POWERHOUSE 2050: THE NORTH'S ROUTEMAP FOR PRODUCTIVITY

THE NORTHERN POWERHOUSE PARTNERSHIP

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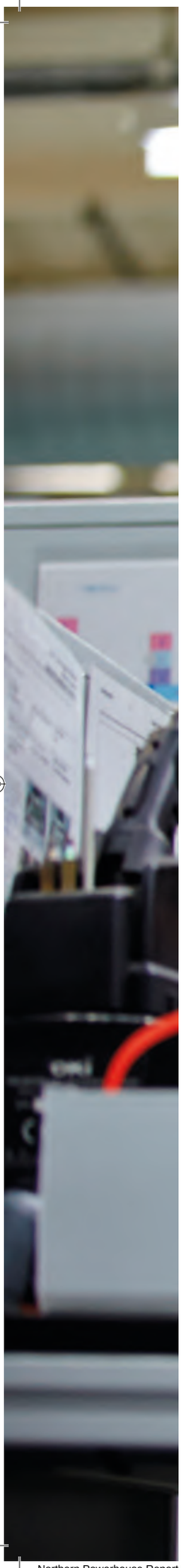


WHAT IS THE NORTHERN POWERHOUSE PARTNERSHIP?

The Northern Powerhouse Partnership (NPP) exists to increase the impact and contribution of the North of England to the UK economy by bringing the individual cities, regions and counties closer together, so that the whole of the North has a greater economic input than its separate parts.

The NPP has a business-led board, with representatives from key companies operating across the North including Manchester Airports Group, Mace, Barclays, Associated British Ports, Siemens, HSBC, Addleshaw Goddard, Arcadis, Drax, Arup, Bruntwood and support from EY. These organisations are expected to play an important role in providing insight and evidence to drive the Partnership forward. We will also pay close attention to the views of small and medium-sized businesses, both directly and with the leading Chambers of Commerce across the North.

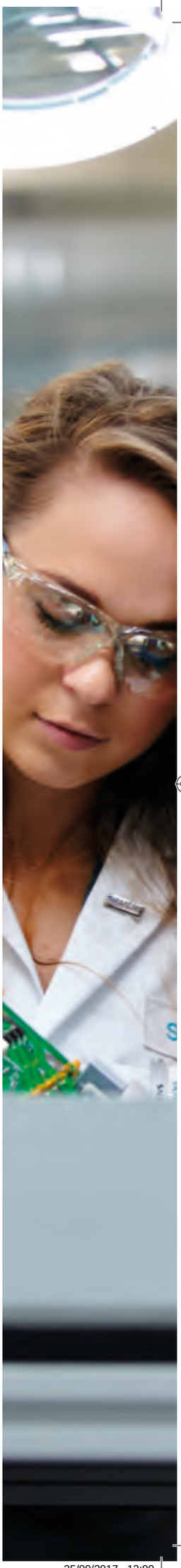
Prominent city leaders across the North of England are represented on the Board, in addition to former Chancellor George Osborne, former Commercial Secretary Lord Jim O'Neill, Chair of Transport for the North John Cridland and Professor Dame Nancy Rothwell to ensure that the NPP maintains a cross-party approach. NPP will engage with businesses and communities right across the North to develop consensus on the issues that will enable the NPP to drive transformational change throughout the Northern economy.

We are focusing on the priority issues which can make the biggest difference to growth across the North, putting in place the evidence base needed to support action, and will continue to take forward the work of the Northern Powerhouse Independent Economic Review (NPIER).

The NPP is a thought leader – producing original research, promoting innovative thinking and driving specific initiatives. The Partnership is helping to promote the North to central government and international investors and encouraging new policy ideas which will improve the North's quality of life and economy.

The NPP is collaborative in its relationships with business and the public sector, working across sectors and party political lines. We add value, not duplicating the work of others. NPP tracks the delivery of Northern Powerhouse commitments made to date – for example transport and devolution commitments - and works with government to ensure the needs of the North are fully reflected in future policies, such as the path of the Industrial Strategy.

To find out more about the partnership visit us online at northernpowerhousepartnership.co.uk or follow us on Twitter @NP_Partnership



SECTION 1

FOREWORD

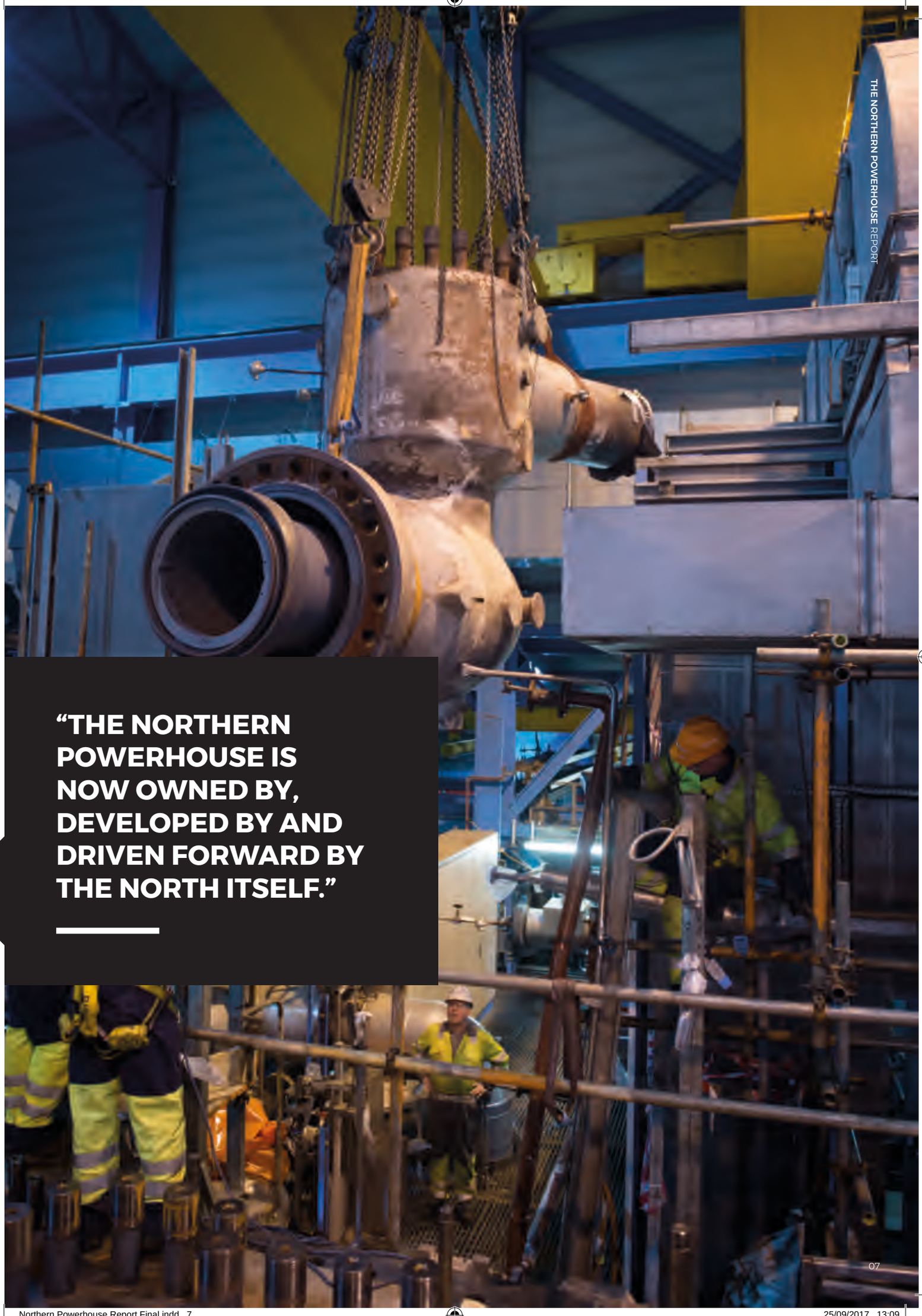
The North of England has all the individual ingredients for a thriving economy that can create opportunities for the 15 million people who live there. It has the cities and towns, the universities and colleges, the industries and innovation to compete in the economy of tomorrow. The key is to bringing those ingredients together, so that we create a Northern Powerhouse that is greater than the sum of its parts. If we do that then we can increase productivity and achieve our goal of raising living standards across the North, and building a more balanced economy for Britain. That is what our Partnership was created last year to achieve - and that is what the report we produce today can help deliver.

Powerhouse 2050: the North's Routemap for Productivity sets out what can be achieved if businesses of all sizes, civic leaders, the North's 27 universities and a wide range of other groups in our community come together to focus on what can make the North a leader in the world economy. It is based on a large number of conversations we have had across the whole region over many months, a huge exercise in bringing together the private and public sector to agree a joint approach. The four prime capabilities of the North identified by the Northern Powerhouse Independent Economic Review (NPIER) – Advanced Manufacturing & Materials, Energy, Digital and Health Innovation – are the economic sectors which together we believe are those where the North of England the greatest global competitive advantage.

But currently these areas of expertise exist in pockets across the region, separated by traditional geographic boundaries in regions with proud local identities.

Our report calls on the North to bring these areas together to provide a critical mass across these four prime capabilities. Unlike any other report from any other group, the unique thing about this report and our Partnership is that we can bring with us the commitment of our members - local government, business, universities and others - to make that happen. National government has an important role too, especially in providing the infrastructure needed - like Northern Powerhouse Rail, the transformational scheme to connect the great cities of the North. There are other investments in science and research and training the government needs to fund, which we cost in this report and which government can clearly afford over the coming years as part of the money it has set aside for its industrial strategy. Bring what the North has committed to deliver and what the government can provide, and you have an economic plan that would raise productivity across the Northern economy and could deliver an additional 850,000 jobs.

Our promise to government at every level is this: work with us provide and Northern businesses will take this plan forward, delivering a return on investment, creating jobs and increasing productivity. For the Northern Powerhouse is now owned by, developed by and driven forward by the North itself.



“THE NORTHERN POWERHOUSE IS NOW OWNED BY, DEVELOPED BY AND DRIVEN FORWARD BY THE NORTH ITSELF.”

SECTION 2

POLICY PROPOSALS

A ROUTEMAP FOR PRODUCTIVITY

The Northern Powerhouse Partnership's vision is to create an additional 850,000 jobs and contribute an extra £100bn to the UK economy[1]. The routemap below demonstrates how this can be achieved, with the support of central and regional government, business and wider groups across the North, all working together to allow the North to truly deliver its potential.

The Northern Powerhouse Partnership (NPP) is calling on government and major businesses to come together on major priorities which would transform the North and dramatically increase the contribution the region makes to the UK economy. This would match the £2.2 bn committed by HSBC[2] to SMEs, alongside the commitments made the by wider banking sector in the North, and fall within the Chancellor's commitment to the UK industrial strategy as evidenced through the £23bn National Productivity Investment Fund.

There are strategic opportunities linked to specific key industrial growth sites that require government involvement to enable them to be made possible. The South Tees Mayoral Development Corporation is one example, where Sirius Minerals are making the largest private capital investment in the Northern Powerhouse and creating more than 1,000 direct jobs in North Yorkshire and Teesside exploring the use of port capability in the development area.

MID-TERM INVESTMENT - £3BN (FROM 2025)

- **Government to provide a share of the £1bn investment needed for a Small Modular Reactor (SMR) joint venture**, including a significant co-investment from the supply chain. SMRs are smaller than conventional reactors, manufactured at a plant and brought to a site to be built, allowing for less on-site construction, increased containment efficiency, and better nuclear material security. This investment would generate a financial return for government and also include commitment of at least half of the £250m from government for nuclear R&D. This would lead to the development of a British SMR fleet, of which at least 90% would be built in the UK, and could be exported across the world. Combined with the wider expert opportunities in nuclear alongside oil and gas decommissioning, this would consolidate the North's position as a global leader in energy.

- **£2bn to transform the entire gas supply to Leeds from natural gas to low carbon hydrogen, produced in the Tees Valley**. This ground-breaking project would significantly contribute to the UK's commitment to reduce carbon emissions and would be a major step towards a Northern green gas network. Developing a viable Carbon Capture and Storage scheme on the Tees Valley is a vital pre-requisite for this to succeed; after the £15m required to reach the next step, **the network will cost £110m to build and £29m a year to operate. This makes it one of the most cost-effective carbon reduction opportunities in the UK**. In addition, as the North is the UK's main producer of hydrogen, it should seek half of the £23m Hydrogen for Transport Programme (HTP) to build hydrogen refuelling stations across the logistics corridors of the North to facilitate the emergence of low carbon transport technologies. This will be partnered by commitment to pan-Northern electric rapid charging, with a quarter of all Europe's electric cars made in the North East.

IMMEDIATE INVESTMENT - £169M

- **£20m for three years as part of the Industrial Digitalisation proposed sector deal for an intensive support pilot to 1,000 firms across the North West**. This will allow the North to become an international beacon for industrial digitisation – how UK manufacturing can increase its use of digital technology and automation to become more productive and competitive. This will generate up to £70m of additional GVA to the region per annum, with **a further £20m for a national adoption programme to support each of the North East and Yorkshire and the Humber**.

- **A total of £100m for connected health cities and data-led clinical trials, considered as the leading Northern dimension to the upcoming Life Sciences sector deal**. The North is already home to the only real-world data-led clinical trial (Salford Lung Study) and the nationally-leading Connected Health Cities data programme. Each of these programmes is already delivering private sector return to the region. Connected Health Cities requires a further investment of £80m to extend over the next five years and scale up the infrastructure underpinning the Salford Lung Study across the UK. Internationally, it requires £20m over the same time period, unlocking at least twice as much in private sector investment.

- These four main recommendations are supported by further investment and improved ways of working, focused on each of the prime capabilities but with links across the common themes of supply chains, the importance of data, and specific challenges of access to finance alongside the wider need to achieve inclusive growth for the North.

[1] The Northern Powerhouse Independent Economic Review Executive Summary (June 2016) p.16
[2] HSBC is already committing £2.25bn in lending to Northern Powerhouse based SMEs annually

ADVANCED MANUFACTURING & MATERIALS

- Ensure better collaboration between academia and industry to address specific industry challenges, including technology demonstrator facilities. Examples of planned collaborative centres include the **Centre for Sustainable Advanced Manufacturing in the North East (CESAM)** focused on automotive, the **High Speed Rail Technology Park in Leeds (requiring £9m of investment to match funding from Leeds University), Hartree at Daresbury** (which received £113m expansion support as part of the Northern Powerhouse Strategy) and the completed Materials Innovation Factory at The University of Liverpool. All of these are industry-challenge led and further linking of many of the existing programmes for innovation in applied areas would also strengthen their impact and reach.

