

A Science & Innovation Audit for the West Midlands

June 2017



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Foreword

In a year of change and challenge on other fronts, this last year has also been one of quiet revolution. This year has seen a dramatic increase across the UK in the profile of science and innovation as a key driver of productivity and its potential to improve the way our public services are delivered. The potential has always been there, but there has been a recent wave of reports and strategies that have brought this front and centre in the minds of business, policy makers and other science and innovation stakeholders. This is reflected by the central importance of science and innovation in the Government's Industrial Strategy Green Paper and the CBI report 'Now is the Time to Innovate'. BEIS has also supported a series of Science and Innovation Audits (SIAs) over the last twelve months, of which the Midlands Engine SIA was one of the first.

The West Midlands Combined Authority (WMCA) with its three partner Local Enterprise Partnerships (LEPs) have worked together with Birmingham Science City to produce a supplementary West Midlands report to the Midlands Engine SIA. This report provides a more detailed picture of our strengths and opportunities in science and innovation, and considers the ecosystem factors we LEPs and the WMCA, along with innovation partners, need to address to enable us to realise the potential of our local economy.

The critical role of science and innovation is not new to policy makers in the West Midlands. The Strategic Economic Plans of the WMCA and all three of our LEPs, see business innovation as vital to the economic strength of our geographies. Birmingham Science City Alliance has been promoting and supporting innovation in the West Midlands for 11 years, in recent years working closely with the LEPs and WMCA.

The West Midlands Science and Innovation Audit (WM SIA) is a report for everyone involved in the innovation ecosystem. By identifying our key market strengths, cross-cutting enabling competencies and innovation ecosystem strengths and challenges, it provides ample evidence to stimulate and steer action and future investment. We fully intend to use it to inform the continued delivery of our Strategic Economic Plans at the LEP and WMCA level, as appropriate. We strongly urge innovation stakeholders across the West Midlands to use this excellent report to inform strategic decision making; evidence and strengthen business cases for investment and funding; and foster increased collaboration between universities, local businesses and the public sector.

There is currently a wave of positive awareness in business and government about the role science and innovation as a key driver of business productivity and the reform of public services. The WM SIA shows that, with the right leadership, cooperation and targeted action, the West Midlands has the science and innovation strengths, assets and relationships to seize this moment to further develop and exploit our science and innovation capabilities maximise growth across our economy.

Andy Street
Mayor of the West Midlands



Jonathan Browning
Chair of Coventry & Warwickshire LEP



Stewart Towe
Chair of Black Country LEP



Steve Hollis
Chair of Greater Birmingham & Solihull LEP



1. Introduction

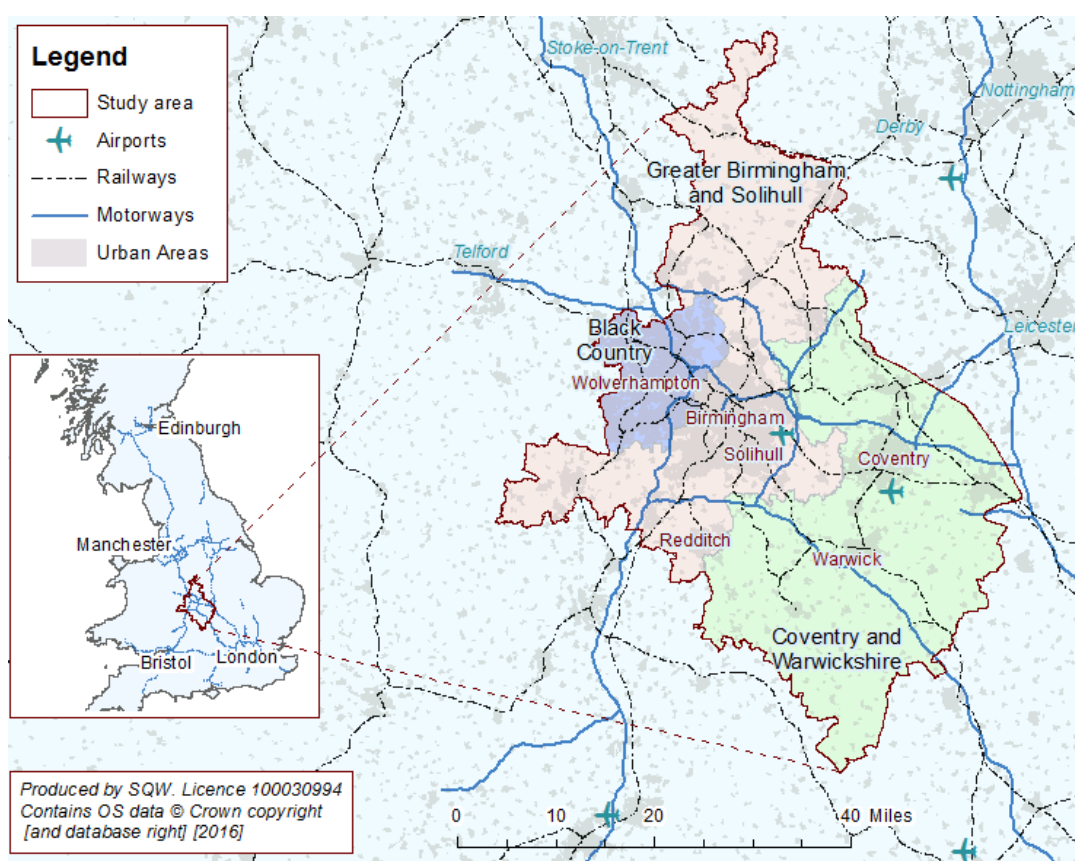
Context and purpose

- 1.1 In 2015, the UK Government launched a programme of Science and Innovation Audits (SIAs) to catalyse a new approach to sub-national economic development. SIAs were intended to enable local consortia to analyse their strengths in science and innovation, and identify specific areas of existing or emerging excellence, which can be built on to drive long-term productivity gains and enable local areas to realise their full economic potential.
- 1.2 The Midlands Engine SIA, developed on behalf of the Midlands Engine Innovation Group, was one of the first to be completed, reporting in September 2016.¹ The Midlands Engine SIA focused on a spatial footprint spanning 11 Local Enterprise Partnership (LEP) areas across the Midlands, including internationally significant cities like Birmingham and Nottingham, growing regional hubs like Coventry, Wolverhampton and Leicester, important market/county towns, and large rural areas.
- 1.3 The Midlands Engine SIA identified the capabilities, challenges, and substantial opportunities for future economic growth across the region. Particular market opportunities were identified around Next Generation Transport, Medical Technologies and Pharmaceuticals, Future Food Processing, and Energy and Low Carbon, supported and underpinned by enabling competences of Advanced Manufacturing and Engineering, Digital Technologies and Data, and Systems Integration.
- 1.4 However, the Midlands Engine SIA also recognised explicitly that within the large and diverse Midlands Engine geography, there was widespread science and innovation capacity, excellence and opportunity that required a more spatially fine-grained and in-depth analysis. This SIA report for the West Midlands is a supplementary study that complements the Midlands Engine SIA, responding directly to this intent. As such, it is designed to help partners identify and shine a spotlight on the science and innovation assets in the West Midlands.
- 1.5 Building on the evidence, and energy amongst partners and stakeholders, developed through the earlier activity, the purpose of the West Midlands SIA was to develop a robust and tailored evidence base on science and innovation activity within and across the Black Country, Coventry and Warwickshire, and Greater Birmingham and Solihull. The SIA was undertaken on behalf of the three LEPs, the West Midlands Combined Authority (WMCA), and their innovation partners.
- 1.6 The West Midlands SIA will be used to help inform both local and national investment priorities. It will help to 'make the case' for further public and private investment to unlock and realise the productivity potential of the area, identify where there is scope for developing more pervasive collaborative cultures, and set out the specific opportunities for building a more resilient and outward facing innovation ecosystem.
- 1.7 This study was funded by the three LEPs, steered by the WMCA Innovation Working Group and managed by Birmingham Science City.

