycosylation. Total value £2m	2014
North East	Biosignatures	Biosignatures has the capability to reliably discover multiple protein-based disease diagnostics	
North East	Quantum DX	Life science tools and diagnostics company. Total value 12m USD	2018

LEP	Title	Description	Date
North East	Total labs	Supporting your research in proteomics, genomics, biochemistry, microbiology, environmental biology, bioprocessing, agricultural and food science. (Netpark)	
North East	IBEX	IBEX-equipped X-ray detectors effectively classify both materials and thickness changes in a sample to deliver improved medical diagnostic imaging as well as detection of impurities, defects and threats. 2018 move onto NET Park Explorer site Total value £1.9m, 1.6m euro	2014- NE Technology fund 2017- Horizon 2020 grant
North East	Reprocell	Reprocell japan acquired Reinnervate in 2014 and brought new and additional management to NETPark. The company makes 3D cell culture products which allow researchers to accelerate research in stem cells, human tissue and 3D cell culture.	2014
North East	Datatrial	Clinical trial data platform	2016
North East	Bristol Laboratories	Pharma manufacturer setting up a plant in Peterlee for solid dose generics. Generated 347 jobs of which 137 were at graduate or postgraduate level. Total value £25m	2014
North East	Neurexpert	Contract research organization providing specialist electrophysiology and neuroscience expertise and solutions to aid drug discovery and academic research for targets such as GPCRs, ion channels and transporters. Relocated from London to be closer to Newcastle University.	2017
North East	TUS Park	Life sciences (amongst other sectors) incubator with China focus. This can accommodate 70+ individuals. <a href="https://www.chroniclelive.co.uk/business/business-news/newcastle-office-block-become-major-13152719">https://www.chroniclelive.co.uk/business/business-news/newcastle-office-block-become-major-13152719</a>	2017
North East	Accord Healthcare	Accord Healthcare is a young and dynamic pharmaceutical company, involved in the development, manufacturing and distribution of pharmaceutical products to more than 70 countries globally. OTC manufacture. Plans to carry out development activity on Fawdon, Newcastle site.  Opened with 60 staff, plans to expand this to 200+ - Site refurbished as part of 5-year multi million-pound investment	2017
North East	PHMR	Experts in health economics, pricing and reimbursement. Based at the Core, Science Central Unknown (c.15 staff)	2014
North East	Non-linear Dynamics	Visualise and analyse complex LC-MS data to support 'omics research	2014
North East	Geneius Labs	DNA investigation and analysis. "Geneius' unique DNA sequencing technology offers the most powerful tool for the rapid and precise identification of all bacteria, yeasts and moulds to sub species level."	2014
North East	NorthGene	DNA paternity and relationship testing for peace of mind, legal, immigration and forensic cases. Cell line authentication and drug & alcohol testing.	2014

LEP	Title	Description	Date
North East	IBEX	IBEX-equipped X-ray detectors effectively classify both materials and thickness changes in a sample to deliver improved medical diagnostic imaging as well as detection of impurities, defects and threats.  2018 move onto NET Park Explorer site	2014- NE Technology fund 2017- Horizon 2020 grant
Liverpool City Region	Proton Partners International/Rutherford Group	Cancer treatment centre (proton therapy) for precision treatment of cancer (£35 m). Related Rutherford Diagnostics investment to enhance precision of treatment and collaborative research with UoL Physics (£1 m)	From 2017
Liverpool City Region	MAST Group	Diagnostics company – investment in new facilities. Supported in part by Regional Growth Fund	
Liverpool City Region	Vitaflor (Nestle Group)	Significant investment in Liverpool’s Vitaflor, which makes precision nutritional products for people with genetic condition. Vitaflor is one of the UK’s most successful start-up companies and was acquired by Nestle.	
Liverpool City Region	ConcertCare	Investment from US SME	
Liverpool City Region	Baltic Triangle Redevelopment	Approximately £200m development including public and private sources in Liverpool. Baltic is home to many of region’s digital health companies/e-health Cluster. Future development going forward.	
Liverpool City Region	Nutricia Liverpool	<a href="https://www.nutriciaresearch.com/about/who-we-are/our-global-presence/nutricia-research-liverpool/">https://www.nutriciaresearch.com/about/who-we-are/our-global-presence/nutricia-research-liverpool/</a>	
Greater Manchester	Chiesi	UK HQ in Manchester, 2 other UK based offices in Oxford and Chippenham. Created revenues of €213 million1 in 2016 and a record of vigorous growth, Chiesi Ltd. aspires to be the largest affiliate in the Chiesi group.	2016/17
Greater Manchester	D-Wise	D-Wise already have a presence in Manchester after landing in 2014. They have an office in Peter House and currently have 3 FTE. They will have approx. 20 employees in the UK by the end of the year.	2016
Greater Manchester	Carbogen Amcis	Dishman continue to invest in Carbogen Amcis site and the business continues to expand but the site is now reaching capacity  Background is: Dishman Pharmaceuticals & Chemicals have registered in the UK by name Dishman Europe Ltd. Dishman Europe Ltd have a sales office in London with about 15 people and a manufacturing unit in Manchester with about 60 people. Dishman Europe Ltd acquired Synprotec, Manchester-based contract research and manufacturing company in 2005.  Dishman Pharmaceuticals & Chemicals has turnover of £150 m and about 2500 people in India and 500 people in Europe (Netherlands, Switzerland and the United Kingdom). Out of 500 people in Europe, 75 are in the United Kingdom.  Current project has created 13 jobs over the last 2 years and further growth of 10% per annum is expected over the next three years.	2014

LEP	Title	Description	Date
Greater Manchester	Premaitha Health	Premaitha have already had one enquiry closed when they achieved 20 staff with corridor growth fund. Since then Premaitha have continued to expand beyond original expectations after an acquisition and aim listing. New projection on 3-year staffing is now 40 jobs so new project is opened and will be closed to reflect this. MIDAS continue to offer support to Premaitha. Most recently we have featured Premaitha as a video case study for mutual benefit. First Premaitha project due for launch Q1. Additional premises have been taken on science Park in Enterprise house (in addition to Rutherford house facility. Numbers at last visit already up to around 2	2015
Greater Manchester	NorthWest EHealth	Provided the technology that enabled the success of the Salford Lung study and the only organisation in the world to have evaluated the safety and effectiveness of a pre-license medicine in a real-world setting.  Now a Manchester based SME that has grown rapidly and recently moved into The Bright Building as they continue to expand headcount and client base.	2016/17
Greater Manchester	Recipharm	Recent acquisitions and new contracts have resulted in likely expansion of existing business. Contact with this company is difficult. Many funding options have been sent along with other support options, but it is unclear if this support has been used. Project is now registered based on direct communication by mail from site manager. (Text embedded below) Action is to work with Tameside to see if we can achieve a confirmed assist around funding options sent.  'Yes we are very active in the acquisition arena at present and i do not expect this to be the only one for Recipharm.  As for this site we have won some major contracts and expect to double turnover in the next year or so complete with circa 60 new jobs and about £6m capex'.	2014

Source: NHS LEP partners

**Table 3.9: Recent major public-sector investments**

LEP	Title
North East	National Innovation Centre for Ageing -PM
North East	National Innovation Centre for Data-D
North East	CPI- Healthcare photonics-PM
North East	CPI-Formulation Centre- PM
North East	CPI-Sensors
North East	Science Central- Life Science Labs
Liverpool City Region	Connected Health Cities
Liverpool City Region	4x Global Digital Exemplars (Royal Liv, Alder Hey, Mersey Care, Arrowe Park)
Liverpool City Region	Liverpool Bioinnovation Hub
Liverpool City Region	Life Sciences Accelerator (details captured in LCR SIA?)
Liverpool City Region	Other digital/sensor investments captured in LCR SIA (to be included) – infection and computing/data focus (including Sensor City, Hartree £350 m investment etc)

LEP	Title
Liverpool City Region	MRC Centre for Drug Safety Science
Liverpool City Region	Wolfson Centre for Personalised Medicine
Liverpool City Region	Centre for Genomic Research
Liverpool City Region	UK Pharmacogenetics and Stratified Medicine Network
Liverpool City Region	GeCIP for stratified healthcare
Liverpool City Region	NIHR CRN Hub for stratified medicine hosted at UoL/Alder Hey
Liverpool City Region	H2020 pre-emptive genotyping programme
Liverpool City Region	Experimental Arthritis Treatment Centre Alder Hey
Liverpool City Region	NIHR Alder Hey Clinical Research Facility
Liverpool City Region	NIHR Royal Liverpool Clinical Research Unit
Liverpool City Region	Alder Hey Innovation Hub
Liverpool City Region	3 ERDF Programmes (Health Innovation Exchange, LCRActivate, LCR4.0)

Source: NHS A LEP partners

**Table 3.10: Pipeline investments**

LEP	Title	Description	Date
North East	National Innovation Centre for Ageing and National Innovation Centre for Digital	Newcastle University. Located in the same building at Newcastle Science Central. NICA works with research specialists, businesses and the public to facilitate the commercialisation of key products, services and technologies to help people live better, longer lives. NICD works with partners in industry, the public sector and academics to work on opportunities offered by the explosion in digital data. Total value is 50 million.	2017
North East	NIHR Innovation Observatory	Newcastle University. The NIHR Innovation Observatory will apply Big Data analytics tools, from text mining, machine learning and cognitive analytics to reveal global trends - and global needs - in health innovation collocated in the NICA/ NICD building. Total value is 10 million.	2017
North East	Centre for Doctoral Training in Digital Civics	Newcastle University will train more than 60 PhD students over the next nine years, exploring how digital technologies can be used to promote public participation in the design and delivery of local services, including education, public health and social care and planning.	2013 by ESPRC
North East	The Northern Alliance Advanced Therapies Treatment Centre (consortium of 15)	Will develop advanced and emerging therapies based on genes, cells and tissues. Led by Newcastle Hospitals NHS Foundation Trust (NUTH), the Centre is tasked with the delivery of advanced therapy to patients addressing issues around supply chain, manufacture and healthcare delivery. Total value is 9 million	2018
Liverpool City Region	Fresenius Kabi	Company that formulated nutritional and medicinal products for individual patients, with treatments delivered in the home setting. Mayor investment/job creation locally in pipeline	

LEP	Title	Description	Date
Liverpool City Region	Allergan	Potential for further development of site	
Greater Manchester	Carbogen Amcis	Current manufacturing site has reached full capacity, looking to purchase additional land on existing site. Alternatively, will consider another location in Manchester (considering Alderly Park) anticipate year on year growth in headcount of 10%. Could be greater if new location can be secured. Property options being prepared for client.	2019/20
Greater Manchester	Qiagen	Details of future expansion announced in Sector Deal.	2018/20
Greater Manchester	Leidos	<ul style="list-style-type: none"> <li>• Health revenue \$1.7billion.</li> <li>• Clinical services: 60 medical clinics across the US, 12,000 physicians.</li> <li>• CareC2 product – analytical solutions pathway. Looking for opportunities to mature product in the UK. Fits into community care and move away from high institution delivered care GM is trying to make.</li> </ul> Leidos ambition to bridge the gap between health and social care also aligned with City developments. Possible interest in collaboration with MFT and their EPR capabilities – help Leidos develop a solution and implementation more specific to UK needs.	2020
Greater Manchester	Now Healthcare	Pharmacy logistics hub supplying prescription medicines to 1million patients in the UK. Currently have small hub in Liverpool but now ambitions to scale to compete with Boots, Lloyds and Wish Groups. Business model offers free online consultations and free delivery. Final stages of securing series B funding. Seeking new logistics facility 10-15,000 sqft Office and 150,000 sqft coldchain storage and general warehousing in secure location, preferably close to Salford. Will consider both Purchase / Lease on brownfield site with good public transport links.  Will need to recruit at scale - Pharmacists, Pharmacy technicians and office and support staff	2018/20

Source: NHS A LEP partners

**Table 3.11: Pipeline public sector investments**

LEP	Title	Description
Liverpool City Region	Digital Health North	
Liverpool City Region	LCR Informatics Research Strategy	
Liverpool City Region	NW Medtech cluster	STFC/Sci-Tech Daresbury led cluster building on their Accelerator programme
Liverpool City Region	LCR Digital Infrastructure Plan – including the development of the LCR Fibre Spine Loop to connect key informatics resources	The Digital Infrastructure Plan will map the city region’s existing infrastructure assets, identify opportunities to best use those assets and suggest potential operating models for the city region’s digital infrastructure. The plan will also set out specific actions to maximise the city region’s digital connectivity and drive economic growth. Following an open tender, the contract was won by a specialist consortium formed by CBN Limited and Adroit Economics.

LEP	Title	Description
Liverpool City Region	Hartree Deep Change	

Source: NHS A LEP partners



## 4 Chapter Three Appendix - Theme 1: Data for Better Health and Wealth

- 4.1 This appendix covers all the appended material from Chapter Three, looking at Theme 1: Data for Better Health and Wealth
- 4.2 With regards to assets and capabilities, [Table 4.1](#) provides a summary of Connected Health Cities (CHC) delivered activities to date and [Table 4.2](#) provides more detail on the specific relevant health-and-data-related assets and capabilities across the North by city. An overview of the N8 supercomputer and its plans for 2018 is shown in [Table 4.8](#) and [Table 4.4](#) provides a non-exhaustive summary of Life Science and health data businesses in the North.
- 4.3 The **Data for Better Health and Wealth** offer, at the level of the North, is founded on the interaction between digital businesses/providers and the North's infrastructure. [Figure 4-1](#) illustrates the location and share of digital health assets across the UK – it shows key assets, e.g., Farr Institute, and growth nodes, e.g., Digital Health Enterprise Zones. [Figure 4-2](#) provides a map of companies operating in the health data space across the UK and provides a non-exhaustive illustrative list of the scope and scale of business operating in this space in the North of England. [Figure 4-3](#) provides a 'heat map' based on the combined digital health infrastructure and business base in the UK. It shows a particularly strong arc running from Liverpool City Region to the Manchester City Region.<sup>10</sup>
- 4.4 [Table 4.5](#) provides a detailed picture of graduate retention for Computer Science, Mathematical Science, and Engineering and Technology by Local Enterprise Partnership, that is, the proportion of graduates from the 2010/11 to 2014/15 cohort (inclusive) that found employment in the LEP area in which they studied. It should be noted that these data are not at a sufficient level of granularity to identify moves into Health ICT, but they provide an indication of the pattern to be expected. [Table 4.6](#) provides a picture of graduate attraction by each of the Northern LEPs. It shows the proportion of graduates employed in a given LEP area that were educated outside that area.

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<sup>10</sup> [Figure 4-1](#), [Figure 4-2](#) and [Figure 4-3](#) are from the government bioscience and health technology annual report in 2015 and these maps have not been updated since, so there may be inconsistencies with data listed elsewhere.

**Table 4.1: Connected Health Cities delivery against objectives**

Objectives	Measurable	Deliverables
<p>Innovation Benefit: Establishment of data sharing strategy and agreements for each region</p>	<p>Creation of four localised data sharing agreements, one in each pilot city region. Secondary agreements, in line with the initial data sharing strategies agreed with linked-data providers.</p>	<ul style="list-style-type: none"> <li>• Production of data sharing guidance to ensure data sharing is legal and ethical, in the form of a Data Sharing Contract and associated Data Sharing agreement template.</li> <li>• Established Data Ark (Trusted Research Environment) for NWC, with structure utilised by the North East.</li> <li>• Information Sharing Gateway established in the North East and North West Coast for IG agreements and concepts integrated into the Ark structure and utilised by Yorkshire and Manchester. The pan-regional deployment of the Information Sharing Gateway has enabled development of Information Sharing agreements at a previously unheard-of scale and pace.</li> <li>• The Great North Care Record (GNCR) established data sharing agreements across the North East and North Cumbria region for 350 GP practices, all out of hours services, 13 Acute Trusts and 3 Mental Health Trusts. The inclusion of social care is underway.</li> <li>• The cYorkshire partnership collaboration has been finalised and signed by local partners. The local partners consist of the Bradford Institute for Health research, University of Leeds, University of York and the University of Sheffield.</li> <li>• Additional secondary agreements have been formalised with local data providers.</li> <li>• Public engagement on the use of patient data and the benefits of data sharing, working with the National Data Guardian, Understanding Patient Data and the Wellcome Trust.</li> <li>• The Information Governance (IG) Manager for Greater Manchester Connected Health City (GM CHC) has been appointed to oversee all IG processes and procedures within GM CHC. Templates for data sharing contracts with terms acceptable to the host institution (University of Manchester) have been established, and each project now has its own privacy impact assessment (PIA).</li> </ul>
<p>Innovation Benefit: Establishment and delivery of governance arrangements for the sharing and usage of data for each region, across the North and the UK</p>	<p>Regulations and guidelines put in place to govern the use of data and links between data providers, formalised and agreed by the CHCs, NHTA, NHS organisations and R&amp;D partners.</p>	<ul style="list-style-type: none"> <li>• Expert IG advice on establishment of governance arrangements was provided to regional CHCs.</li> <li>• Citizens Juries have been held to inform developments.</li> <li>• The linked Bradford dataset has ethical approval for a research database which is overseen by a committee that will govern the use of data for cYorkshire projects.</li> <li>• The linked Sheffield dataset has ethical and confidentiality advisory group (CAG) and use of the data is overseen by a Steering Group. Local R&amp;D approval from each trust has also been received.</li> <li>• Guidelines have been put in place on how data can be accessed within the Bradford and Sheffield Ark.</li> <li>• CHC NWC has established local information governance system to give oversight to CHC. Including an appointment of CHC Senior Information Responsible Officer (SIRO); establishment of information governance group; and explicit link to Trust NHS information governance arrangements and Board.</li> <li>• GM CHC has harmonised datasets according to a common data model, completing a review of information governance practices of other UK data safe havens.</li> </ul>

Objectives	Measurable	Deliverables
<p>Innovation Benefit: Workforce arrangements optimised, CPD requirements identified and new skills base established</p>	<p>Recruitment of a professional, multispecialty workforce within each CHC Ark and the central CHC Hub. CHC career pathways for the differing staff roles. Increasing the size of the UK workforce and talent pool able to process and create value from health data.</p>	<ul style="list-style-type: none"> <li>• Recruitment achieved.</li> <li>• CHC has linked with the Farr Institute and will be running a CPD programme in June 2018.</li> <li>• CHC NENC staff co-located with Newcastle University Bioinformaticians.</li> <li>• Alignment with Genome Medicine training programmes through PGcert has been established at Sheffield.</li> <li>• A number of specialist consultants from the Ambulance Service and Emergency departments have been identified and are working on the CHC Sheffield project on a consultancy basis.</li> <li>• NWC CHC held two Senior Analyst Development Days/Workshops - the first at STFC Hartree and the second at Lancaster University (in partnership with ISD).</li> <li>• NWC CHC supported the creation of a Bioinformatics Skills Framework, which identifies skills needs, providers and a structured pathway to gain a professional certification.</li> <li>• Postgraduate Certificate in Professional Practice (Evidence Based Health &amp; Care Services) is established at Lancaster University to support evidence based approaches to commissioning and design of services.</li> </ul>
<p>Innovation Benefit: Creation of the Ark as an analytical platform</p>	<p>Creation of secure centralised and local Ark data-analysis facilities with at least GP, hospital admissions/discharge, hospital laboratory and social care data.</p>	<ul style="list-style-type: none"> <li>• Production of a consent management tool to support the management of patient data: initial integration developed with the Born in Bradford.</li> <li>• Hub support provided for ARK/ Trustworthy Research Environment (TRE) management boards to gain ISO27001 certification.</li> <li>• The TRE is a secure data analytics facility located at the GM CHC Ark. It provides users with access to the datasets and analytical tools needed to conduct population health studies within a trusted and highly secure environment that minimises the risk of unauthorised access. Information Technology security best-practice methods have also been implemented.</li> <li>• The GM CHC Ark allows the re-use of patient data under appropriate governance controls and trust frameworks. It is an infrastructure space designed to drive both economies of scale and scope through optimal use of resources, where expertise together with data and methods are employed to create actionable information.</li> <li>• GM CHC has developed a safe research environment-training programme that helps minimise the risk of disclosing personal information when conducting data intensive research.</li> <li>• The Ark in Bradford currently hosts data from primary care, hospital and social care data. This data is searchable and continues to grow as the number of data providing organisations increases.</li> <li>• The Ark in Sheffield currently hosts data from NHS hospitals Accident and Emergency and admitted patient care episode data sets enabling systems analysis.</li> </ul>

Objectives	Measurable	Deliverables
<p>Health Benefit: Pathway analysis, variation assessment and improvements identification</p>	<p>A pipeline of patient pathways suitable for investigation identified within each CHC pilot region. Pathways will be deemed suitable if there is reported variation in patient outcomes and a detailed enough range of data available in order to undertake analysis.</p> <p>Eight care pathways to be redesigned across the four CHC pilot regions, with the care pathway redesign resulting in a reduction in Data Action Latency and an increase in health outcomes for those pathways.</p>	<ul style="list-style-type: none"> <li>• CHC NENC have produced a clear technical plan for region-wide patient record development that will patients well cared for and able to produce an outstanding Learning Health System.</li> <li>• Genomics clinical record improvements implemented to reduce reporting time and align with reporting systems across Yorkshire.</li> <li>• The Urgent and Emergency Care linked datasets across Yorkshire and the Humber will be used to provide a greater understanding of patient pathways through the A&amp;E departments.</li> <li>• NWC CHC has developed smarter phenotyping algorithms, pathway analytics and data visualizations to reflect the diversity of case mix, patient journeys and key milestones of disease progression – allowing more precise targeting of patient sub-groups or localities for co-ordinated intervention.</li> <li>• NWC CHC has established a contact lists of key clinicians for dissemination of aggregate reports and shared pilot data, bridging the gap in knowledge and actionable information that is available to front-line teams.</li> <li>• NWC CHC is combining the three discrete 'commissioning' datasets for hospitals (Admitted Patient Care, Outpatient Visits and AED attendances) to construct complete patient journeys and to track the progress of individual patients.</li> </ul>
<p>Wealth Benefit: Frameworks and integration with R&amp;D partners and attracting Foreign Direct Investment</p>	<p>An increase in inward investment from commercial partner organisations into health-related research and development.</p> <p>An increase in the number of R&amp;D partnerships with private sector organisations in the North and across the UK.</p>	<ul style="list-style-type: none"> <li>• CHC CC has successfully established and launched a pre-competitive collaborative consortium for companies working in the health ICT sector, which aims to drive economic development. The consortium currently has 16 members, from micro SMEs to large multi-national companies and offers co-creation opportunities for its members to address problems facing the health ICT sector.</li> <li>• International collaboration and/or investment has been led by the Hub with ongoing conversations with Brazil, Columbia, Singapore, India, China and Australia plus facilitation of relationships with the care pathways e.g. BRIT with a collaboration in Denmark.</li> <li>• cYorkshire implemented a genomics genome data decision support system with Fabric Genomics.</li> <li>• NWC CHC has established a Patient and Public Involvement Senate (PIEs) to provide insight and reference to CHC work.</li> </ul>