- Establish global centres of excellence based on existing expertise, including the Henry Royce Institute and in lightweighting at the AMRC in Sheffield. The Royce Institute can deliver for the North an **integrated UK Coatings Technology Centre, two-thirds funded by UK businesses**, and the remainder from higher education funders. Alongside existing assets such as the Materials Processing Institute and TWI this would advance the competitiveness of UK industry, improve productivity and conserve materials, as well as meeting forthcoming environmental legislation and adding value across a wide range of products.

- **Invest £25m to allow SMEs to take advantage of pan-Northern supply chain opportunities** by mapping them and their capabilities across advanced manufacturing and other prime capabilities. This would be delivered by leveraging existing supply chain programmes, the Growth Hubs as partners and those more widely across the North including the North West Regional Manufacturers Forum. This will complement planned investment in new technologies, including additive manufacturing, which will make re-shoring more cost competitive.

ENERGY

- The government should use all available mechanisms (such as the Carbon Price Floor, Contracts for Difference and Capacity Market) to **support Northern generators who are best placed to provide a combination of low carbon electricity and flexible generation**, such as gas, to ensure stability on the electricity system at the lowest cost.

- Build on the existing pan-Northern university strengths in energy technologies to **establish a Northern Energy Centre of Excellence**, funded from the Industrial Strategy Challenge Fund and focused on commercialisation of existing research across the North, engaging both with larger firms and SMEs. This centre of excellence would focus on energy for transportation and energy intensive industries, including a fully-integrated pilot scale-up facility, smart energy distribution, cyber security and sub-sea engineering to underpin offshore renewables[3], in which the North has significant existing capabilities.

DIGITAL

- Establish '**Digital North**', focusing on how access to finance would create significant economic growth at comparatively low levels of investment, leveraging assets such as Newcastle's recently awarded National Innovation Centre for Data. This would include a **£30m fund for tech start-ups**, better utilising money already allocated and under management by the British Business Bank in addition to identifying what further assets will be needed longer term to capitalise on smart infrastructure and digital in the construction industry.

- Building on ultra-fast roll out pilots in Greater Manchester and West Yorkshire, utilise **£70m remaining from the Digital Infrastructure Investment Fund to deliver a step change on full fibre connectivity** across the North. Additionally, a further investment of **£30m for the development of a North East-wide 5G network and equivalent investment for a Leeds testbed trial**.

- Establish a **Northern Centre of Excellence for Civic Computation, a hub and spoke approach of an observatory with a network in each part of the North, supported by £20m** from the Industrial Strategy Challenge Fund and leveraging private investment. This would create the synergies between the strengths of the North in AI, machine learning and data analytics by bringing together individuals' data held by public bodies to address real world problems, particularly those arising from social and economic inequalities.

HEALTH INNOVATION

- Bring together public funding and private equity to create a **Patient Capital Growth Fund of £100m public investment, leveraging a further £100m private equity for health sciences** in the North, to support the commercial potential of the region in alignment with the Treasury's ongoing review. The North produces the same number of life science patents as London but does not have access to the same commercial growth capital to fully exploit these inventions. For the UK to commercially and economically capitalise on the North's health innovation strengths, requires a pan-northern growth fund linked to its universities, research intensive teaching hospitals and spin-out/start-up clusters.

- Provide targeted investment to support the development of existing city-based and regional capabilities across the Northern Powerhouse, aligned with strengths in Health Innovation to help underpin and catalyse the whole region's growth potential. There are a series of strategic investments based on smart specialisation. Together these would form a **mutually re-enforcing programme aligned with the UK Life Sciences Strategy with a total cost of £160m**.

INNOVATION NORTH

- The North's 11 Local Enterprise Partnerships have come together with the N8 Partnership of research intensive universities to develop Innovation North. This will address the common challenges and identify key actions to improve investment in Research & Development, driving innovation, **including challenge competitions linked to the prime capabilities aimed at global challenges and engaging SMEs, up to a value of £50m** from the Industrial Strategy Challenge Fund.

INCLUSIVE GROWTH CHALLENGE

- Convene the North's developers, planners and established businesses to address the need for incubators and co-working spaces, alongside attractive places for start-ups, in communities beyond the major city centres. This should include the development of affordable living and work space for young people with ready access to mentoring and support and connections to local businesses. Re-purposing existing assets, including the more than 1,300 mills identified by Historic England in cities like Bradford and many former mill towns in West Yorkshire alone, demonstrates the potential for this. The North needs to identify and support a pilot using existing housing and local funding streams.

[3] Newcastle University (2017), Offshore Energy; Science and Innovation Audit

SECTION 3

INTRODUCTION

1. The first report by the Northern Powerhouse Partnership, published in February [4], demonstrated that the North of England has significant assets as well as a huge potential to increase its economic contribution to the UK economy, if it is able to be more effective in acting collectively. Individually the cities and places of the North are strong, but together they can be world-leading and achieve a lot more – a Northern Powerhouse. The report identified four areas the North should focus on to achieve its potential and address the key challenge of productivity:

   - Infrastructure and Assets;
   - Education and Skills;
   - International Competitiveness; and
   - Leadership and Learning

UNLOCKING THE POTENTIAL OF THE NORTHERN POWERHOUSE

2. The recommendations in the first report build upon the evidence base developed through the Northern Powerhouse Independent Economic Review (NPIER) [5] which was commissioned by Transport for the North. Published in 2016, NPIER sought to characterise the North's economic position and the drivers underpinning performance, and identify those opportunities where 'pan-Northern' effort can sensibly support existing local activities.

3. The Review found that the economy of the North has the potential to be around £100bn (15%) [6] bigger – with an extra 850,000 jobs and a 4% increase in productivity - by 2050 [7], over a 'business as usual' scenario. Under this transformational economic future for the North, there would be substantial improvements in the skills base, in innovation performance, and in transport connectivity, helping to close the productivity gap and boosting the earning power of the people of the North.

WHAT ARE PRIME CAPABILITIES?

4. As part of its work, the NPIER looked to understand the scale, nature and causes of the North's gaps, and its distinctive capabilities (pan-Northern collectives of sectoral, academic, skills and hard asset strengths of international substance). The Review identified the North as having four highly-productive prime capabilities which can compete on the national and international stage. These strengths are not just concentrated in the major cities but are genuinely pan-Northern. The challenge going forward is how to build the connections, interactions, and relationships between these capabilities. These pan-Northern strengths are articulated as 'capabilities' rather than traditional 'sectors', in line with Smart Specialisation thinking. This focuses on 'unique assets and capabilities based on a region's distinctive industry structures and knowledge bases' and reflects the connections and themes that run within and across sectors and the wider knowledge base.

5. The four pan-Northern prime capabilities are: Advanced Manufacturing & Materials, Energy, Digital and Health Innovation. Across the four, the North is home to international-class assets, expertise, research and businesses that are genuinely distinctive, are highly productive and can compete at national and international scales. Additionally, the capabilities can combine to create a distinctive and coherent offer for the North – for example, digital strengths in computation and data playing important roles both in Advanced Manufacturing design and Health Innovation specialisms around e-health.

INTERNATIONAL COMPETITIVENESS

6. In relation to international competitiveness, the first report stated that it must be a priority for the North to drive higher levels of productivity, innovation, commercialisation and enterprise across the Northern economy.

7. Some of the world's most innovative, productive and ambitious businesses are based in the North. Our roundtable discussions uncovered examples of enterprises right across the North carving out new global markets. The NPIER has clearly articulated the case for four different capabilities or sectors across the Northern Powerhouse. Marrying the talents of those industries with the research and related capabilities of the universities, creating companies of size to make a significant impact on the future Northern Powerhouse economy, is critical.

8. The North therefore has huge potential to increase levels of enterprise, drive innovation, increase exporting and radically improve productivity – the essential ingredient for higher growth and rising living standards. The areas where internationally competitive firms already exist have been identified – the NPIER's prime and enabling capabilities – and individual cities are capitalising on them. A co-ordinated strategy for exploiting the collective Northern assets in each of these capabilities (including appropriate investment in the science infrastructure to support them) would now start to unlock greater productive potential. At the moment pockets of excellence exist across the North, but their combined strength is untapped and often unrecognised. Evidence from elsewhere in the world suggests that a bold and innovative ambition for each capability (developed with the private sector, government, and recognising the crucial role of our universities) would create attractive propositions for international investors and help to transform the economy and deliver the Powerhouse.

[4] Northern Powerhouse Partnership: First Report (February 2017)
[5] Transport for the North - Northern Powerhouse Independent Economic Review (2016)
[6] Based on 2015 prices
[7] Transport for the North - Northern Powerhouse Independent Economic Review (2016)

WORKSHOPS

9. To support the development of this report a series of business-facing workshops were held across the North during the summer months. This aimed to draw out views on the key actions that would make the biggest difference to increase economic growth in the Northern Powerhouse, and to support the evidence base. In total, more than 500 people attended an event or responded to an in-depth survey undertaken by NPP.

10. Participants were asked to think long term about growth. Industry bodies and business leaders from companies of all scales shared their evidence and analysis of the challenges and potential interventions needed in order to accelerate growth in the North and allow us to be global leaders in the four capabilities.

11. Advanced Manufacturing & Materials: workshops were run in Hull, Middlesbrough, Crewe and Preston. These were led by Jüergen Maier, Chief Executive, and Justin Kelly, Head of Business Development, of Siemens UK. Each workshop identified the need for further work on encouraging smaller enterprises in adopting innovation in products and industrial digitalisation. SMEs who attended our workshops highlighted the difficulty of accessing and becoming part of some supply chains.

12. Energy: Five energy workshops were held and led by Andy Koss, CEO Drax Power. These were in York, Hull, Warrington, Lancaster and Carlisle. There was recognition from all businesses, regardless of generation method, that energy provision and innovation is a long-term process. More certainty in the future market and decision making would lead to more investment and planning for established technologies, such as wind, to emerging ones such as tidal and geothermal, with the chance to further develop UK content and expertise in maintenance of assets. Interest in nuclear was demonstrated not only from those companies developing the technology but potential supply chains and wider as a potential global export of technology and expertise. There was also discussion of projects underway looking at hydrogen production, Carbon Capture and Storage and distribution all across the North.

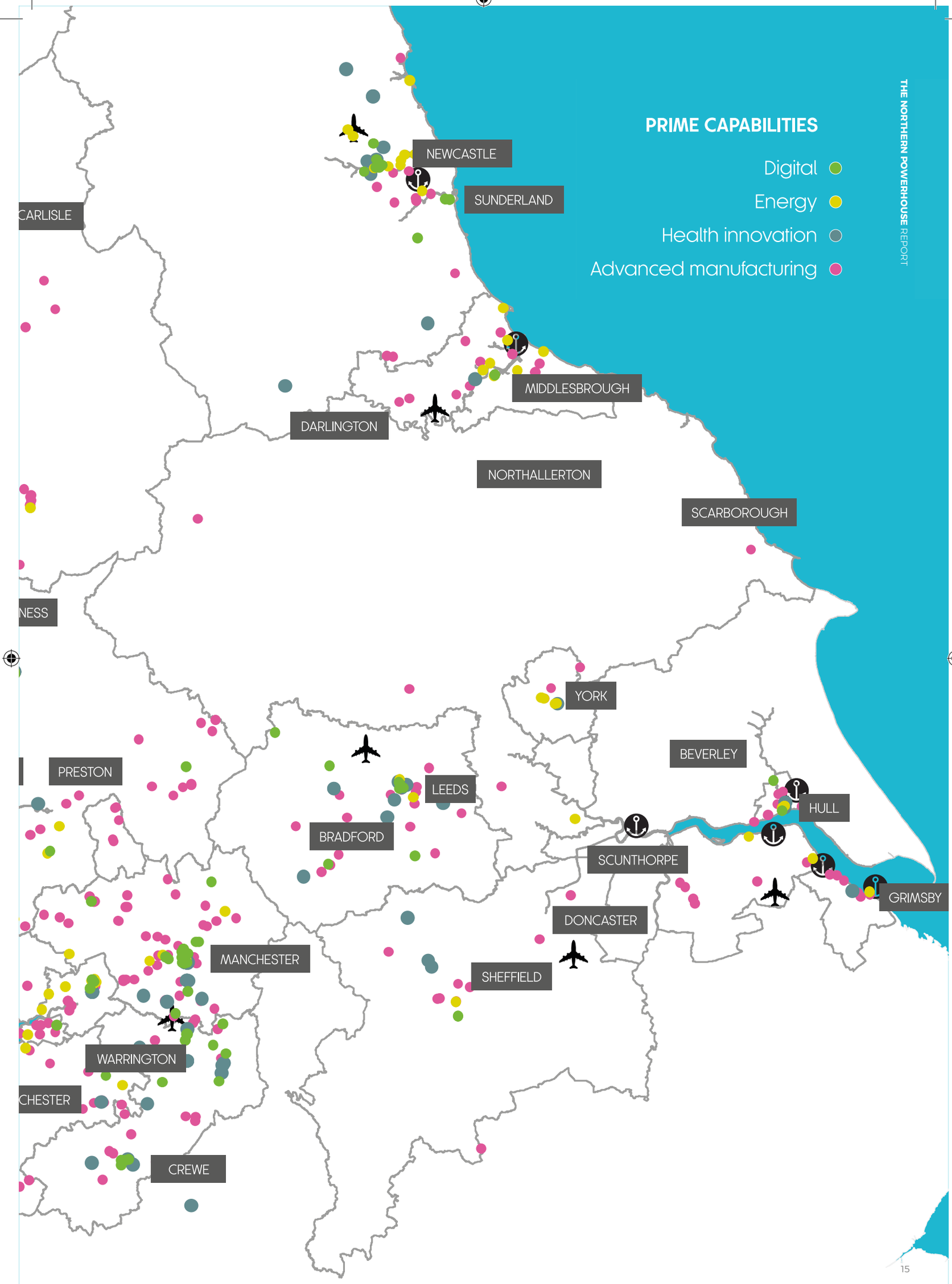
13. Digital: six workshops were run in Liverpool, Manchester, Newcastle, Leeds, Sheffield and Hull. This work was led by Stephen Church, his colleagues from EY, including each of the regional managing partners for the North West, Yorkshire and the North East, supported by Steve Turner from Arup. There was consensus that lack of connectivity was inhibiting growth in the UK and the North's digital sector. Each workshop identified that the potential in cross cutting areas such as cyber security should be exploited.