Introducing the area

- 1.8 The area covered by the LEPs of the Black Country; Coventry and Warwickshire; and Greater Birmingham and Solihull is home to four million people, over 6% of the UK total, including some of the most diverse communities in the country, and Birmingham, the UK's second city.
- 1.9 Our strategic road and rail networks, including the M5, the M6 and the West Coast Mainline, are of national importance and crucial in the effective transportation of goods and people, and facilitating supply-chain relationships, across the country. HS2, with its headquarters in Birmingham, and Phase One providing a high-speed link between Birmingham and central London, will strengthen further our offer at the centre of the UK's strategic transport network. Our excellent international linkages are also at the heart of our offer as a place to invest, work, live and play; Birmingham Airport handles more than 10 million passengers annually, and with HS2, will be the UK's first and only high-speed rail connected airport.

Figure 1-1: Map of the study area



Developing the SIA

- 1.10 This SIA draws on an extensive evidence base, and has benefited from considerable testing and validation with partners and stakeholders across the area, including the Innovation Working Group of the West Midlands Combined Authority, with representation from the three LEPs, universities, local networks and Birmingham Science City.

- 1.11 The SIA process has been shaped through two core strands of complementary evidence:
- **Data collation and analysis:** drawing on publicly available data on science and innovation from national sources (e.g. Research Excellence Framework, Research Councils, Innovate UK), analysis of the Business Register and Employment Survey (using the latest available data), and information provided by local partners. We have also analysed data on research quality and collaborations from Sci Val.²
 - **Stakeholder engagement:** two workshop events were held in January and February 2017, which together were attended by around 80 stakeholders, to secure feedback on the underpinning evidence base and inform the identification of key strengths and opportunities for the future.
- 1.12 The qualitative and quantitative evidence has informed the development and population of a bespoke '*West Midlands Science and Innovation Framework*', which has been approved by the WMCA Innovation Working Group and used as the basis for the SIA report. The Framework is described more fully in Section 3 of this report, with the subsequent Sections providing the underpinning evidence base and characterisation of how the Framework is operating practically and being realised – through the Innovation Ecosystem, Enabling Competences, and Market Strengths.
- 1.13 Prior to turning to the Framework, Section 2 provides an overview of the scale, breadth, and nature of the economic and research landscape within which science and innovation happens across the Black Country; Coventry and Warwickshire; and Greater Birmingham and Solihull.

Local innovation community perspectives

"Our world is challenging us to innovate - economically, socially and environmentally. But at a time when our world is changing very quickly, and when both the public and private sectors are under great pressure, very few organisations have the breadth and depth of resources to innovate effectively on their own - we rely on collaborating with our customers, suppliers and partners in an innovation ecosystem. The West Midlands has a great breadth and depth of capacity in science, technology and business innovation, and the strong regional ties that have allowed us to build the trust that makes collaboration after collaboration succeed. The West Midlands Science and Innovation audit is an important, objective record of those strengths that should give national and international funding agencies and investors the confidence that our region can deliver a return on their investments in innovation."

Dr Rick Robinson FBCS CITP FRSA AoU, Director of Technology, Amey

2. Economic and research landscape

Summary of key messages

- The Black Country, Coventry and Warwickshire, and Greater Birmingham and Solihull together constitute one of the UK's major economic drivers and, with a GVA of c.£90bn annually, the most significant single functional economic area in England outside of London. Our traditional economic strength of manufacturing remains; we account for 9% of all manufacturing employment in GB. But we also have an increasingly diversified economic base, including important construction, financial/professional services, and cultural/creative sectors.
- Our area supports c.350k employees in 'science and technology' sectors, representing one in five jobs, consistent with the national picture. Science and Technology employment is distributed widely, but there are particular concentrations; in Birmingham, Coventry and Wolverhampton city centres, in Edgbaston (with a particular focus on life sciences), the area surrounding Birmingham Airport, in Gaydon, Warwickshire (a hub of automotive activity, and home to JLR and Aston Martin), and in Warwick and Leamington Spa (including the 'Silicon Spa' cluster of computer game software developers).
- Despite our strengths, productivity performance is well below the national average level, and the dial has not shifted over the last decade. There is no short-term fix, but leveraging our science and innovation excellence to drive-up productivity is a core focus of this SIA process, reflecting the commitment of partners across the area.
- The research landscape across our area is multi-faceted, spanning the full 'Technology Readiness Level' spectrum, from basic and experimental research, through to applied and collaborative R&D, and on to commercial implementation. Our area includes eight universities, including two Russell Group institutions that consistently rank highly in national and international assessments of research quality, and that are amongst the country's most successful institutions in securing competitive research funding, with particular strengths in the broad areas of engineering and physical science and the biosciences.

The economic landscape

In scale ...

- 2.1 The Black Country, Coventry and Warwickshire, and Greater Birmingham and Solihull – referred to throughout this report as 'the area' or the '3-LEP area' – is one of the UK's major economic drivers. The area contains 160,000 businesses, supports 1.8m work-based employees, and generates Gross Value Added (GVA) of approaching £90bn annually.
- 2.2 Together, the SIA geography forms England's second largest functional economic area after London; generating higher levels of GVA than either Greater Manchester, the Leeds City

Region, or the South East LEP geography. We have also benefited from faster GVA growth than these comparator areas over the period 2010 to 2015 (Table 2-1).

Table 2-1: GVA in 2015 and growth 2010-15 for the area and comparators

Area	GVA in 2015 (£bn)	GVA growth 2010-15
London	378.4	27%
3-LEP WM SIA geography	87.5	20%
South East	85.8	18%
Leeds City Region	64.6	14%
Greater Manchester	59.6	16%

Source: ONS, Gross Value Added (GVA) for Local Enterprise Partnerships (LEPs)

- 2.3 Encouragingly, our employment performance has also been strong in recent years, despite the challenging external economic climate; over 2009-2015, private sector employment increased by over 160k employees, with the proportion of all employment in the private sector at 82% in 2015, equal to the national level (and 85% in Coventry and Warwickshire).

Local innovation community perspectives

“The West Midlands economy is larger than Greater Manchester’s and nearly as large as the Scottish economy. The region has highly innovative supply-chains in existing and emerging markets and world-class universities supporting the research, technology, talent and facilities which enable them to innovate further.”

Prof Stuart Croft, Vice-Chancellor, University of Warwick

... and structure

- 2.5 Our area has long been recognised as the heart of the UK’s manufacturing and engineering sectors – a position we confidently retain, alongside an increasingly diversified economy. As shown in Table 2-2, manufacturing supported 210,000 work-based employees in 2015, with an employment Location Quotient (LQ)³ of 1.45, indicating that manufacturing remains far more evident across our economy than the average nationally (with 1.0 equal to the GB level). Given the potential for manufacturing as a driver of export-led growth, this is a significant economic advantage for our area.
- 2.6 Other important business sectors, from where sustainable economic growth will be generated and where we have an LQ above 1.0, include ‘Transportation and Storage’, and ‘Construction’. The scale of our ‘Professional, scientific and technical activities’ sector is also significant, supporting over 130,000 jobs; whilst our economy remains under-represented in this broad sector, this reflects in part the dominance of our manufacturing base. The ‘Electricity, gas, steam and air conditioning supply’ is also a significant employer (supporting 11,500 jobs), and has a high LQ, indicating the strength of our area in energy, reflected in the recent development of the Energy Capital - discussed in greater detail in Section 6.

Table 2-2: Workplace based employment by industrial Section (2015)

	Employment	LQ
Mining and quarrying	350	0.10
Manufacturing	210,000	1.45
Electricity, gas, steam and air conditioning supply	11,500	1.52
Water supply; sewerage, waste management & remediation activities	12,000	1.06
Construction	93,000	1.11
Wholesale and retail trade; repair of motor vehicles & motorcycles	301,000	1.07
Transportation and storage	111,000	1.35
Accommodation & food service activities	110,000	0.86
Information and communication	46,000	0.63
Financial and insurance activities	52,000	0.84
Real estate activities	28,000	0.86
Professional, scientific & technical activities	131,000	0.86
Administrative and support service activities	162,000	1.04
Public administration & defence; compulsory social security	66,000	0.86
Education	169,000	1.06
Human health & social work activities	214,000	0.92
Arts, entertainment & recreation	37,000	0.85
Other service activities	39,000	1.08
Total	1,793,000	1.00

Source: SQW analysis of BRES data. Note: Table excludes agriculture

Local innovation community perspectives

“The HVM Catapult was formed from seven existing centres. Each of the centres originated in areas where there was a strong manufacturing pedigree and clusters of expertise and opportunities. Two of the seven centres therefore reside in the West Midlands. Due to its rich history and a strong pedigree in manufacturing and innovation, working with our partners and companies in the West Midlands has made a telling contribution towards our performance and economic impact to date. We intend to build on and strengthen these partnerships during the next 5 years as we work towards a shared goal of having a vibrant manufacturing sector which drives growth and creates jobs.”