Objectives	Measurable	Deliverables
<p>Health and Wealth Benefit: Production of a business model suitable for scaling and sustainable for delivery in the NHS</p>	<p>Agreement on the CHC Ark business mode</p>	<ul style="list-style-type: none"> <li>• Urgent and emergency care linked dataset in cYorkshire provides an operationally large dataset which can be scaled across the CHC regions. There will be opportunities to link with other datasets within Yorkshire and across the North, and the UK.</li> <li>• A functional operational platform has been demonstrated in NWC with associated governance and library of data sharing requirements (ISG).</li> <li>• GM CHC has (co-) developed a strategy for industry engagement across the three streams listed below:                         <ol style="list-style-type: none"> <li>1) Pre-Competitive Collaborative Consortium (PCCC) - This stream is led by the CHC Hub and aims to develop generic codes of practice and standardised APIs to support the learning health system methodology. GM CHC now has representation on the PCCC management board and contributed towards refinement of the deliverables.</li> <li>2) "Spin-in" lab - This stream provide companies with an opportunity to develop and validate products for the health care market. GM CHC will support qualifying companies with data analytics and data brokerage resources. An exemplar project with Intelligent Medical Objects is currently underway focused on investigating the automation of clinical coding from digital clinical text.</li> <li>3) Product development for care pathways re-design - The focus of this stream is on marketable and commissionable products, which would extend the scope of the pathway projects but will require investment from industry partners.</li> </ol> </li> </ul>

Source: NHTA

**Table 4.2: Data for Better Health & Wealth Capabilities across the North**

Location	Capabilities
Bradford	<ul style="list-style-type: none"> <li>• <b>Digital Health Enterprise Zone’s Digital diagnostics partnership with Philips</b> developing tools and techniques for digital histopathology.</li> <li>• <b>Bradford Evaluation and Trials Unit</b>, which develops and implements cost-effective methodology for rigorous, independent appraisal of digital health and health service management innovations.</li> <li>• <b>Digital Bradford 2020 Board</b></li> <li>• <b>Centre for Visual Computing</b></li> <li>• <b>Born in Bradford</b></li> </ul>
Durham	<ul style="list-style-type: none"> <li>• The <b>School of Medicine, Pharmacy and Health (Newcastle University)</b> encompasses clinical, social care, mental health policy, public health and pharmacy. With campuses at Durham and Stockton, the <b>School and the Wolfson Institute for Health</b> work with <b>Durham and the Tees Valley NHS</b> data and clinicians across four Trusts. It acts as an academic unit for a large mental health trust, with strong links with public health and social care at local authority level. World-leading research in health policy is supported by anthropology, computer science, mathematics and geography, such as work on healthcare related projects, such as the forecasting of urgent care footfall.</li> <li>• The University has invested heavily in high performance computing and boasts exceptional facilities. Durham also provides analytics, and public access services of UK census and employment data for the Office for National Statistics (ONS) and is seeking accredited safe haven status for NHS data.</li> <li>• <b>The Institute of Advanced Research Computing</b> provides expertise in predictive and prescriptive analytics, cognitive computing, HPC, Cloud and infrastructure development.</li> <li>• The <b>Centre for Health and Inequalities Research (CHIR)</b> is an internationally leading, interdisciplinary centre for the study of socioeconomic, gender, health and other inequalities.</li> <li>• The <b>Centre for Medical Humanities</b> explores the human side of medicine and the relationship between medicine and our broader ideas of health, wellbeing and flourishing, funded by the Wellcome Trust.</li> <li>• The <b>Centre for Public Policy and Health</b> focuses on policy and management, evidence, decision-making and policy implementation, inequalities in health, health effects of public policy and work, and worklessness and health.</li> <li>• Centre for Process Innovation (CPI) (Sedgefield Site) and NetPark hosts a cluster that includes the CPI Healthcare Photonics Centre, the Formulation Centre, Sensors and companies including Polyphotonix and Kromek which are examples of both digital heavy and health applied technologies.</li> <li>• The <b>Centre for Integrated Health Care Research</b> focuses on clinical research, with an emphasis on the management of patients across the primary/secondary care interface.</li> </ul>
Lancaster	<ul style="list-style-type: none"> <li>• Lancaster University (LU) has significant strengths in biostatistics/data science relating to health/medicine including: The <b>Combining Health Information, Computation and Statistics (CHICAS) group</b>; computer science, with £3.5m research projects in health data science; and <b>Security Lancaster</b>, a multidisciplinary centre studying the ethics and privacy of health data.</li> <li>• The <b>Centre for Ageing Research</b> conducts multidisciplinary research into ageing.</li> <li>• LU has created a <b>Data Science Institute</b> with a focus on ‘big data’ including a health track (<a href="http://www.lancaster.ac.uk/dsi/">www.lancaster.ac.uk/dsi/</a>) and also collaborates as a key player (through CHICAS) in statistical methods developed in the Farr Institute.</li> <li>• LU is actively involved in larger NHS regional networks, particularly The Innovation Agency (North West Coast (NWC) AHSN), NIHR Clinical Research Network (CRN) NWC, NIHR Collaboration for Leadership in Applied Health Research (CLAHRC) NWC, NHTA and Bionow, largely through the Lancaster Health Hub.</li> <li>• Local NHS regions comprise a population of 2.7m with huge, highly relevant demographic/morbidity variation for implementation of a Lancashire-wide health e-record system and the development of the Lancaster Digital Health Forum.</li> </ul>

Location	Capabilities
Leeds	<ul style="list-style-type: none"> <li>• Leeds is home to one of the top 10 British universities, partnering with the UK's second largest NHS Trust (3,500 beds, 870 Consultants, £1.1bn budget) providing secondary and tertiary care to a vast population of diverse ethnicity and social mix.</li> <li>• With a flagship MBChB programme and varied portfolio of postgraduate training (c.3000 students), the <b>Medical School</b> undertakes research excellence in four core areas of international strength: cardiovascular disease (ranked 5th in UK in British Heart Foundation income), musculoskeletal disease (<b>NIHR Biomedical Research Unit</b>), cancer/surgery and pathology (<b>CRUK Centre, Experimental Cancer Medicine Centres, NIHR Diagnostic Evidence Co-operative</b>) and health services research.</li> <li>• The university played the leading role in establishing the NIHR Clinical Research Network and is now the <b>lead for the NIHR Clinical Research Network National Coordinating Centre</b> in collaboration with Guy's &amp; St Thomas's NHS Foundation Trust.</li> <li>• <b>Leeds Teaching Hospital</b> hosts the <b>NIHR Trainees National Coordinating Centre</b> and is second only to Newcastle for a number of NIHR CRN portfolio studies.</li> <li>• Cross-cutting platforms include one of the largest clinical trials units in the UK, medical bioinformatics (MRC and Economic Social Research Council Centres, PPM), imaging (MRC and BHF) and genetics (MRC).</li> <li>• Outstanding NIHR infrastructure including <b>NIHR Biomedical Research Unit in MSK, Diagnostic Evidence Cooperative, Health Technology Cooperative in Colorectal Therapies and Clinical Research Facility</b>.</li> <li>• <b>Leeds Institute for Data Analytics (LIDA)</b> within the University of Leeds, connecting academic research with external partners in business, government and the third sector; LIDA is matching the world-class capabilities of university research with the needs and opportunities of local organisations.</li> <li>• A unique selling point of Leeds is a culture of infusion of physical-chemical sciences, computational and structural biology (e.g. <b>Astbury Centre</b>) and engineering into medicine.</li> <li>• N8 - 'Supercomputer' Raackable Cluster, Xeon E5-2670 8C 2.600GHz, Infiniband QDR hosted by the University of Leeds.</li> <li>• Over 200 FTEs in the <b>Institute of Biomedical Engineering (iMBE</b> - the largest faculty in Europe) with major programmes in medical bioengineering, including tissue engineering and robotics. iMBE is supported by more than £70m of research funding from the EPSRC, Wellcome Trust and other major funders. Leeds was a designated <b>Wellcome Trust/EPSC Centre of Excellence in Medical Engineering</b> (others: Oxford, KCL and Imperial) and is an EPSRC/Innovate UK Innovation and <b>Knowledge Centre in Tissue Engineering</b>.</li> <li>• Designated by Innovate UK as a <b>Precision Medicine Centre</b>.</li> </ul>

Location	Capabilities
<b>Liverpool</b>	<p>Driven by Liverpool’s academic strengths with the University of Liverpool, Liverpool School of Tropical Medicine and Liverpool John Moores University as well as and Liverpool Health Partners amongst others, Liverpool provides an operational ecosystem for success in Healthcare and Digital Health, including the following assets of particular relevance:</p> <ul style="list-style-type: none"> <li>• <b>Department of Computer Science, University of Liverpool</b></li> <li>• Access to an annual patient population of 2.1m.</li> <li>• <b>Wolfson Centre for Personalised Medicine</b></li> <li>• <b>MRC Centre for Drug Safety Science</b></li> <li>• <b>UK IBD Registry Analytics Hub</b></li> <li>• <b>MHRA-accredited Clinical Research Facility at Alder Hey Hospital</b></li> <li>• <b>EPSRC Liverpool Centre for Mathematics in Healthcare</b></li> <li>• <b>Liverpool Health Partners Biomedical Research Centre in Personalised Health</b></li> <li>• <b>Liverpool Health Genomics Laboratory</b></li> <li>• Federated biobanks of more than 500,000 well-phenotyped clinical samples in the new <b>Liverpool Bio-Innovation Hub</b></li> <li>• <b>MRC North West Hub for Trial Methodology Research</b></li> <li>• <b>Clinical Trials Research Centre</b></li> <li>• MHRA accredited <b>Clinical Research Unit at the Royal Liverpool Hospital</b></li> <li>• <b>Liverpool Clinical Laboratories</b></li> <li>• NIHR North West Collaboration for Leadership in Applied Health Research and Care.</li> <li>• <b>Farr Institute e-health research facility</b></li> <li>• Innovate UK ‘More Independent (MI)’ pilot region</li> <li>• <b>The Innovation Agency</b> (North-West Coast Academic Health Science Network)</li> <li>• <b>Heseltine Institute for Public Policy and Practice</b></li> <li>• Technology Directorate; recently enhanced with £5m MRC Clinical Infrastructure award for stratified medicine</li> <li>• One of four UK government-backed University Enterprise Zones</li> <li>• Local Enterprise Partnership with Personalised Medicine as a key theme</li> <li>• The <b>Hartree Centre</b>, a world-class high-performance computing, AI and data analytics research and development facility based at Sci-Tech Daresbury. Strategic partnership with IBM Research.</li> </ul>

**Manchester** Greater Manchester is internationally connected and forms the largest conurbation outside of London with access to c.3.6m patients and £6bn per annum NHS spend.

It has major hospital-based incubator space including **City Labs** and **Alderley Park**, all owned by Manchester Science Partnerships.

The **University of Manchester** (UoM) has c.£900m pa turnover, of which c.£120m is ‘health-related’ external research income (£18m from business).

It is ranked top by Elsevier for business engagement, has more than 2,000 medical students and was ranked fifth in research power in REF2014.

The **Manchester Academic Health Science Centre** (MAHSC) is the only NIHR-accredited AHSC outside the South East with six partner Trusts/CCG with £2.8bn annual turnover, c3,800 beds, **3 NIHR Clinical Research Facilities**, and **one Clinical Trials Unit**.

UoM has many relevant assets, including:

- **NIHR Musculoskeletal BRC**
- **MRC/Farr Institute for e-health and national informatics hub**
- **Greater Manchester CLAHRC**
- **CRUK Manchester Institute**
- **CRUK ‘Major centre’** (one of two nationally, UK Research Partnership Investment Fund award of £13m)
- **Two Arthritis UK centres.**
- Three MRC precision medicine awards (£13m)
- **Imaging centre** (£26m)
- **Inflammation centre-GSK and AZ** (£15m)
- Unique GSK e-health lung trial (c£50m)
- The **NIHR Patient Safety Translational Research Centre** (£6m).



Location	Capabilities
<p><b>Newcastle</b></p>	<p>Newcastle has an established track record in precision medicine and computing science relevant to Health North. In personalised medicine (PM) Newcastle leads two MRC-funded stratified medicine consortia and is a key partner in three others.</p> <p>Newcastle co-chairs the NIHR Rare Diseases Translational Research Collaboration, leading the liver theme, and hosts a <b>Wellcome Trust Centre for Mitochondrial Disease</b>, the <b>National Innovation Centre for Ageing (to be co-located with the National Innovation Centre for Ageing)</b> and an <b>MRC Single-Cell Functional Genomics Unit</b>.</p> <p>Newcastle’s joint NHS/university translational infrastructure includes a <b>Biomedical Research Centre in Ageing and Chronic Disease</b>, a <b>Biomedical Research Unit in Dementia</b> (both NIHR-funded), and three Clinical Research Facilities (CRFs).</p> <p>Newcastle’s science village the <b>International Centre for Life</b>.</p> <p>Newcastle university are building a £58 million Urban Sciences Building to house the School of Computing Science. It will also contain an <b>Urban Observatory and Decision Theatre</b> to analyse and explore real time data and improve understanding of the interaction between city’s energy, water, transport, waste and digital control systems.</p> <p>In 2013/14, Newcastle recruited 15,800 patients into NIHR “portfolio” studies. Newcastle, therefore, has the expertise, infrastructure and experience to drive modern PM.</p> <p>Newcastle Science Central will hosts the <b>EPSRC Centre for Doctoral Training in Cloud Computing for Big Data</b>, creating the next generation of experts in the use of advanced statistical methodologies and cloud computing techniques, addressing an acute worldwide skills shortage.</p>
<p><b>Sheffield</b></p>	<p>Sheffield has broad and deep capacities, with world-recognised expertise in the exploitation of health data. It has tight collaborations and dedicated infrastructure of NHS and academic institutions. Together, the University of Sheffield, Sheffield Teaching Hospitals NHSFT, Sheffield Children’s NHSFT and Sheffield Hallam University deliver clinical and biomedical informatics, machine learning and computational biology, multi-scale modelling, genomics, health systems research, assistive technologies and advanced manufacturing. Key relevant assets include:</p> <ul style="list-style-type: none"> <li>• Machine learning/computational biology</li> <li>• <b>Sheffield Institute for Translational Neuroscience (SITraN)</b>.</li> <li>• <b>Centre for Genome Translation</b></li> <li>• <b>INSIGNEO Institute for in silico medicine</b></li> <li>• <b>Sheffield Diagnostic Genetics Service</b></li> <li>• Health data-sharing/research data services</li> <li>• <b>School of Health and Related Research (ScHARR)</b></li> <li>• <b>Sheffield Bioinformatics Hub</b></li> <li>• <b>Centre for Assistive Technology and Connected Healthcare (CATCH)</b>.</li> <li>• <b>Advanced Wellbeing Research Centre</b></li> <li>• NIHR Devices for Dignity (D4D) MedTech and In vitro diagnostic Co-operative (MIC)</li> <li>• <b>Advanced Manufacturing Research Centre (AMRC)</b>, including <b>Medical AMRC</b></li> <li>• The Care2050/Hospital2050 Project.</li> </ul>
<p><b>Sunderland</b></p>	<ul style="list-style-type: none"> <li>• Sunderland Software City/ Digital Catapult and their work with Clinical Commissioning Groups and the Great North Healthcare Record</li> </ul>

Location	Capabilities
York	<p>The <b>University of York and Hull-York Medical School</b> operate within a diverse population across North and East Yorkshire and the Humber. The University of York’s research strengths span fundamental underpinnings of health and disease through evaluating interventions to informing policy and practice. We draw on a wide range of academic skills and disciplines, working together to discover, refine and apply new interventions to improve health and wellbeing.</p> <p>Key relevant assets at the University of York include:</p> <ul style="list-style-type: none"> <li>• BioArch</li> <li>• Biological Physical Sciences Institute (BPSI)</li> <li>• Bioscience Technology Facility</li> <li>• Cancer Research Unit</li> <li>• Cardiovascular Health Research Group (CHRG)</li> <li>• Centre for Health Economics (CHE)</li> <li>• Centre for Housing Policy (CHP)</li> <li>• Centre for Hyperpolarisation in Magnetic Resonance (CHyM)</li> <li>• Centre for Immunology and Infection (CII)</li> <li>• Centre for Reviews and Dissemination (CRD)</li> <li>• Epidemiology and Cancer Statistics Group (ECSG)</li> <li>• Health Services and Policy Research Group</li> <li>• Jack Birch Unit for Molecular Carcinogenesis</li> <li>• Mental Health and Addiction Research Group (MHARG)</li> <li>• Public Health and Society Research Group</li> <li>• Social Policy Research Unit (SPRU)</li> <li>• York Health Economics Consortium (YHEC)</li> <li>• York Neuroimaging Centre (YNIC)</li> <li>• York Structural Biology Laboratory (YSBL)</li> <li>• York Trials Unit</li> </ul>

Source: NHSA

**Table 4.3: N8 High-Performance Computing (HPC) programme**

<p>Overview</p> <ul style="list-style-type: none"> <li>• N8 HPC is building on the academic strengths and collaborative commitment of the N8 Research Partnership. N8 HPC currently offers a shared ‘Tier 2’ HPC facility underpinning world-class research, enabling collaborations between institutions and creating the opportunity to engage more effectively with business and the community.</li> <li>• Overall, this is a step-change in the computing capability and capacity available to leading researchers in the N8 universities, providing a platform for sharing methodological and technical expertise and creating new opportunities for business-facing collaborative research.</li> </ul> <p>Going forward into 2018</p> <ul style="list-style-type: none"> <li>• 2018 will see a period of change within N8 HPC. The current machine, Polaris is five years old, increasingly expensive to maintain and is comprised of dated hardware – it is approaching the end of life and is due to be switched off on the 17th July 2018.</li> <li>• All 8 universities will be contributing to an N8 HPC Centre of Excellence which will accelerate progress in areas of research that are of strategic importance to the N8 partners, including some that have not made heavy use of technology in the past. Led by academics, each area will identify software tools, methodology, expertise etc. that could benefit each research area. A research roadmap will be developed for each selected theme, identifying key opportunities for us to accelerate progress, proposing a joint programme of work, and building a community of practice.</li> <li>• The 8-member universities of N8 HPC have been in consultation for the past year as to how to proceed after this point. Three universities (Lancaster, Manchester and York) are planning to jointly fund and procure a new cluster. This will be hosted at Durham, who will receive 5% of available resources in return. There will also be an investment in cloud-based resources by Manchester and Leeds. (Sharing of resources will allow users from Lancaster and York access to cloud cycles and users from Leeds access to the new cluster.)</li> </ul>
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Source: N8 High-Performance Computing

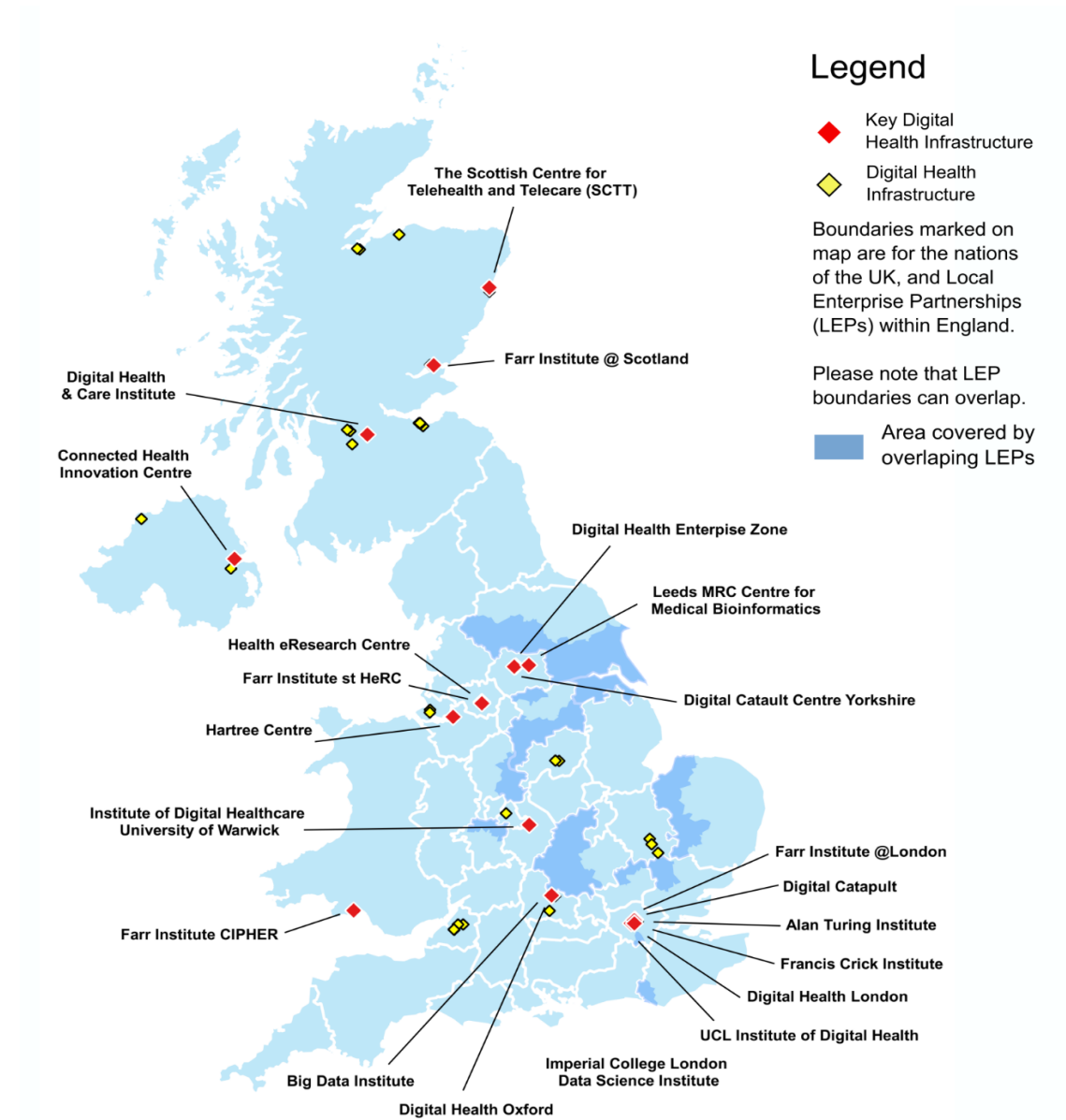
**Table 4.4: Life Science and Health Data Businesses in the North, non-exhaustive**

Advanced Digital Innovation Ltd
AIMES Grid Services Ltd
Alcyomics
Allscripts
Aridhia
Arquerdiagnostics
Biosignatures
Changing Health
Cisco Systems
Citrus Suite
CSC
Damibu
Datatrial Ltd
EMIS Health Ltd
Gendius
Glythera
Hitachi EU
IBEX
InHealthcare
Intel
InterSystems
Kromek
MDSAS
Medical Data Solutions and Services (MDSAS)
Microsoft
Msoft
New Cells Biotech
Nonlinear Dynamics
NorthWest EHealth (NWEH)
Orcha
PC-MIS
Polyphotonix
Quantum DX
Quaenam
RedNinja Studios
Reprocell
Rescon Technologies
Sciformix Europe
Sensapharm
Telefonica