14. Health Innovation: workshops were held in Sheffield, Newcastle and Manchester, with the advice and support of Dame Nancy Rothwell as well as the assistance of Dr Hakim Yadi OBE, Chief Executive of the Northern Health Services Alliance and his colleagues. The important opportunities to attract the right funding to businesses, the capabilities to hold clinical trials across the North, as well as developing the North's manufacturing in health were common themes.

WORKSHOP AND SURVEY CONSENSUS AREAS

Across all sectors and locations, the workshops concluded their conversations with areas of much common agreement:

- Better transport connections across the North are needed to aid doing business and increase recruitment catchment areas, supporting the case for the North's first strategic transport plan as developed by Transport for the North and in particular Northern Powerhouse Rail.
- More opportunities to innovate together, whether through co-location or better and wider business interconnectedness, between digital meet-ups in different cities to those in related fields in manufacturing.
- More dialogue with academia across both the N8 research intensive institutions and the North's universities as a whole to better drive their innovation and research outcomes, and, most importantly to commercialise these to generate maximum economic benefit through pan-Northern centres of excellence.
- A need to deal with the historic legacy of a gap in investment in skills, and to ensure that those entering the workforce are better prepared and engaged for the world of work.



SECTION 4

THE ECONOMY OF THE NORTH

OVERVIEW

In our first report, the case for achieving growth through agglomeration was made. The economic and social benefits of lifting the North's 15 million people to the same performance of London and its surrounding area is clear. It would generate such an economic boost as to raise the trend growth rate of the UK economy significantly, something which would be beneficial to the whole country. In this report, when looking across all the assets identified by the Northern Powerhouse Independent Economic Review (NPIER) in the prime capabilities, we have considered the interrelationship between agglomeration and the network economies thesis. It is useful in order to help explain the links between assets which are not necessarily in physical proximity to the North's largest cities, most notably in the energy sector, but where the economic activity they generate will require additional further direct knowledge intensive activity elsewhere, including in the enabling capabilities, right through the coming decades to 2050.

This mutually re-enforcing relationship between the North's traditional industrial heartland communities, coastal based assets and its largest cities in metro economies is integral, including the M62 corridor of Liverpool across to Yorkshire's cities. The enabling capabilities cannot succeed without success in the prime capabilities of Advanced Manufacturing & Materials, Energy, Digital and Health Innovation.

Arup in their Future North report [8] made the case that both physical and trading links are needed that can exchange people, goods and ideas across the North. These connections might represent: cooperation between different agencies and institutions, the flow of information, and the social relationships within the total system. Pan-Northern transport links, the focus of Transport for the North, is one condition. However, other business, social, financial, digital and governance linkages can help create a dynamic and prosperous networked economy across from the North East to Cumbria, the energy estuary on the Humber to the Liverpool City Region. This report outlines the case for action in these areas for the prime capabilities, whilst leaving the most significant constraining factor on all four areas, that of skills. The proper link of skills to the education system will be the focus for our next report, to be published at the beginning of 2018 after further research and consultation.

The Northern Powerhouse Independent Economic Review (NPIER) produced detailed local area profiles for 11 economic geographies of the North focusing on the key economic strengths and assets in each area in addition to the challenges each of them faced. The review focused on the productivity of each region by measuring the gross value added (GVA) per job and comparing this with the rest of the North as well as the average for the rest of England, excluding London.

The NPIER was clear that currently the economy of the North is not as productive or innovative as it could be. Too many companies appear to adopt a low cost, low added value business model, and levels of enterprise are lower. There are 32 people per business in the North, compared with 27 across the UK and 19 in London. The growth rate of business start-ups was 7.3% in the North, compared with 8.2% across the UK and 11.9% in London (2009-2014) – if start-ups in the North had set up at the same rate as London, the GVA of the North would be £1.8bn higher [9].

Equity networks are not as well developed in the North, compared with London and the South East. Businesses in the North make 13.8% of UK R&D expenditure and 10.5% of R&D Tax Credit claims – and levels of R&D in the UK are lower than many comparator countries. Yet the North already exports £52bn of goods each year (25% of goods exported from England), making it a larger exporter than 13 EU countries; with the potential to export more [10].

Foreign Direct Investment (FDI) is growing in the North overall, with some differences between regions. The EY UK Attractiveness Survey has highlighted the significant increase in FDI projects in the North since the term 'Northern Powerhouse' was first coined and the potential of devolution to increase the attractiveness of the North to global investors. There were 214 foreign direct investments across the Northern Powerhouse in 2016, with the North East's national share 2.3%, the North West 7.9% and Yorkshire and the Humber's 8.6% [11].

THE PRODUCTIVITY GAP

Ten of the 11 economic sub-regions of the North were shown to have a lower GVA per job than the average for the rest of England (excluding London), according to the NPIER [12]. The report then attempted to quantify the issues contributing to the productivity gap in each area. Perhaps unsurprisingly these differed by economic geography, though all have important implications for any attempts to narrow the gap between the Northern Powerhouse and the rest of England, in order to allow the UK as a whole to succeed in the global race. The major cause, common to eight of the 11 economic geographies in the North, was skill levels.

Where a skills deficit was identified, this was generally characterised as low proportions of the population having higher levels of qualifications, defined by the review as NVQ4+. In some places, such as Greater Manchester for example, problems with skill levels exist at both ends of the spectrum with a lower proportion of the population holding NVQ4+ qualifications than the national

average and a high proportion of the population holding no qualifications at all.

Given the evidence that high skills levels are correlated with a more productive workforce, this would suggest that a pan-Northern approach to addressing the skills gap, with decision making on how to achieve the specified outcomes at the place level, could go some way to unlocking the unrealised economic potential of the North. A more in-depth report into education and skills, the interplay between them both and the skills shortage, will be published by the NPP in early 2018.

The next most commonly cited barrier to improved productivity was low levels of business density, highlighted particularly for its prevalence in the North East, Tees Valley, Leeds City Region and Greater Manchester. This area likely warrants further investigation to understand the exact nature of the problem. It could arise simply from a lack of business start-ups and a reliance on a small number of large employers. Similarly, the public sector could be a more dominant employer. It is worth considering whether a pan-Northern strategy to support business start-ups would be warranted. Connectivity within city regions was highlighted in the economic geographies of the North West outside the two which include core cities; Cumbria, Lancashire, and Cheshire and Warrington. This is connectivity within the area's geography itself, without even considering the opportunities for corridors of connectivity which cross the Northern Powerhouse, for which Transport for the North has recently completed its evidence base.

[8] Arup (2016) *Future North*
[9] SQW (2016) *Northern Powerhouse Independent Economic Review*
[10] Northern Powerhouse Partnership (2017) *First Report*
[11] EY (2016) *Attractiveness Survey 2016: Investing in the North*
[12] SQW (2013) *Northern Powerhouse Independent Economic Review*

THE TRANSFORMATIONAL ECONOMIC SCENARIO

The NPIER outlined a transformational economic scenario where substantial progress was made on the barriers to higher productivity outlined in the previous section. Under this scenario, in the period 2015-50, GVA increased by 0.4pp per annum, jobs by 0.2pp, productivity 0.2pp and population by 0.2pp over and above the 'business as usual' scenario. This equates to an additional £97bn of GVA[13] and 850,000 additional jobs.

It is of course possible for the North to exceed the transformational scenario by 2050. Based on current performance, the levels of GVA growth such as in the Cheshire and Warrington economic area under the transformational scenario may not be ambitious enough. As the Northern Powerhouse Partnership, we will continue to monitor data sources, such as the Lloyds Bank Regional Purchasing Managers' Index under which performance has been shown to exceed that of London for two of the three constituent regions of the North[14], to monitor where the Northern Powerhouse and wider industrial policy interventions may be starting to have a discernible impact over the coming years.

This scenario can now be published here at a greater geographic disaggregation to get an understanding of how each region could benefit from such an outcome. Graph 1 and Graph 2 below provide this breakdown for GVA per head and employment respectively. Note that the geographies are slightly different to those presented earlier in this section.

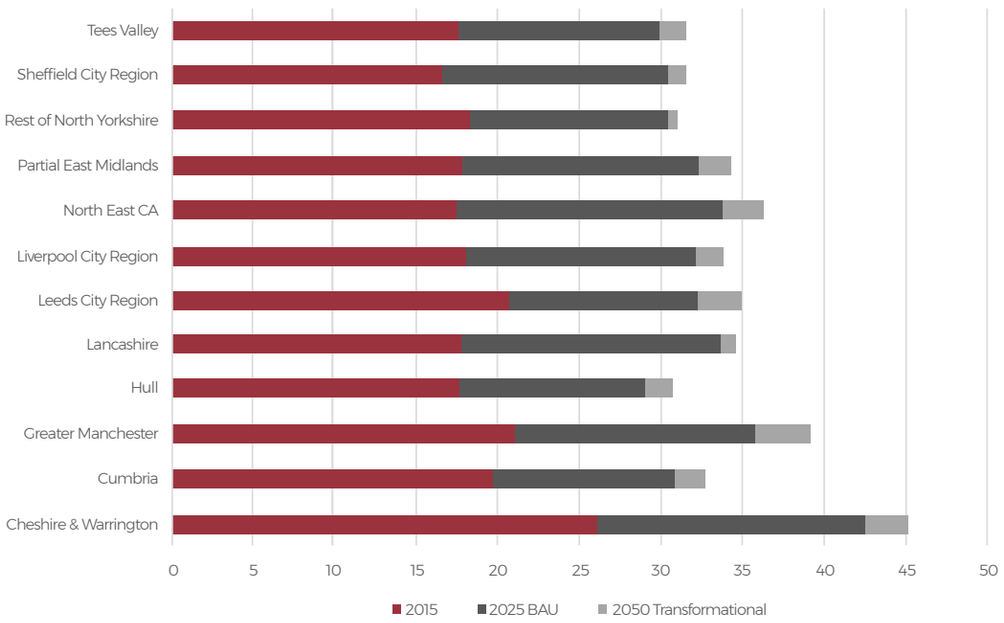
TABLE 1

Table [1]: Regional changes in GVA (£m in 2011 prices) under a business as usual and a transformational economic scenario

	BUSINESS AS USUAL		TRANSFORMATIONAL		ADDITIONAL
Region	2015	2050	2015	2050	2050
The North	302,273	603,352	302,273	694,568	91,215

GRAPH 1

GVA PER HEAD FOR NORTHERN POWERHOUSE



[13] Figures in 2015 prices.
[14] http://www.lloydsbankinggroup.com/globalassets/documents/media/press-releases/lloyds-bank/2017/170911_regionalpmi.pdf

TABLE 2

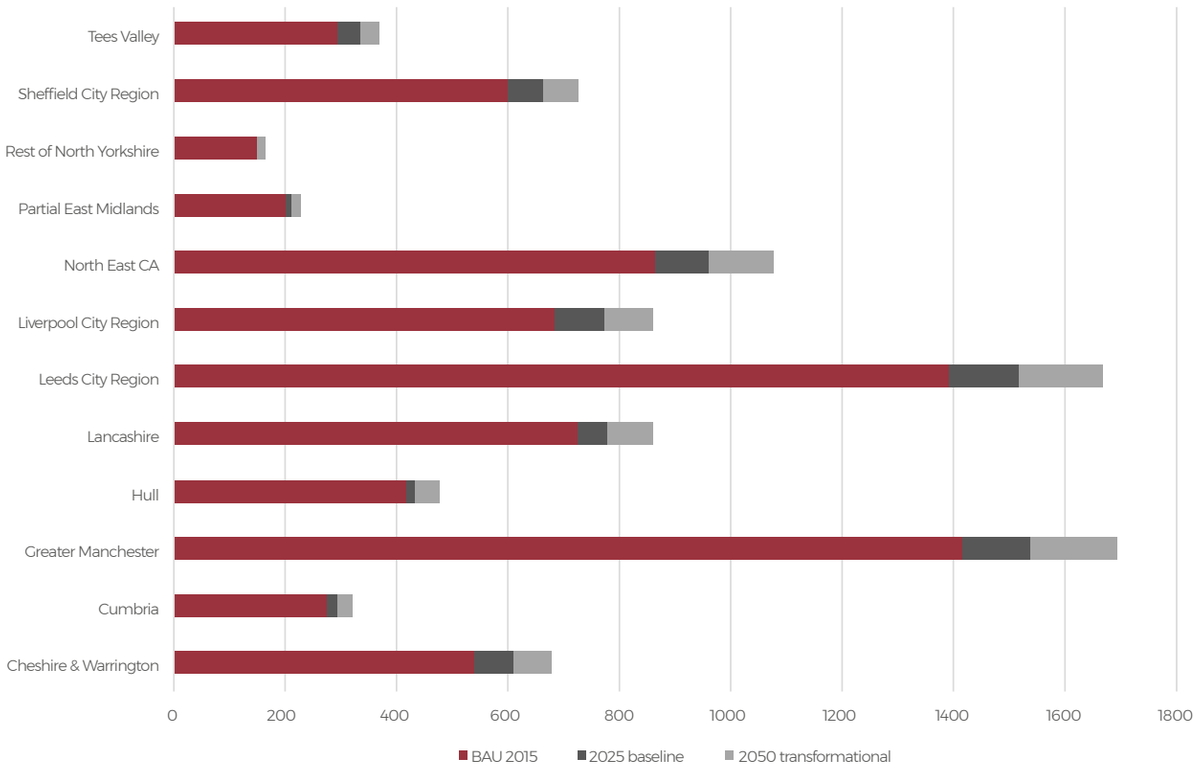
As Table 2 below shows, when average annual growth rates are compared the whole of the North benefits greatly under such a transformational scenario.

Table [2]: Regional average annual growth rates (2035-50) under the transformational economic scenario.