Paul John, Business Director, High Value Manufacturing Catapult

2.8 Looking beyond manufacturing, energy and construction, our area is home to world-leading firms across a wide range of other industries. For example:

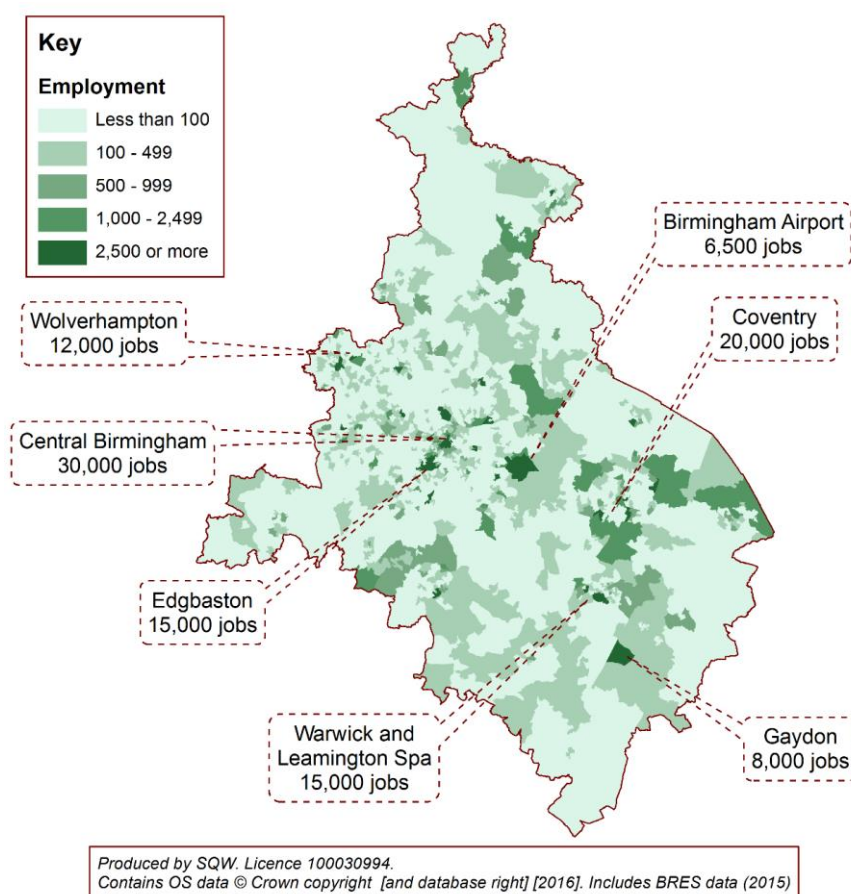
- The financial and insurance sector employs over 50k workers and plays a key role as both a direct source of economic activity and in supporting the growth of other sectors: NFU Mutual is headquartered in Warwickshire, Deutsche Bank is based in Birmingham and, looking forward, HSBC is relocating 1,000 staff to a new UK head office of its ring-fenced bank in Birmingham in early-2018.

- The arts, cultural and creative sector is already a major employer, and one with significant future potential. Birmingham is becoming the home of BBC Three, and the Custard Factory and wider Digbeth area in Birmingham acts as a hub for new start-ups and in-movers e.g. Asos a global online fashion retailer has established a key technology hub in the area. Research has found that the WM SIA area has experienced greater growth within digital and creative sectors over the past five years than any other comparative region within the UK.⁴

Science and Technology activity

- 2.9 The Office for National Statistics has developed a formal definition of 'Science and Technology' sectors; whilst imperfect (as are all sector-based definitions, given that businesses work increasingly across industrial classifications and many technologies are converging rapidly), this definition provides a useful indicator of the scale of our employment focused on science and technology activity.
- 2.10 The data indicate there were around 350k employees in 'science and technology' sectors across our area in 2015; this is a major part of our economy, representing one in five jobs. This proportion is similar to the average across the country⁵, although growth has been slower than elsewhere, with a 4% uplift recorded over the period 2009-2015 compared to 9% nationally. Science and technology employment is found across our geography (Figure 2-1).

Figure 2-1: Science and technology employment at LSOA level (2015)

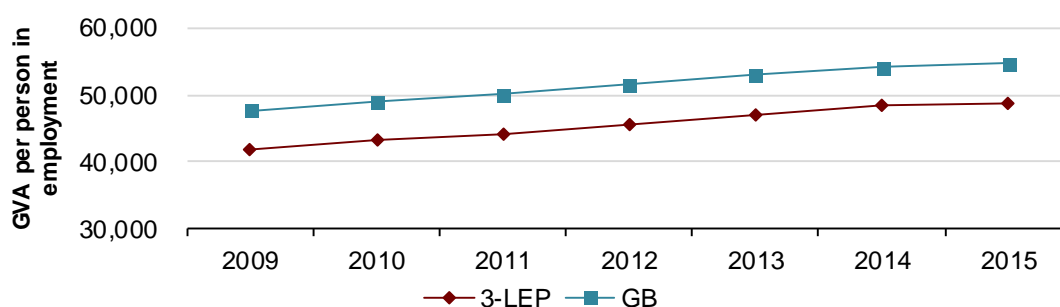


- 2.11 However, there are a number of science and technology ‘hot spots’ across the geography including: the city centres of Birmingham, Coventry and Wolverhampton; in Edgbaston (an area that includes the University of Birmingham and a collection of health and life sciences assets); the area surrounding Birmingham Airport; Warwick and Leamington Spa (including the ‘Silicon Spa’ cluster of computer games developers); and in Gaydon, Warwickshire, which is a major hub of automotive innovation, employment and home to both Jaguar Land Rover (JLR) and Aston Martin.

Our productivity challenge

- 2.12 The data indicate that in many ways our economy is in a good place: we have a large and increasingly high-value manufacturing sector alongside a diversified service economy; an equal proportion of employment in science and technology sectors as is the case nationally; and importantly in terms of future growth prospects, the scale of our economy provides the potential for significant ‘agglomeration effects’. These are (broadly speaking) the benefits that can be derived from firms (and consumers) being close to one another, in the form of higher productivity and pay as a result of specialisation and knowledge-spillovers. These effects tend to be realised in larger cities, and particularly in city-based service industries.
- 2.13 However, despite these clear strengths, our productivity performance is well below the national level. This is not a recent or short-term challenge; as shown in Figure 2-2, since 2009 the productivity deficit has not closed, and by 2015 our GVA per person in employment was 89% of the GB average. The aggregate data masks variation across the area, however in all three LEP areas GVA per person in employment was below the GB average (83% in the Black Country, 97% in Coventry and Warwickshire, 92% in Greater Birmingham and Solihull).

Figure 2-2: Productivity over the period 2009-2015 (£)



Source: SQW analysis of BRES and Gross Value Added for LEPs data

- 2.14 A wide range of factors are at play here, and the WMCA has established a Productivity and Skills Commission⁶ to understand the true extent of the productivity challenge in the West Midlands, identifying the component causes and making recommendations to address the issues identified. Focussed on a GVA per head measure (rather than per employee discussed above), initial analysis by the Commission has indicated there are issues across the full range of productivity drivers, with skills deficits, having too few people in employment, and the quantum and quality of the business base all significant factors in explaining the current productivity gap.
- 2.15 There is no short-term fix, and science and innovation will play only one part in addressing these productivity challenges. However, the scope for science and innovation excellence to