Totallab
TPP Ltd
Tunstall Healthcare (UK) Ltd
UKFast
UK Cloud
X-Lab Limited

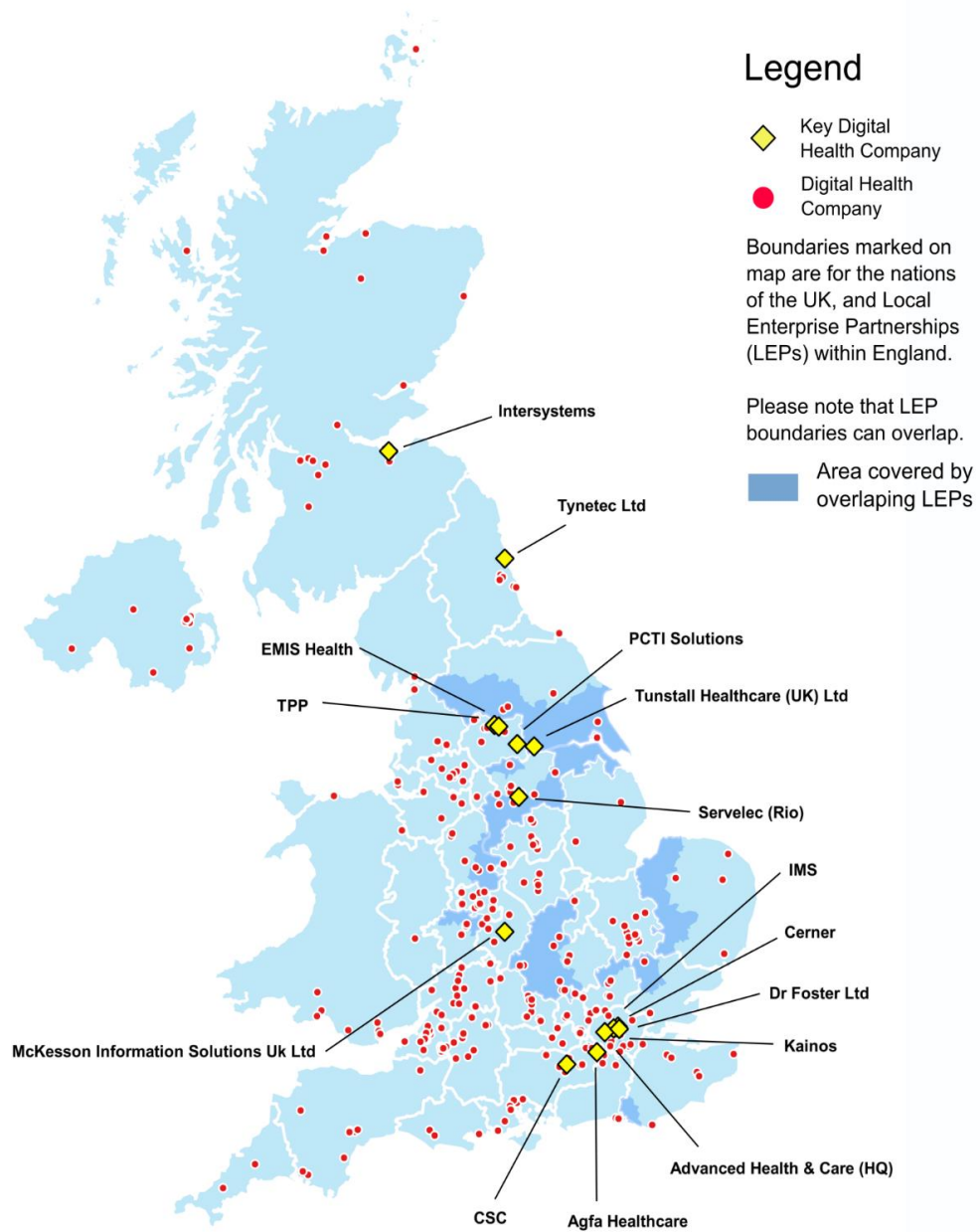
Source: NHTA

Figure 4-1: Digital Health infrastructure 2015



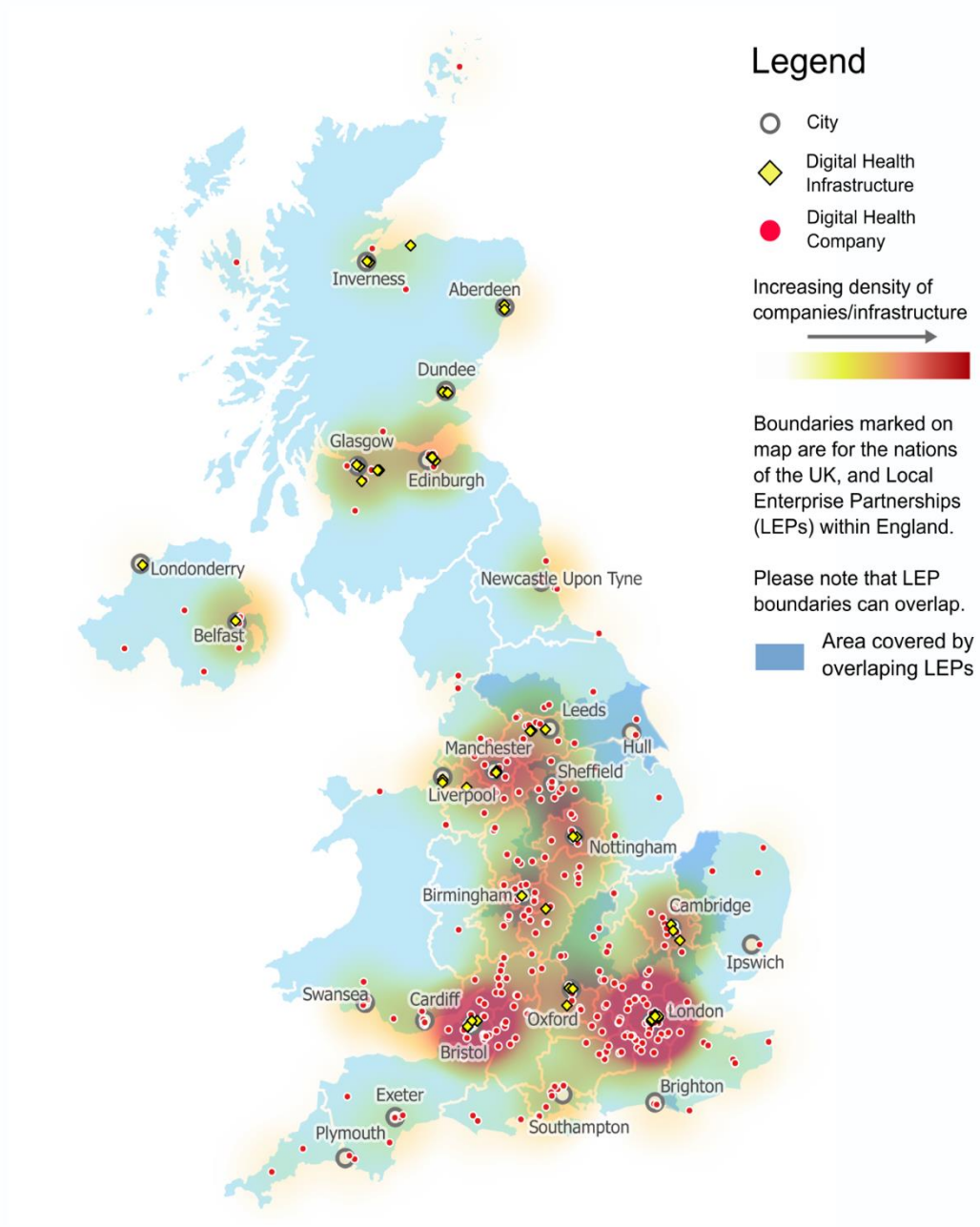
Source: <https://www.gov.uk/government/publications/bioscience-and-health-technology-database-annual-report-2015>

Figure 4-2: Digital health companies in the UK 2015



Source: <https://www.gov.uk/government/publications/bioscience-and-health-technology-database-annual-report-2015>

Figure 4-3: Heat map of combined digital health infrastructure and companies



Source: <https://www.gov.uk/government/publications/bioscience-and-health-technology-database-annual-report-2015>

**Table 4.5: Computer Science, Engineering and Technology and Mathematical Sciences graduate retention by Local Enterprise Partnership in the North**

Study LEP	Computer Science		Engineering and Technology		Mathematical Sciences		Total	
	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates
Cheshire and Warrington	105	54%	-	-	35	45%	140	43%
Cumbria	-	-	-	-	-	-	-	-
Greater Manchester	880	61%	1045	38%	340	43%	2265	47%
Humber	205	46%	140	51%	-	-	345	33%
Lancashire	360	39%	240	38%	55	18%	655	31%
Leeds City Region	945	58%	1000	39%	235	31%	2180	43%
Liverpool City Region	425	56%	360	30%	110	35%	895	40%
North East	715	64%	745	41%	230	25%	1690	43%
Sheffield City Region	505	45%	445	26%	140	25%	1090	32%
Tees Valley	365	41%	350	53%	-	-	715	31%
York, North Yorkshire & East Riding	55	23%	45	22%	60	17%	160	21%
<b>Grand Total</b>	<b>4560</b>	<b>52%</b>	<b>4370</b>	<b>42%</b>	<b>1205</b>	<b>22%</b>	<b>10135</b>	<b>39%</b>

Source: SDG-ED analysis of HEFCE data, 2010-2011 to 2014-2015

**Table 4.6: Computer Science and Engineering and Technology and Mathematical Sciences graduate attraction by Local Enterprise Partnership in the North**

Employment LEP	Computer Science		Engineering and Technology		Mathematical Sciences		Total	
	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates
Cheshire and Warrington	440	81%	-	-	160	82%	600	87%
Cumbria	75	61%	325	72%	-	-	400	76%
Greater Manchester	625	42%	760	42%	365	52%	1750	45%
Humber	110	36%	255	64%	-	-	365	63%
Lancashire	175	33%	500	67%	115	67%	790	56%
Leeds City Region	520	36%	720	42%	430	64%	1670	47%
Liverpool City Region	315	43%	320	47%	115	51%	750	47%
North East	260	27%	370	33%	70	24%	700	28%
Sheffield City Region	230	31%	405	48%	140	50%	775	43%
Tees Valley	40	10%	185	35%	-	-	225	47%
York, North Yorkshire & East Riding	330	86%	490	92%	105	64%	925	81%
<b>Grand Total</b>	<b>3120</b>	<b>44%</b>	<b>4330</b>	<b>58%</b>	<b>1500</b>	<b>67%</b>	<b>8950</b>	<b>56%</b>

Source: SDG-ED analysis of HEFCE data, 2010-2011 to 2014-2015



## 5 Chapter Four Appendix - Theme Two: Precision Medicine

- 5.1 This appendix covers all the appended material from Chapter Four, looking at Theme Two: Precision Medicine.
- 5.2 The Northern Powerhouse in Health Research has an impressive Precision Medicine asset base in terms of scale, diversity and quality. Public and private sector Precision Medicine capabilities across different locations is shown in [Table 5.1](#), disease-specific academic and clinical assets is shown in [Table 5.2](#) and clinical trials, e-health, diagnostics, bioinformatics and health economics expertise can be found in [Table 5.3](#). [Table 5.4](#) then shows the Northern assets supporting the creation of a diagnostic testing, prototyping, development laboratory and [Table 5.5](#) is a non-exhaustive list of Precision Medicine Businesses in the North.
- 5.3 [Figure 5-1](#) maps employment in Life Sciences in the UK, [Figure 5-2](#) maps employment in Medtech and [Figure 5-3](#) maps employment in Biopharma.
- 5.4 [Table 5.6](#) provides a more detailed picture of graduate retention for Anatomy, Physiology and Pathology; Biological Sciences; Chemistry; Medicine and Dentistry; Nursing and Subjects Allied to Medicine; Pharmacology and Toxicology and Pharmacy by Local Enterprise Partnership, that is, the proportion of graduates from the 2010/11 to 2014/15 cohort (inclusive) that found employment in the LEP area in which they studied. [Table 5.7](#) provides a picture of graduate attraction by each of the Northern LEPs. It shows the proportion of graduates employed in a given LEP area that were educated outside that area.

**Table 5.1: Precision Medicine Capability by Location**

Capability	Location(s)
Antimicrobial Resistance Centre	<ul style="list-style-type: none"> <li>• Alderley Park</li> </ul>
Astbury Centre	<ul style="list-style-type: none"> <li>• Leeds</li> </ul>
Cancer Research UK Centres	<ul style="list-style-type: none"> <li>• Manchester</li> <li>• Newcastle</li> </ul>
Experimental Cancer Medicine Centres	<ul style="list-style-type: none"> <li>• Leeds</li> <li>• Liverpool</li> <li>• Manchester</li> <li>• Sheffield</li> </ul>
FUTURE Initiative	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>
Genomics England NHS Genomics Medical Centres	<ul style="list-style-type: none"> <li>• Liverpool</li> <li>• Manchester</li> <li>• Newcastle</li> <li>• Leeds &amp; Sheffield</li> </ul>
InnovateUK Medicines Discovery Catapult	<ul style="list-style-type: none"> <li>• Alderley Park</li> </ul>

Capability	Location(s)
Leading Practitioners in Health Economics Assessment	<ul style="list-style-type: none"> <li>• Lancaster</li> <li>• Leeds</li> <li>• Manchester</li> <li>• Sheffield</li> <li>• York</li> </ul>
Medical Research Council Pathology Nodes	<ul style="list-style-type: none"> <li>• Leeds</li> <li>• Manchester</li> <li>• Newcastle</li> </ul>
Medical Research Council Stratified Medicine Consortia (n3)	<ul style="list-style-type: none"> <li>• Manchester</li> <li>• Newcastle</li> </ul>
National Headquarters for Children’s Research and National Stratified Medicine	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>
NIHR Biomedical Research Centres	<ul style="list-style-type: none"> <li>• Leeds</li> <li>• Manchester</li> <li>• Newcastle</li> <li>• Sheffield</li> </ul>
NIHR Clinical Research Facilities for Experimental Medicine	<ul style="list-style-type: none"> <li>• Lancashire</li> <li>• Leeds</li> <li>• Liverpool</li> <li>• Manchester</li> <li>• Newcastle</li> <li>• Sheffield</li> </ul>
NIHR Innovation Observatory	<ul style="list-style-type: none"> <li>• Newcastle</li> </ul>
NIHR Medtech and In vitro diagnostics Co-operatives (MICs)	<ul style="list-style-type: none"> <li>• Leeds</li> <li>• Sheffield</li> </ul>
Stoller Biomarker Discovery Centre	<ul style="list-style-type: none"> <li>• Manchester</li> </ul>
The Centre of Excellence in Infectious Disease Research (CEIDR)	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>
The MRC Centre for Drug Safety Science	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>
The NHS Blood and Transplant Tissue Banking Facility	<ul style="list-style-type: none"> <li>• Speke, Merseyside</li> </ul>
The North West England Medical Research Council Clinical Research Training Fellowship in Clinical Pharmacology and Therapeutics	<ul style="list-style-type: none"> <li>• Liverpool</li> <li>• Manchester</li> </ul>
UK Pharmacogenetics and Stratified Medicine Network	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>
Wolfson Centre for Personalised Medicine	<ul style="list-style-type: none"> <li>• Liverpool</li> </ul>

Source: NHTA

**Table 5.2: Academic and Clinical Facilities by Disease**

Disease	Academic and Clinical Facilities
Cancer and Genomics	<ul style="list-style-type: none"> <li>• Centre for Skin Sciences (Bradford)</li> <li>• CRUK Lung Cancer Centre of Excellence (Manchester)</li> <li>• CRUK-EPSC Cancer Imaging Centre (Manchester)</li> <li>• Experimental Cancer Medicine Centres (Leeds and Bradford, Sheffield, Liverpool, Manchester)</li> <li>• Haematological Malignancies Research (York)</li> <li>• Institute for Cancer Therapeutics (Bradford)</li> <li>• Liverpool Cancer Trials Unit</li> <li>• MRC Clinical Proteomics Centre (Manchester)</li> <li>• NIHR Clinical Research Network (North East and North Cumbria, North West Coast, Yorkshire and Humber and Greater Manchester)</li> <li>• NIHR Colorectal Healthcare Technology Cooperative (Leeds)</li> <li>• NIHR Rare disease TRC led by Newcastle</li> <li>• Prostate Cancer UK Centre of Excellence (Manchester)</li> <li>• Sheffield Cancer Clinical Trials Centre</li> <li>• Sir Bobby Robson Cancer Research Trials Unit (Newcastle)</li> <li>• Wolfson Centre for Personalised Medicine</li> <li>• Yorkshire Cancer Medicine Research Centre</li> <li>• Yorkshire Cancer Research Early Clinical Trials Unit</li> </ul>
Infectious Diseases	<ul style="list-style-type: none"> <li>• Centre for Immunology and Infection</li> <li>• Centre of Excellence in Infectious Diseases Research (University of Liverpool and LSTM)</li> <li>• Infectious Disease Unit (Sheffield Teaching Hospitals NHS Trust) (largest in the UK)</li> <li>• Institute of Clinical Sciences - Virology, TB, C. Difficile - (University of Leeds).</li> <li>• Institute of Infection and Global Health (University of Liverpool)</li> <li>• Liverpool School of Tropical Medicine (LSTM)</li> <li>• NIHR Health Protection Research Unit in Emerging and Zoonotic Infections (University of Liverpool)</li> <li>• NIHR Health Protection Research Unit in GI Infections (University of Liverpool)</li> <li>• The Florey Institute (University of Sheffield)</li> </ul>
Inflammatory Disease	<ul style="list-style-type: none"> <li>• Arthritis UK Centre of Excellence (Manchester)</li> <li>• Centre for Skin Sciences</li> <li>• MRC Arthritis UK Research Centre for Integrated Research into Musculoskeletal Ageing (CIMA), a strategic collaboration between researchers and clinicians at the Universities of Liverpool, Sheffield and Newcastle</li> <li>• MRC Move Laboratory (Newcastle)</li> <li>• MRC Stratified Medicine Programme in Primary Biliary Cirrhosis - Psoriasis, lupus and rheumatoid arthritis</li> <li>• NIHR Leeds BRC in Musculoskeletal disease</li> <li>• NIHR Manchester BRC in Musculoskeletal disease</li> <li>• NIHR Manchester Respiratory &amp; Allergy Clinical Research Facility</li> <li>• NIHR Newcastle Biomedical Research Centre (BRC) in Ageing &amp; Chronic Disease</li> <li>• NIHR Newcastle Dementia Biomedical Research Unit (BRU)</li> <li>• UK Centre of Excellence for Childhood Lupus (Liverpool)</li> <li>• UK Experimental Arthritis Treatment Centre for Children (Liverpool)</li> </ul>

Source: NHSA

**Table 5.3: Clinical Trials, e-health, Diagnostics and Bioinformatics Expertise by location**

Expertise	Location
Clinical Trials	<ul style="list-style-type: none"> <li>• Bradford Evaluation and Trials Unit</li> <li>• Clinical Trial Research Units (CTRU) across the North</li> <li>• Covance and Liverpool NHS first in main trial centre</li> <li>• Economic Evaluation (TEETHA, Centre for Health Economics)</li> <li>• Four NIHR Clinical Research Networks (CRNs) Greater Manchester, North West Coast, North East &amp; North Cumbria, Yorkshire &amp; Humber</li> <li>• Leeds MRC Medical Bioinformatics Centre</li> <li>• Liverpool Clinical Trials Collaboration</li> <li>• Liverpool NIHR Medicines for Children Research Network</li> <li>• Manchester MRC Health eResearch Centre</li> <li>• MRC North West Hub for Trials Methodology Research</li> <li>• NIHR Clinical Research Network Coordinating Centre at the University of Leeds</li> <li>• NWeHealth</li> <li>• Pfizer Inspire Clinical Trial facility</li> <li>• Sheffield NIHR Research Design Services</li> <li>• York Health Economics Consortium (YHEC)</li> <li>• York NIHR Research Design Service</li> <li>• York Trials Unit</li> <li>• Yorkshire Cancer Research Centre</li> </ul>
Diagnostics	<ul style="list-style-type: none"> <li>• Centre for Genomics Research in Liverpool</li> <li>• Liverpool Health Genomics Laboratory</li> <li>• MRC Pathology (Nodes in Leeds, Manchester and Newcastle)</li> <li>• MRC Single Cell Genomics, Leeds</li> <li>• NIHR Leeds In Vitro Diagnostics Co-Operative</li> <li>• NIHR Newcastle In Vitro Diagnostics Co-operative</li> </ul>
Bioinformatics	<ul style="list-style-type: none"> <li>• Centre for Vivo Imaging, Newcastle University</li> <li>• Department of Computer Science, University of Liverpool</li> <li>• Durham Institute of Advanced Research Computing</li> <li>• ESRC Informatics Centre Leeds</li> <li>• Genomics and Bioinformatics Laboratory</li> <li>• Liverpool Department of Biostatistics</li> <li>• Manchester Centre for Biostatistics</li> <li>• Manchester Centre for Health Informatics</li> <li>• MRC Farr Institute</li> <li>• MRC Health eResearch Centre (part of Farr Institute)</li> <li>• MRC Medical Bioinformatics Centre (Leeds)</li> <li>• Newcastle Bioinformatics Support Unit</li> <li>• Newcastle Institute of Health &amp; Society</li> <li>• Newcastle School of Computing Science</li> <li>• Newcastle School of Mathematics &amp; Statistics</li> <li>• NIHR Central Informatics Services (Leeds)</li> <li>• Sheffield Bioinformatics Biostatistics Hub</li> <li>• Yorkshire Centre for Health Informatics</li> </ul>

Source: NHTA

**Table 5.4: Supporting the creation of a diagnostic testing, prototyping, development laboratory, the Northern assets.**

Clinical Research and Discovery	<ul style="list-style-type: none"> <li>• Four Northern NIHR BRCs</li> <li>• Cancer Research UK Manchester Institute</li> <li>• Cancer Research UK Centres in Newcastle and Manchester</li> <li>• 4 Experimental Cancer Medicine Centres</li> <li>• 4 Clinical Research Networks</li> <li>• Liverpool 1st in Man Covance trail centre, first NHS facility in England to be granted MHRA standard and supplementary Phase I Accreditation</li> <li>• Three MRC Single cell genomics centres</li> <li>• Four Genomics England Ltd Centres</li> <li>• New £13m MRC clinical proteomics centre for stratified medicine in Manchester</li> <li>• Medicines Discovery Catapult</li> <li>• Newcastle leads the NIHR Rare Disease TRC</li> <li>• Newcastle’s £20m National Centre for Ageing Science and Innovation</li> <li>• Liverpool’s MRC Centre for Drug Safety Science recently awarded £5m for stratified medicine infrastructure</li> <li>• Liverpool Wolfson Centre for Personalised Medicine</li> <li>• MRC Clinical Pharmacology Training scheme in Liverpool &amp; Manchester</li> </ul>
Diagnostics Development	<ul style="list-style-type: none"> <li>• NIHR Medtech and In vitro Diagnostic Co-operatives (MICs):                             <ul style="list-style-type: none"> <li>• NIHR Leeds In Vitro Diagnostic Co-operative</li> <li>• NIHR Surgical MedTech Cooperative</li> <li>• NIHR Newcastle In Vitro Diagnostics Co-operative</li> <li>• UK BioBank at Stockport</li> </ul> </li> <li>• CEPA Biobank at Newcastle</li> <li>• UK Biobank</li> <li>• Access to key biobanks in inflammatory disease &amp; oncology linked closely to cohorts of well-phenotyped patients consenting to and very engaged in clinical research, including but not limited to Rheumatoid Arthritis, Asthma, COPD, Psoriasis and major solid tumours</li> </ul>
Health Economics and Market Access	<ul style="list-style-type: none"> <li>• University of Sheffield’s Health Economics and Decision Science group (works closely with NICE and the NHS)</li> <li>• University of York’s Centre for Health Economics (works closely with NICE and the NHS)</li> <li>• NICE is HQ in Manchester</li> </ul>
Health Informatics and access to eHR	<ul style="list-style-type: none"> <li>• MRC £40m Farr Health Informatics Institute at the University of Manchester as well as the EPSRC cloud computing centre in Newcastle</li> <li>• NorthWest eHealth providing access to 1.2m health records (3m in under 5 years). With Newcastle &amp; Liverpool partnered with the Farr</li> <li>• Leeds’ NIHR Clinical Research Network Coordinating Centre and NIHR central informatics services at the University of Leeds</li> </ul>