REGION	GVA	GVA PER HEAD
Cheshire & Warrington	2.4%	1.6%
Cumbria	1.9%	1.5%
Greater Manchester	2.6%	1.8%
Hull	2.3%	1.7%
Lancashire	2.6%	1.9%
Leeds City Region	2.4%	1.5%
Liverpool City Region	2.5%	1.8%
North East CA	2.9%	2.2%
Partial East Midlands	2.9%	2.1%
Rest of North Yorkshire	2.2%	1.4%
Sheffield City Region	2.7%	1.8%
Tees Valley	2.4%	1.7%
The North	2.5%	1.8%

GRAPH 2

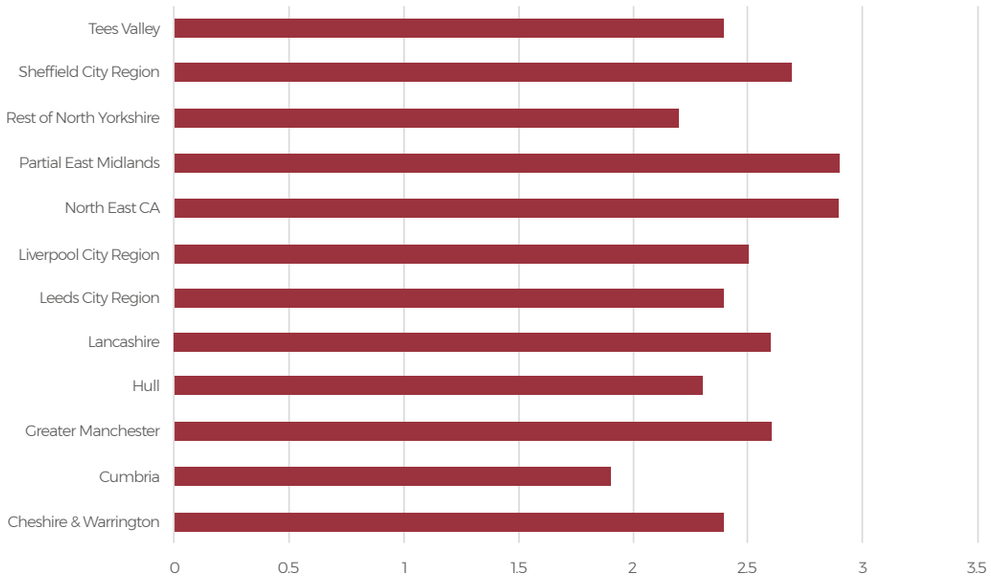
JOBS



GRAPH 3

GVA

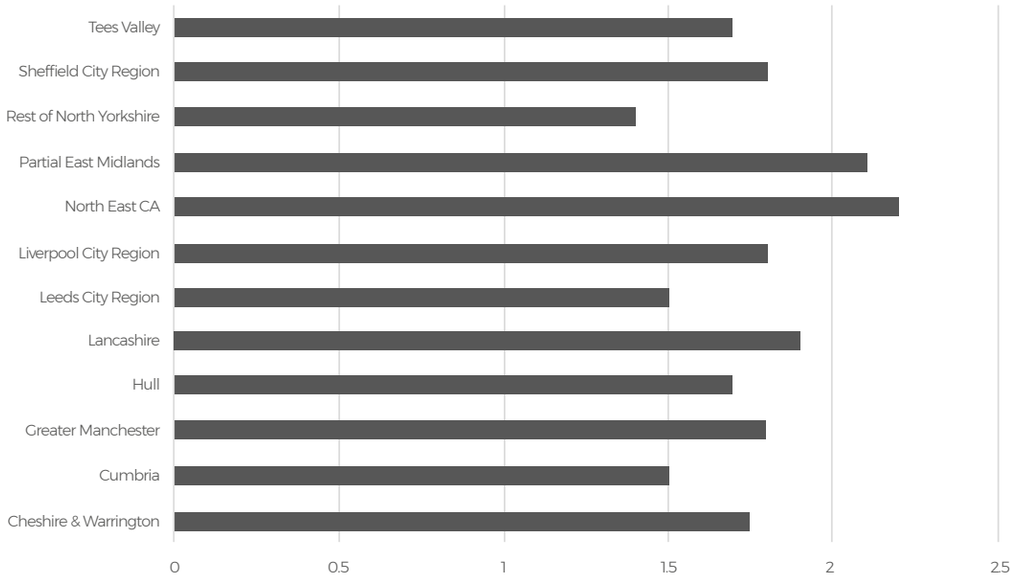
Regional average annual growth rates (2035-50) under the transformational economic scenario.



GRAPH 4

GVA PER HEAD

Regional average annual growth rates (2035-50) under the transformational economic scenario.



IN BRIEF CONCLUSION

The evidence above has highlighted a number of key areas of focus for narrowing the productivity gap between the Northern Powerhouse and the rest of England. First and foremost, the skills shortage at the higher end must be addressed as virtually all economic geographies of the North face the same issue. Additionally, some areas would benefit particularly from measures to support a greater entrepreneurial culture and increase the number of businesses operating in their area. Finally, improved connectivity would have a direct impact on productivity within some economic geographies whilst undoubtedly supporting progress on the other priorities in others.

It has also been demonstrated that achieving a transformational economic scenario will benefit all regions of the North not just a select few, whether this is measured by GVA or the number of jobs. The rewards are clearly there for all to share and a co-ordinated response at a pan-Northern geography is the most sensible approach to increase the chances of success.

NPP has undertaken to establish, based on the transformational scenario, what the broad requirements of the prime capabilities will be in skills terms in demand for workers, and will return to the challenge of how best to meet this need in our next report.

SECTION 5

ADVANCED MANUFACTURING & MATERIALS

Advanced Manufacturing & Materials are areas in which the North has leading assets and capabilities. The GVA growth predicted from 2015 to 2050 is from £33.4bn to £58bn in 2011 prices. Productivity as measured by GVA per job is also expected to rise from £58k in 2015 to over £178k in 2050[15].

Advanced Manufacturing & Materials will be vital to driving high productivity, automated and digital manufacturing techniques. These capabilities show both broad and deep sectoral specialisation across the North, based on historic strengths, and a very strong collection of pure and applied knowledge assets and facilities in business and higher education.

“ The Material Processing Institute, based in the Tees Valley, has achieved significant success working with SMEs ”

Based on the NPIER, we argue here that the North’s real strengths in Advanced Manufacturing & Materials are using manufacturing to develop improvements in processes to improve productivity, as well as developing innovative products, drawing specifically upon pan-Northern excellence in lightweighting including the emerging area in industry transfer of 2D materials, and high-precision engineering as horizontals (these sit alongside the verticals of pharmaceuticals, chemicals, fuels, metals, textiles, food/beverages, autos, machinery, engineering services, and aspects of Agri-tech).

The period up to 2050 will require wholesale changes to the current industrial base of the Northern Powerhouse, and indeed for all economies around the world. Traditionally, industry has demonstrated variable levels of adoption of automation, particularly amongst some industrial SMEs. However, the Material Processing Institute, based in the Tees Valley, has achieved significant success working with SMEs with a wide package of support, focusing on innovation diffusion.

Industrial digitalisation is the defining opportunity for the Northern Powerhouse to take a step ahead and differentiate by maximising disruption as an opportunity, not just as a threat. In Advanced Materials, processing is key to setting properties, creating competitive advantage and undertaking continuous, relentless innovation to improve productivity. There are a wide range of functions and properties coming into play. These are likely to include self-healing, self-cleaning materials; ‘memory metals’ that can return to their original shape; piezoelectric ceramics and crystals which convert pressure into energy, and advanced prototyping, production and supply chain management capabilities.

[15] These corresponding figures, for each prime capability, are taken from the Northern Powerhouse Independent Economic Review
[16] https://www.liverpool.ac.uk/materials-innovation-factory/

PITTSBURGH - ADDITIVE MANUFACTURING

This city provides a blueprint for how Advanced Manufacturing industries have been adopted and driven forward.

- A strong focus on R&D in universities has helped generate significant research funding inflows and resulted in a high number of new start-up companies.
- Collaboration between academia and industry gives businesses access to cutting-edge equipment and highly-skilled individuals whilst increasing revenues for universities.
- Universities in Pittsburgh have responded to suggestions that business is struggling to recruit individuals with the skills they need in additive manufacturing. Some are already offering short-course training to individuals and businesses.
- The region hosted the largest conference dedicated to additive manufacturing, providing further exposure to the universities and businesses located there.

In the North, we have an opportunity to be able to use the wider prime capabilities to leverage the opportunities for additive manufacturing. In the Humber, for example, for maintenance in offshore wind rather than importing parts through a long and expensive supply chain. There is also investment in 3D printing equipment to be hosted at the University of Hull, with a clear approach that local businesses will be able to use vouchers to investigate how similar equipment could be used in their own company.

LIGHTWEIGHTING AND 2D MATERIALS

The importance of lightweighting is significant, helping to minimise the use of resources and contributing to addressing the challenges being faced globally. Alongside new manufacturing processes, 2D materials including graphene and more than 500 carbon analogues and also non-carbon 2D materials are yet to be fully capitalised upon. From 2D materials, with the National Graphene Institute at The University of Manchester where the whole story began, to lightweighting of metals is a central theme, led by the University of Sheffield and drawn together through the Henry Royce Institute. As an institution it has the potential to integrate collective strengths across the North to create a genuine centre of excellence available for companies and researchers across the Northern Powerhouse to capitalise on. There is also a particular opportunity in the area of exploiting machine learning and big data for materials design and materials processing.

The lightweight alloys, composite materials and ceramics made possible by research advances in materials need to be commercialised, which is why further materials capabilities in knowledge transfer, using the Advanced Manufacturing Research Centre (AMRC), would be a boost to the North's capabilities for the longer term. At Rolls-Royce in Barnoldswick, there is the opportunity to develop and test their new composite Ultrafan blade technology, which will be a key element of next generation engine development.

It is also clear that wider assets, including drawing on work led by the University of Sunderland with industry partners including Nissan in the North East, will include these strengths in the context of other capabilities, but applied specifically to vehicles and mobility.

Materials expertise will have two effects for the Northern Powerhouse if adopted at pace across the range of businesses in the North. Firstly, significant productivity gains for well-established industries which can embrace these to become more competitive. Secondly, opportunities for entirely new products, where both a research base and businesses actively seeking commercialisation opportunities in these fields is vital.

HIGH-PRECISION ENGINEERING

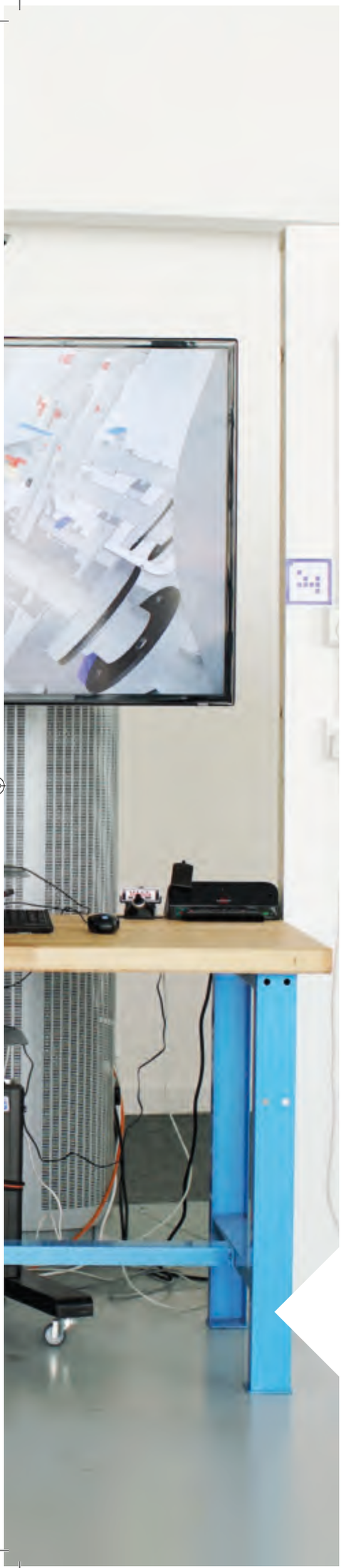
The vertical strengths of the North in specific areas are significant, with car manufacture linked heavily to the government agenda of replacing petrol and diesel with alternatives such as electric vehicles: more than 30,000 jobs in the North East alone are in the automotive sector, Cheshire notable for the presence of Bentley, and Vauxhall and Jaguar Land Rover in the Liverpool City Region. Lancashire is the regional centre of the world's fourth-largest aerospace cluster, and Boeing investing in Sheffield demonstrates its pan–Northern importance. Lancashire Enterprise Partnership is working with the AMRC in Sheffield to establish the AMRC NW at the Samlesbury Aerospace Enterprise Zone, with the first of three phases of development to open by the end of 2019.

Increasing international trading opportunities on a cross-cutting basis will make a significant difference to maximising the value of the North's engineering assets. Interventions such as the dedicated Northern Powerhouse team at the Department for International Trade, and delivery such as by the Growth Company, is most valuable if linked to wider partnerships. Well-established enablers such as the Chamber International and work by businesses such as Barclays providing direct face to face encouragement and support for new exporters by bringing their customers together is vital. This opportunity is cross cutting across all the prime capabilities, but in Advanced Manufacturing and Materials there is the greatest scale of opportunity due to the presence of these types of business in our economy, from Burnley to Barnsley across the North.

MATERIALS INNOVATION FACTORY (MIF)[16]

Funded by Unilever and delivered in partnership with the University of Liverpool with HEFCE backing.

MIF will support major companies through access to shared robotic testing, scale-up and proof-of-concept facilities; SMEs through access to synthesis and characterisation services and facilities they would not otherwise afford; start-ups and spin-outs through access to expertise and pump-priming support. It will comprise a Materials Design Engine focussed on academic research of industrial relevance and several Materials Applications Engines specific to industry sectors. The integrated facility will help to de-risk investment in new materials for a wide variety of applications.



SUPPLY CHAIN DEVELOPMENT AND OPPORTUNITIES

The reshoring of Britain's supply chain is a significant challenge, and an opportunity to be grasped. Of 30,000 components in a car, 41% are made in the UK according to the Society of Motor Manufacturers & Traders (SMMT)– whereas only 15% of Nissan parts are made in the UK. Efforts to address maximising UK content are underway by those including the AMRC in Sheffield. There have been locally-focused initiatives such as the Furness Economic Development Forum[17] which was set up to target assistance to 300 local SMEs, with the proposed Borderlands initiative for Cumbria and Scottish border areas heavily focused on supply chain development.

Across the Local Enterprise Partnership areas of the North, there is a commitment to bring more original equipment manufacturers to their areas, such as those focused on automotive in Cheshire and Warrington. However, this disadvantages significant clusters in areas such as the Leeds City Region where there is an SME manufacturing base but not the head of a supply chain. Using existing frameworks such as the North West Regional Manufacturing Forum and Chambers of Commerce across the North, it would be possible to create pan-Northern supply chain links with original equipment manufacturers across the key sectors and facilitate enhanced UK manufacturing contracting and economic outputs. This would include specifically looking across sector boundaries to ensure that a capability was applied to similar applications.

INDUSTRIAL DIGITALISATION

Sometimes described as the fourth Industrial Revolution or Industry 4.0, Industrial Digitalisation is how UK manufacturing can increase its use of digital technology and automation to become more productive and competitive. It is the merging between the physical and digital worlds to significantly enhance performance and productivity.