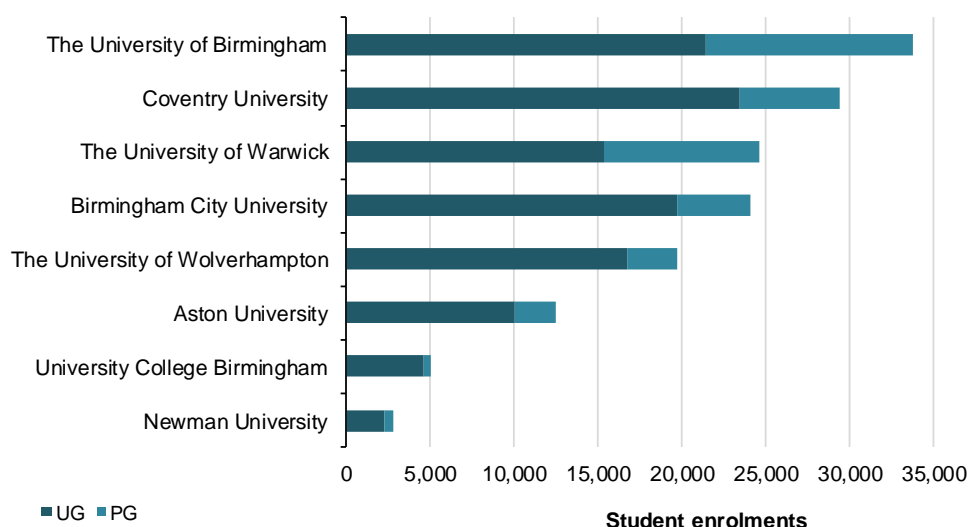
drive-up productivity has been a central and consistent theme of this SIA process, reflecting the commitment of partners across the area, as seen in the three LEPs' and the WMCA Strategic Economic Plans. In order to 'move the dial' on the productivity performance relative to the national level, identifying, supporting and exploiting fully the existing strengths in our business base, and leveraging the critical mass of world-class science and innovation assets in the region, will be critical.

The research landscape

- 2.16 The research landscape across our area is multi-faceted, spanning the full 'Technology Readiness Level' (TRL) spectrum, from basic, experimental 'discovery', through to applied and collaborative R&D. Our area includes world-class universities (with Birmingham and Warwick both ranked in the Top 100 globally⁷), innovative and nationally significant research and technology organisations (RTOs⁸), and major private sector R&D establishments that are internationally connected and globally significant.
- 2.17 The following section provides a high-level summary of the *higher education* research landscape across our area, across the full range of research areas, and summarises the key RTOs and other knowledge assets in the area. Subsequent sections of the report drill-down into more detail on specific assets, research areas, innovation activities and disciplines relevant to the SIA Framework presented in Section 3, including across our RTOs and the private sector.

Our universities ...

- 2.18 Our eight universities (see Figure 2-3) are key drivers of economic growth: as teaching institutions, educating, up-skilling and inspiring the workforce, innovators and entrepreneurs of the future; and as hubs of scientific research, developing, testing, and progressing new ideas and concepts, that have the potential to be commercialised or translated into new products, processes, and services in the public or private sector.
- 2.19 Our universities provide a complementary mix of teaching-focused and research-oriented activities, and vary considerably in both nature and scale. Over 150,000 students were enrolled across our eight universities in 2015/16, some 7% of the UK total. Our area includes some of the largest universities in the country; when the Open University is excluded, the University of Birmingham has the third highest number of students, and Coventry University the tenth. Scale matters, and this concentration of higher education assets provides our businesses, and wider society, with a major growth engine. If we can unlock the potential of, and retain in the area, this stock of well-educated and skilled (largely) young people, we will be in a strong position to compete confidently and effectively on the international stage.

Figure 2-3: Universities in the 3 LEP area and student enrolment numbers in 2015/16

Source: SQW analysis of HESA data

Local innovation community perspectives

"This audit confirms the significant existing contribution of the West Midlands to the UK economy and highlights key areas where future investment will deliver substantially enhanced innovation and economic growth."

Prof. Tim Softley, PVC for Research & Knowledge Transfer, University of Birmingham

... and their research strengths**REF 2014**

- 2.21 Turning to research, whilst now somewhat dated, the REF 2014 offers an important indication of the scale and relative quality of the research conducted across our Higher Education Institutions (HEIs). Our HEIs accounted for over 5% of all FTE Category A submissions⁹, with over 2,500 staff submitting research for assessment under the REF.
- 2.22 Demonstrating the breadth of excellence within our university research base, at least one of our universities was ranked in the top 20 nationally for the power and/or quality of their research in 33 of the 36 REF Units of Assessment (Table 2-3).¹⁰ Put another way, across nearly all disciplines, the West Midlands is home to some of the UK's leading research.

Table 2-3: REF 2014 Power and Quality – WMCA universities ranked in the Top 10 and 11-20 nationally

Unit of Assessment	Power		Quality	
	Top 10	11-20	Top 10	11-20
Aeronautical, Mechanical, Chemical and Manufacturing Engineering		2	1	1
Agriculture, Veterinary and Food Science			1	
Allied Health Professions, Dentistry, Nursing and Pharmacy	1		1	1
Area Studies		2	2	
Art and Design: History, Practice and Theory		2		2
Business and Management Studies	1	1		2
Chemistry		1	1	
Civil and Construction Engineering		1	1	
Classics	2		2	
Clinical Medicine	1			
Cultural and Media Studies, Information Management			1	
Computer Science and Informatics		1	1	
Biological Sciences				1
Earth Systems and Environmental Sciences		1		
Economics and Econometrics	1	1	1	1
Education	1	1	1	1
Electrical and Electronic Engineering, Metallurgy and Materials		2		1
English Language and Literature	1	1	1	1
General Engineering	1			1
History	2		2	
Law		2	1	
Mathematical Sciences	1	1	1	
Modern Languages and Linguistics	1	1		1
Music, Drama, Dance and Performing Arts	1	1	1	1
Philosophy	1	1	2	
Physics	1	1		1
Politics and International Studies	2		1	
Psychology, Psychiatry and Neuroscience		1	1	1
Public Health, Health Services and Primary Care		2		2
Social Work and Social Policy		1		
Sociology	1			
Sport and Exercise Sciences, Leisure and Tourism	1		1	
Theology and Religious Studies		1	1	

Source: SQW analysis of REF 2014 data

- 2.23 In the context of this breadth of research strength, two of our institutions – Birmingham University and Warwick University – were commonly ranked in the Top 10 nationally by research power and/or research quality in Units of Assessment that are directly relevant to an SIA i.e. those focused on scientific, applied, and technical research. These areas are set out in Table 2-4, with ‘Top 5’ rankings - where our institutions are clearly and unequivocally amongst the ‘best in class’ in the UK - highlighted in bold.

Table 2-4: Top 10 rankings on research power and/or quality in the REF 2014

Birmingham University	Warwick University
<ul style="list-style-type: none"> • Aeronautical, Mechanical, Chemical & Manufacturing Engineering • Civil and Construction Engineering • Clinical Medicine • Psychology, Psychiatry and Neuroscience • Sport & Exercise Sciences, Leisure & Tourism 	<ul style="list-style-type: none"> • Agriculture, Veterinary and Food Science • Business and Management Studies • Chemistry • Computer Science and Informatics • Economics and Econometrics • General Engineering • Mathematical Sciences • Physics