Source: NHSA

**Table 5.5: Precision Medicine Businesses in the North, non-exhaustive**

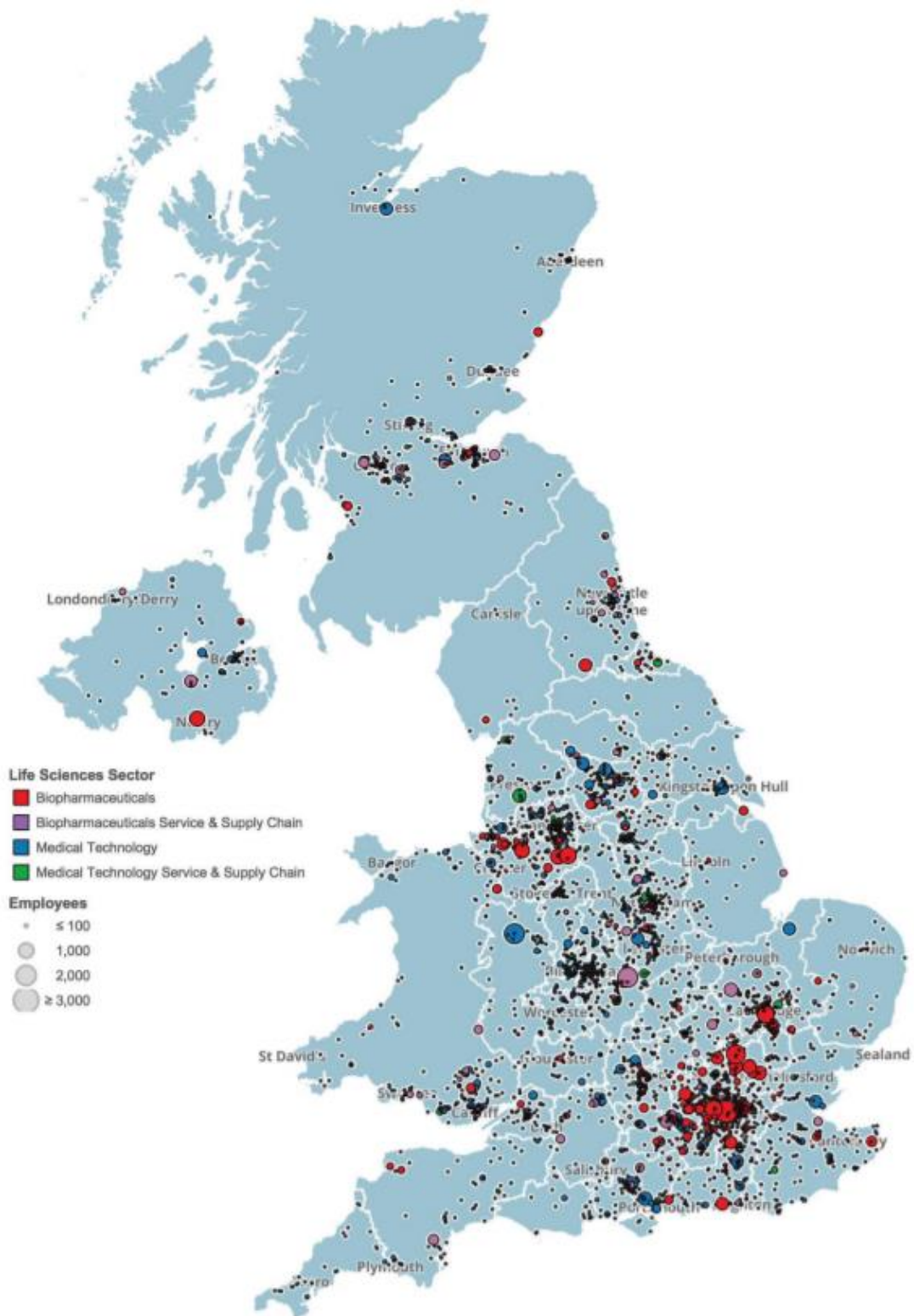
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Advanced Medical Solutions
Agenda 1 analytical Services Ltd
Alere Limited
Associates of Cape Cod International Inc.
Astec Ltd
Avacta Ltd

Name
Baxter Healthcare
Bio Alternative Medical Devices
Bioanalytical Technologies Ltd
Biofortuna Ltd
Biomer Ltd
BiOracle
BioSignatures Ltd
Butters Innovation Ltd
Byotrol Ltd
Cellect Biotech Ltd
Chiesi Ltd
Credent Medical
Cytox Ltd
Delta Diagnostics/Elucigene
Dialog Devices
Drew Scientific Co Limited
Eden Biodesign Ltd
Elanco Ltd (Lilly)
Eli Lilly
Elucigene Diagnostics
Epistem Ltd
Euprotech Ltd
Frazer Nash Consultancy
GE Healthcare
Gentronix Ltd
Global Biodiagnostics Ltd
Glythera
Hart Biologics Ltd
Hologic / Tepnel Pharma Services
Hydra Polymers
IF Sensing
Imagen Biotech Ltd
Intercytex Ltd
Invitrogen
Kanichi Research Ltd
Kershaw Technology Services
Lab M
Mast Group Ltd
Medalytix (Group) Ltd
Medimmune Ltd
Microvisk Technologies

Name
MIDS Medical
NewGene Limited
PalindromX Ltd
Peakdale Molecular Ltd
Pharmapac
Precision Medicines
Premaitha Health Ltd
Pro-Lab Diagnostics Ltd
Promega Health Ltd
Qiagen
QuantuMDx Group Ltd
Reacta Biotech
RedX Pharma
Sensam
Sigma-Aldrich
Spectromics
Spheritech Ltd
Watson Pharmaceuticals
Wheatsheef Investments
Zilico

Source: NHSA and NPiHR Stakeholder Partners

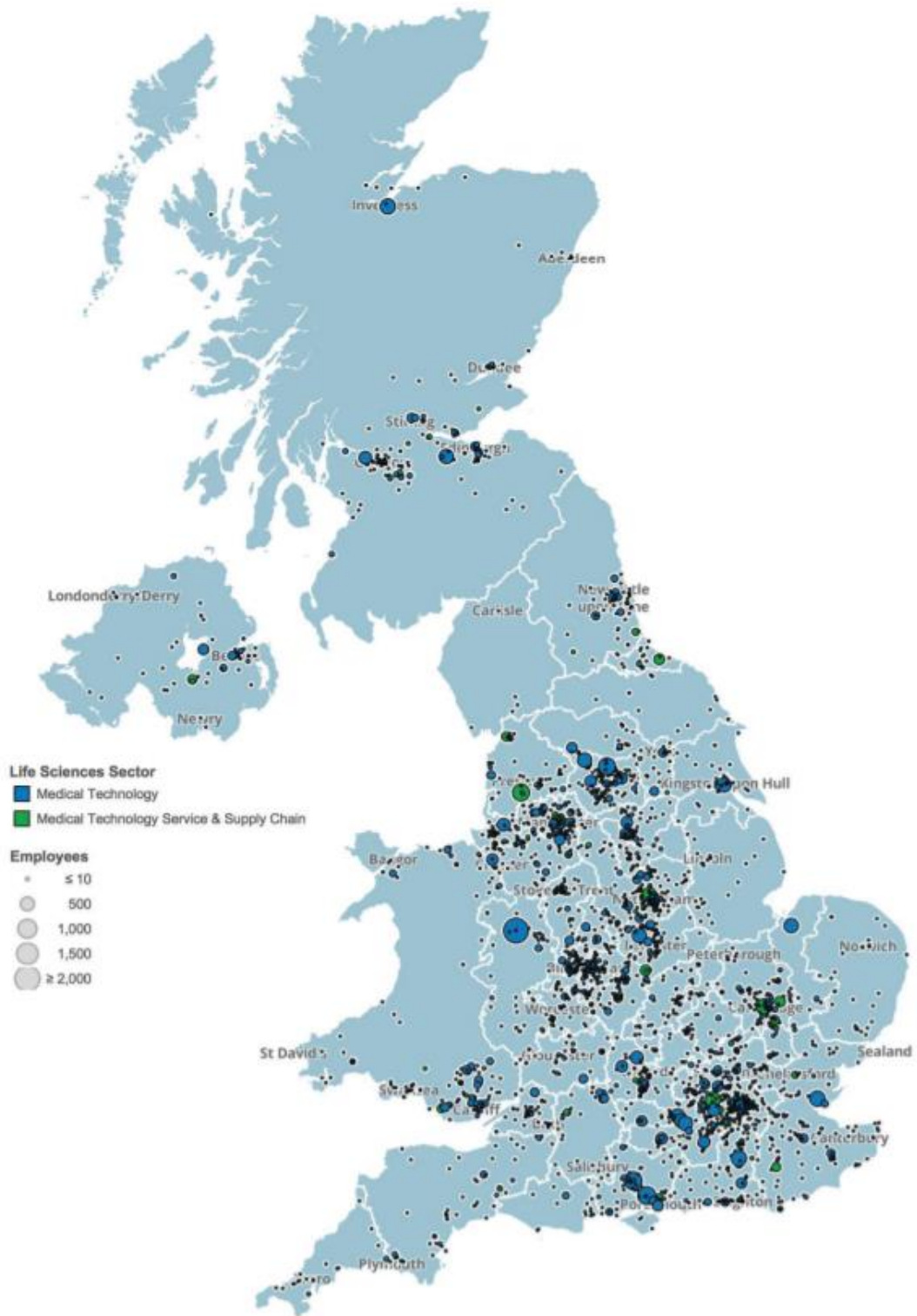
Figure 5-1: Life Sciences Employment, 2017



Source : [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf)

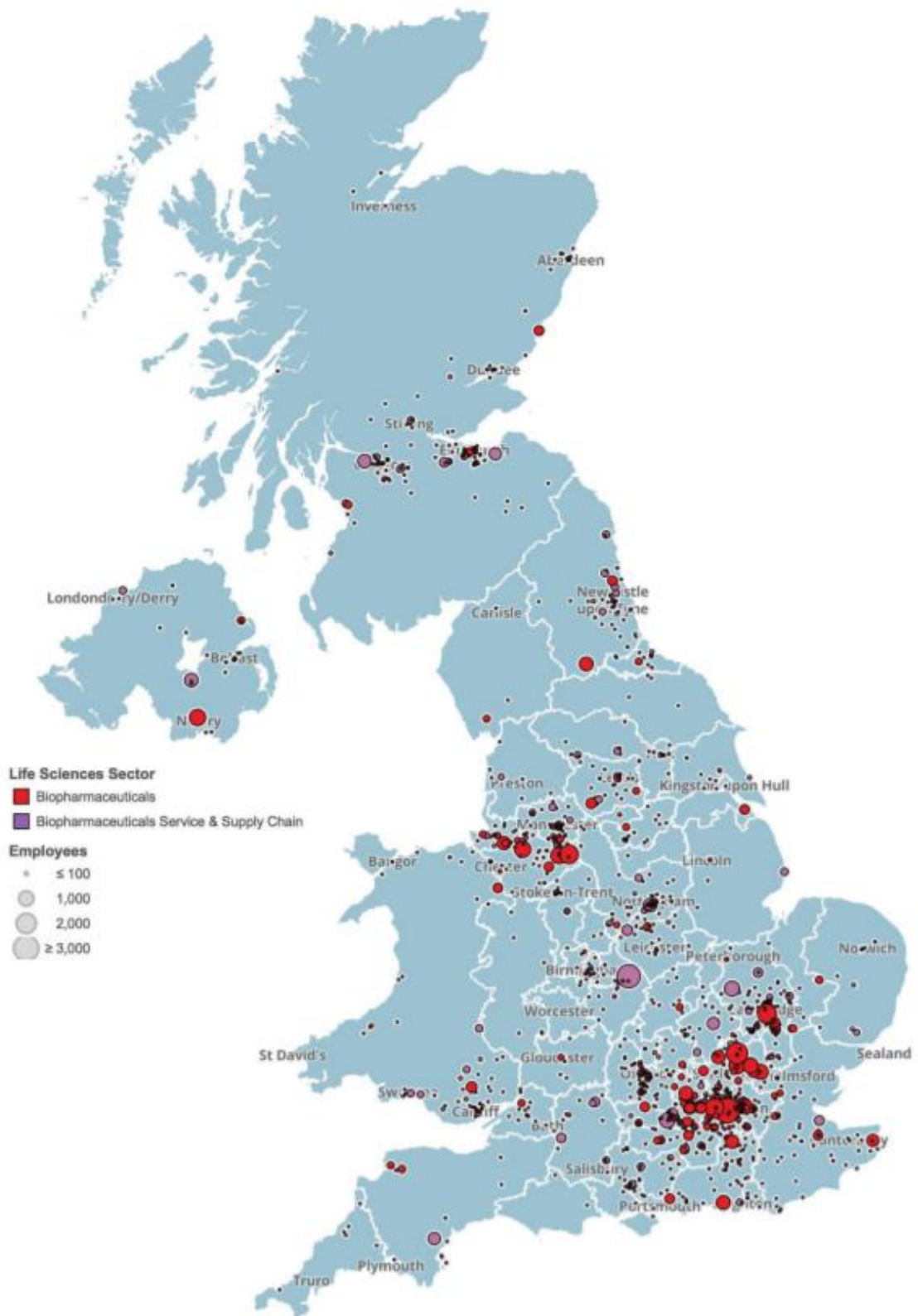


Figure 5-2: Medtech employment, 2017



Source : [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf)

Figure 5-3: Biopharma employment, 2017



Source:  
[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707072/strength-and-opportunity-2017-bioscience-technology.pdf)

**Table 5.6: Graduate retention across health by Local Enterprise Partnership in the North**

Study LEP	Anatomy, Physiology and Pathology		Biological Sciences		Chemistry		Medicine and Dentistry		Nursing and Subjects Allied to Medicine		Pharmacology, Toxicology and Pharmacy		Total	
	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates	Graduates retained for employment in study LEP	% of total graduates
Cheshire and Warrington	-	-	15	24%					525	47%			890	32%
Cumbria	20	38%	-	-	-	-	-	-	165	60%	-	-	280	35%
Greater Manchester	275	38%	810	48%	230	40%	675	39%	3055	67%	225	42%	6270	50%
Humber	-	-	155	32%	125	50%	75	30%	95	76%	-	-	905	47%
Lancashire	85	40%	145	40%	15	36%	65	23%	1575	50%	130	50%	2835	38%
Leeds City Region	275	34%	515	39%	245	34%	680	47%	1955	56%	370	48%	6130	44%
Liverpool City Region	85	35%	335	42%	70	37%	530	32%	825	57%	185	39%	2830	41%
North East	125	50%	470	41%	225	36%	775	50%	1070	73%	195	53%	4435	52%
Sheffield City Region	110	30%	200	31%	65	22%	545	50%	840	47%	-	-	2595	33%
Tees Valley	50	48%	35	60%	25	47%	15	38%	885	62%	-	-	1625	52%
York, North Yorkshire & East Riding	35	21%	115	26%	45	16%	45	20%	335	47%	-	-	940	30%
<b>Grand Total</b>	<b>1060</b>	<b>37%</b>	<b>2795</b>	<b>35%</b>	<b>1045</b>	<b>32%</b>	<b>3405</b>	<b>37%</b>	<b>11325</b>	<b>58%</b>	<b>1105</b>	<b>39%</b>	<b>29735</b>	<b>42%</b>

Source: SDG-ED analysis of HEFCE data, 2010-2011 to 2014-2015

**Table 5.7: Graduate attraction across health by Local Enterprise Partnership in the North**

Study LEP	Anatomy, Physiology and Pathology		Biological Sciences		Chemistry		Medicine and Dentistry		Nursing and Subjects Allied to Medicine		Pharmacology, Toxicology and Pharmacy		Total	
	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates	Graduates attracted from other LEPs	% of total graduates
Cheshire and Warrington	140	100%	340	95%	160	100%	400	100%	495	49%	105	100%	2290	84%
Cumbria	35	66%	-	-	50	100%	175	100%	240	59%	30	100%	760	83%
Greater Manchester	165	37%	480	37%	140	38%	725	52%	1110	27%	405	64%	4905	49%
Humber	105	100%	105	41%	90	42%	330	82%	375	80%	-	-	1315	64%
Lancashire	145	63%	240	62%	110	87%	605	90%	535	25%	175	57%	2385	58%
Leeds City Region	180	40%	490	49%	210	46%	850	56%	755	28%	190	34%	3855	40%
Liverpool City Region	160	66%	210	39%	130	66%	365	41%	1305	61%	90	33%	3010	50%
North East	75	37%	150	24%	55	20%	315	29%	640	37%	65	24%	1795	28%
Sheffield City Region	140	57%	300	60%	80	54%	405	43%	595	41%	170	100%	2590	57%
Tees Valley	40	46%	85	72%	70	75%	345	96%	215	19%	65	100%	1110	59%
York, North Yorkshire & East Riding	95	72%	275	71%	140	76%	450	91%	485	59%	85	100%	2250	75%
<b>Grand Total</b>	<b>1280</b>	<b>62%</b>	<b>2675</b>	<b>59%</b>	<b>1235</b>	<b>64%</b>	<b>4965</b>	<b>71%</b>	<b>6750</b>	<b>44%</b>	<b>1380</b>	<b>73%</b>	<b>26265</b>	<b>59%</b>

Source: SDG-ED analysis of HEFCE data, 2010-2011 to 2014-2015

## 6 Chapter Five Appendix - Understanding the Synergies: Data for Better Health and Wealth & Precision Medicine, together

6.1 This appendix covers the appended material from Chapter Five, looking at the synergies across Data for Better Health and Wealth and Precision Medicine.

6.2 **Table 6.1** gives a breakdown of ageing assets across the North.

**Table 6.1: Ageing Assets in the North**

Location	Assets
Bradford	<ul style="list-style-type: none"> <li>Elderly Care and Rehabilitation Research Team (Bradford Teaching Hospitals NHS Foundation Trust, University of Leeds collaboration through the Bradford Institute for Health Research in Bradford Royal Infirmary)</li> <li>Scope for future work in years to come with the Born in Bradford Study</li> </ul>
Lancaster	<ul style="list-style-type: none"> <li>Centre for Ageing Research (C4AR) – Lancaster University</li> <li>Lancaster Health Innovation Campus</li> </ul>
Leeds	<ul style="list-style-type: none"> <li>Academic Unit of Elderly Care and Rehabilitation, University of Leeds</li> <li>Leeds Older People’s Forum (LOPF)</li> <li>The Community Ageing Research 75+ (CARE 75+) cohort study (NIHR CLAHRC Yorkshire and Humber)</li> <li>Timescapes – an ESRC qualitative longitudinal study. Project 7 – The Oldest Generation: Events, Relationships and Identities in Later Life</li> </ul>
Liverpool	<ul style="list-style-type: none"> <li>European Reference Site in Active and Healthy Ageing (Liverpool)</li> <li>Institute of Ageing and Chronic Disease (University of Liverpool)</li> <li>Integrative Genomics of Ageing Group (University of Liverpool)</li> <li>MRC-Arthritis Research UK Centre for Integrated research into Musculoskeletal Ageing (CIMA) (University of Liverpool, Sheffield and Newcastle)</li> </ul>
Manchester	<ul style="list-style-type: none"> <li>Dementia and Ageing Research Team (DART) (University of Manchester)</li> <li>European Reference Site in Active and Healthy Ageing (Greater Manchester)</li> <li>Greater Manchester Ageing Hub (UK’s first age-friendly city region as recognised by the World Health Organisation)</li> <li>Healthy Ageing Research Group (University of Manchester)</li> <li>Manchester Institute for Collaborative Research on Ageing (University of Manchester)</li> <li>Manchester Urban Ageing Research Group (MUARG) (University of Manchester)</li> </ul>

Location	Assets
Newcastle	<ul style="list-style-type: none"> <li>• Centre for Integrated Systems Biology of Ageing and Nutrition</li> <li>• Clinical Ageing Research Unit (CARU), Newcastle University</li> <li>• Dementias and Neurodegenerative Diseases (DemaNDs) Research Group (Newcastle University)</li> <li>• Global Challenges Academy – Newcastle University</li> <li>• Lifelong Health and Wellbeing Centre for Ageing and Vitality (Newcastle University)</li> <li>• MRC-Arthritis Research UK Centre for Integrated research into Musculoskeletal Ageing (CIMA) (University of Liverpool, Sheffield and Newcastle)</li> <li>• Newcastle City Council’s building on Newcastle age-friendly city status with it’s work in ‘Housing our ageing population’</li> <li>• Newcastle Helix includes 450 houses to use as age-friendly housing</li> <li>• Newcastle University Institute of Ageing (NUIA)</li> <li>• National Innovation Centre for Ageing (NICA)</li> <li>• NIHR Clinical Research Network Specialty Cluster (Newcastle University)</li> <li>• NIHR Newcastle Biomedical Research Centre</li> <li>• NIHR Newcastle Clinical Research Facility (CRF)</li> <li>• The Ageing, Health and Society (AHS) Research Group (Newcastle University)</li> </ul>
North East	<ul style="list-style-type: none"> <li>• European Reference Site in Active and Healthy Ageing (North East England)</li> <li>• CPI’s use of printable electronics for ‘smart med’ monitoring of medicines/sensor technology assets</li> </ul>
North West	<ul style="list-style-type: none"> <li>• European Reference Site in Active and Healthy Ageing (North West Coast of England)</li> </ul>
Sheffield	<ul style="list-style-type: none"> <li>• Designing for wellbeing in environments in later life (DWELL) (University of Sheffield)</li> <li>• MRC-Arthritis Research UK Centre for Integrated research into Musculoskeletal Ageing (CIMA) (University of Liverpool, Sheffield and Newcastle)</li> <li>• New Dynamics of Ageing (Based out of the University of Sheffield)</li> <li>• NIHR Sheffield Biomedical Research Centre for Neurological Disorders</li> <li>• NIHR MIC – Devices for Dignity</li> <li>• Sharing Ageing Research Models (ShARM) (University of Sheffield and Newcastle)</li> <li>• Sheffield Institute for Studies on Ageing (SISA) (University of Sheffield)</li> </ul>
York	<ul style="list-style-type: none"> <li>• Social Policy Research Unit, which conducts applied research in policy and practice across the life course, with a particular focus on health and social care in older age.</li> <li>• Centre for Housing Policy, including research on housing and later life</li> <li>• Biomedical research at the University of York including work on neurodegenerative diseases, cancers and many other biomedical aspects of ageing</li> </ul>
Yorkshire	<ul style="list-style-type: none"> <li>• European Reference Site in Active and Healthy Ageing (Yorkshire and the Humber)</li> </ul>

Source: SDG-ED

## 7 Sci-VAL Data

- 7.1 The bibliometric analysis in this report uses Scopus SciVAL data. As with most emerging fields of research, sophisticated keyword-based searches provide the most accurate evidence on research performance. These keyword strings have been developed through consultation with expert researchers in the NHSA and have undergone robust testing.
- 7.2 The analysis has also benefitted from sharing data, and efforts to run these keyword searches, with a parallel study of precision medicine and advanced medical informatics in Northern Ireland funded by Invest NI. The latter is not an SIA study, but shares many characteristics of an SIA hence it has been useful to combine efforts in extracting and using the bibliometric data.
- 7.3 One major advantage of this collaboration over data has been to spread the (significant) workload in extracting data for comparator institutions. An additional advantage has been that colleagues in Queens University Belfast liaised with technical experts in Elsevier Scopus/SciVAL to check and validate the keyword strings developed for the NHSA study. These keyword strings were then set-up within the main Elsevier Scopus database, providing a faster and more effective basis for data extraction. This involvement of Scopus expertise provides a useful degree of assurance that these complex keyword searches for precision medicine and for advanced medical informatics have been executed accurately (useful because the SciVAL portal was not designed for complex keyword searches).
- 7.4 Consequently, results for Queens University Belfast (QUB) and for Ulster University have been included in the following results. This augments then ‘calibration’ spread in the data by giving a better sense of how NHSA performance compares to both the leading UK and international research institutions the fields of research in this SIA.
- 7.5 Unless stated otherwise, the results presented are for the time period 2012 to date (in practice 2017 for many metrics). This fairly recent times-span is appropriate for emerging and fast-moving fields of research of the type being considered here. For each research area, the comparator institutions (aside from those in Northern Ireland) are those that SciVAL identifies as the top ranked in each field.
- 7.6 The following keyword strings have been used to extract the bibliometric results discussed in this report. Precision Medicine has been included as a search term for advanced medical informatics as so much of precision medicine is in data, and without it the results for advanced medical informatics would be too partial.