The technologies it includes are; (i) Artificial Intelligence/Machine Learning & Data Analytics, (ii) Additive Manufacturing, (iii) Robotics, where the North already has the National Facility for Innovative Robotic Systems and York University's Robotic Laboratory in the Leeds City Region, (iv) Virtual Reality & Augmented Reality with cognitive computing strengths at Daresbury and VR simulation, and (v) Industrial Internet of Things (IIOT) and Connectivity (5G, LPWAN etc.)

The upcoming developments in robotics will change production processes and logistics based on advances in machine vision, artificial intelligence, machine-to-machine communication, sensors and actuators. It is also clear that additive manufacturing will allow on-demand production for bespoke parts to order for businesses and products in urban factories for end consumers, reducing transport costs and environmental impact; 'bio printed' organs will potentially revolutionise medical practice.

Research by EEF showed that 87% of businesses say they will have to invest in new technology to meet customer expectations and 61% say they could be using digital technologies more to boost their productivity[18]. Looking at how digital cross-cuts the other prime capabilities, there is evidence that manufacturers do not associate the use of digital to improve process technologies as advanced manufacturing, whereas they would associate digital technologies to develop products. EEF in the North is already creating online communities, seeking to create peer-to-peer support across sectors, in particular for SMEs.

> *"Upcoming developments in robotics will change production processes and logistics"*

The Industrial Digital Technology Commission (IDTC) is an ambitious initiative that will advance the UK's global leadership in Industrial Digitalisation. The Commission will provide leadership, a united direction, regional access for the UK manufacturing base, and technology and business transformation to position the UK as an international leader.

In Advanced Manufacturing the North has opportunity to;

- In the North West, develop existing work such as LCR 4.0, pilot a regional approach to Industrial Digitalisation for £20m and a further £20m each to expand to both Yorkshire and the Humber and North East to ensure the Northern Powerhouse will be able to lead the UK in embedding this approach.
- Ensure better collaboration between academia and industry to address specific industry challenges, requiring funding for CESAM focused on automotive and £9m for the High Speed Rail Technology Park in Leeds.
- Integrated UK Coatings Technology Centre, two-thirds funded by UK businesses and the remainder from higher education funding.
- Utilise £25m to pilot greater support to allow SMEs to take advantage of pan-Northern supply chain opportunities.

[17] Woodcock, J. (2012). *A national cradle for advanced manufacturing: towards a new economic vision for Furness*

[18] https://www.eef.org.uk/business-support/news-blogs-and-publications/blogs/2017/apr/4ir-evolving-your-business-whitepaper

SECTION 6

ENERGY

The GVA growth predicted from 2015 to 2050 is a rise from £8.9bn to £15.3bn in 2011 prices. Productivity as measured by GVA per job is also expected to rise from £77k in 2015 to £170k in 2050.

The North has historically been the powerhouse for the rest of the country. Thanks to decades of building power stations in the region – and more recently renewable projects harnessing wind and solar energy -- it currently generates 41% of England's electricity[19]. It also hosts a number of energy intensive industries in hubs such as Teesside and the Humber.

The Northern Powerhouse Independent Economic Review originally identified Northern energy sector strengths in electricity generation, storage and low carbon technologies including nuclear, offshore wind and bioenergy. Since this report was published, new opportunities have been created in areas such as battery storage and electric vehicles; a quarter of Europe's entire fleet is manufactured in the North East. Other organisations such as IPPR Northern Energy Taskforce[20] have identified strengths and opportunities in areas such as shale exploration and adopting hydrogen technology.

This report builds on these assessments by identifying key areas where the North is particularly well placed to capitalise on these strengths and harness the economic opportunities associated with the UK's transition to a low carbon economy.

RE-USING AND RE-PURPOSING EXISTING INFRASTRUCTURE

The North of England has significant legacy energy infrastructure thanks to its rich heritage as the country's source of baseload power. However, the energy system is changing. In recent years, the drive to decarbonise the power system has led to an exponential growth in renewable technologies such as biomass, onshore wind, solar and offshore wind -the blades of which are built in Hull at the Siemens factory as part of the city's Green Port development. These technologies are now increasingly competitive on price compared to established technologies, as demonstrated by the strike price of £57.50/MWh secured by Hornsey Project Two in the September 2017 renewable auction. They have also created significant supply chains, including the investment by DONG Energy in Grimsby and Drax's rail freight supply chain.

Against this backdrop of a growing renewables sector, a number of carbon-intensive coal-fired power stations across the North and elsewhere have been forced off the system. Whilst welcome from a decarbonisation perspective, the closure of these plants has created a new challenge in reducing the number of power stations that can provide vital support services to manage the stability of the grid, such as inertia, voltage control and frequency response.

There is a real opportunity for the North to establish itself as the nation's hub for both low carbon and flexible energy generation. This will involve a combination of constructing new renewable projects, such as offshore wind farms in the North and Irish Seas, and re-purposing existing power stations that already have access to grid infrastructure and the national rail network. We have already witnessed some of the North's largest power stations convert their existing coal units to use biomass and are seeing developers re-permit old power station sites to build highly efficient gas plant either as new build or as re-powering opportunities, all of which can ramp their output up or down at short notice to respond to the needs of the grid. In addition to generating electricity, these power station sites can also be utilised for other high value uses that benefit from their existing infrastructure and connectivity, such as advanced manufacturing.

The key catalyst to maximising the opportunities in the energy sector in the North is long-term regulatory certainty from government. Recent policies such as carbon price support and CfD auctions have provided the framework needed for the private sector to invest in the North. These should be extended beyond their current cliff edge of the early 2020s to build on this momentum. Moving forward, there is now an opportunity for the North to become the country's 'flexibility hub' as the need for energy in the UK begins to change. National Grid estimates that the value of support services to the grid will double from £1bn to £2bn between now and 2020, with projections that this will continue to rise into the 2030s.

BUILDING ON THE NORTH'S NUCLEAR STRENGTHS

The North's world-class industrial and academic assets, allied to its expertise and highly developed supply chain, place it in a unique position to become the centre of a Small Modular Reactor (SMR) design, manufacture and maintenance programme. The government has already launched a £250m fund for research and development alongside the competition

[19] BEIS (2016) *5.10 Power Stations in the UK*
[20] Baxter, D. and Cox E. (2017). *Who will power the powerhouse? (IPPR North)*
[21] National Nuclear Laboratory. (2014). *Small Modular Reactors (SMR) Feasibility Study. p.3*

to identify the best SMR design for the UK. In addition to providing a scalable source of low carbon power for the country, the global market for SMRs is currently estimated to be worth up to £250-£400bn. This offers the North a tremendous opportunity to once again become a world leader in nuclear by exporting its technology and knowledge abroad. This could complement the North's strength in nuclear decommissioning, the global market for which is also estimated to be worth up to £250bn over the same period, which the North is well placed for with its oil and gas knowledge.

Companies based in the North already have the skills and the capability to support projects as uniquely complicated as a nuclear new build programme. This includes a strong base of predominantly North West nuclear design engineering capability, manufacturing capability of the large nuclear forgings and steam generators and manufacturing a nuclear fuel supply from the Springfields facility near Preston for example.

France has historically been successful in exporting nuclear expertise thanks to targeted interventions by its government, which has provided the ecosystem needed for technical innovation and improvement to develop at home and exported abroad. The UK government should match this ambition to deliver a world-leading SMR programme, building a fleet re-purposing sites from Trawsfynydd in North Wales to Hartlepool.

NUCLEAR CATAPULT – SHEFFIELD & BIRKENHEAD

The Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) aims to enhance the capabilities and competitiveness of the UK civil nuclear manufacturing industry, and help British manufacturing companies compete for nuclear contracts worldwide. It is based in bespoke facilities on the Advanced Manufacturing Park in South Yorkshire and its new facility in Birkenhead.

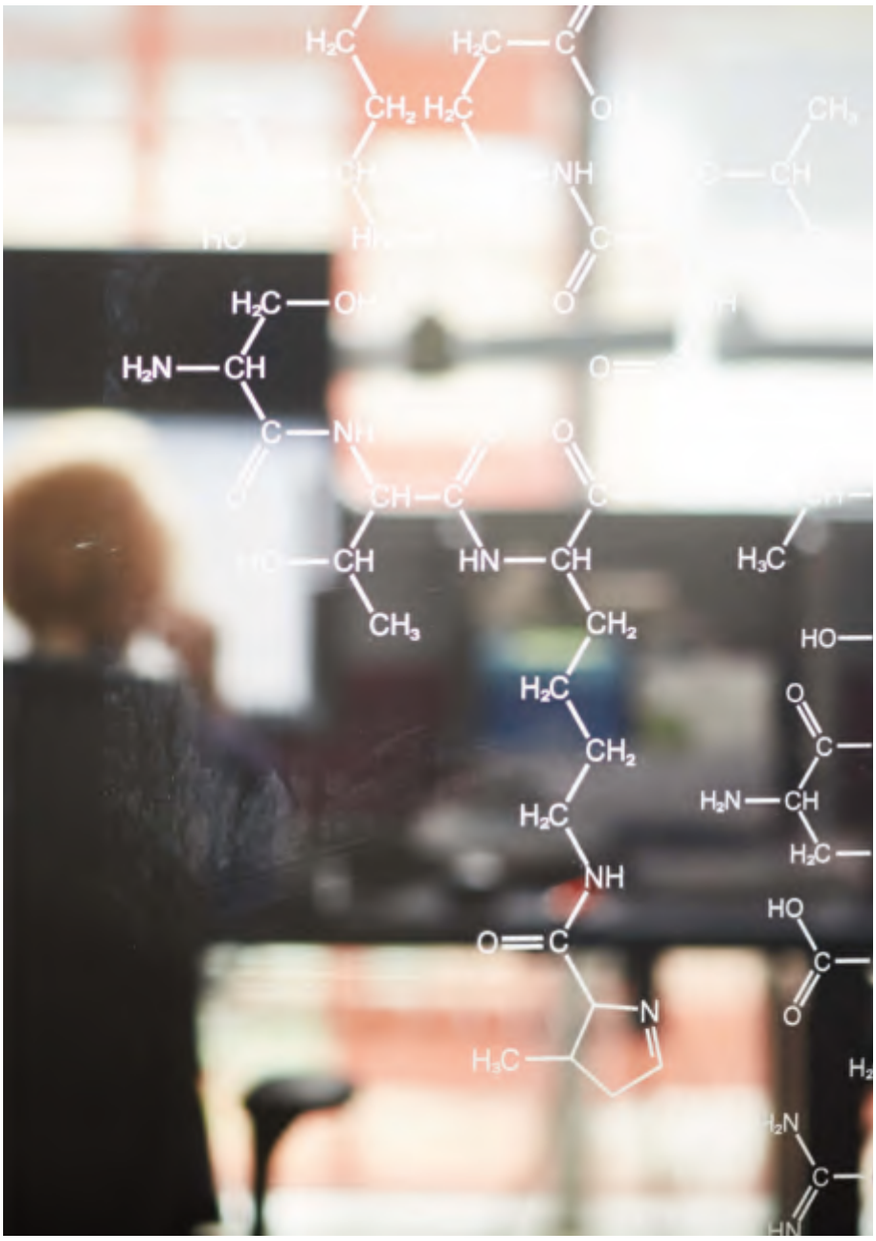
The specifics of the Fit for Modules programme are to ensure the UK is prepared and enable existing UK module capability, for example in shipbuilding and civil construction, to be effectively transferred and ensure that the UK is ready to build the modules required for a fleet of new reactors. NAMRC are working with companies such as Cammell Laird, Westinghouse, Laing O'Rourke, Arup and FrazerNash, who each have extensive expertise and experience which can contribute to delivery of a world class module manufacturing capability in the UK.

DELIVERING A SCALABLE LOW CARBON HEAT SOLUTION

Decarbonising the heat sector is one of the great challenges facing us over the next 20 years. It is widely recognised that the UK is going to fall short of its original projections for securing heat from renewable sources by 2020. Given the size of the challenge, a range of solutions is needed to reflect local conditions – from heat pumps and biomass boilers for off grid users to scalable solutions for those reliant on gas.

Northern Gas Networks has already embarked on a pioneering project to explore the feasibility of substituting natural gas with hydrogen in the gas distribution network in Leeds. Similar proposals are being explored for the gas network of areas in the North West. If successful, these projects could be rolled out to all major cities across the UK to decarbonise the heat network at scale [22].

The key to unlocking both the economic and environmental benefits of using hydrogen in the gas grid is Carbon Capture and Storage (CCS). [23] Producing hydrogen by conventional low-cost processes produces CO2, requiring this to be captured and stored to create green hydrogen. The carbon capture networks which would transport and store CO2 from hydrogen production would also be used to capture CO2 from energy intensive industry and power sectors. This will increase the competitiveness of UK industry and attract inward investment from international firms. Ongoing work by Summit Power suggests that CCS could generate £49.8bn of GVA across the North [24].