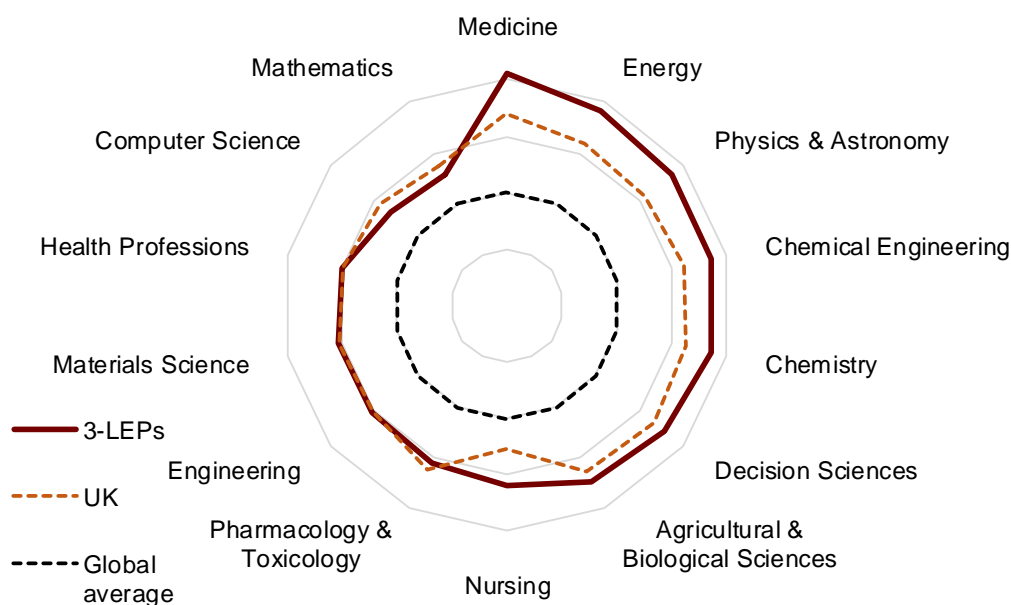
Source: SQW analysis of REF 2014

- 2.24 Although there were no individual 'scientific' Units of Assessment where both institutions ranked in the Top 10, the data highlight our shared strength in broad 'engineering' disciplines. Health related research is also a clear strength: Birmingham is ranked in the Top 10 for two medical research areas, and Aston University also ranked in the Top 10 nationally in 'Allied Health Professions, Dentistry, Nursing and Pharmacy', for both research power and quality (ranked 8 for the latter).
- 2.25 Other 'Top 10' rankings in the REF 2014 for our institutions were Wolverhampton University for 'Communication, Cultural and Media Studies, Library and Information Management' (ranked 5 nationally on Quality), and Aston University for Area Studies (ranked 5 nationally on Power). Warwick and Birmingham also perform strongly in humanities disciplines.

Citations analysis

- 2.26 To provide a further perspective on national and international research excellence in our area, we have used Elsevier's SciVal database. A bespoke sub-group has been set up for our institutions¹¹ (titled '3-LEPs'), with data collected on Field Weighted Citation Index (FWCI): this metric is an indicator of the quality of research undertaken by institutions, as identified by citation levels, and enables a comparison between national and international averages¹².
- 2.27 The FCWI for our institutions for key areas of science and research is set out in Figure 2-4. The data indicate the excellence of our research in subject areas including Medicine, Energy, Physics and Astronomy, and Chemical Engineering, and Chemistry; in these subjects, the average FCWI is well above both the international, and the UK average.

Figure 2-4: Field Weighted Citation Index for the 3 LEP HEIs relevant subject areas



Source: SQW analysis of SciVal data

- 2.28 There is considerable variation across universities and it is important that these average data are treated with caution. However, the data highlight the strength of research undertaken across the West Midlands, not just by institutions within it (where the REF is particularly insightful). Building-up associated networks, and the shared excellence across our

universities, for example in Medicine, Energy and other subjects, needs to be a core focus going forward; a process which will be catalysed and reinforced by this SIA.

- 2.29 The Sci Val database includes more granular analysis on individual subject/discipline areas; these are considered in more detail in subsequent Sections of this report, as they relate to elements of the SIA Framework.

Research Council funding

- 2.30 Data from Gateway for Research indicates our universities hold 'active' research funding from the UK Research Councils of approaching £550m, equivalent to 6.5% of the England total, and 10.2% excluding the 'Golden Triangle' institutions¹³. The breakdown by Research Council for our institutions combined, and the proportion of the total active funding across all English institutions, is set out below.
- 2.31 The data indicate the strength of our institutions – both absolutely and relatively – in research on engineering and physical sciences (EPSRC), and in bioscience (BBSRC), as well as in the humanities (AHRC).

Table 2-5: Active research council funding for our HEIs

Research Council	Active funding (£m)	Proportion of England
AHRC	18.1	8.7%
BBSRC	84.6	8.2%
EPSRC	299.6	7.4%
ESRC	39.3	5.0%
MRC	48.4	4.1%
NERC	23.1	3.9%
STFC	34.0	6.7%

Source: Gateway for Research

- 2.32 The University of Birmingham and University of Warwick account for the vast majority of this funding (around £530m), reflecting their status as large research-intensive universities, and members of the Russell Group. These two institutions ranked 11 and 12 nationally in terms of the scale of active research funding from research councils, and 7 and 8 if the 'Golden Triangle' institutions are excluded. As discussed in Section 3, our other institutions secure significant income from other sources, including participation in Horizon 2020 projects (see Table 4-8) and engagement in commercialisation activities (see Table 4-11). This provides the WM SIA institutions with a complementary mix of funding streams supporting active participation in research and innovation activity.

Wider research and innovation assets

- 2.33 Alongside our universities, the WM SIA area includes a critical mass of RTOs and other assets and institutions supporting research and innovation activity. The table below summarises some of the key assets in our area. The list is not exhaustive, and these and other assets are discussed more fully in relation to the specific elements of the SIA Framework in subsequent

sections of the report. However, key examples are summarised here to provide an indication on the scale and breadth of our research base.

Table 2-6: Selected key research assets in the WM SIA area

Advanced Propulsion Centre (APC) Hub, University of Warwick

- With its Hub at the University of Warwick¹⁴, the APC aims to position the UK as a global centre of excellence for low carbon propulsion development and production. Its mission is to turn new low carbon propulsion technologies into products for the automotive industry by supporting collaborations and providing funding.

Birmingham Institute of Translational Medicine (ITM)

- Located on the University of Birmingham campus between the Medical School and Queen Elizabeth Hospital Birmingham, the ITM acts as a central hub for clinical trials acceleration and stratification, and clinical informatics. The ITM brings together researchers from different disciplines, such as cancer, inflammation, rare diseases and bioengineering to speed up the translation of new discoveries into health applications.

Energy Systems Catapult (ESC)

- Based in Birmingham, the ESC aims to help the UK navigate the transformation of the energy system and capture commercial opportunities this creates. The ESC is focused on electricity, heat and combustible gases. Key activities include the Smart Systems and Heat programme, and the Future Power Systems Architecture project.

European Bioenergy Research Institute (EBRI)

- Based at the University of Aston, EBRI acts as a focus for pan-European activities on scientific and technological aspects of biomass conversion and utilisation of products for renewable power, heat, transport fuels, hydrogen and chemicals.

High Temperature Research Centre (HTRC)

- Based in Coventry, the HTRC is a collaboration between the University of Birmingham and Rolls-Royce, and provides production scale research and experimentation to deliver rapid high quality product and process innovation. The HTRC focuses on the key design and manufacturing aspects of investment casting, and is a self-contained investment casting foundry.

Institute for Advanced Manufacturing and Engineering (IAME)

- A collaboration between Coventry University and Unipart Manufacturing Group, the IAME brings together academia, industry and R&D in a 'live' manufacturing environment. The focus is on R&D in a range of sectors including automotive, aerospace, oil and gas, power generation and rail.

Manufacturing Technology Centre (HVM Catapult)

- Based in Coventry (and founded by Birmingham, Loughborough and Nottingham Universities with TWI¹⁵), the MTC provides manufacturing system solutions in partnership with industry, academia and RTOs. The MTC is focused on three core technology areas: Assembly Systems; Component Manufacturing Systems; and Data Systems for Manufacturing.

National Transport Design Centre (NTDC)

- Opening in May 2017, the NTDC is based at Coventry University focused on exploring new areas of transport design research using technology in new ways, as well as new technology. The vision of the NTDC is to be recognised as a world leader in understanding the factors which influence transport design, and how that understanding is articulated in physical and virtual form.

Warwick Manufacturing Group (HVM Catapult)

- Part of the wider Warwick Manufacturing Group at the University of Warwick, the HVM Catapult at WMG works with business to transfer research to industry. The WMG Catapult is focused on the global challenge of Low Carbon Mobility and in particular two priorities areas: Lightweight Technologies; and Energy Storage and Management. WMG also has expertise in digital/data through visualisation team and cyber security centre.