**Table 7.1: Keyword strings used in the bibliometric analysis**

Research field	Keyword string
Precision Medicine	<p>biomarker OR "biotech drugs" OR biotechnology OR cdx OR "companion diagnostic*" OR "companion test" OR "gene signature*" OR "gene therap*" OR "genetic medicine" OR "genetic test*" OR "genetically-guided therap*" OR "genomic medicine" OR "genomic test*" OR "genomics-enabled medicine" OR "genomics-guided medicine" OR "genotype-guided" OR immunotherapy OR "individuali?ed medicine" OR "individuali?ed therap*" OR "integrated diagnostics and therapeutics" OR "molecular diagnos*" OR "molecular drugs" OR "molecular medicine" OR "molecular profil*" OR "molecular stratification" OR "molecular therap*" OR "molecular-based diagnostic*" OR "molecular-based testing" OR omic* OR "P4 medicine" OR "patient specific therap*" OR "patient cent*ed care" OR "personal genetics" OR "personal genom*" OR "personal phenotyping" OR "personal* med*" OR "personali?ed genomics" OR "personali?ed health care" OR "personali?ed healthcare" OR "personalized therap*" OR pgx OR pharmacodiagnostic* OR pharmacogenetic* OR pharmacogenomics* OR "precision medicine*" OR "predictive medicine*" OR "preventative medicine*" OR "prospective medicine*" OR "Rx-cDx" OR "Stratified Medicine" OR "stratified therapy" OR "tailored drug" OR "tailored therapeutics" OR "tailored treatment*" OR "target*ed drug*" OR "target*ed therap*" OR "target*ed treatment*" OR "target*ed agents" OR theragnostic* OR theranostic* OR cytomic* OR epigenomic* OR glycomic* OR lipidomic* OR metabolomic* OR nutrigenomic* OR proteomic* OR toxicogenomic* OR transcriptomic* OR "deep learning" OR "Digital engagements and interventions" OR microbiota OR "molecular chemistry" or "molecular pharmacology" OR "target identification" OR genetics OR transcriptome OR proteome OR metabolome OR genomics or "biomarker identification" OR "biomarker validation" OR "molecular diagnostics" OR "Next Generation Sequencing" OR "Nucleic Acid Amplification Tests" OR exosome or "signs and symptoms" or genome OR epigenome OR microbiome OR "environmental risk mapping" OR "clinical diagnosis" OR "clinical treatment choices" OR "health outcomes monitoring" OR "real world health economics" OR "deep phenotyping" OR "Proteomics" OR High content stratification" OR "Multiplex Immunohistochemistry" OR "High content trials" OR "Outcomes based reimbursement" OR "stratified medicine" OR "digital therapeutic" OR "health outcome" OR "market access" OR "pricing and market access" OR "cohort analysis" OR "biobanks" OR "phenotyped cohorts" OR "complementary diagnostic" OR "probabilistic medicine"</p>
Advanced Medical Informatics	<p>"Electronic Health Records" OR "Electronic Medical Records" OR "Routinely Capture Data" OR "Personal Health Records" OR "Data Analytics" OR "Health Insights" OR "Artificial Intelligence" OR "Machine Learning" OR "Algorithm Development" OR "Cognitive Computing" OR "Pattern Recognition" OR "Decision Support" OR "Predictive Models" OR "Big Data" OR "Health Data Science" OR "Learning Health Systems" OR "Real World Evidence" OR "Graphical Models" OR "Mobile Health" OR "Connected Health" OR "Privacy and Confidentiality" OR "Health Informatics" OR "Public Health Informatics" OR "Disease Surveillance" OR "Pharmacovigilance" OR "Augmented Intelligence" OR "Learning Health System" OR "Clinical Informatics" OR "Health Informatics" OR "Medical Informatics" OR "Next Generation Informatics" OR "Big Data" OR "Secondary Use" OR "Population Health" OR "Health Information Technology" OR "Patient Confidentiality" OR "Information Governance" OR "Natural Language Processing" OR "deep learning" OR "Digital engagements and interventions" OR "cognitive quantum computing" OR "data visualisation" OR "data and cyber security" OR "machine based learning" OR "m-health" OR "biomedical informatics" OR "decision support" OR "computer vision" OR "Comparative effectiveness" OR "Statistical anonymization" OR "Federated analytics" OR "Federated informatics" OR "Real world health economics" OR "digital phenotyping" OR "digital biomarkers" OR "precision medicine" OR "stratified medicine"</p>



## 8 Technopolis analytical support on the assessment of research capacity

### This Appendix

- 8.1 This Appendix presents the highlights of an analysis carried out by Technopolis as part of the bespoke analytical support for the Northern Powerhouse in Health Research SIA. The objective of this analysis is to provide a comprehensive view of the level of research and innovation activity in the partnership area, with a special emphasis on the themes that are of interest to the partnership.

### Methodology

- 8.2 The source of data analysed is UKRC's Gateway to Research<sup>11</sup>, which includes most R&D activity funded by the UK research councils, but also any grants by InnovateUK. This means that these data not only comprise research grants, but also feasibility studies, pilots, prototypes and proof of concepts, KTNS, innovation voucher grants, etc.
- 8.3 Cutting these data sources thematically at a level that is relevant to the topics mentioned by the SIA is only possible with the use of more advanced data classification techniques. In this case we have run a semantic text analysis of the titles and abstracts of each project/activity (totalling more than 60,000 grants, which identified more than 100,000 different concepts and more than 140,000 different categories). This allows extracting of the concepts mentioned in each project/activity, which are in turn structured in concept categories.
- 8.4 The topics of relevance for the SIA have been implemented as a set of categories from this semantic text analysis, which in turn comprise multiple topics each. The result is a large thesaurus of words and expressions that are used to identify relevant grants. Any research activity contained in the dataset is deemed to be relevant to a topic if any of the categories or concepts of said topic has been found within its title or abstract. We then look at the level of research activity from different perspectives (number of projects led, number of projects participated, overall value of funding of projects led, and overall value of funding of projects participated) and use both time-series and geo-location information to answer the questions of analysis. During the analysis specification phase, we agreed with the partnership that we will provide information on:
- Number and value of grants in the topics of interest, including their percentage of the total and how they compare with the national averages in the same thematic areas (Location Quotients);
  - Number and value of such grants over a 10-year period; and,

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<sup>11</sup> Gateway to Research, August 2017 snapshot. Available at <http://gtr.rcuk.ac.uk>

- A list of institutions active in the partnership area, for each of the topics and overall.

8.5 Location quotients (LQs) provide a way of showcasing whether the partnership area has a higher concentration of research activity relative to the UK average. A more detailed explanation on how we derive LQs is provided in 0. In short however, an LQ of 1 indicates that research activity under a topic is as heavily concentrated in the partnership area as it is across the comparator geography overall (in this case the UK as a whole). An LQ greater than 1 indicates that a given topic accounts for a larger share of all the partnership area’s research activity than would be expected when compared to the UK average. In other words, LQs substantially greater than 1 signals a level of activity/specialisation that exceeds what would normally be expected nationally. More narrowly defined topics and smaller geographies can display LQ values that are more volatile, so comparison across topics should not be taken literally. On the other hand, for a topic as wide as data and a geography as broad as the Northern Powerhouse, LQs that are just slightly below or above 1 are also interesting.

**Caveats:**

8.6 In this particular case, the topics of interest as defined by the partnership are very broad. Even though we have adjusted the search with the help of the keywords provided by the partnership, during the course of this analysis, we have found that the nature of the analysis and even the nature of the keywords used lends itself to a larger than desired presence of false positives. For example, keywords and expressions related to ‘aging’ can appear in the description of a research grant related to the diseases of aging (in scope), aging in children (somewhat in scope) as well as the aging of materials or wine (not in scope). This issue is not easily mitigated by filtering by funder (e.g. excluding grants funded by the EPSRC or the AHRC) or by enforcing the presence of ‘health’ concepts. These filters would eliminate many false positives, but it would also eliminate interesting interdisciplinary activities in the design of medical devices for the elderly, brain imaging, diagnostic sensors, as well as social sciences and humanities research that is related to old-age welfare, etc. As a result, we present results as they emerge. Since false positives will be present both for NPiHR and the UK as a whole the LQ measures which divide one by the other should still give a (weaker) signal of where the specialisms are.

**Research activity and Location Quotients**

8.7 The following tables show the results for the analysis of publicly-funded research and innovation activity for the topics of interest. We can see that the SIA region has led around 20% of all UK research and innovation grants and has participated in around 25% of them over the period 2007 - 2017. This gives an idea of the sheer size and critical mass of the geography of the Northern Powerhouse. In terms of the topics of interest, aging seems to be one of the salient themes, with this concept being related to around 20% of all the grants led during the period. In relative terms, the area is on par or slightly above the country as a whole in the area of aging, and on par or slightly below the national average in the areas of Digital Health and Precision Medicine. Considering that we are comparing the NP geography to the national figures, which include London and its neighbouring areas, these are not modest results.

**Table 8.1: SIA organisation as the lead organisation in the grants with respect to the UK, 2007-2017**

	Projects led from the SIA	% of UK projects	LQ	Overall value of projects with leadership from an SIA org. (£m)	% of UK funding	LQ
Aging	438	21.27%	1.04	283.46	24.00%	1.38
Data and data for health	1320	18.23%	0.89	651.32	17.18%	0.99
Precision medicine	1582	16.57%	0.81	713.85	14.30%	0.82
<b>All topics</b>	<b>13655</b>	<b>20.42%</b>	--	<b>5010</b>	<b>17.35%</b>	--

Source: Technopolis, based on Gateway to research data

**Table 8.2: SIA organisation as a participant organisation in the grants with respect to the UK, 2007-2017**

	Projects participated from the SIA	% of UK projects	LQ	Overall value of projects with participation from an SIA org. (£m)	% of UK funding	LQ
Aging	555	26.95%	1.08	432.25	36.59%	1.22
Data and data for health	1682	23.21%	0.93	1160	30.46%	1.02
Precision medicine	1985	20.79%	0.83	1240	24.88%	0.83
<b>All topics</b>	<b>16729</b>	<b>24.98%</b>	--	<b>8660</b>	<b>29.95%</b>	--

Source: Technopolis, based on Gateway to research data

- 8.8 As requested, the figures below provide time series data for the number and overall value of projects in which SIA organisations have participated (Figure 8-1 to Figure 8-4), for the different topics of interest. The data shows volatile figures year-to-year<sup>12</sup> but with overall an ascending trend in the numbers of projects participated for all the topics of interest (except for 2017, as this dataset only contains data until August). We suggest focusing on the numbers of projects rather than the funding, since funding data is only available for the overall value of the grants, and does not distinguish what percentage of the funding goes to each participant in collaborative projects. Additionally, funding metrics are likely to be affected by budget cuts.
- 8.9 We have also included information on the funders of grants for each of the topics, which illustrates the reliance on the different research councils for the different topics of interest. The grant start year has been used to produce these figures, and frequently grants will last for 2-4 years, smoothing the real resources available to organisations to conduct research activities in the field.

<sup>12</sup> Oftentimes, data for topics which are narrowly defined will display such volatile behaviour as calls for projects from the main UK funders are not launched every year.

Figure 8-1: Number and value of projects participated by an SIA organisation, all topics, 2007-2017

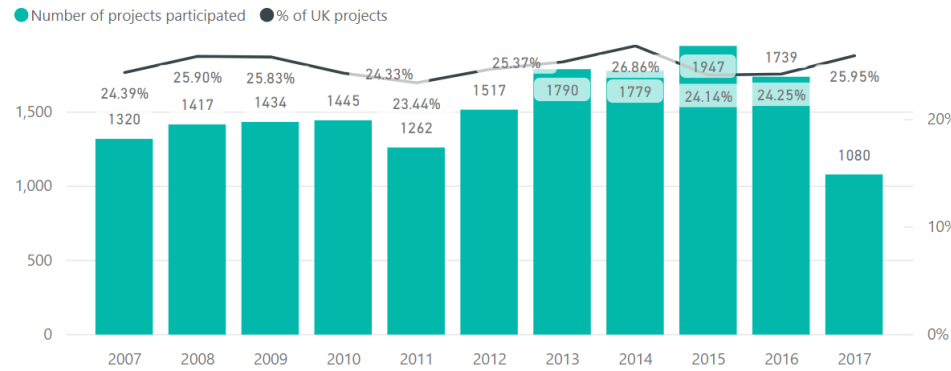
**16730**  
Projects from SIA

**24.98%**  
% of UK projects

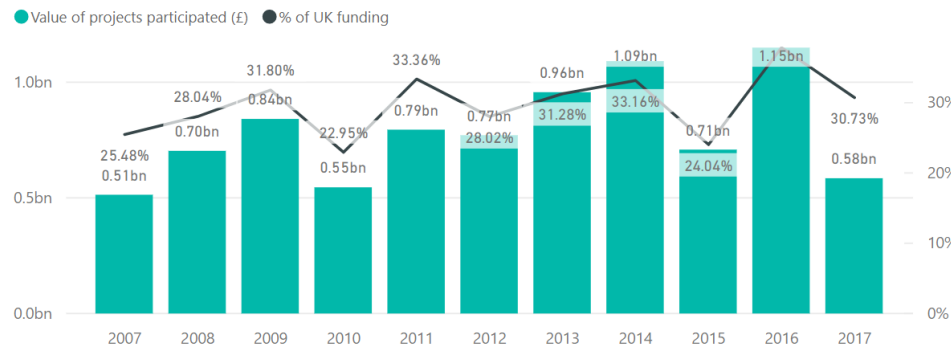
**8.66bn**  
Value of projects from SIA (£)

**29.95%**  
% of UK funding

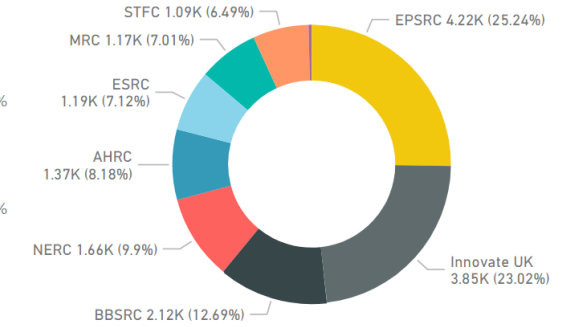
Number of projects participated and % of UK projects by Year



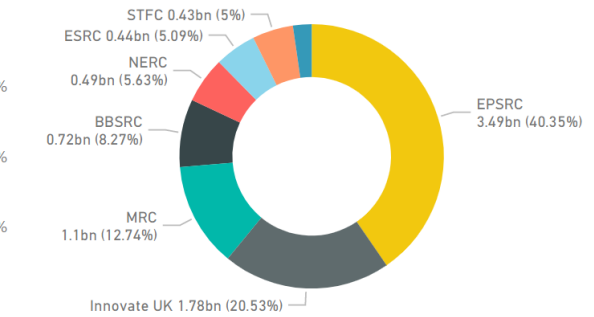
Value of projects participated (£) and % of UK funding by Year



Number of projects led by funder

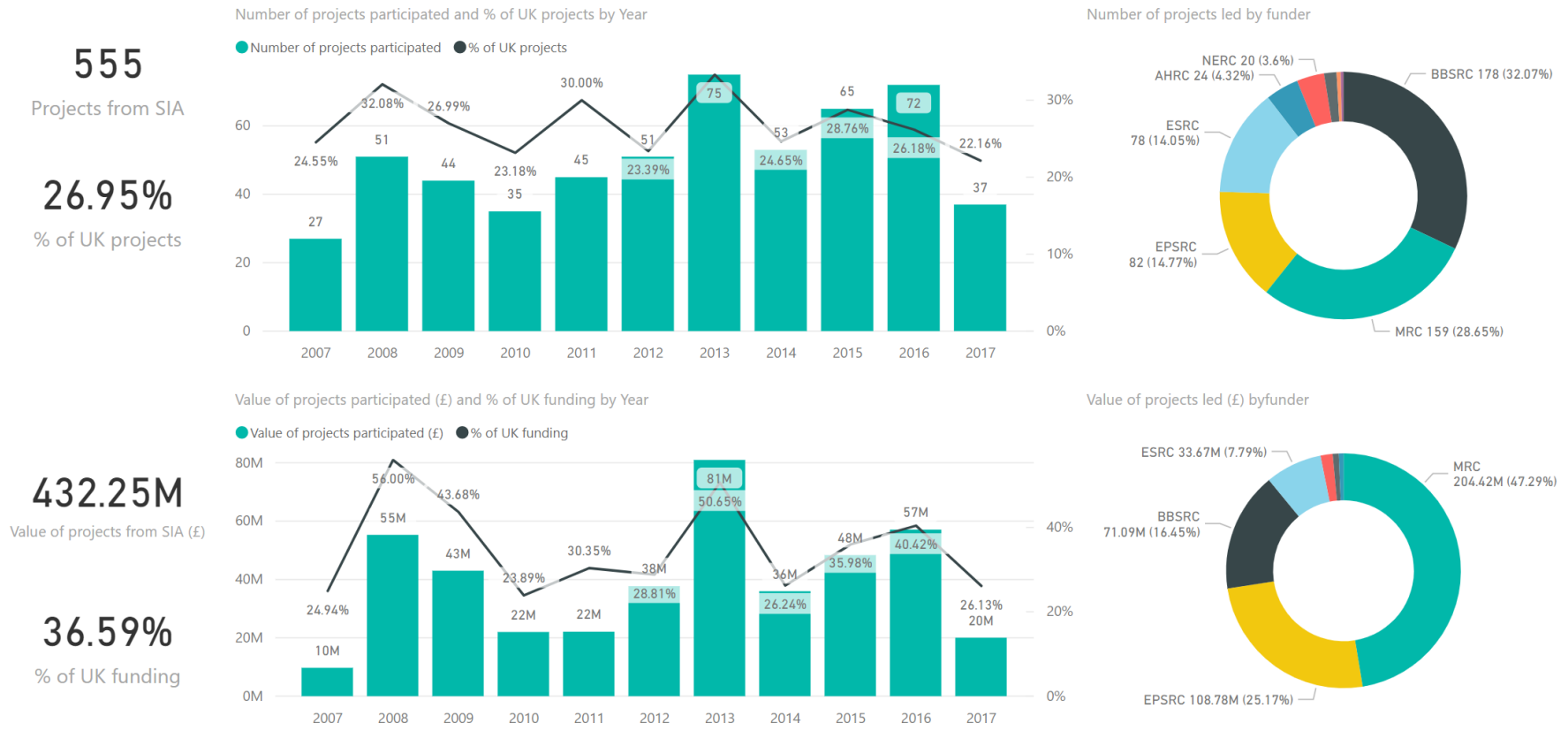


Value of projects led (£) by funder



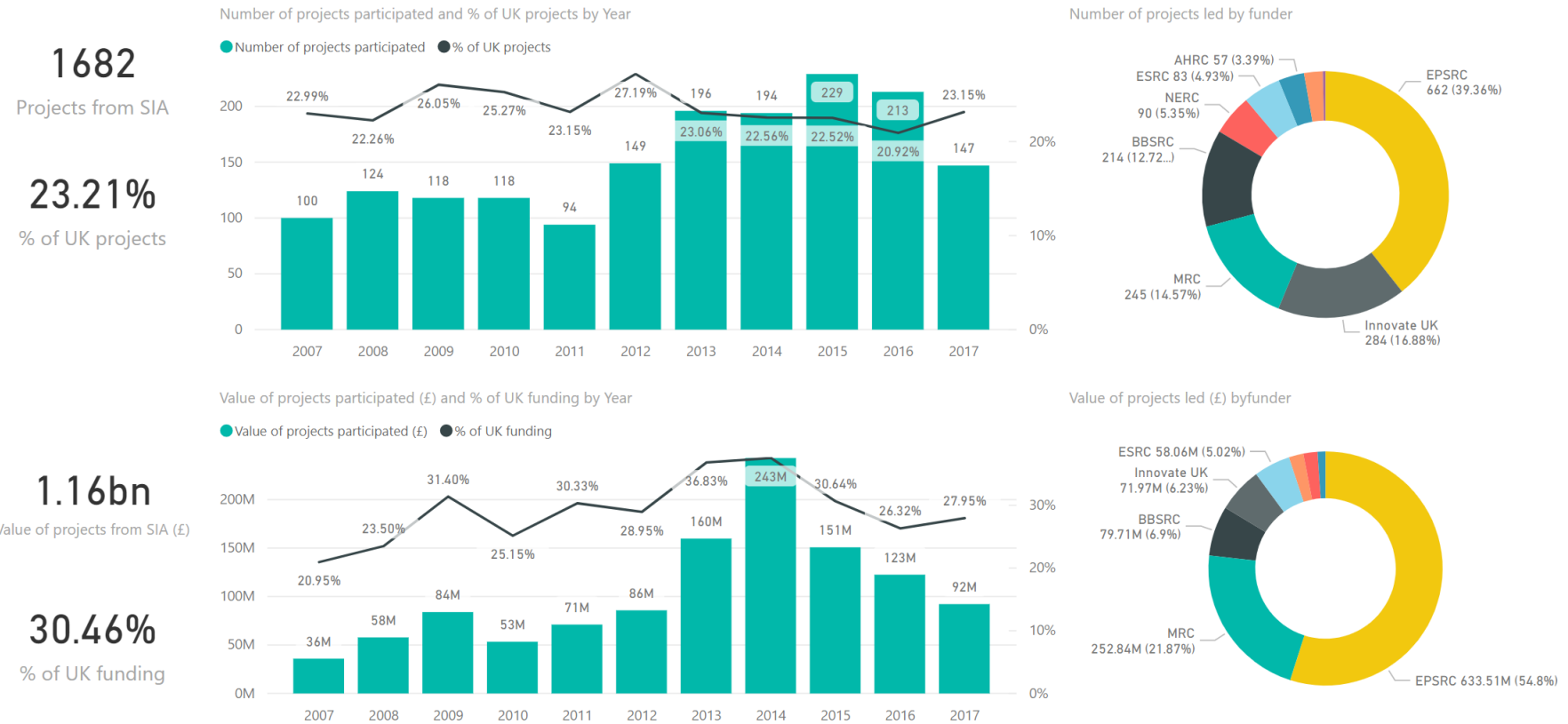
Source: Technopolis, based on Gateway to research data