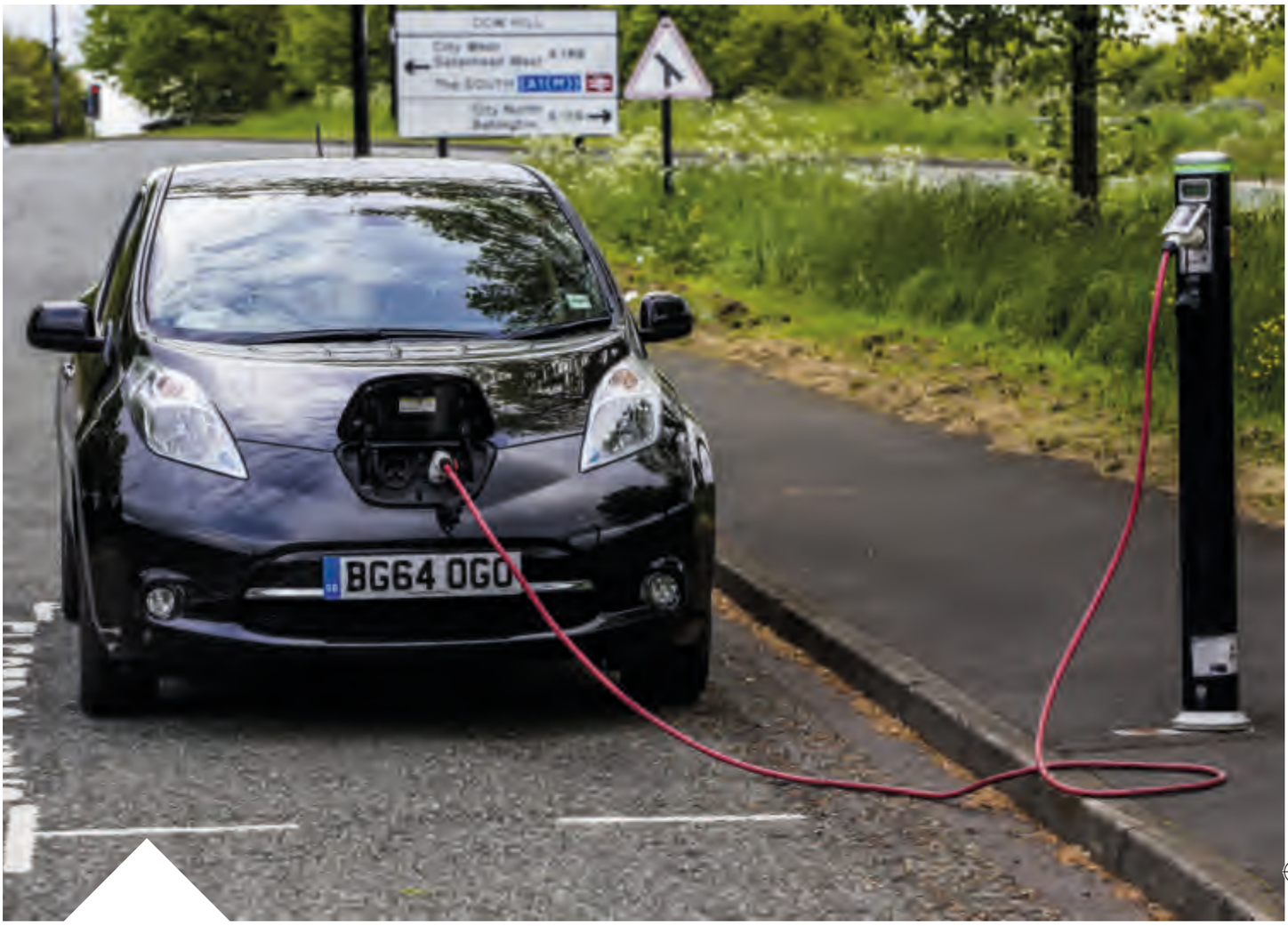
HYDROGEN CONVERSION AND CARBON CAPTURE AND STORAGE

The Leeds H21 City Gate report recognised the potential to decarbonise significant parts of the existing gas network by replacing natural gas with low carbon hydrogen [25]. This would significantly contribute to the UK's 2050 and Paris Agreement commitments on reducing carbon emissions. Teesside has been selected as the ideal location for the hydrogen production facility with CCS for the Leeds H21 project for a number of reasons: a large chemical industrial heartland with half the UK's existing hydrogen production, availability of salt caverns to store the hydrogen and a well-developed carbon capture and storage proposal.

The North is uniquely placed to take advantage of existing industrial and natural assets to convert existing gas networks to hydrogen. Both the Manchester-Liverpool cluster and the North East coast are ideal areas to locate an industrial hydrogen conversion projects. Both are close to a cluster of industrial process industries, have access to future offshore CO2 storage facilities and both are close to extensive salt deposits already used for natural gas storage.

Led by Teesside Collective, a cluster of leading industries, Industrial Carbon Capture and Storage (ICCS) is a ground-breaking initiative with a vision to establish Tees Valley as the go-to location for future clean industrial development by creating Europe's first ICCS equipped industrial zone.

[22] Northern Gas Networks/Wales & West Utilities/Kiwa Gastec/ Amec Foster Wheeler. (2016). - *Leeds City Gate H21 Report, p208*
[23] Ibid., *p1*
[24] Analysis provided in research undertaken for Summit Power.
[25] Ibid.,



A LOW CARBON TRANSPORT ECONOMY

The opportunity to create a low carbon transport economy powered by electric vehicles is a significant one. In recent months the government has signalled its intention to take petrol and diesel vehicles off the roads by 2040 and replace them with electric alternatives.

“ In recent months the Government has signalled its intention to take petrol and diesel vehicles off the roads by 2040 ”

Areas of the North have already made inroads in rolling out the necessary charging technology – however the approach is naturally somewhat fragmented. For example, the £7.8m Plugged in Places North East project created a network of 1,163 electric vehicle charge points across the region and the North East Local Enterprise Partnership has been granted £1.5m funding from the Go Ultra Low programme to develop the next generation of electric vehicle filling stations. Whilst these initiatives, which have also benefited York, are to be welcomed, the North needs a joined-up approach to ensure investment in rapid charging infrastructure is targeted and emissions zones across individual local authorities are consistent.

In linking hydrogen infrastructure and fast electric vehicle charging together, there is an opportunity to increase adoption of low carbon across transport between and within city regions.

ELECTRIC VEHICLES

There is emerging best practice from across Europe which the North can learn from. In Norway, one of the reasons for increase in penetration of Electric Vehicles is that companies have innovated ways to engage the customers – for example using apps to reserve charging spots or choose rates of charging.

The German government provided grants to E.ON to set up world’s first modular large-scale battery storage, thus supporting innovation.

According to European Union analysis of Norway’s electric vehicle regime, the three main factors for electric vehicle uptake have been VAT exemption, access to bus lanes and free toll roads. In Norway, Fortum has interlinked its utility business to provide charging infrastructure for electric vehicles.

INTEGREL (INTEGRATED TRANSPORT ELECTRICITY GAS RESEARCH LABORATORY)

Through the pioneering partnership between Newcastle University, Northern Gas Networks and Northern Powergrid, the UK's first fully integrated energy systems research, development and demonstration site has been opened in Gateshead. The laboratory is being developed in partnership with the EPSRC National Centre for Energy Systems Integration [26]. The utility scale laboratory allows development of technologies across heat, transport and electricity and identifies and demonstrates opportunities for mutual benefit; e.g. power-to-gas when renewable electricity generation is high; gas-to-power when additional power is required. This is a new and exciting sector which will let the North take the lead in taking a whole energy systems approach to the future energy challenges. InTEGReL is geographically situated at an intersection of the utility power, utility gas and transport networks, allowing a full scale, real-world demonstration of energy network innovation.

[26] http://www.ncl.ac.uk/press/news/2017/09/integrel/
[27] http://energy2050.ac.uk/
[28] http://www.energy.leeds.ac.uk/
[29] https://ore.catapult.org.uk/
[30] http://www.nnl.co.uk/
[31] http://www.dalton.manchester.ac.uk/
[32] http://www.uclan.ac.uk/research/explore/groups/uclan_nuclear.php

ENERGY R&D ASSETS

As a global hub for research and innovation in low carbon energy generation, distribution and industrial technologies, the North provides an excellent testing ground for new utility and industrial scale products.

Other leading energy assets in the North include:

- The University of Sheffield's Energy 2050 [27], jointly funded by Siemens AG and the Engineering and Physical Sciences Research Council (EPSRC).
- Energy Leeds [28], the umbrella organisation bringing together multidisciplinary research and innovation expertise at the frontiers of energy and environmental research. Connected research facilities include the Energy Research Institute and the Centre for Integrated Energy Research.
- In terms of Catapult infrastructure, the Offshore test centre at Blyth [29] which is looking at wind, wave and tidal power linking to world leading expertise in subsea.
- The National Grid Power Systems Research Centre at The University of Manchester houses nationally leading high-voltage laboratory which is capable of testing equipment for use on the 400kV network.
- A number of demonstrator facilities which could be better networked together to leverage the existing investment, including at Thornton as part of the Cheshire Energy Hub collaboration.

The North also boasts world-leading centres of expertise specifically in nuclear technology and R&D. These include:

- The National Nuclear Laboratory (NNL) [30], which supports new reactor build, reactor operation, fuel processing plants and decommissioning and clean-up.
- The University of Manchester's Centre for Nuclear Energy Technology and the Dalton Nuclear Institute, established in 2005 to drive forward its ambitions [31].
- The University of Liverpool has an international reputation in the fields of condensed matter physics, nuclear physics, particle physics and accelerator science.
- The John Tyndall Institute for Nuclear Research at the University of Central Lancashire [32] working in nuclear science, technology and engineering.
- Lancaster University has a multi-disciplinary team of engineering researchers working in nuclear safety, robotics, nuclear instrumentation, energy policy and environment.
- The Cockcroft Institute of Accelerator Science and Technology at Daresbury Science and Innovation Campus in Cheshire [33], is one of the UK's leading centres for particle accelerator research.

Links with industry are also well established in The Nuclear Decommissioning Authority (NDA) [34], the public body responsible for the clean-up of the UK's civil nuclear sites; with a budget of £3.1bn a year, headquartered at Westlake's Science Park in Whitehaven, with Sellafield and Birchwood Park nearby.

In Energy, the opportunities that emerge linked to the other prime capabilities are:

- Government to provide a share of the £1bn investment needed for a Small Modular Reactor (SMR) joint venture.
- £2bn to transform the entire gas supply to Leeds to low carbon hydrogen, made possible by Teesside CCS network costing £110m to build and £29m a year to operate and half of the existing £23m Hydrogen for Transport Programme (HTP) to build hydrogen refuelling stations.
- Use all available mechanisms to support Northern generators who are best placed to provide a combination of low carbon electricity and flexible generation.
- Build on the existing pan-Northern university strengths in energy technologies and establish a Northern Energy Centre of Excellence.

[33] http://www.sci-techdaresbury.com/the-campus/cockcroft/
[34] https://www.gov.uk/government/organisations/nuclear-decommissioning-authority

SECTION 7

DIGITAL

The GVA growth predicted to 2050 is a rise from £9.2bn to £41.1bn in 2011 prices. Productivity as measured by GVA per job rising from £71K in 2015 to £190k in 2050[35].

The North will be globally-leading in digital by leveraging where it can have the biggest impact drawing on the wider economy, most directly in the other prime capabilities of health, energy and advanced manufacturing. Whether it be cyber security applied to manufacturing, energy assets or health, or the North's growing reputation for FinTech in the enabling capability of financial and professional services, the widest possible interpretation is necessary to understand the fundamental importance of digital for all the North's economy. Digital in the North includes a significant tech sector, people and a large amount of innovative activities in line with the specific cross cutting dynamics of this prime as outlined in the NPIER.

Notable strengths in the North's digital sector include high performance computing, cognitive computation, data analytics, simulation, modelling and machine learning. It is crucial, however, that before exploring these in detail we explore the ecosystem, skills and underlying infrastructure of digital capability in the North.

With its research and academic institutions and access to office space, The North is well placed to build a strong ecosystem of digital start-ups. The Tech Nation 2017 report[36] highlighted Manchester's pre-eminent scale of tech as a sector overall including edtech, digital advertising and marketing, fintech, with MediaCity the largest purpose-built media location in Europe. It also highlighted the North East as having more high-growth digital businesses than London with typical growth rates exceeding 100% per annum. Previously published work by DataCity Leeds, in partnership with ODI Leeds & Bloom Agency, identified more than 3,500 digital businesses in Leeds and a total of 8,500 across the Leeds City Region. Across the North these insightful statistics could be replicated, particularly if a broader understanding of what constitutes a digital business is accepted, and the true scale and breadth of the North's digital economy could be better understood.

The number of people employed in digital businesses in the North is growing fast but skills shortages are holding back business growth. As referenced elsewhere in this report, the issue of skills this will be revisited in the Partnership's next report and Tech North will also be publishing their own analysis of the challenges in this area.

Each of the North's regions has a unique digital specialism – from data analytics in Leeds to gaming in Sunderland – with businesses such as Sage in Newcastle, who appear on the FTSE 100, considered world leaders in their field.

> *"The North is well placed to build a strong ecosystem of digital start-ups"*

The North's investment in transport, combined with its digital capabilities, provide it with the opportunity to commit to smart infrastructure. By deploying technology across its transport assets, it will be possible to optimise their potential, bring benefits to the customer and user and improve overall connectivity and journey experience across the network. This is a far more cost-effective way of investing to achieve improvements for passengers than investing in infrastructure alone, and sits alongside the need for wider investment. Indeed, with partners from Transport for the North, the North could be a global focus for smart infrastructure. In addition, Building Information Modelling has a focus in the North East, with leveraging these assets an opportunity to secure linked productivity opportunities in the delivery of construction schemes, both in the North and globally.

FUTURE CONNECTIVITY INFRASTRUCTURE

The Northern Powerhouse has the aspiration to be a virtual city, underpinned by a networked economy, by 2050.

There remain challenges, however, around its digital infrastructure; an issue which is pervasive across the whole of the UK. However, by aggregating public sector demand our Northern cities will be able to create stronger markets and opportunities for investors and providers.

In terms of ultrafast broadband the North remains significantly behind London with most of this based on fibre to cabinet technology. However, in Hull, KCOM's focus on the deployment of full fibre networks is a contributing factor to the data presented here[37]. This has acted as a positive factor in development of tech businesses and digital within the wider economy. It also contributes to the North currently being slightly ahead in fibre to the premises relative to London, 2.2% to 1.9%,[38] though masking significant variation across different parts of the North and dramatically behind the performance of many European countries, such as Spain.

The recent commitment by government to West Yorkshire and Manchester for fibre to the premises, which will be replicated across the North[39], demonstrates the steps needed. Partnered with the Universal Service Obligation, broadband access across major cities and rural areas will provide the building blocks for future growth. Some opportunities, such as the building of the metro link system in Manchester, were missed with the opportunity to lay fibre infrastructure between a ring of data centres. As Tameside trials utilising ducts with government support, which has also been considered and proposed in Liverpool, there is a need to focus on what has worked. Channelling investment in prime capability industries, using a pan Northern scheme leveraging the experience in Manchester and Leeds, would provide much-needed impetus to the digital sector.

However, infrastructure is wider than simply fibre to the premises, including international links such as those to Northern Europe being developed from Tyneside as well as internet exchanges. IX Leeds is one of only three operators in the UK and the only one outside of London. Its aims are to promote regional cooperation across the North between different network operators to raise awareness of the purpose and importance of a solid internet exchange and digital infrastructure fabric across the UK.

[35] Northern Powerhouse Independent Economic Review: Scenarios for Future Growth, p.21
[36] http://technation.techcityuk.com/

CO-WORKING, INCUBATORS, ACCELERATORS

Co-working spaces are closely associated with the tech sector, and have a key role in supporting start-up formation, across the digital prime capability and more widely. Incubators across the prime capabilities are accessible across the North, and accelerators are emerging in Manchester, despite the fact that more than half of the UK's total are in London [40].