Source: SQW analysis

3. The West Midlands SIA Framework

Developing the Framework

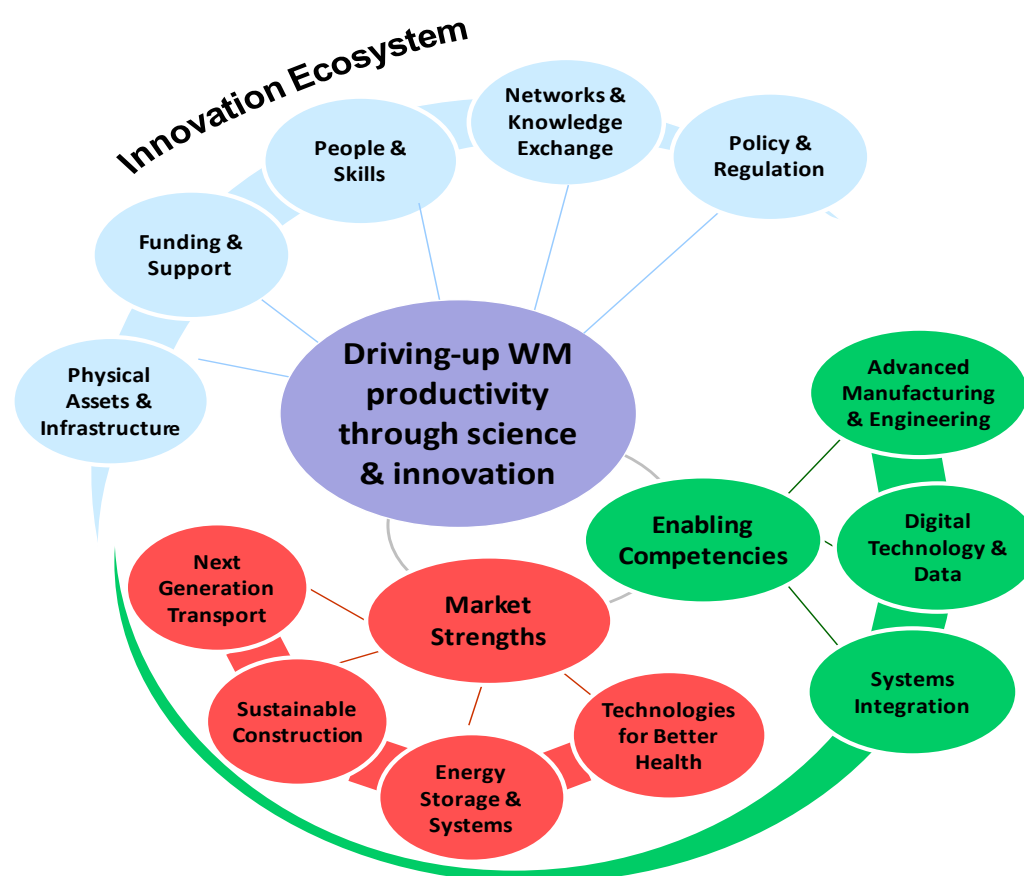
- 3.1 The starting point for the framework for the West Midlands (WM) SIA was the equivalent framework developed for the precursor SIA for the Midlands Engine. As set out above, the WM SIA has been designed to act as a more detailed supplementary analysis. The ME framework was, of course, influenced heavily by the science and innovation strengths in the WM SIA area. However, it also reflected the broader strengths evident across the wider Midlands geography.
- 3.2 As a first step for the West Midlands SIA, the relevance of the content of the earlier framework was tested both quantitatively and qualitatively, identifying those parts of the framework where the evidence remained strong for the WM SIA area, and where it did not. Alongside this analysis, the strategic priorities, economic strengths, and science and innovation assets of the WM SIA area were mapped against the Midlands Engine SIA framework. Again, this process was a mix of both quantitative and qualitative analyses, including feedback from stakeholders at two workshops designed to test, probe, and develop the framework. Three key messages emerged from this process:
- First, the structure and logic of the earlier framework developed for the Midlands Engine remained appropriate for the West Midlands specifically, with the three component parts (each of equal weighting and importance, and all interacting) of ecosystem factors; enabling competencies (spanning numerous industries, sectors and markets); and areas of market strength and opportunity. This architecture has therefore been retained – providing a strong level of strategic alignment to activity that has been progressed in our area and elsewhere over the past six months following the publication of the Midlands Engine SIA report. The innovation ecosystem factors identified in the earlier framework were also regarded as being consistent, covering the key conditions and factors – both hard and soft – that need to be in place and working effectively for the area’s potential to be realised fully. The WM SIA has, however, gone into more depth on the ecosystem factors, as this is an area of potentially effective intervention at a LEP or WMCA scale, as appropriate.
 - Second, at a headline level, the cross-cutting enabling competencies identified in the Midlands Engine framework were found to remain highly relevant and applicable for the West Midlands geography. The detailed emphases are different for our local area than was the case across the wider geography (as detailed in Section 5). However, ‘Advanced Manufacturing and Engineering’, ‘Digital Technologies and Data’, and ‘Systems Integration’ were again found to be competencies that will continue to support much of the innovative business activity across our region and where we have a critical mass of assets and expertise.
 - Third, the market areas of strength and opportunity for the West Midlands were in some cases broadly similar, but in other cases quite different, to the Midlands Engine framework. This is to be expected, and reflects the different industrial structures and science and innovation assets that are evident across an area as large and diverse as

the Midlands. The market strengths identified in this West Midlands SIA reflect the distinctive offer and capacities across the WM SIA area (see Section 6).

Framework components

- 3.3 The WM SIA Framework that emerged from the analysis – both quantitative and qualitative and drawing on extensive feedback from partners across our ecosystem – is presented at Figure 3-1. The framework articulates where our area has existing strengths and specialisms. Crucially, it is also forward facing. It has been developed in the context of a wide range of market and technology drivers of change which are influencing how businesses research, commercialise, produce and distribute their products and services, and the rapidly changing demands of consumers.
- 3.4 The WM SIA Framework also highlights the way in which these individual component parts interact and complement one another. Indeed, it is where the market strengths and enabling competences converge, supported by a well-developed ecosystem, that the best science and innovation in our area happens. Specific examples of how these components are working together on the ground to leverage synergies and deliver impactful results are provided as case studies at Annex A.

Figure 3-1: The West Midlands SIA Framework



Source: WMCA and SQW

- 3.5 The underpinning evidence base, detailed profiles and analyses for each of the component parts of the SIA Framework are discussed in Sections 4 to 6 of this report. Summaries of the coverage of each of the framework elements are provided in Table 3-1.

Table 3-1: Coverage of the components parts of the West Midlands SIA Framework

Innovation Ecosystem Factors	Enabling Competencies	Market Strengths
<p>Physical Assets and Infrastructure</p> <p>Covering the area's assets for science and innovation including science parks, incubators and accelerators, and those other assets that facilitate business growth and development, e.g. key transport assets, Enterprise Zones and super-fast broadband connectivity.</p> <p>Funding and Support</p> <p>Covering private sector investment including early-stage finance for start-ups, scale-ups and R&D investment, and public sector science and R&D investment, including Research Councils and Innovate UK.</p> <p>People and Skills</p> <p>Covering labour market engagement and skills profile, including graduates, science and technology employment, and the broader culture and quality of life offer that attract people to live and work in the area.</p> <p>Networks and Knowledge Exchange</p> <p>Covering the strategic alliances, networks and groups in science and innovation in which our universities participate, research collaboration across and between universities and industry, and engagement by industry in knowledge exchange and commercialisation, e.g. KTPs, Collaborative R&D programmes.</p> <p>Policy and Regulation</p> <p>Covering national, sub-national and local policy priorities, and the regulatory framework with direct relevance to science and innovation.</p>	<p>Advanced Manufacturing and Engineering</p> <p>The area's pervasive leading-edge technical knowledge, and practical know-how in the research and industry base, in designing, validating, producing, and servicing new products and industrial processes. The Competence supports a diverse and integrated range of sectors and markets – including food and drink manufacturing, automotive, aerospace, rail, electronics, construction, energy and medical technologies.</p> <p>Digital Technologies and Data</p> <p>The strengths in the area's academic, research and industrial base in exploiting and understanding big data, analytics, simulation and modelling etc, and the use of digital technologies and media in product, process and service development and commercialisation across the full range of markets and sectors.</p> <p>Systems Integration</p> <p>Assets, expertise, and insight in the area's academic, research and industrial base on how increasingly complex systems – including energy systems, manufacturing processes, service delivery, and logistics – can be better designed, managed and operated, to deliver improved performance and outcomes.</p>	<p>Next Generation Transport</p> <p>The R&D, design, production, and aftercare, in the 'next generation' of automotive and aerospace products and services, including the use of digital processes enhancing the total information offering, and servitisation. The Strength leverages links to the motorsport cluster, and recognises the R&D & UK/international supply-chain opportunities across industries from 'next generation rail', including HS2.</p> <p>Sustainable Construction</p> <p>The significant construction industry across the area (including HQs of leading firms), and the supporting research and technology transfer base. The Strength focuses on the R&D and commercial deployment of energy efficient and lower carbon building technologies, across commercial and residential construction.</p> <p>Energy Storage and Systems</p> <p>Excellence in the research base across the area's universities and innovation assets in energy storage (for application across industries), and research on the development/deployment of smart energy systems - drawing on the wider energy industry across the area.</p> <p>Technologies for Better Health</p> <p>Medical technologies, covering the R&D, design and production of devices, diagnostics, (including in-vitro diagnostics), and software as a medical device. The Strength also covers strengths in translational medicine and the accelerated access to new drugs, treatments and health technologies, with a particular spatial (and community) opportunity around Birmingham's developing life sciences campus in Edgbaston, drawing on a concentration of complementary clinical and research assets.</p>