Figure 8-2: Number and value of projects participated by an SIA organisation, aging, 2007 - August 2017



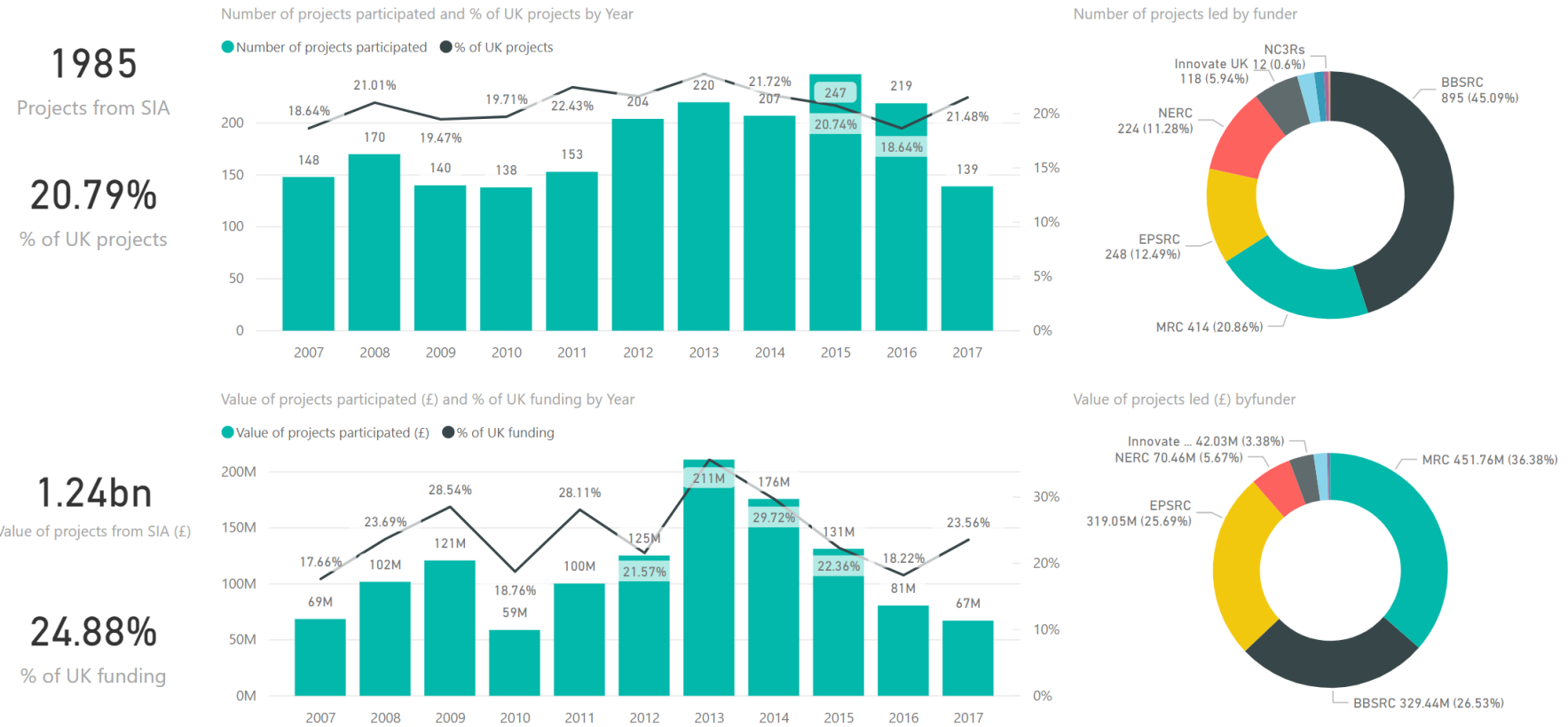
Source: Technopolis, based on Gateway to research data

Figure 8-3: Number and value of projects participated by an SIA organisation, data for health, 2007 – August 2017



Source: Technopolis, based on Gateway to research data

Figure 8-4: Number and value of projects participated by an SIA organisation, precision medicine, 2007 – August 2017



Source: Technopolis, based on Gateway to research data

## List of active organisations

8.10 The following tables show the Top-50 organisations in the SIA area in the different topics of interest, by the number of grants in which they have participated (2007-17). Grants include both Research Council funding as well as Innovate UK. Duplicates may exist where organisations have bid under different names (which is sometimes the case where an organisation uses different subsidiaries to bid for public funding). The complete list is available in the Excel file provided as part of this analysis.

### All topics

Name of organisation	Number of projects participated	Overall value of projects participated (£)
University of Manchester	2641	1,670,208,912
University of Leeds	1852	930,018,454
University of Sheffield	1848	1,405,053,054
Newcastle University	1392	823,977,703
University of Liverpool	1356	710,435,371
University of York	1103	486,120,477
Durham University	1062	459,192,401
Lancaster University	698	223,063,370
University of Hull	209	52,032,574
Northumbria University	193	62,794,827
Manchester Metropolitan University	159	44,451,170
Liverpool John Moores University	148	51,669,230
University of Huddersfield	131	68,802,786
University of Central Lancashire	128	25,503,645
Centre for Process Innovation Limited	124	579,336,145
University of Salford	120	62,584,171
University of Bradford	118	35,222,850
Sheffield Hallam University	94	33,820,664
Siemens Public Limited Company	80	153,961,509
Liverpool School of Tropical Medicine	75	61,911,774
National Nuclear Laboratory Ltd	72	96,814,182
Natural England	72	35,226,741
National Institute for Health Research	61	85,994,874
University of Teesside	53	28,981,605
C-Tech Innovation Limited	50	15,339,156
Shell Global Solutions UK	47	68,535,550
Leeds City Council	39	38,351,209
University of Bradford(The)	36	28,599,014
University of Salford(The)	35	5,037,370
Sellafield Ltd	34	40,132,722
Leeds Teaching Hospitals NHS Trust	33	56,569,507
Leeds Metropolitan University	31	13,992,269
Newcastle City Council	31	56,274,663
Northumbrian Water Ltd	30	53,675,832
Unilever UK Central Resources Ltd	29	69,632,559
Manchester City Council	27	38,685,001
Pilkington Group Limited	27	60,826,102
AMEC Nuclear UK Limited	25	29,817,368
Food & Environment Research Agency - FERA	24	9,938,568
Waters Corporation / Micromass U K Ltd	22	22,100,699
Aimes Grid Services Community Interest Company	21	6,553,819
Cybula Limited	21	12,909,777
ITM Power plc	21	26,067,002
H W Communications Limited	20	11,136,457
Pragmatic Printing Limited	20	4,129,662
University of Chester	20	2,368,050
JBA Trust	19	35,944,961
Leeds Beckett University	19	5,789,704
Netcomposites Limited	19	7,474,606



## Aging

Name of organisation	Number of projects participated	Overall value of projects participated (£)
University of Manchester	132	130,996,862
Newcastle University	109	122,366,967
University of Leeds	66	56,891,831
University of Sheffield	66	68,285,081
University of Liverpool	62	43,118,494
University of York	34	15,951,269
Durham University	25	9,745,934
Lancaster University	15	3,116,909
Manchester Metropolitan University	10	6,838,027
National Institute for Health Research	10	20,749,568
Northumbria University	9	21,777,078
University of Bradford	9	3,658,631
Sheffield Hallam University	8	9,453,669
University of Hull	8	8,232,128
Liverpool School of Tropical Medicine	7	6,766,892
Manchester City Council	6	6,297,078
UK Biobank	5	18,345,605
University of Salford	5	2,902,288
BioTransformations Ltd	4	1,792,606
Marshall's Mono Ltd	4	1,792,606
Mayer Brown	4	1,792,606
Newcastle City Council	4	15,347,582
Siemens Public Limited Company	4	7,094,181
Smith and Nephew	4	20,805,048
Invivio Limited	3	5,978,478
Leeds Metropolitan University	3	350,496
Liverpool John Moores University	3	6,584,667
Simulation Solutions	3	9,725,573
University of Chester	3	154,099
BITECIC Ltd	2	11,967,429
Equal Arts	2	130,219
Hull York Medical School	2	652,907
Inventya Ltd	2	1,153,294
Leach Rhodes Walker Architects	2	49,913
Manchester mHealth Ecosystem	2	5,661,748
Salford City Council	2	4,098,392
Sellafield Ltd	2	152,168
The Sage Gateshead	2	12,379,042
Tunstall Healthcare (UK) Limited	2	1,277,287
University of Central Lancashire	2	417,218
University of Teesside	2	3,172,578
Yorkshire Forward	2	11,967,429
2-Dtech Limited	1	5,327,896
AB SCIEX UK Limited	1	318,755
adidas Group	1	6,150,603
Advancing Quality Alliance AQUA	1	4,022,446
Arthritis Research UK	1	2,099,998
Axordia Ltd	1	7,073,464
BASF Coatings Ltd	1	95,751

## Data and health

Name of organisation	Number of projects participated	Overall value of projects participated (£)
University of Manchester	310	233822537
University of Sheffield	203	152451300
Newcastle University	182	130188102
University of Leeds	157	106535881
University of Liverpool	147	81372286
University of York	99	81058387
Durham University	85	47496770
Lancaster University	75	41594333
Northumbria University	21	3870863
Liverpool School of Tropical Medicine	18	14298243
Siemens Public Limited Company	17	34935827
University of Hull	17	4353670
National Institute for Health Research	16	39515407
Manchester Metropolitan University	14	2874354
University of Salford	13	19964322
University of Huddersfield	11	17376274
Cybula Limited	10	3892571
University of Bradford	10	2240508
Centre for Process Innovation Limited	9	22198658
Liverpool John Moores University	9	6767165
University of Central Lancashire	9	3470153
Leeds Teaching Hospitals NHS Trust	8	22298862
UK Biobank	8	28923574
Newcastle City Council	7	19700297
Sellafield Ltd	7	8252292
Sheffield Hallam University	7	6604065
University of Teesside	7	1562869
Aimes Grid Services Community Interest Company	6	1138603
Food & Environment Research Agency - FERA	6	5339269
JBA Trust	6	14948089
Manchester City Council	6	10417765
NXP Semiconductors UK Limited	6	2499657
Unilever UK Central Resources Ltd	6	15736745
Cadscan Limited	5	549717
EM Renewables Ltd	5	869943
Natural England	5	1467892
New & Renewable Energy Centre Ltd	5	869943
Shell Global Solutions UK	5	8105496
Food and Environment Research Agency (FERA)	4	954026
H W Communications Limited	4	2509778
Leeds City Council	4	6209643
Leeds Metropolitan University	4	1088444
National Nuclear Laboratory Ltd	4	17113466
Oxehealth Limited	4	3084935
Pre Chasm Research Limited	4	167642
Red Hats Labs	4	9147072
Salford Royal NHS Foundation Trust	4	9859916
Silistix Ltd	4	4906663
Simulation Solutions	4	14406999

## Precision medicine

Name of organisation	Number of projects participated	Overall value of projects participated (£)
University of Manchester	459	326089720
University of Liverpool	275	168266529
University of Sheffield	260	149774739
Newcastle University	255	189141013
University of Leeds	219	127310066
University of York	182	77808941
Durham University	77	39792224
Lancaster University	48	24086050
University of Hull	27	11038167
Centre for Process Innovation Limited	19	43719056
Liverpool School of Tropical Medicine	18	13063866
National Institute for Health Research	18	18707713
Northumbria University	15	2944981
University of Bradford	12	3247114
Food & Environment Research Agency -FERA	11	6809607
Leeds Teaching Hospitals NHS Trust	11	9235705
Manchester Metropolitan University	11	4970652
Natural England	9	3744583
UK Biobank	9	33240686
Waters Corporation / Micromass U K Ltd	9	12064774
Siemens Public Limited Company	8	10069830
Unilever UK Central Resources Ltd	8	27919201
Shell Global Solutions UK	7	13373609
University of Huddersfield	6	1369088
Fujifilm Diosynth Biotechnologies	5	16438683
Sheffield Hallam University	5	1168586
Avacta Group Plc	4	6041040
CPI Ltd	4	14327688
Croda Europe Limited	4	1017717
Prozomix Limited	4	4559784
Salford Royal NHS Foundation Trust	4	10620895
Unilever R&D	4	0
Avecia Biologics Ltd	3	12991000
Chemoxy International Ltd	3	2530394
Food and Environment Research Agency (FERA)	3	625491
Hull York Medical School	3	2611296
National Nuclear Laboratory Ltd	3	8102210
Oj-Bio Limited	3	992351
Orla Protein Technologies Limited	3	755081
University of Central Lancashire	3	575410
University of Salford	3	4649636
University of Teesside	3	788723
Yorkshire Dairy Goats	3	1622412
AB SCIEX UK Limited	2	462806
Ai2 Limited	2	250000
Arcis Biotechnology Holdings Limited	2	209294
Badrilla Limited	2	48461
Badrilla Ltd	2	531702
BASF Coatings Ltd	2	528560

## Keywords

8.11 The following table describes the keywords that were used to implement the different topics of interest for the SIA as a set of equivalent or related semantic text analysis categories.

SIA Topic	SIA keywords
Aging	<p><b>Ageing (MeSH Keywords)</b>                      ‘Aging%’ or title like ‘%Ageing%’ or title like ‘%Ageing Well%’ or title like ‘%Aging Well%’ or title like ‘%Healthy Ageing%’ or title like ‘%Healthy Aging%’ or title like ‘%Well Aging%’ or title like ‘%Well Ageing%’ or title like ‘%Middle Age%’ or title like ‘%Homes for the Aged%’ or title like ‘%Old Age Home%’ or title like ‘%Adult Day Care Centers%’ or title like ‘%Housing for the Elderly%’ or title like ‘%Biological Aging%’ or title like ‘%Biological Ageing%’ or title like ‘%Aging, Biological%’ or title like ‘%Ageism%’ or title like ‘%Age Discrimination%’ or title like ‘%Senior Centers%’ or title like ‘%Centers for the Aged%’ or title like ‘%Old Age Assistance%’ or title like ‘%Old Age Security%’ or title like ‘%Elder Abuse%’ or title like ‘%Elder Neglect%’ or title like ‘%Aged Abuse%’ or title like ‘%Aging in Place%’ or title like ‘%Ageing in Place%’ or title like ‘%Aged, 80 and over%’ or title like ‘%Centenarians%’ or title like ‘%Nonagenarians%’ or title like ‘%Octogenarians%’ or title like ‘%Oldest Old%’ or title like ‘%Elderly%’</p> <p><b>Ageing (MeSH Keywords – Precision Medicine)</b>                      ‘Cognitive Aging%’ or title like ‘%Cognitive Ageing%’ or title like ‘%Macular Degeneration%’ or title like ‘%Age-Related Macular Degeneration%’ or title like ‘%Age-Related Maculopath%’ or title like ‘%Maculopathies, Age-Related%’ or title like ‘%Maculopathy, Age-Related%’ or title like ‘%Dental Care for Aged%’ or title like ‘%Dentistry for Aged%’ or title like ‘%Osteoporosis%’ or title like ‘%Age-Related Osteoporosis%’ or title like ‘%Bone Loss, Age-Related%’ or title like ‘%Senile Osteoporosis%’ or title like ‘%Osteoporosis, Senile%’ or title like ‘%Health Services for the Aged%’ or title like ‘%Health Services for Aged%’ or title like ‘%Elder Nutritional Physiological Phenomena%’ or title like ‘%Aged Nutrition%’ or title like ‘%Age-Related Memory Disorders%’ or title like ‘%Memory Disorders, Age-Related%’ or title like ‘%Demographic Ageing%’ or title like ‘%Demographic Ageing%’ or title like ‘%Frail Elderly%’ or title like ‘%Frail Elder%’ OR ‘Frail Older Adults%’ or title like ‘%Functionally-Impaired Elderly%’ or title like ‘%Geriatrics%’ or title like ‘%Gerontology%’ or title like ‘%Geriatric Dentistry%’ or title like ‘%Geriatric Nursing%’ or title like ‘%Geriatric Assessment%’ or title like ‘%Geriatric Psychiatry%’ or title like ‘%Alzheimer% Disease%’ or title like ‘%Alzheimer Dementia%’ or title like ‘%Alzheimer Syndrome%’ or title like ‘%Alzheimer’s Amyloid Fibril Protein%’ or title like ‘%Arthritis%’ or title like ‘%Rheumatoid Arthritis%’ or title like ‘%Osteoarthritis%’ or title like ‘%Arthritis, Degenerative%’ or title like ‘%Osteoarthritis%’ or title like ‘%Osteoarthritis Deformans%’ or title like ‘%National Institute on Aging%’</p>
Data and health	<p>‘Electronic Health Records%’ or title like ‘%Electronic Medical Records%’ or title like ‘%Routinely Capture Data%’ or title like ‘%Personal Health Records%’ or title like ‘%Data Analytics%’ or title like ‘%Health Insights%’ or title like ‘%Artificial Intelligence%’ or title like ‘%Machine Learning%’ or title like ‘%Algorithm Development%’ or title like ‘%Cognitive Computing%’ or title like ‘%Pattern Recognition’ OR ‘Decision Support%’ or title like ‘%Predictive Models%’ or title like ‘%Big Data%’ or title like ‘%Health Data Science%’ or title like ‘%Learning Health Systems%’ or title like ‘%Real World Evidence%’ or title like ‘%Graphical Models%’ or title like ‘%Mobile Health%’ or title like ‘%Connected Health%’ or title like ‘%Privacy and Confidentiality%’ or title like ‘%Health Informatics%’ or title like ‘%Public Health Informatics%’ or title like ‘%Disease Surveillance%’ or title like ‘%Pharmacovigilance%’ or title like ‘%Augmented Intelligence%’ or title like ‘%Learning Health System%’ or title like ‘%Clinical Informatics%’ or title like ‘%Health Informatics%’ or title like ‘%Medical Informatics%’ or title like ‘%Next Generation Informatics%’ or title like ‘%Big Data%’ or title like ‘%Secondary Use%’ or title like ‘%Population Health%’ or title like ‘%Health Information Technology%’ or title like ‘%Patient Confidentiality%’ or title like ‘%Information Governance%’ or title like ‘%Natural Language Processing’ OR ‘deep learning%’ or title like ‘%Digital engagements and interventions%’ or title like ‘%cognitive quantum computing%’ or title like ‘%data visualisation%’ or title like ‘%data and cyber security%’ or title like ‘%machine based learning%’ or title like ‘%m-health%’ or title like ‘%biomedical informatics%’ or title like ‘%decision support%’ or title like ‘%computer vision%’ or title like ‘%Comparative effectiveness%’ or title like ‘%Statistical anonymization%’ or title like ‘%Federated analytics%’ or title like ‘%Federated informatics%’ or title like ‘%Real world health economics%’ or title like ‘%digital phenotyping%’ or title like ‘%digital biomarkers%’ or title like ‘%precision medicine%’ or title like ‘%stratified medicine’ [included in the topic of precision medicine below]</p>
Precision Medicine	<p>biomarker OR ‘biotech drugs’ OR biotechnology OR cdx OR ‘companion diagnostic%’ or title like ‘%companion test%’ or title like ‘%gene signature%’ or title like ‘%gene therap%’ or title like ‘%genetic medicine%’ or title like ‘%genetic test%’ or title like ‘%genetically-guided therap%’ or title like ‘%genomic medicine%’ or title like ‘%genomic test%’ or title like ‘%genomics-enabled medicine%’ or title like ‘%genomics-guided medicine%’ or title like ‘%genotype-guided’ OR immunotherapy OR ‘individual?ed medicine%’ or title like ‘%individual?ed therap%’ or title like ‘%integrated diagnostics and therapeutics%’ or title like ‘%molecular diagnos%’ or title like ‘%molecular drugs%’ or title like ‘%molecular medicine%’ or title like ‘%molecular profil%’ or title like ‘%molecular stratification%’ or title like ‘%molecular therap%’ or title like ‘%molecular-based diagnostic%’ or title like ‘%molecular-based testing’ OR omic% OR ‘P4 medicine%’ or title like ‘%patient specific therap%’ or title like ‘%patient cent?ed care%’ or title like ‘%personal genetics%’ or title like ‘%personal genom%’ or title like ‘%personal phenotyping%’ or title like ‘%personal med%’ or title like ‘%personal?ed genomics%’ or title like ‘%personal?ed health care%’ or title like ‘%personal?ed healthcare%’ or title like ‘%personalized therap%’ OR pgx OR pharmacodiagnostic% OR pharmacogenetic% OR pharmacogenomics% OR ‘precision medicine%’ or title like ‘%predictive medicine%’ or title like ‘%preventative medicine%’ or title like ‘%prospective medicine%’ or title like ‘%Rx-cDx%’ or title like ‘%Stratified Medicine%’ or title like ‘%stratified therapy%’ or title like ‘%tailored</p>

drug%' or title like '%tailored therapeutics%' or title like '%tailored treatment%%' or title like '%targeted drug%%' or title like '%targeted therap%%' or title like '%targeted treatment%%' or title like '%targeted agents' OR theragnostic% OR theranostic% OR cytomic% OR epigenomic% OR glycomic% OR lipidomic% OR metabolomic% OR nutrigenomic% OR proteomic% OR toxicogenomic% OR transcriptomic% OR 'deep learning%' or title like '%Digital engagements and interventions' OR microbiota OR 'molecular chemistry%' or title like '%molecular pharmacology%' or title like '%target identification' OR genetics OR transcriptome OR proteome OR metabolome OR genomics or 'biomarker identification%' or title like '%biomarker validation%' or title like '%molecular diagnostics%' or title like '%Next Generation Sequencing' OR 'Nucleic Acid Amplification Tests' OR exosome or 'signs and symptoms' or genome OR epigenome OR microbiome OR 'environmental risk mapping%' or title like '%clinical diagnosis%' or title like '%clinical treatment choices%' or title like '%health outcomes monitoring%' or title like '%real world health economics%' or title like '%deep phenotyping %' or title like '%Proteomics' OR High content stratification%' or title like '%Multiplex Immunohistochemistry%' or title like '%High content trials%' or title like '%Outcomes based reimbursement%' or title like '%stratified medicine%' or title like '%digital therapeutic%' or title like '%health outcome%' or title like '%market access%' or title like '%pricing and market access%' or title like '%cohort analysis%' or title like '%biobanks%' or title like '%phenotyped cohorts' OR 'complementary diagnostic%' or title like '%probabilistic medicine'

## Methodological note on the use and meaning of Location Quotients

- 8.12 Throughout the SIA process we have been asked as providers of data and analysis to provide not only raw figures, but also some help in making sense of them. If the data sources allow, we do this through metrics and indicators that are normalised or referenced to different baselines or comparators. This can help the readers of the figures to make comparisons or to figure out if a particular data point is high or low with regards to a particular baseline.
- 8.13 For this, we usually provide the shares of particular metrics with respect to the national averages. For some data sources where we work thematically in addition to geographically, we try to go a bit beyond and provide another metric called the Location Quotient (LQ). We use the LQs to try and abstract as much as possible the size of the object of analysis (in this case an SIA partnership region) and to give some indication on whether an activity (be it research and innovation funding, employment, patent output, etc.) is above or below an expected baseline/threshold.
- 8.14 Location quotients have been used in the past by the ONS and the ERC in the Witty review and the previous UK Industrial Strategy, using data of employment and number of companies, in order to work out areas of industrial and jobs concentration throughout the UK. It can be a bit tricky to unpack what the LQ conveys, because it is sometimes referred as a “concentration/specialisation” metric while in other occasions it is referred as “position over or under, relative to a baseline”. These two explanations are compatible and come from the fact that you can write the formula for calculating the LQ in two (equivalent) ways (see formula below).

$$LQ = \frac{\frac{region_{theme}}{region_{all}}}{\frac{country_{theme}}{country_{all}}} = \frac{\frac{region_{theme}}{country_{theme}}}{\frac{region_{all}}{country_{all}}}$$

- 8.15 From the ERC’s own paper Localisation of Industrial Activity across England’s LEPs (which underpinned the LQs used in the Witty review): “Location Quotients are used to provide a broad illustration of the extent to which a particular activity is over- or under-represented [in a particular region] relative to the national average.” [...] “If the LQ for an activity is less than 1, the [region] has

a smaller share of [activity] than the GB average; if the LQ for an activity is greater than 1, the [region] has a larger share of [activity] than the GB average.”<sup>13</sup>

- 8.16 At the same time, other definitions emphasise the “agglomeration” aspect. From NESTA’s Creative Clusters and Innovation report: “Location quotients are a standard metric of agglomeration in economic geography that measure a given area’s degree of specialisation in a sector, compared with the national average. A location quotient larger than 1 indicates that a particular sector is more important to the local economy than it is to the British economy.”<sup>14</sup>

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<sup>13</sup> This paper is available at: <https://www.enterpriseresearch.ac.uk/wp-content/uploads/2013/12/RP15-LEP-Clusters-Report- Dec-2013-Final.pdf>

<sup>14</sup> This definition is very close to the phrasing used in previous ONS papers and these NESTA reports are available at:  
[https://www.nesta.org.uk/sites/default/files/creative\\_clusters\\_and\\_innovation.pdf](https://www.nesta.org.uk/sites/default/files/creative_clusters_and_innovation.pdf)  
and  
[https://www.nesta.org.uk/sites/default/files/summary\\_geography\\_uks\\_creative\\_high-tech\\_economies2015.pdf](https://www.nesta.org.uk/sites/default/files/summary_geography_uks_creative_high-tech_economies2015.pdf)

## 9 Technopolis analytical support on further patent analysis

### This Appendix

- 9.1 This Appendix has been prepared by Technopolis to supplement the analysis of patenting activity in the Northern Powerhouse in Health Research (NPIHR) Science and Innovation Audit (SIA), undertaken by SDG Economic Development. The goal of this analysis is to understand the volume of patent applications in the areas of interest of the SIA, using international patenting data. We replicate as closely as possible the same methodology, using a different data source to corroborate some of the findings of the previous analysis.