The government's investment of £11m for tech hubs is already coming on stream, with Platform in Leeds delivered by Bruntwood [41] one example alongside the funding by Leeds City Council of East Street Arts [42] and other complimentary programmes to support the tech sector. In addition, the rapidly-evolving £1bn Newcastle Science Central scheme is being anchored by national innovation centres in data and ageing – providing a mix of collaboration, incubation and office space.

BARCLAYS' EAGLE LAB SALFORD & LIVERPOOL [43]

Barclays have already opened Eagle Labs at Media City, Salford at The Landing, working alongside large media and tech firms; in Liverpool in partnership with Avenue HQ; and an Eagle Live in Sheffield, run in partnership with Sheffield Hallam University.

Barclays Eagle Labs provide access to co-working space as well as resources including expert mentoring, collaboration events, 3D printers, laser cutters and other rapid prototyping tools. This means businesses will have the tools they need to rapidly produce and test prototypes without having to import from overseas, which can significantly reduce the time and cost taken from concept to market.

Barclays is committed to expanding this network in the North, providing practical resources alongside Barclays' financial expertise to help people succeed. These tools and resources will help businesses accelerate growth, helping to address productivity issues across the North.

[37] Ofcom – Connected Nations 2016
[38] NPP analysis of Thinkbroadband calculation of Superfast, USC, USO and Fibre Broadband Coverage across the UK, its nations and regions for premises
[39] http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/418567/UK_Next_Generation_Network_Infrastructure_Deployment_Plan_March_15.pdf
[40] https://www.nesta.org.uk/blog/incubators-and-accelerators-updated-directory-uk
[41] http://bruntwood.co.uk/our-locations/leeds/platform/
[42] https://eaststreetarts.org.uk/
[43] https://labs.uk.barclays/locations

DATA AS INFRASTRUCTURE

The investment of £30m in the new National Innovation Centre for Data will act as the North's centre of excellence for data held in the private sector. This will mirror the infrastructure which is needed for data on individuals held by the public sector on their behalf, but which they themselves must take ownership for; a centre for civic computation.

Data analytic assets in Leeds include the Institute for Data Analytics [44], the National Consumer Data Research Centre [45], and the Open Data Institute Node [46] which are all key parts of a thriving data cluster. Central to this is Data Mill North [47], which has the potential to build an emerging cluster of data driven businesses. Throughout the Northern Powerhouse Partnership's engagement, we identified businesses that could see the value of data they hold but cannot fully exploit, and were also aware that data from others in the North could be valuable to their business.

DIGITAL CATAPULT – NORTH EAST AND TEES VALLEY

Based in the heart of Sunderland, Digital Catapult Centre North East and Tees Valley [48] offers cutting-edge incubation space for start-ups and SMEs developing new data-driven products and services using emerging technologies – supported by a team of industry experts and academics. It helps organisations of all sizes transform their business through digital innovation by accelerating the practical application of emerging technologies, such as the Internet of Things, 5G, AI and immersive technologies.

The Centre applies knowledge of the digital SME marketplace to create commercial opportunities for technology SMEs, the public sector and academia – supporting the competitiveness, longevity and growth of corporate organisations and the North East's digital tech sector. By offering multiple exploration routes, from hackathons to commercial business challenges, and working alongside businesses throughout the innovation process, it can help identify barriers and investigate opportunities.

FUNDING ECOSYSTEM

The Northern Powerhouse has significant public resources, including the Northern Powerhouse Investment Fund and comparative infrastructure in the North East and wider comparable opportunities, such as JEREMIE funds administered by Finance Yorkshire [49].

The £400m Northern Powerhouse Investment Fund will, in collaboration with the LEPs in the region and the British Business Bank, invest in local smaller businesses. Supported by funding from the European Regional Development Fund and the European Investment Bank, this fund, combined with the North East's fund for SMEs, will facilitate over £500m of investment in Northern businesses in the coming years [50].

In both the domain of health around patient capital and in digital, there is value to funds which allow for co-investment models between public and private equity. A proposal from Tech North would manage existing British Business Bank funds to the value of £30m alongside private investment partners into high-growth tech companies from across the North. This could be delivered in partnership with existing platforms, such as NorthInvest [51].

The longstanding barriers to accessing venture capital in the North need to be tackled, but are not the only route available to the North's entrepreneurs. It is worth highlighting that equity finance is part of the pathway for start-ups seeking to secure funding. For example, Barclays has developed a specific debt funding package for high growth and entrepreneurially-led businesses. [52] Start-ups are often characterised by losses in the first one or two years whilst they re-invest in the business to create a more valuable franchise in the longer term. Since 2014, Barclays have lent more than £150m and have a total allocation of £250m so far to this specific group of businesses [53].

[44] http://lida.leeds.ac.uk/
[45] https://www.cdrc.ac.uk/
[46] https://theodi.org/nodes/leeds
[47] https://datamillnorth.org/
[48] https://www.digitalcatapultcentre.org.uk/local-centre/netv/
[49] http://www.finance-yorkshire.com/about/
[50] http://www.npif.co.uk/
[51] https://northinvest.co.uk/
[52] http://www.barclays.co.uk/business-banking/sectors/entrepreneurs/
[53] Ibid

CASE STUDY: NORTHINVEST

NorthInvest is a not-for-profit company, connecting ventures with mentors and investors. Working with major influencers and other key ecosystems in the North, they provide an inclusive platform that allows access to relevant and passionate investors. NorthInvest offers Angel Investment and mentoring to help businesses improve their offer, while connecting them with the right partners, mentors and ecosystems.

The platform also acts as a gateway to larger funds from larger institutional investors, and the team is also in the process of constructing a co-investment fund, aimed at businesses that have a focus on job creation in the region.

HIGH PERFORMANCE & COGNITIVE COMPUTING

The markets in High Performance Computing, particularly relating to AI and Cognitive Computing, are already large and predicted for high growth. There are a number of assets across the North, including through the N8 High Performance Computing partnership and Hartree Centre [54] which is hosted by the Science & Technology Facilities Council (STFC). The latter received £113m as part of the government's Northern Powerhouse strategy in 2015, and requires its assets to be updated every four years.

Deep Change is a path-finding, three-stage programme designed with dual aims. Firstly, to embed a pervasive understanding of High Performance & Cognitive Computing technologies and methods across all parts of the Liverpool City Region economy, and, based on learning from this, to develop a model for national application. Secondly, to provide the wide expertise of those involved in delivering the programme to find and develop potential 'unicorns' suitable for future venture investment. Ensuring that the e-infrastructure ecosystem is effectively integrated with Advanced Manufacturing and Materials for instance, is a differentiator in how Digital can support the wider prime capabilities.

> *"The markets in High Performance Computing...are already large and predicted for high growth"*

The digital prime capability is not only about enabling tech businesses, but also unlocking the wider prime capabilities by:

- Providing a £30m fund for tech start-ups.
- Utilising £70m remaining from the Digital Infrastructure Investment Fund to deliver a step change on full fibre connectivity across the North and investing £30m for a North East-wide 5G test bed trial from commitment to 5G.
- Establishing a Northern Centre of Excellence for Civic Computation, supported by £20m for the pilot phase for two years.

[54] http://www.n8research.org.uk/economic-impact/n8-efficiency/n8-hpc-and-link/

SECTION 8

HEALTH INNOVATION

The Northern Powerhouse Independent Economic Review (NPIER) [55] identified Health Innovation as a cross-cutting and underpinning Northern strength that links to the North's excellence in research, applied science, digital and its advanced manufacturing and materials base. The GVA growth predicted under the transformational scenario up to 2050 is a rise from £17.5bn to £43bn in 2011 prices. Productivity GVA per job rising from £31k in 2015 to £67k in 2050.

The government's Industrial Strategy for Life Sciences also made very clear reference to the North of England's strength in the life sciences research and development through to health innovation and new medicines manufacturing [56]. Indeed, the North is well placed to deliver on many of the specific recommendations in Sir John Bell's report to government, including reinforcing the UK science offer through further improving clinical trial capabilities, identifying and promoting regional strengths, delivering NHS collaboration, unlocking the value of clinical data and developing a skills base to support a new labour force able to capitalise on the opportunities provided by 21st century innovation in health.

Health Innovation capabilities are found in all of the North's city regions with examples including the pharmaceutical manufacturing assets in Cheshire and Warrington, Tees Valley, the North East, the Liverpool City Regions, and Cumbria. The North East also has leading medical device strengths, as does the Leeds City Region and Sheffield City region, alongside the North's data and clinical trial strengths in Leeds, Manchester and Newcastle that place it at the forefront of clinical trial delivery.

As well as identifying numerous pan-Northern strengths in Health Innovation, the NPIER identified a number of specific regional assets, including drug discovery in the Liverpool City Region, Cheshire and Manchester, alongside therapeutic and technical specialisms in 'ageing, cancer, paediatrics, orthopaedics, diagnostics, advanced wound care, healthcare technology, biologics and biotechnology in other city regions.' [57]

> *" The government's Industrial Strategy for Life Sciences made very clear reference to the North of England's strength "*

These health research strengths should not be considered in isolation; they are inextricably linked to the delivery of health and social care across the North. The impact of this sector is significant, as the private sector alone employs more than 38,000 people across 1,000 Northern life science companies. Combined these companies exported £7.3bn worth of medicinal and pharmaceutical products in 2015 equating to 44.7% of UK exports in this category [58].

While the North has world-leading strengths in health innovation, it is equally challenged by a deep-rooted health inequality compared with other regions of the UK. Recent research from The University of Manchester and University of York published in the BMJ [59] identifies worryingly persistent health inequalities between the North and South of England. The research shows that there is a 20% higher premature death rate for those living in the North of England compared to their southern counterparts across all age groups, with premature death rates soaring for those aged 35-44 (up to 49%) since the mid-nineties. This amounts to more than one million Northerners dying earlier than if they had experienced the same life chances as those in the South over the last 50 years.

The North is home to some of England's worst health outcomes and inequalities, yet the public funding for research and innovation that leads to new ways in diagnosing, managing and treating disease is focused elsewhere. Research funding analysis (2014) suggests the North receives only 13.5% of total funding across UK [60] and in most recent NIHR BRC funding allocation of £816m, the North received 6.7% of the total while the 'golden triangle' of Oxford, Cambridge and London received almost 83% [61]. Interestingly, the North receives 20% of the private sector's health innovation investment [62]. This clearly highlights the fact that the UK public sector currently underfunds the North's health economy relative to private sector investment.

The government has the opportunity to address this funding inequality through the new UK Life Science Strategy, and accompanying sector deal, which we argue would be most effectively deployed within recognised clusters such as the North of England with the highest population health needs and where the private sector is already investing and growing. As a guiding principle, in practice the government could address

the difference between private and public spending by ensuring that that one pound in every five of the life sciences sector deal, plus other government and related investments, is made in the North. This would match the estimated research and development investment from the private sector, and would enable the Northern health innovation sector to not only capitalise on the North's strengths in clinical research, but also have a positive impact on reducing the health inequality between the North and the South. This would enable the North to more actively contribute to the wider UK life sciences sector, and improving Northern health would also lead to improved productivity and close the gap in GVA between the North and the South.

[55] Northern Powerhouse Independent Economic Review Workstream 3: Competitive Advantage and Sector Strengths – Final Report, p32
[56] https://www.gov.uk/government/publications/life-sciences-industrial-strategy
[57] Northern Powerhouse Independent Economic Review Workstream 3: Competitive Advantage and Sector Strengths – Final Report, p32
[58] HMRC 2016
[59] http://jech.bmj.com/content/71/9/928
[60] hVp://www.hrcsonline.net/pages/reports
[61] https://www.nihr.ac.uk/about-us/how-we-are-managed/our-structure/infrastructure/biomedical-research-centres.htm
[62] IPPR North, Breathing Life into the Northern Powerhouse, 2016

The North is already developing a coordinated response through the Northern Health Science Alliance (NHSA) where the North will commit to support the delivery of many of the UK Life Science Strategy Recommendations where the region is best positioned to deliver. These include:

- **Reinforcing the UK science expertise by further improving UK clinical trial capabilities:** The North has already established new pan-regional ways of working in clinical trials and is working to position the North as a world leading, real-world trial centre through scale up of the Salford Lung Study.

- **Identifying and selling regional strengths:** Organisations like the NHSA, N8 and BioNow are already developing global recognition for the North as a research cluster through enhancement of joint working and the co-location of industry and academia.

- **Supporting the growth of life sciences clusters:** The Northern cluster 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 GW4 Alliance to promote a 'single front door' to the UK for research collaboration, partnership and investment as well as cross-cluster collaboration.

- **NHS collaboration:** The NHSA unites eight NHS Teaching Trusts, eight top universities and four Academic Health Science Networks. The North is ensuring that health research and delivery projects work in partnership across the region through a collaborative model with potential to be rolled out across the UK.

- **Data:** Health North: Connected Health Cities (CHC), a leading pan-northern health programme, is harnessing consented information and data to diagnose, treat and deliver services more effectively and efficiently for the benefit of patients across the region. It is a prime example of an innovative data ecosystem across multiple geographies of 3-5 million populations enabling easy linkage and comparison of data. In this arena the North is leading the country in delivering potential of health data.

- **Medtech Centres of Excellence:** Academic centres and NHS regional partnerships should also provide support for specific medtech themes, focusing on research capability in a single medtech domain such as orthopaedics, cardiac, digital health, or molecular diagnostics. This would align regional capabilities with a single medtech focus, allowing them to compete globally. The UK needs to grow centres that are globally-leading in specific medtech or diagnostic domains. Through centres in Leeds, Sheffield, Newcastle and Manchester and recent designation of the NIHR MICs uniquely position the North to deliver on the creation of Medtech Centres of Excellence.

- **Bio-Manufacturing:** There have been significant positive developments in the North's health manufacturing sector, including AZ at Macclesfield, which is expanding, as are GlaxoSmithKline at Barnard Castle. The Centre for Process Innovation (CPI) from its presence in the North East is one partner to the REMEDIES project, a nationwide initiative looking at pharma supply chains. The North is well placed to support and deliver on the UK's aims to attract 10 large (£50-250m capital investment) and 10 smaller (£10-50m capital investments) in life science manufacturing facilities in the next five years.

- **Skills:** Through direct work with leading teaching hospitals and research intensive universities, the North is improving the attraction and retention of skilled talent, including for first and second jobs after graduation, and is actively seeking to increase opportunities for vocational training and in attracting inward investment.