Source: WMCA and SQW

4. Innovation Ecosystem

Summary of key messages

- In addition to a strong research base (chapter 2), our area boasts a well-developed network of science parks, associated innovation and incubator centres, as well as accelerator programmes. Along with the high availability of superfast broadband, this provides our businesses, wherever they are located, with the necessary physical assets and 'hard' infrastructures to support their growth and development.
- The funding landscape across our area is improving with increasing amounts of business expenditure on R&D and venture capital investment being reported, but increasing this further, as well as follow-on capital funding to scale up processes, is key to improving our productivity performance.
- In addition to this private finance, organisations based in our area secured 8% of all Innovate UK grant funding over the 2010-15 period, some £247.5m. Proportionately, this is a higher share of Innovate UK funding than our population of firms and HEIs would suggest and indicates the innovative nature of our businesses and the commercial engagement of our academics. There is, however, a perception of fragmentation of availability of support and funding, with a small number of institutions – Warwick and Birmingham universities, JLR, and the MTC and WMG Catapult Centres – responsible for a high proportion of the Innovate UK (and other) funding secured by the area.
- Our area faces multiple skills challenges. This is a major issue for the development of innovative businesses, with too few people with high-level qualifications relative to the UK, and too many with no qualifications.
- We have an impressive set of local networks, and our institutions are actively engaged at regional, national and international levels, with significant industrial and academic collaborations and partnerships in place. Our ecosystem is underpinned by a strong local policy focus on driving-up levels of innovation and maximising the potential of our key assets, including our major research intensive universities, RTOs and R&D active firms.

Role and purpose

- 4.1 Science and innovation do not happen in isolation. They are enabled by, and emerge from, the interactions and relationships between people, businesses, and knowledge institutions, supported by underpinning infrastructures, funding (public and private) and policy and regulatory frameworks. The experience of many truly innovative economies – from Silicon Valley in the USA, to Cambridge in the UK – is that it is the working interfaces of the knowledge base with these other factors that is key for long-term innovation success. Getting these factors 'right' is essential in creating a successful knowledge-based economy, and exploiting fully the science and innovation potential in our region.
- 4.2 Five key, broad factors have been identified through the WM SIA process – building on experience and learning from the West Midlands and elsewhere – that support effective science and innovation in our area: Physical Assets and Infrastructure; Funding and Support;

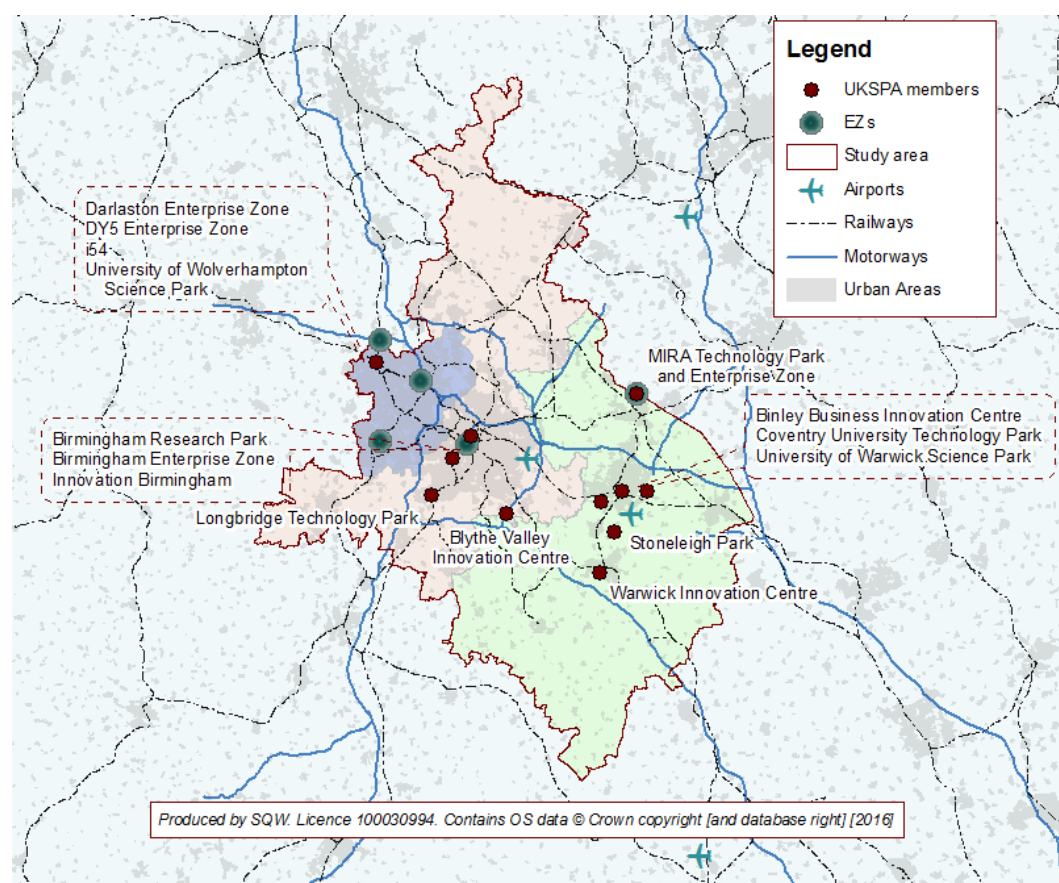
People and Skills; Networks and Knowledge Exchange; and Policy and Regulation. Key evidence – both quantitative and qualitative – on the assets, excellence, and in some cases challenges, in each of these five areas is set out sequentially below.

Evidencing our ecosystem

Physical Assets and Infrastructure

- 4.3 Our area benefits from a large network of land and property assets and infrastructure supporting innovation including science parks, business incubators, and Enterprise Zones (Figure 4-1) supported by a well-developed transport network including key external links provided by the M5, M6 and M40 (and the M1 just to our east) as well as the West Coast Mainline, with internal connections via the M42 and our suburban rail network.

Figure 4-1: Key physical assets supporting science and innovation



Source: Produced by SQW. Licence 100030994. Contains OS data © Crown copyright [and database right] [2016]

Science Parks, incubators and accelerators

- 4.4 There are 11 United Kingdom Science Park Association (UKSPA) member sites in our geography (four of which are part of the University of Warwick Science Park network) providing a highly competitive land and property offer for firms seeking space for start-up and grow-on space. Our offer includes a combination of science parks focused on particular sectors and disciplines (e.g. Innovation Birmingham Campus on the digital and technology sectors, Birmingham Research Park on biomedical, and Stoneleigh Park on science-based

rural industries), as well as those with a broader remit to focus on supporting technology-rich and science-based firms across sectors, including the science parks associated with Coventry, Warwick and Wolverhampton universities. The geographic spread is important as start-ups frequently prefer to be close to home or their 'parent' organisation.

- 4.5 Often operating as part of our science parks, incubators provide flexible property and value-added business support services to new start-up firms. Recent research for BEIS identified 14 incubators in our area (around 7% of the UK total), set out in Table 4-1.