### Methodology

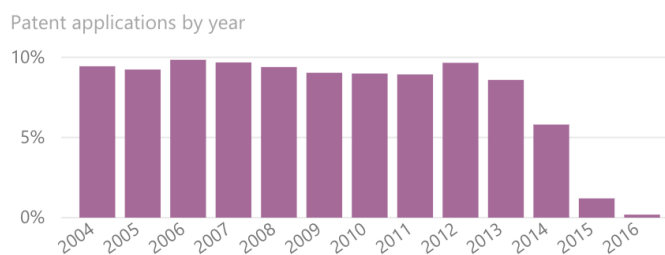
- 9.2 The data was compiled by Technopolis based on the EPO - PATSTAT Worldwide Patent Statistical Database (Spring 2017 version)<sup>15</sup>. To locate applicants and inventors behind each patent application we use the regionalised PATSTAT information, which gives geo-location information of applicant and inventor addresses at the level of NUTS3 areas.
- 9.3 The areas of interest for the SIA have been specified as a combination of WIPO technology areas, as follows:
- 9.4 Medical and biological:
- Analysis of biological materials;
  - Biotechnology;
  - Medical technology;
  - Organic fine chemistry; and,
  - Pharmaceuticals.
- 9.5 IT & data:
- Computer technology;
  - Digital communication; and,
  - IT methods for management.

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<sup>15</sup> Available at: <https://www.epo.org/searching-for-patents/business/patstat.html>

9.6 Note that geo-located patent information exists only for a small subset of patents (13.76%) where there is complete address information of applicants and inventors. Assuming that geo-located patents are randomly distributed, we also give grossed up estimates based on this general percentage. Although we would caution against relying on these figures directly, the percentages and distributions can be useful to profile the strengths of the regions and to compare them against the national picture. Where possible, Location Quotients have been calculated to illustrate the relative output specialisation of the SIA are with respect to that of England as a whole.

9.7 The Spring 2017 PATSTAT database used in this analysis contains patent applications up to mid-2017. However, patent application data has long time lags to publication in international databases, which is why this database can be considered complete only for years up to 2013 (see picture below).



9.8 For this reason, we show here aggregate data in the period 2004-16, which is an earlier period than the one considered by SDG in the analysis of IPO data. The reason for this is that we are aiming to have at least a 10-year window of reasonably complete data in the region.

## Results

9.9 The NPiHR area accounts for around 20% of all of England’s patent applications for the analysis period, in all technology sectors. Patent applications in the medical and biological fields account for around 22% of all medical and biological patent applications in England, while for the IT & data theme the NPiHR region only accounts for 6.5% of England’s patent applications in these fields. The numbers of unique applicants and unique inventors are similar when looking at all technology fields, but in the case of IT & data they show that a higher proportion of all English unique applicants are situated in the NPiHR area (13% vs 6.5% for patent applications).

**Table 9.1: Profile of Northern Powerhouse patenting for medical and biological and for IT & data related patent applications, 2004-2016**

		<i>Geo-located patents</i>	<i>Total patents (estimate)</i>	<i>Geo-located unique applicants</i>	<i>Unique applicants (estimate)</i>	<i>Geo-located unique inventors</i>	<i>Unique inventors (estimate)</i>
All technology areas	NPiHR	14,330	104,093	2,902	21,080	18,351	133,302
	England	69,736	506,565	14,261	103,592	94,029	683,030
	% NPiHR	20.5%	20.5%	20.3%	20.3%	19.5%	19.5%
Medical and biological	NPiHR	3,949	28,685	679	4,932	6,129	44,521
	England	17,992	130,694	3,714	26,978	30,765	223,478
	% NPiHR	21.9%	21.9%	18.3%	18.3%	19.9%	19.9%
IT & data	NPiHR	770	5,593	257	1,866	976	7,089
	England	11,783	85,592	1,997	14,506	14,184	103,033
	% NPiHR	6.5%	6.5%	12.9%	12.9%	6.9%	6.9%



**Source: Technopolis analysis of PATSTAT data**

- 9.10 In the tables below, we present disaggregated results for the two areas of interest. Patent applications can be assigned to multiple WIPO fields and the totals have been calculated taking this into account (so as to avoid double counting). The topic of medical and biological has a slightly higher concentration of patenting activity than the English average. This is owed to the medical technologies and organic fine chemistry technology areas, where the NPiHR area shows relative strength.

**Table 9.2: Geo-located patent applications in the Medical and biological topic, 2004-2016**

	<i>NPiHR</i>	<i>England</i>	<i>% NPiHR</i>	<i>% England</i>	<i>LQ</i>
Analysis of biological materials	272	1672	1.90%	2.40%	0.79
Biotechnology	601	3493	4.20%	5.01%	0.84
Medical technology	1424	5562	9.94%	7.98%	1.25
Organic fine chemistry	1448	6051	10.11%	8.68%	1.16
Pharmaceuticals	1007	6877	7.03%	9.87%	0.71
<b>Total</b>	<b>3949</b>	<b>17992</b>	<b>27.56%</b>	<b>25.80%</b>	<b>1.07</b>

- 9.11 The results for the area of IT & data show a very poor patent output for the NPiHR area, relative to the England figures. This aligns with the same analysis results from SDG using IPO data. The reasons for such poor figures can also be influenced by several factors in addition to low patent output, such as the low tendency for patenting in these technology fields combined with the headquarter's effect from London. Nevertheless, the results show a low level of patent output specialisation in this topic.

**Table 9.3: Geo-located patent applications in the IT & Data topic, 2004-2016**

	<i>NPiHR</i>	<i>England</i>	<i>% NPiHR</i>	<i>% England</i>	<i>LQ</i>
Computer technology	468	5519	3.27%	7.92%	0.41
Digital communication	232	6202	1.62%	8.90%	0.18
IT methods for management	154	1187	1.08%	1.70%	0.64
<b>Total</b>	<b>770</b>	<b>11783</b>	<b>5.37%</b>	<b>16.90%</b>	<b>0.32</b>

- 9.12 To put these figures in context, the table below shows results for all 35 WIPO technology areas. Some of the technology areas outside the topics of interest of the NPiHR SIA have high patent output specialisation scores. For example, the region shows a high patent output specialisation in different areas of chemistry and mechanical engineering. These are precisely some of the areas of interest of the other Northern Powerhouse SIA consortia.

**Table 9.4: Geo-located patent applications in all WIPO technology areas, 2004-2016**

<i>WIPO domain</i>	<i>WIPO technology area</i>	<i>NPiHR</i>	<i>England</i>	<i>% of NPiHR</i>	<i>% of England</i>	<i>LQ</i>
Chemistry	Basic materials chemistry	2053	4232	14.33%	6.07%	2.36
Chemistry	Macromolecular chemistry, polymers	636	1377	4.44%	1.98%	2.24

<i>WIPO domain</i>	<i>WIPO technology area</i>	<i>NPiHR</i>	<i>England</i>	<i>% of NPiHR</i>	<i>% of England</i>	<i>LQ</i>
Chemistry	Surface technology, coating	499	1369	3.48%	1.96%	1.78
Chemistry	Materials, metallurgy	524	1461	3.66%	2.10%	1.74
Chemistry	Chemical engineering	917	3044	6.40%	4.37%	1.46
Chemistry	Environmental technology	386	1464	2.69%	2.10%	1.28
Chemistry	Organic fine chemistry	1448	6051	10.11%	8.68%	1.16
Chemistry	Biotechnology	601	3493	4.20%	5.01%	0.84
Chemistry	Food chemistry	235	1504	1.64%	2.16%	0.76
Chemistry	Micro-structural and nano-technology	34	232	0.24%	0.33%	0.73
Chemistry	Pharmaceuticals	1007	6877	7.03%	9.87%	0.71
Electrical engineering	Electrical machinery, apparatus, energy	1159	4502	8.09%	6.46%	1.25
Electrical engineering	Semiconductors	241	1621	1.68%	2.33%	0.72
Electrical engineering	IT methods for management	154	1187	1.08%	1.70%	0.64
Electrical engineering	Audio-visual technology	291	2535	2.03%	3.64%	0.56
Electrical engineering	Computer technology	468	5519	3.27%	7.92%	0.41
Electrical engineering	Telecommunications	163	2982	1.14%	4.28%	0.27
Electrical engineering	Basic communication processes	53	984	0.37%	1.41%	0.26
Electrical engineering	Digital communication	232	6202	1.62%	8.90%	0.18
Instruments	Medical technology	1424	5562	9.94%	7.98%	1.25
Instruments	Control	331	1855	2.31%	2.66%	0.87
Instruments	Analysis of biological materials	272	1672	1.90%	2.40%	0.79
Instruments	Measurement	746	5249	5.21%	7.53%	0.69
Instruments	Optics	211	1718	1.47%	2.46%	0.60
Mechanical engineering	Textile and paper machines	538	1334	3.76%	1.91%	1.97
Mechanical engineering	Machine tools	485	1588	3.39%	2.28%	1.49
Mechanical engineering	Other special machines	786	2620	5.49%	3.76%	1.46
Mechanical engineering	Mechanical elements	708	2784	4.94%	3.99%	1.24
Mechanical engineering	Handling	689	2799	4.81%	4.02%	1.20
Mechanical engineering	Thermal processes and apparatus	230	1103	1.61%	1.58%	1.02
Mechanical engineering	Engines, pumps, turbines	719	3766	5.02%	5.40%	0.93

<i>WIPO domain</i>	<i>WIPO technology area</i>	<i>NPiHR</i>	<i>England</i>	<i>% of NPiHR</i>	<i>% of England</i>	<i>LQ</i>
Mechanical engineering	Transport	587	3464	4.10%	4.97%	0.82
Other fields	Civil engineering	791	2864	5.52%	4.11%	1.34
Other fields	Other consumer goods	510	2213	3.56%	3.17%	1.12
Other fields	Furniture, games	395	2075	2.76%	2.98%	0.93

9.13 Finally, we attempt to replicate the analysis at the level of LEPs and regions. Regionalised PATSTAT information exists only at the NUTS3 Level for a sub-set of geo-located patents where address information exists for the patent applicants. The table below shows the percentage of geo-located patent applications in the WIPO technology areas of interest. LEPs are represented as a collection of NUTS3 areas, but the fit between both geography layers is not perfect, so data is presented without aggregation (LEPs also overlap in different areas of the SIA region, which should be taken into account when attempting to aggregate figures from different LEP areas).

**Table 9.5: Geo-located patent applications in LEP and NUTS areas of the NPiHR SIA, for selected WIPO technology areas**

LEP	NUTS3	Total	Analysis of biological materials	Biotechnology	Medical technology	Organic fine chemistry	Pharmaceuticals	Computer technology	Digital communication	IT methods for management
Cheshire and Warrington	Cheshire East	1332	1%	6%	16%	26%	30%	2%	1%	2%
Cheshire and Warrington	Cheshire West and Chester	777	2%	2%	7%	10%	4%	1%	2%	1%
Cheshire and Warrington	Warrington	247	2%	2%	5%	9%	5%	5%	3%	3%
Cumbria	East Cumbria	205	0%	1%	6%	1%	1%	4%	3%	0%
Cumbria	West Cumbria	171	1%	9%	1%	4%	2%	2%	0%	0%
Derby, Derbyshire, Nottingham and Nottinghamshire	East Derbyshire	233	1%	0%	13%	1%	2%	2%	0%	4%
Derby, Derbyshire, Nottingham and Nottinghamshire	North Nottinghamshire	338	0%	1%	7%	4%	4%	3%	1%	1%
Derby, Derbyshire, Nottingham and Nottinghamshire	South and West Derbyshire	1264	1%	2%	4%	3%	3%	3%	1%	1%
Greater Lincolnshire	North and North East Lincolnshire	93	1%	1%	5%	0%	2%	2%	0%	3%
Greater Manchester	Greater Manchester North East	378	1%	0%	14%	2%	2%	4%	3%	2%
Greater Manchester	Greater Manchester North West	269	3%	0%	7%	3%	3%	3%	0%	3%
Greater Manchester	Greater Manchester South East	606	2%	3%	8%	5%	4%	6%	1%	1%
Greater Manchester	Greater Manchester South West	564	4%	3%	11%	7%	5%	5%	3%	2%
Greater Manchester	Manchester	931	5%	11%	6%	8%	11%	7%	1%	1%
Humber	East Riding of Yorkshire	441	1%	1%	13%	34%	6%	1%	1%	0%
Humber	Kingston upon Hull, City of	321	0%	1%	25%	17%	10%	0%	0%	1%
Humber	North and North East Lincolnshire	93	1%	1%	5%	0%	2%	2%	0%	3%
Lancashire	Blackburn with Darwen	164	0%	0%	3%	1%	0%	15%	1%	3%
Lancashire	Blackpool	23	4%	0%	9%	0%	0%	4%	0%	0%
Lancashire	Chorley and West Lancashire	269	2%	1%	5%	3%	1%	3%	1%	0%
Lancashire	East Lancashire	171	6%	2%	10%	2%	1%	1%	4%	1%
Lancashire	Lancaster and Wyre	181	2%	1%	11%	3%	4%	4%	1%	1%
Lancashire	Mid Lancashire	428	2%	2%	6%	2%	2%	5%	3%	1%
Leeds City Region	Barnsley, Doncaster and Rotherham	376	2%	1%	5%	1%	1%	4%	0%	0%
Leeds City Region	Bradford	599	2%	3%	7%	6%	5%	4%	11%	1%

LEP	NUTS3	Total	Analysis of biological materials	Biotechnology	Medical technology	Organic fine chemistry	Pharmaceuticals	Computer technology	Digital communication	IT methods for management
Leeds City Region	Calderdale and Kirklees	484	1%	2%	8%	8%	4%	2%	2%	1%
Leeds City Region	Leeds	869	2%	3%	29%	8%	6%	3%	2%	1%
Leeds City Region	North Yorkshire CC	714	3%	5%	12%	7%	5%	4%	2%	1%
Leeds City Region	Wakefield	191	6%	1%	16%	6%	2%	4%	1%	0%
Leeds City Region	York	426	4%	11%	39%	4%	6%	5%	1%	4%
Liverpool City Region	East Merseyside	580	2%	3%	7%	7%	2%	2%	1%	0%
Liverpool City Region	Liverpool	323	6%	6%	12%	11%	21%	3%	1%	0%
Liverpool City Region	Sefton	113	3%	5%	11%	4%	7%	3%	1%	0%
Liverpool City Region	Wirral	897	2%	1%	4%	34%	6%	1%	0%	1%
North East	Durham CC	672	2%	3%	5%	8%	3%	2%	0%	0%
North East	Northumberland	560	1%	4%	6%	4%	3%	1%	0%	0%
North East	Sunderland	141	4%	2%	4%	8%	7%	2%	1%	3%
North East	Tyneside	1071	2%	8%	5%	5%	7%	4%	2%	0%
Tees Valley	Darlington	135	1%	0%	1%	21%	1%	0%	3%	1%
Tees Valley	Hartlepool and Stockton-on-Tees	331	2%	15%	8%	18%	2%	1%	0%	0%
Tees Valley	South Teesside	255	2%	3%	6%	21%	2%	2%	0%	0%
York, North Yorkshire and East Riding	East Riding of Yorkshire	441	1%	1%	13%	34%	6%	1%	1%	0%
York, North Yorkshire and East Riding	North Yorkshire CC	714	3%	5%	12%	7%	5%	4%	2%	1%
York, North Yorkshire and East Riding	York	426	4%	11%	39%	4%	6%	5%	1%	4%
Sheffield City Region	Barnsley, Doncaster and Rotherham	376	2%	1%	5%	1%	1%	4%	0%	0%
Sheffield City Region	East Derbyshire	233	1%	0%	13%	1%	2%	2%	0%	4%
Sheffield City Region	North Nottinghamshire	338	0%	1%	7%	4%	4%	3%	1%	1%
Sheffield City Region	Sheffield	672	2%	11%	8%	2%	9%	5%	2%	1%
Sheffield City Region	South and West Derbyshire	1264	1%	2%	4%	3%	3%	3%	1%	1%

Source: Technopolis group based on PATSTAT data.

## Top 50 applicants and inventors

### Medical and biological

9.14 The table below shows the Top-50 applicants and inventors for geo-located patents in the area of medical and biological, 2004-2016.

#### Applicants

Applicant or inventor name	No. of patent applications	Type of applicant/inventor	NUTS3 region
Depuy International Limited	83	Company	Leeds
The University of Manchester	61	University	Manchester
CRODA INTERNATIONAL PLC	33	Company	East Riding of Yorkshire
THE UNIVERSITY OF LIVERPOOL	29	University	Liverpool
Renovo Limited	26	Company	Manchester
UNIVERSITY OF LEEDS	24	University	Leeds
THE UNIVERSITY OF YORK	21	University	York
THE UNIVERSITY OF SHEFFIELD	20	University	Sheffield
BRIGHTWAKE LIMITED	19	Company	North Nottinghamshire
Innospec Limited	18	Company	Cheshire West and Chester
UNIVERSITY OF DURHAM	18	University	Durham CC
Asterion Limited	17	Company	Sheffield
FUJIFILM Diosynth Biotechnologies UK Limited	16	Company	Hartlepool and Stockton-on-Tees
University of Newcastle upon Tyne	16	University	Tyneside
Invibio Limited	15	Company	Lancaster and Wyre
Depuy International Ltd	14	Company	Leeds
NORTON HEALTHCARE LIMITED	14	Company	Wakefield
Oxyrane UK Limited	14	Company	Manchester
Medtrade Products Limited	13	Company	Cheshire East
Surgical Innovations Limited	12	Company	Leeds
THE UNIVERSITY OF LEEDS	12	University	Leeds
Jackel International Limited	11	Company	Northumberland
The University of Hull	11	University	Kingston upon Hull, City of
UNIVERSITY OF BRADFORD	11	University	Bradford
University of Sheffield	11	University	Sheffield
Xiros Limited	11	Company	Leeds
Deb IP Limited	10	Company	South and West Derbyshire
Medical Device Innovations Limited	10	Company	East Merseyside
Perachem Limited	10	Company	Leeds
QIAGEN Manchester Limited	10	Company	Manchester
EPISTEM LIMITED	9	Company	Manchester
Medtrade Products Ltd.	9	Company	Cheshire East
Dr. Reddy's Laboratories (EU) Limited	8	Company	East Riding of Yorkshire
E-Therapeutics plc	8	Company	Tyneside
Ineos Fluor Holdings Limited	8	Company	East Merseyside
T.J. Smith & Nephew Limited	8	Company	Kingston upon Hull, City of
Ciba Specialty Chemicals Water Treatments Limited	7	Company	Bradford
Craig, Roger Kingdon	7	Individual	Cheshire East
Redx Pharma Limited	7	Company	Liverpool
University of Sunderland	7	University	Sunderland
Avecia Pharmaceuticals Limited	6	Company	Manchester
F2G Limited	6	Company	Greater Manchester South West
Implants International Limited	6	Company	Hartlepool and Stockton-on-Tees
Nanoco Technologies Ltd	6	Company	Manchester
NEUTEC PHARMA PLC	6	Company	Manchester
Newcastle-Upon-Tyne Hospitals NHS Trust	6	Hospital	Tyneside
Phoenix Chemicals Limited	6	Company	Wirral
Polyphotonix Limited	6	Company	Durham CC
Protomed Limited	6	Company	Cheshire East
Regent Medical Limited	6	Company	Greater Manchester South West
SHS International Ltd.	6	Company	Liverpool
University of Central Lancashire	6	University	Mid Lancashire

#### Inventors



Applicant or inventor name	No. of patent applications	Type of applicant/inventor	NUTS3 region
EKMAN, Matthew	90	Inventor	Cheshire East
KHOSHDEL, Ezat	28	Inventor	Wirral
MACARTHUR, Ross	24	Inventor	Cheshire East
O'KANE, Sharon	24	Inventor	Manchester
GREENER, Bryan	23	Inventor	York
Smith, Christopher James	22	Inventor	Cheshire East
PAUL, Prem, Kumar, Cheyalazhagan	21	Inventor	Wirral
ASHBY, Alan	19	Inventor	York
OCCLESTON, Nicholas	19	Inventor	Manchester
Conradie, Alex Van Eck	18	Inventor	Hartlepool and Stockton-on-Tees
COTTON, Stephen	18	Inventor	North Nottinghamshire
FERGUSON, Mark, William, James	18	Inventor	Manchester
MURRAY, Andrew, Malcolm	18	Inventor	Wirral
SUNLEY, John, Glenn	18	Inventor	East Riding of Yorkshire
GOLDING, Stephen	17	Inventor	Wirral
MCKERRECHER, Darren	17	Inventor	Cheshire East
NICOLINI, Derek	17	Inventor	East Riding of Yorkshire
YOUNG, Duncan	17	Inventor	Leeds
Gracey, Benjamin, Patrick	16	Inventor	East Riding of Yorkshire
JAMES, Arthur	16	Inventor	West Cumbria
NICOLINI, Derek	16	Inventor	York
SLEMMEN, John	16	Inventor	Wirral
SUNLEY, John Glenn	16	Inventor	East Riding of Yorkshire
WANG, Changsheng	16	Inventor	Durham CC
FRANKLIN, Kevin, Ronald	15	Inventor	Wirral
PERRY, John	15	Inventor	Tyneside
PIKE, Kurt, Gordon	15	Inventor	Cheshire East
Ross, Richard	15	Inventor	Sheffield
WANG, Dong	15	Inventor	Liverpool
ARTYMIUK, Peter	14	Inventor	Sheffield
BATCHELOR, Stephen, Norman	14	Inventor	Wirral
Fraser, Stuart	14	Inventor	Cheshire West and Chester
HARTWELL, Edward	14	Inventor	York
GRACEY, Benjamin Patrick	13	Inventor	East Riding of Yorkshire
HARTWELL, Edward Yerbury	13	Inventor	East Riding of Yorkshire
HARTWELL, Edward, Yerbury	13	Inventor	York
MOORE, Gary	13	Inventor	Leeds
SAYERS, Jon	13	Inventor	Sheffield
WILLIAMSON, Gary	13	Inventor	North Yorkshire CC
Chen, Changlin	12	Inventor	Hartlepool and Stockton-on-Tees
EASTHAM, Graham Ronald	12	Inventor	South Teesside
LAW, David John	12	Inventor	East Riding of Yorkshire
LEE-WEBB, Julian	12	Inventor	York
COLLINSON, Sarah, Jenny	11	Inventor	York
CULLEN, Breda, Mary	11	Inventor	North Yorkshire CC
HORLOCK, Mark, Philip	11	Inventor	Greater Manchester South West
LAW, David, John	11	Inventor	East Riding of Yorkshire
PHAM, Thuy-Anh	11	Inventor	Wirral
ROCK, Michael	11	Inventor	Leeds
BUTLIN, Roger, John	10	Inventor	Cheshire East
GOLDING, Bernard	10	Inventor	Tyneside
HARDY, Craig	10	Inventor	Cheshire East
HARTWELL, Edward, Yerbury	10	Inventor	East Riding of Yorkshire
MONTES DE OCA BALDERAS, Horacio	10	Inventor	York
NIELD, Kerry	10	Inventor	Manchester
SAXBY, Carl	10	Inventor	York
SKINNER, Richard	10	Inventor	Wirral
WARING, Michael, James	10	Inventor	Cheshire East

## IT & Data

The table below shows the Top-50 applicants and inventors for geo-located patents in the area of IT & data, 2004-2016.