MEDICAL INNOVATION & LIFE SCIENCES IN THE NORTH

The UK is globally unique in its ability to leverage the National Health Service as an asset for research, innovation and in developing new models of healthcare delivery. Other leading life science clusters in the US, Europe and Asia look in envy at the opportunity the UK has to better use our national patient care records to discover, develop and provide access to new medicines. Through Health North: Connected Health Cities, the North is leading on a new dialogue with its citizens on the use of their information to help provide better care for them, their neighbours and the wider population of the North. Connected Health Cities is therefore a pivotal project unlocking a renaissance in medical innovation in the North and is awaiting renewed commitment of funding from government for its second phase.

“Through Health North: Connected Health Cities, the North is leading on a new dialogue with its citizens on the use of their information to help provide better care for them.”

In a highly decentralised approach, the Northern Powerhouse Partnership would recommend supporting the roll out of a wider Connected Health Cities commitment enabling every Northern citizen to be in control of their own data, not just in health but in other areas of their lives as well.

REGIONAL CAPABILITIES IN THE NORTH

A real strength in Northern health innovation lies in its place-based clusters, their local assets, and the interrelationship and extensive collaboration between them. Local strengths are exemplified in the following clusters:

In the North East, the universities of Newcastle and Durham have developed an international reputation for work on ageing, rare diseases, clinical trials, data and photonics, while Darlington is host to the CPI Biologics Factory of the Future and the National Biologics Manufacturing Centre. Most recently, investments in the North East in the National Centre for Smart Data, National Innovation Centre for Ageing and National Centre for Healthcare Photonics place it at the forefront of the convergence between health, data and technology.

In Yorkshire and the Humber there is a strong medical technology cluster with key medical equipment, prosthetics and tissue repair manufacturers linked closely with research and innovation hubs at Leeds, Sheffield and Bradford universities and the new Advanced Wellbeing Research Centre. Recent recognition of these strengths was seen through the designation of four Medical Technology and In Vitro Diagnostic Co-operatives in the region. Yorkshire and the Humber leads the country in health economic modelling and assessment through the universities of York and Sheffield. The Yorkshire and Humber health economy is underpinned by data assets including the Leeds Institute for Data Analytics, with Leeds being the home of NHS Digital and the NHS Data Spine.

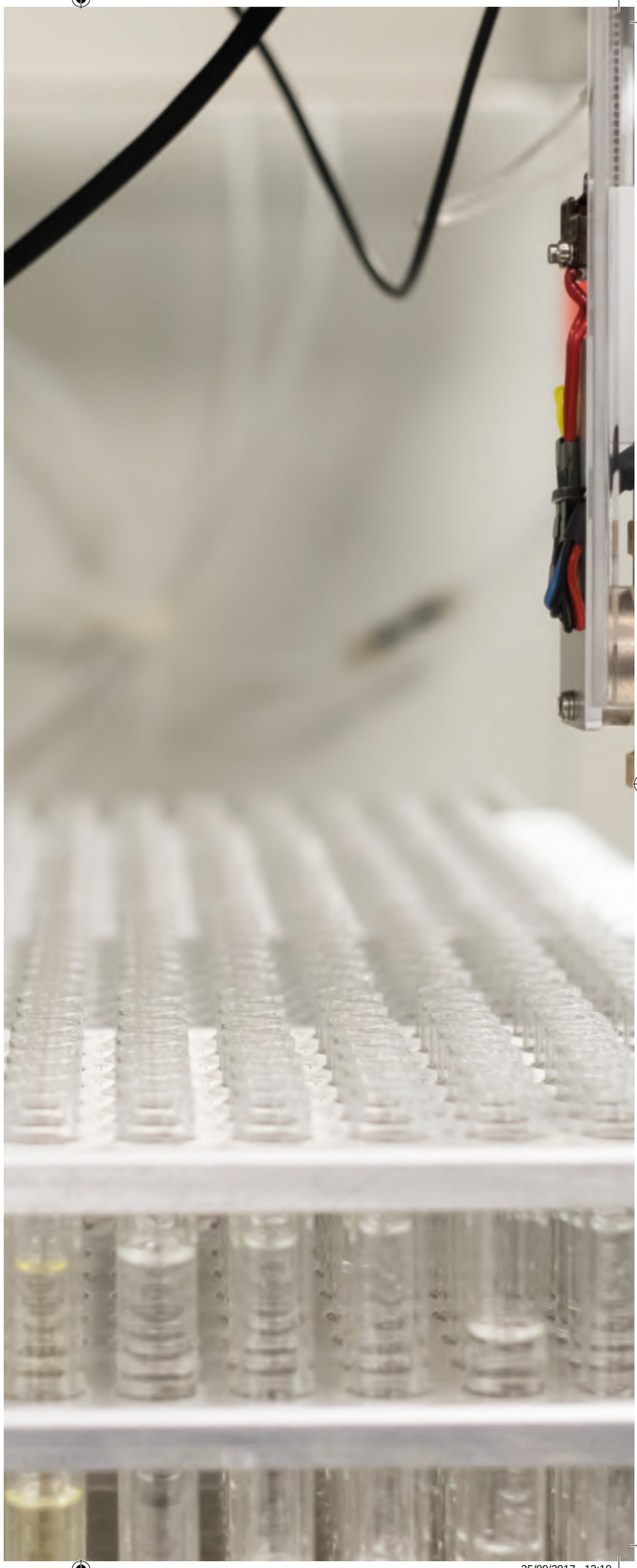
The North West is home to the Manchester and Cheshire life sciences corridors as well as the Liverpool & Lancaster medical innovation hubs. The Manchester-Cheshire corridor combines the assets at University of Manchester, City Labs and at Alderley Park – originally AstraZeneca’s global headquarters and now home to over 150 small biotech firms – many university spin-offs, the Health E-Research Centre (HeRC), the Antimicrobial Resistance Centre, NWeHealth and the world leading Salford Lung Study and the new Medicines Discovery Catapult. This is linked with the Liverpool city-region’s biologics cluster; its nationally-leading pharmacogenomics institute as well as the world-renowned Liverpool School of Tropical Medicine and Europe’s largest biologic manufacturing clusters in Speke.

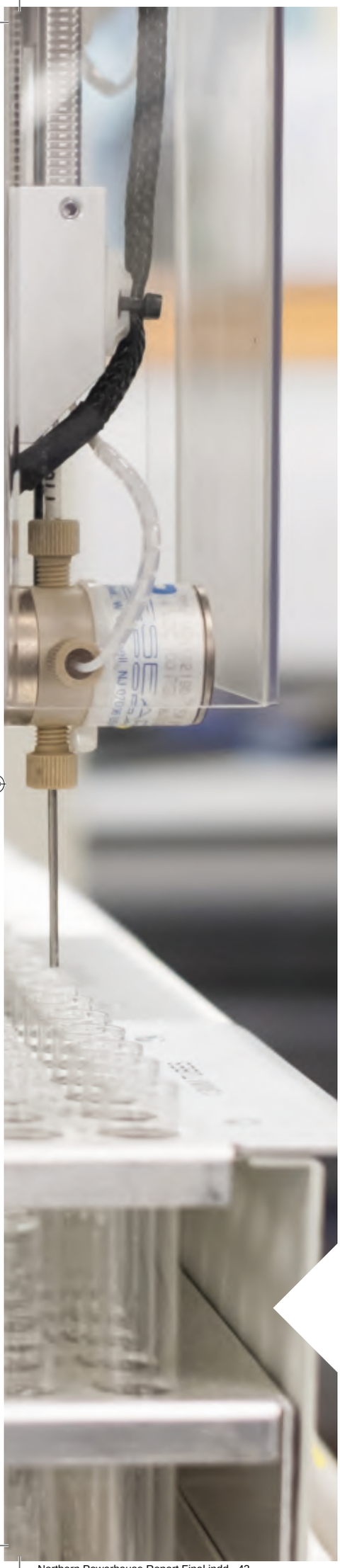
THE FUTURE OF HEALTH INNOVATION

The use of health data to inform decision making in pre-clinical research, clinical research, healthcare delivery and diagnosis (machine-based learning and AI), underpins a 21st century model of health and life sciences. Health service commissioners will increasingly use health procurement to maximise clusters and supply chains and drive up local economic uplift. The North is at the forefront of innovation in health delivery, including health devolution in Manchester as well the pan-Northern approach to the use of data and analytics in transforming patient care and delivering research through clinical trials through Health North: Connected Health Cities and through the scale up of the Salford Lung Study by NWeHealth.

Unlike other international health innovation clusters that often reside within a single city e.g. Boston and Singapore or cities in close proximity e.g. the Golden Triangle of London-Cambridge-Oxford, the Northern 'cluster' is distributed across its great cities and its population.

The scale of organisations such as the newly forming Manchester University NHS Foundation Trust (MFT), which will be the largest NHS clinical research campus in the UK, is a core component of this ecosystem. The immediately adjacent vicinity of Manchester Airport with more than 210 global destinations and the putative HS2 and Northern Powerhouse Rail airport station, mean that the North is well positioned to establish itself as a global engine for private and public





investment, jobs, manufacturing and export trade with a rigorous focus on translating these gains into improved health and care within the North's most deprived communities. There is a similar scale of opportunity presented by the Leeds Innovation District for a 21st century science park centred on the universities and the Leeds General Infirmary in the northern part of the city centre, attracting investment across the city from firms that want access to the knowledge created by the universities and hospital.

"The North is at the forefront of innovation in health delivery"

Together the clusters of the North have the required combination of deep science, embedded within its research intensive universities, clinical innovation within its nationally leading NHS trusts, and commercial application from its life science companies to address national and international health challenges.

Working collaboratively through organisations like the N8 research intensive universities alongside wider universities, the NHSA and BioNow, the North has the scale and ability to use its health innovation assets to address the needs of the North, and global health challenges.

Our recommendations for Health Innovation include providing targeted investment, pulling cities and region capabilities together:

1. £14m for Phase II of the Lancaster Health Innovation Campus. The Campus will have a major impact on driving innovation to improve population health, including a Validation Live Spaces facility, focusing on 'real world' testing and demonstration of innovative applications of materials, biomedical and engineering sciences relevant to population health.

2. £50m for the Manchester Pankhurst Centre for Research in Health, Technology and Innovation identified through the Greater Manchester SIA to capitalise on health devolution opportunities to address major health problems, and unlock synergies between strengths in health, materials, digital and biotechnology.

3. £10m Investment in the Leeds City Region to develop sustainable infrastructure to enable cutting-edge medical technologies and business capability to exploit significant growth opportunities in the global med-tech market-place. The Science & Innovation Audit (SIA) in Medical Technologies (Leeds City Region) demonstrated a concentration of excellence in industry, science and public health. However, to take advantage of opportunities in the rapidly changing and growing global med-tech market, there is an urgent need for strategic intervention to drive med-tech innovation and economic growth.

4. Sheffield has developed health innovation capabilities from cradle to grave and seeks £40m investment to develop the Sheffield Child Health Technology Centre as part of the Olympic Park Legacy Investment as well as establishing a Northern manufacturing facility for the production of viral carriers suitable for human gene therapy. Currently in the UK, manufacturing facilities for the production of viral carriers suitable for human treatment and commercialisation cannot meet demand, thus there is a bottleneck at the translation stage of moving exciting gene therapies into clinical trials which this facility would address.

5. A further £20m investment in The Campus for Ageing and Vitality (CAV) in Newcastle to support the redevelopment of the remaining 28 acres of the site into a mixed-use, urban development encompassing academic, residential, industrial and commercial users with healthy ageing R&D and innovation underpinning the core philosophy, physical regeneration and end-user activities at CAV.

6. York is developing a Health Innovation Institute (H2I) bringing together leading scientists and clinicians to accelerate innovation, linking fundamental science with its real world application. H2I will include computing and data storage infrastructure that will be used across the physical, biomedical and applied health sciences, providing critical infrastructure for York's cutting edge genomics sequencing technologies.

7. The CPI National Smart Packaging, Formulation and Device Centre (£26m) in the North East is seeking to tackle one of the major innovations happening in the supply chain of novel medicines, tracking right to patient, and will bring with it private funding of at least £20m.

CONCLUSION

This, the Northern Powerhouse Partnership's (NPP) second report *Powerhouse 2050: the North's routemap for productivity*, has both short term and medium term policy proposals. They have in some cases been associated with one particular prime capability, but many have cut across them, underpinning the most significant challenges and opportunities in the North. Every proposal has been subject to significant engagement, and will be considered further with interested parties to ensure that we can deliver what businesses and wider stakeholders can do collaboratively.

In a number of cases, government has a vital role in the path forward. In the upcoming Budget, we are calling on government to provide financial support, whether in grants or borrowing, for proposals the North has a credible plan to deliver and to leverage business co-investment and support. The overall strategy behind this work, the Northern Powerhouse Independent Economic Review, makes clear the scale of productivity change which can be unlocked over years to come. This makes the case for action clear if the UK is to be successful in raising the productivity of UK plc as a whole in years to come.

NEXT STEPS

The NPP's next report will be published at the start of 2018, and will lay out the equivalent measures in skills and education needed for all prime capabilities, and the North's wider economy.

The priorities for the North are clear: drive higher levels of productivity, innovation and enterprise across the Northern economy. This can be achieved by capitalising on the collective Northern strengths in each prime capability. In order to achieve this, the NPP will bring employers together with those working across our Local Enterprise Partnerships and our universities to complete the development of a Productivity and Innovation Strategy. This will build on the government's Northern Powerhouse Strategy (published at the 2016 Autumn Statement) , and contribute to the government's Industrial Strategy. This plan should analyse what needs to be done at each spatial level to drive productivity including the following issues:

- How we break down the barriers to entrepreneurship in the North, increasing female entrepreneurship, and supporting firms looking to grow, going beyond UK-wide interventions to understand and address specific factors in the North.
- How we help more small companies grow into medium companies;
- How we help all companies innovate more using the science and innovation base by developing Innovate North approach;
- How workforces can be developed to help companies break out of the low-pay, low-skill, low-productivity cycle;
- How business networks can be improved to create joined-up action;
- How leadership in firms can be developed, including developing proposals made at the roundtables for small and medium firms to be able to partner and
- How we can best capitalise on the collective strength of the North's prime capabilities to drive the Northern economy and international investment.

Proposals developed previously by Northern core cities prior to the drafting of the Northern Powerhouse Strategy can be built on, including: regeneration packages linked to global investment; development of air connectivity; and a pan-Northern strategic events programme.

THE NORTH SHOULD AIM TO:

- Be one of the easiest and best places in Europe to start up, develop and grow a high-productivity business;
- Have start-up and productivity rates at least equivalent to the UK average;
- Have innovation and exporting rates at least equivalent to the European average;
- Set a bold ambition for where our prime capabilities could become globally-leading.

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