### Applicants

Applicant or inventor name	No. of patent applications	Type of applicant/inventor	NUTS3 region
Eldon Technology Limited	34	COMPANY	Bradford
Pace Plc	21	COMPANY	Bradford
Promethean Limited	21	COMPANY	Blackburn with Darwen
Eldon Technology Limited trading as Echostar Europe	14	COMPANY	Bradford
Micromass UK Limited	9	COMPANY	Manchester
Nomad Spectrum Limited	8	COMPANY	Tyneside
Phase Focus Limited	8	COMPANY	Sheffield
Promethean Ltd	7	COMPANY	Blackburn with Darwen
Depuy International Limited	6	COMPANY	Leeds
The University of Manchester	6	UNIVERSITY	Manchester
Texecom Limited	5	COMPANY	East Lancashire
University of Newcastle upon Tyne	5	UNIVERSITY	Tyneside
ADVA Optical Networking Ltd.	4	COMPANY	York
Kapur, Rajesh	4	INDIVIDUAL	Barnsley, Doncaster and Rotherham
AppSense Limited	3	COMPANY	East Merseyside
Avecto Limited	3	COMPANY	Greater Manchester South East
Bibliotheca Limited	3	COMPANY	Greater Manchester South East
HAGAN, CHRIS	3	INDIVIDUAL	Calderdale and Kirklees
Hyde, John	3	INDIVIDUAL	Barnsley, Doncaster and Rotherham
Intelligent Limited	3	COMPANY	Greater Manchester South East
KIROCO LIMITED	3	COMPANY	Leeds
Lancaster University Business Enterprises Limited	3	UNIVERSITY	Lancaster and Wyre
Mood International Limited	3	COMPANY	York
Nonlinear Dynamics Ltd.	3	COMPANY	Tyneside
Peratech Limited	3	COMPANY	North Yorkshire CC
Renovo Limited	3	COMPANY	Manchester
THE UNIVERSITY OF SHEFFIELD	3	UNIVERSITY	Sheffield
THE UNIVERSITY OF YORK	3	UNIVERSITY	York
UNIVERSITY OF BRADFORD	3	UNIVERSITY	Bradford
ZYTRONIC DISPLAYS LIMITED	3	COMPANY	Tyneside
Advanced Analysis and Integration Limited	2	COMPANY	Manchester
Bifold Fluidpower Limited	2	COMPANY	Greater Manchester North East
Broca Communications Limited	2	COMPANY	East Lancashire
Conductive Inkjet Technology Limited	2	COMPANY	Wakefield
Cuckle, Howard Stephen	2	INDIVIDUAL	North Yorkshire CC
Cybula Ltd	2	COMPANY	York
EchoStar UK Holdings Limited	2	COMPANY	Bradford
Imorphics Limited	2	COMPANY	Manchester
Innovia Films Limited	2	COMPANY	West Cumbria
ITIS Global Services Limited	2	COMPANY	Greater Manchester South West
Itis Holdings PLC	2	COMPANY	Greater Manchester South West
KALIBRATE TECHNOLOGIES PLC	2	COMPANY	Manchester
Money Controls Limited	2	COMPANY	Greater Manchester North East
NEWTON, Michael	2	INDIVIDUAL	Cheshire West and Chester
OMLIS LIMITED	2	COMPANY	Tyneside
PILKINGTON PLC	2	COMPANY	East Merseyside
Protomed Limited	2	COMPANY	Cheshire East
Remote Operations Ltd.	2	COMPANY	North Yorkshire CC
Salamander Enterprises Limited	2	COMPANY	York
SMARTWATER TECHNOLOGY LIMITED	2	COMPANY	Liverpool
StepNexus Ltd	2	COMPANY	Warrington
SURECORE LIMITED	2	COMPANY	Leeds
SurfControl plc	2	COMPANY	Cheshire East
Swivel Secure Limited	2	COMPANY	Leeds
TECHNOLOGY BUSINESS MANAGEMENT LIMITED	2	COMPANY	Cheshire East
The Salamander Organisation Ltd.	2	COMPANY	York



Applicant or inventor name	No. of patent applications	Type of applicant/inventor	NUTS3 region
The University of Hull	2	UNIVERSITY	Kingston upon Hull, City of
THE UNIVERSITY OF LANCASTER	2	UNIVERSITY	Lancaster and Wyre
THE UNIVERSITY OF LEEDS	2	UNIVERSITY	Leeds
Trevor Burke Technology Limited	2	COMPANY	Liverpool
University of York	2	UNIVERSITY	York
WADARO LIMITED	2	COMPANY	East Merseyside
Websense Hosted R&D Limited	2	COMPANY	Cheshire East
Xvista Ltd	2	COMPANY	Leeds

### Inventors

Applicant or inventor name	No. of patent applications	Type of applicant/inventor	NUTS3 region
PEARCE, Nigel	10	Inventor	Blackburn with Darwen
Mountain, Dale Llewelyn	8	Inventor	Bradford
MORRIS, Melvyn	7	Inventor	South and West Derbyshire
BARRACLOUGH, Gavin	6	Inventor	Manchester
GOLDSTONE, Jeremy	6	Inventor	Greater Manchester North East
Whittington, Dick	6	Inventor	York
Pinchen, Stephen Paul	5	Inventor	South and West Derbyshire
Smith, Simon	5	Inventor	York
THOMAS, David	5	Inventor	Cheshire West and Chester
Truelove, Stephen	5	Inventor	East Cumbria
ALEXANDER, Peter	4	Inventor	Greater Manchester South West
Chadbourne, Andrew	4	Inventor	Greater Manchester South East
CLEARY, Michael	4	Inventor	Liverpool
Darwood, Peter	4	Inventor	Sheffield
Dove, Anthony Michael	4	Inventor	Bradford
Edwardson, Andrew	4	Inventor	Blackburn with Darwen
Magee, Anthony	4	Inventor	North Yorkshire CC
PHILLIPS, Simon	4	Inventor	York
Sayers, Ian	4	Inventor	Cheshire East
Turner, Rick	4	Inventor	Manchester
Ward, Martyn Ross	4	Inventor	Bradford
ASHBY, Alan	3	Inventor	York
AUSTIN, James	3	Inventor	East Riding of Yorkshire
Barker, Nick	3	Inventor	Tyneside
BATES, Susan	3	Inventor	Wirral
Blythe, Greg	3	Inventor	East Riding of Yorkshire
BRAMWELL, David	3	Inventor	Tyneside
BUCHANAN, Roderick	3	Inventor	Mid Lancashire
Burton, David	3	Inventor	North Yorkshire CC
CARROLL, Caleb	3	Inventor	Tyneside
HALL, Neale	3	Inventor	Bradford
Hey, Andrew	3	Inventor	Bradford
Hodgson, Simon	3	Inventor	York
KAPFERER, Anna	3	Inventor	Tyneside
MAIDEN, Andrew	3	Inventor	Sheffield
MORRISON, ANDREW	3	Inventor	Tyneside
Mountain, Dale	3	Inventor	Bradford
North, Geraint	3	Inventor	Manchester
Oakley, Andrew	3	Inventor	Blackburn with Darwen
REVIE, Ian	3	Inventor	North Yorkshire CC
ROBERTS, David, A.	3	Inventor	Warrington
SAMUELS, John	3	Inventor	Chorley and West Lancashire
SMITH, Glyn Barry	3	Inventor	East Derbyshire
Stephens, Matthew	3	Inventor	North Yorkshire CC
Thornberry, Kevin	3	Inventor	Leeds
UNSWORTH, Peter	3	Inventor	Blackburn with Darwen
WATSON, STUART	3	Inventor	North Nottinghamshire
YVON, Jean-Marc	3	Inventor	Greater Manchester South West

## 10 Symbiosis Life Science Patent Search

### Scope of the search

10.1 The search was conducted by Symbiosis for NHTA to identify patents filed in the life sciences and healthcare sector (from Drugs - Devices - eHealth) from the institutions below:<sup>16</sup>

- North
  - Durham University, Lancaster University, University of Leeds, University of Liverpool, Liverpool School of Tropical Medicine, University of Manchester, Newcastle University, University of Sheffield, University of York and University of Hull
- London
  - Imperial College, King's College London and UCL
- Oxford
  - University of Oxford
- Cambridge
  - University of Cambridge
- Scotland
  - University of Edinburgh, Glasgow University, Dundee University, St Andrews University and University of Strathclyde.

### Patent search

10.2 The search was undertaken using Espacenet, the patents database created and maintained by the EPO. The search was undertaken on 21-22 March 2017. The database contains details of all published patent applications on those dates. There is, however, an eighteen-month time lag after filing before patents publish and so become available for searching using this portal. It follows that the searching is representative of a 10-year window of patent filings that are at least 18 months old.

10.3 When looking at the search results, please bear in mind that the data simply relate to filings that were made and proceeded to publication; filings made but abandoned within the 18 months before publication will not appear. Moreover, we have not investigated whether the filings were continued beyond publication and so prosecuted to grant. This means the commercial value of the filings cannot be derived from the attached. However, it is a rough

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<sup>16</sup> Including any NHS IP from their associated NHS Trusts, over the last ten years – broken into two five-year periods

guide as to the amount of innovative, and possibly translational, research that has been undertaken at the institutions of interest to you.

10.4 As you will see we have searched broadly to capture technologies generally related to the life science field. Additionally, we have searched for the specified Universities as Applicant and also their associated hospitals as Applicant but we found few, if any, patent filings in the name of the hospitals thus reflecting our experience that the NHS lacks a budget for patent filings and tends to commercialise its technology using other tools such as licencing know how, copyright and designs.

10.5 Looking now at the search results.

**Figure 10-1**

10.6 This shows the total number of life science patent publications for the previous ten years (grouped into two five-year periods) for those regions of interest to you. The North and Scotland appear to have maintained a steady level of activity, whilst London and Oxford have increased their activity in the 2012-2017 period and Cambridge has reduced its patent activity in the life sciences.

**Figures 10-2 and 10-3**

10.7 These graphs show the total number (life science and other technologies) of patent publications for the previous ten years (grouped into two five-year periods) for each member of those regions of interest to you. Some trends become apparent from this data. Manchester has slightly increased the level of its patent activity over the 2012-2017 period (compared to the previous 2007-2011 period) and maintained its dominance in the North. Similarly, Leeds and Liverpool have also increased their level of patent activity in the past five years but Sheffield and York's patent activity appears to have been reduced over this same interval.

10.8 Imperial and King's patent activity has been maintained over the 2012-2017 period, whereas UCL and Oxford's patent activity has increased. Cambridge has decreased its patent activity.

10.9 The Scottish Universities appear to have maintained their patent activity, Glasgow shows a slight increase whereas Dundee appears to have experienced a slight reduction in patent activity over the 2012-2017 period.

10.10 NB whether any of the slight changes in activity mentioned herein are significant, we cannot comment.

**Figure 10-4**

10.11 This figure compares the total number of life science (only) patent publications for each University for the two five-year periods under investigation. Manchester's dominance is apparent as is Leeds's and Liverpool's advancement and Sheffield and York's reduction in life science patent activity.

10.12 UCL and Oxford's investment in life science patent activity is apparent, as is Cambridge's reduction in life science patent activity.

10.13 Glasgow's increase in patent activity is apparent as is Dundee's reduction in life science patent activity.

## Conclusion

- 10.14 Figures 10-1 to 10-4 appear to present the information you are seeking to identify the most clearly. When investigating regions, it is clear that the North has the greatest life science patent activity (in terms of patents published at the 18-month interval) followed by Scotland and then the three members of the ‘golden triangle’. Clearly, if the results for London, Oxford and Cambridge were combined they would lead the field. Moreover, Figure 10-1 shows the patent activity in the North and Scotland is relatively stable.
- 10.15 Figure 10-4 shows the relative contribution that each member of each region makes to the overall life science patent activity. The spread of life science patent activity amongst the Universities in the North is more variable than that in Scotland and the greatest contribution in the North is provided by Manchester followed, in more recent years, by Leeds and Liverpool. In Scotland Edinburgh’s life science patent activity is consistent whilst that of Glasgow appears to be on the increase and Dundee’s life science patent activity has been reduced in recent years.

Figure 10-1: Total number of life science patent applications

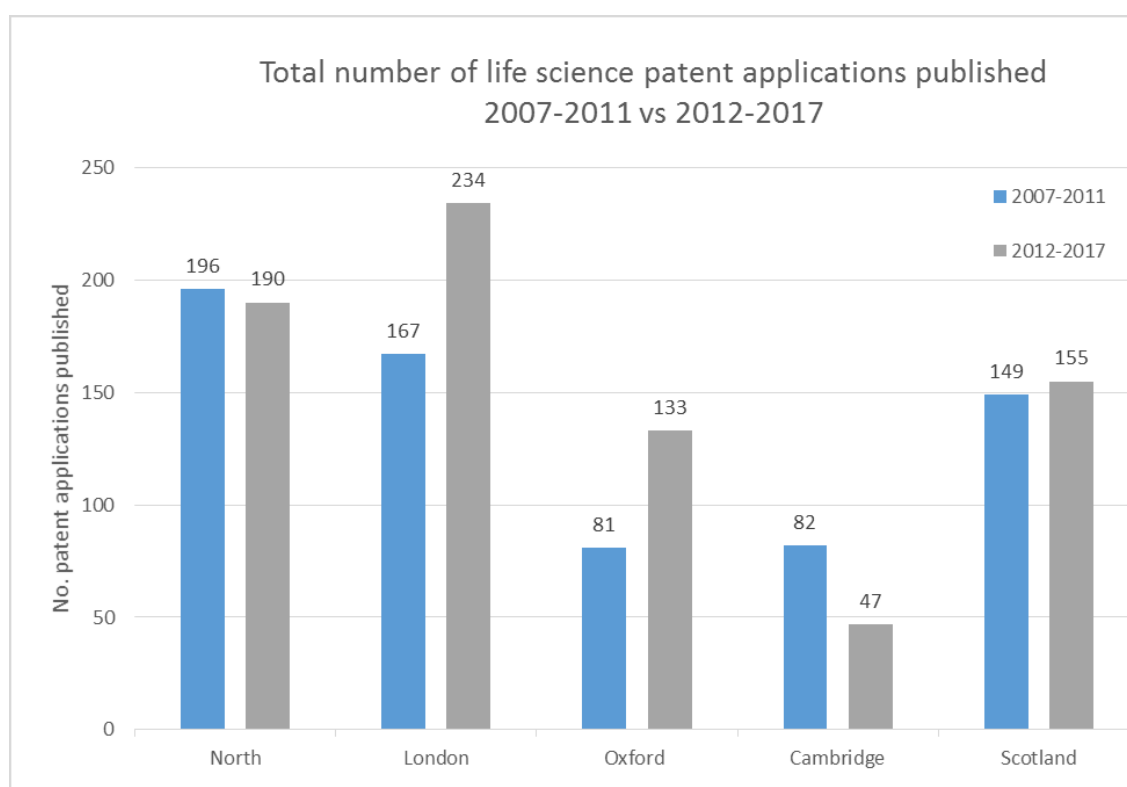


Figure 10-2: Total number of patent applications published 2007-2011

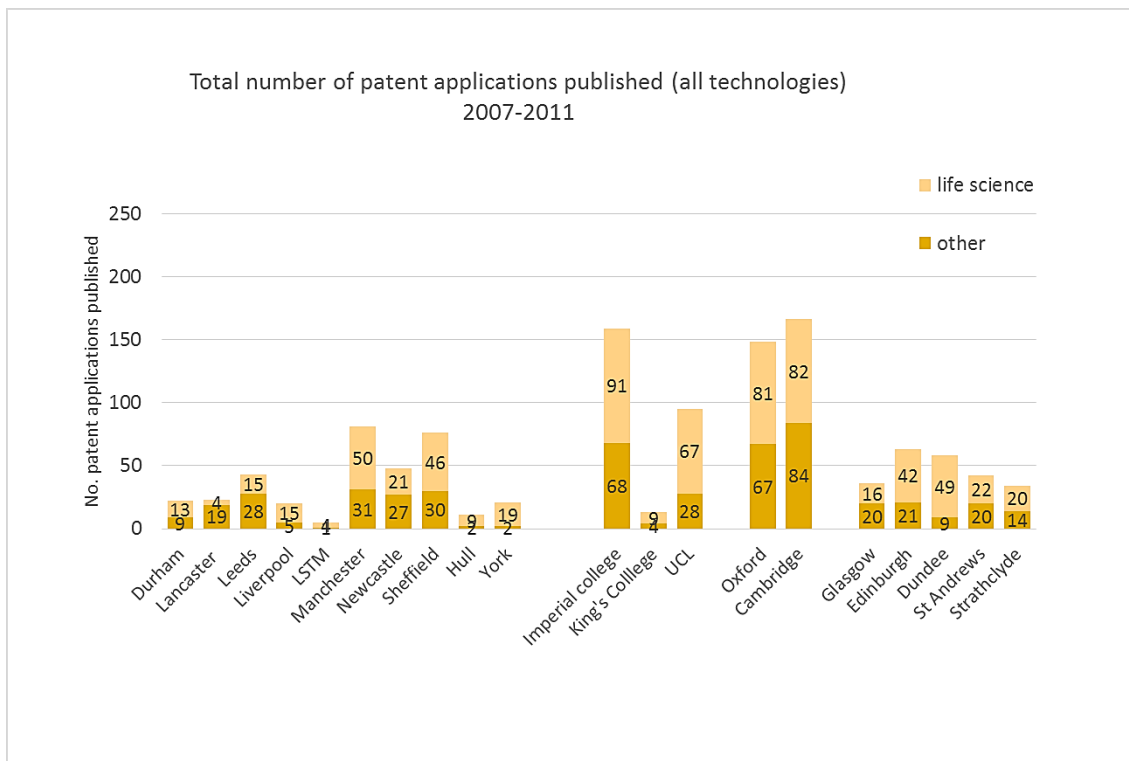


Figure 10-3: Total number of patent applications published 2012-2017

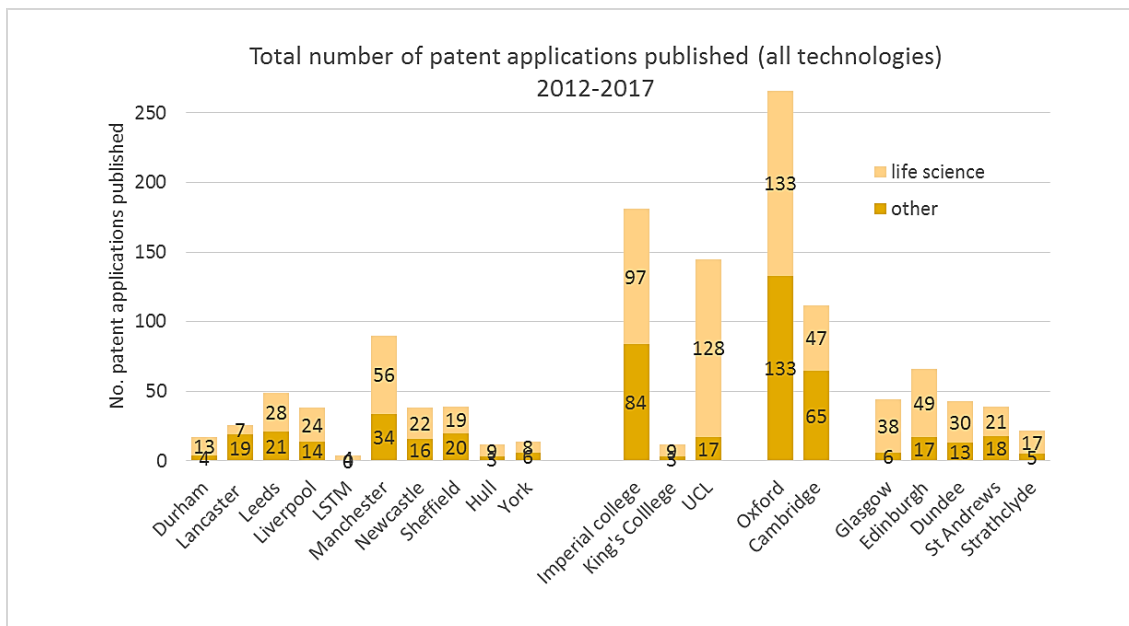


Figure 10-4: Total number of life science applications published 2007-2011 vs 2012-2017