Table 4-1: Incubators in the WM SIA area

<ul style="list-style-type: none"> Barclays Eagle Lab (located in Serendip) BizzInn Business Incubator (<i>part of Birmingham Research Park</i>) e4f.Incubator (<i>part of Innovation Birmingham Campus</i>) ignite incubator, Binley Innovation Centre (<i>part of Warwick Science Park</i>) ignite incubator, The Venture Centre (<i>part of Warwick Science Park</i>) ignite incubator, Warwick Innovation Centre (<i>part of Warwick Science Park</i>) i-SE - Women's Enterprise Hub (Digbeth) 	<ul style="list-style-type: none"> i-SE - Women's Enterprise Hub (Sparkbrook) Serendip (<i>part of Innovation Birmingham Campus</i>) SPARK Business Incubation Centre (<i>part of Wolverhampton Science Park</i>) STEAMHouse (<i>Birmingham City University</i>) The BioHub Birmingham (<i>part of Birmingham Research Park</i>) The Enterprise Hub (<i>part of Coventry University Science Park</i>) Warwick Ventures Software Incubator
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Source: SQW analysis of Business Incubators and Accelerators: The National Picture, BEIS, 2017

- 4.6 The research for BEIS also mapped 'accelerators': like incubators, accelerators are focused on supporting the growth of early-stage firms, but do this through a highly selective, cohort-based programme of limited duration, which may or may not include the offer of physical space. The research identified 10 accelerators in our area, all of which were based in the Greater Birmingham and Solihull LEP geography, set out below.

Table 4-2: Accelerators in the WM SIA area

<ul style="list-style-type: none"> Aston Programme for Small Business Growth Birmingham Hatchery Civic Foundry Climate-KIC Accelerator Programme (Birmingham) Healthcare and wellbeing – Birmingham – PocZero 	<ul style="list-style-type: none"> London Midland Labs Accelerator Open Future_ Midlands Oxygen Accelerator Seedpod The Birmingham Skills for Enterprise and Employability Network (BSEEN)
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Source: SQW analysis of Business Incubators and Accelerators: The National Picture, BEIS, 2017

- 4.7 Notably, the Greater Birmingham and Solihull LEP had the highest number of accelerators per 10,000 new businesses of any LEP/equivalent area across the UK (at 1.43), including above the number in London (1.32).
- 4.8 Indeed, the research highlights the importance of Birmingham as a location for incubators, accelerators and other related infrastructure to support the development of knowledge-based firms with high growth potential. Birmingham was the city with the third most incubators identified in the research (8), behind only London (27) and Edinburgh (10), and including all assets covered by the research¹⁶, Birmingham had the second most assets of any city (22) behind London, and ahead of comparator cities such as Edinburgh (14), and Manchester, Belfast and Oxford (all 10). The data indicate that our area, and particularly Birmingham as

the sub-regional core, has a very strong offer both in terms of property solutions and value-added services to support growth for early stage firms.

Enterprise Zones

- 4.9 The science parks and incubators for technology-rich businesses are complemented by Enterprise Zones (EZs) which provide further space for our businesses to grow and develop:
- MIRA Technology Park
 - Birmingham City Centre Enterprise Zone, comprises 26 sites in seven clusters at Westside, Snow Hill District, Eastside, Southern Gateway, Digbeth Creative Quarter, Birmingham Science Park Aston and the Jewellery Quarter
 - The Black Country EZs is based at two sites, at Wolverhampton North (including i54), and Darlaston.
 - The most recently designated EZ is DY5, Dudley's Business & Innovation Enterprise Zone.¹⁷

Superfast broadband

- 4.10 Superfast broadband connectivity is becoming increasingly important to businesses across the country. Our area has high levels of access to the fastest broadband speeds (above 30Mbps/s), with only three of our nineteen districts recording superfast broadband (SFBB) availability of less than the national average of 89%. These three districts are East Staffordshire, North Warwickshire and Stratford-upon-Avon and this reflects the national issues regarding SFBB coverage in rural areas.
- 4.11 Our geography benefits from the work of three programmes funded via the national Superfast Broadband Programme dedicated to increasing access to superfast broadband via infrastructure development: 'Superfast Staffordshire', 'Coventry Solihull Warwickshire (CSW) Superfast Broadband', and 'Black Country Broadband.'
- 4.12 Looking forward, a WMCA Digital Connectivity Group is working on ambitious plans for ultrafast (100Mbps) broadband, and a fit for the future approach to digital connectivity across our area.

Funding and Support

- 4.13 Science, technology and business markets are constantly evolving. Our businesses, RTOs and the research base rely on private and public funding to support innovation. The innovation ecosystem includes the levels of expenditure by firms on R&D investment, early-stage finance for start-ups and scale-ups which is largely focused on technology-rich and knowledge-based businesses, and public funding from Innovate UK.

R&D investment

- 4.14 Business investment on R&D (BERD) is available at a regional level only i.e. the 'West Midlands' geography, which includes areas outside of the spatial focus of this SIA including

the Marches LEP, Stoke and Staffordshire LEP and Worcestershire LEP. The data should therefore be seen as indicative only for the WM SIA.

- 4.15 Businesses across the West Midlands region invested some £2.2bn in R&D in 2015 (covering both capital and non-capital expenditure), accounting for 10% of the UK total, with an increase in the share of all UK BERD undertaken in the West Midlands since 2010 (see Table 4-3). The number of FTEs employed in R&D also increased in both real and proportionate terms from 2010 to 2015; in 2015, there were 19k employees engaged in R&D across the West Midlands, accounting for 9% of the UK total.

Figure 4-2: Private sector R&D expenditure and employment in the West Midlands level (2010-15)

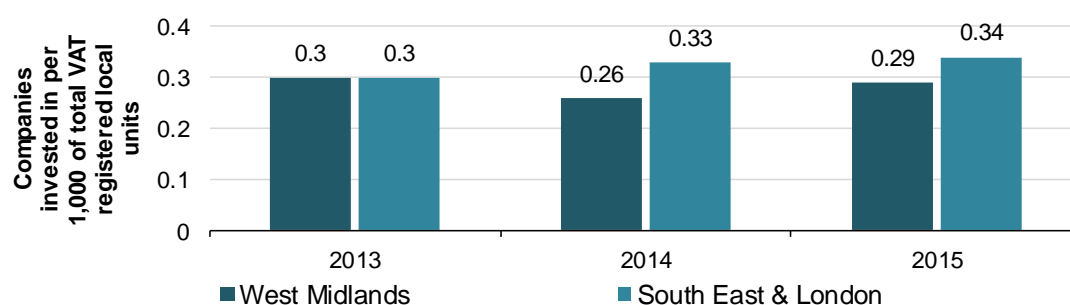


Source: SQW analysis of Research and Development in UK Businesses

- 4.16 Data on the breakdown of business R&D expenditure, including the balance between capital and non-capital R&D expenditure, and by industrial sector, is not available at a regional or sub-national level. Such data would be helpful in better characterising the nature of R&D activity in our area, and should be considered by partners at local and national levels as a potential area of further research and analysis going forward.

Venture capital and early stage investment

- 4.17 Data from the British Venture Capital Association (BVCA) provide an indication of the level of venture capital (VC) investment secured by firms across the UK. VCs invest in high growth firms, so this data provide a helpful proxy for the extent to which our firms are accessing the private finance required to help support scaling-up, relative to the national picture. Again, the data are for the 'West Midlands' region as a whole (including the areas set out in 4.14).
- 4.18 These data indicate that 66 companies in the West Midlands received a total investment of private equity and VC investment of £288m in 2015. In absolute terms this is significant, although it is important to recognise that the UK VC investment landscape is heavily skewed towards London, with London/South East alone accounting for over half of all investment in 2015.
- 4.19 However, positively, on a per business basis our area performs well relative to other regions outside of London/South East. As set out in Figure 4-3, in 2015, 0.29 companies per 1,000 local units secured VC investment in the West Midlands, just behind the 0.34 receiving investment in the South East and London, and well above the 0.13 receiving investment in both the East of England and the East Midlands.

Figure 4-3: Companies invested in per 1,000 of total VAT registered local units (2013-2015)

Source: SQW analysis of BVCA Private Equity and Venture Capital Report on Investment Activity 2015, Autumn 2016

- 4.20 Our firms secure investment for early-stage growth from national and international sources, with external investors complementing local investors who play an important role in making growth finance available to companies of different size and stages of maturity. Local investors include Birmingham based venture capital firm Midven, Mercia based in Warwickshire (arguably the most significant national fund for high tech spin-outs nationwide after Imperial Innovations in London), and Minerva, the Midlands Business Angel Network, formed by the University of Warwick Science Park, with investors groups also located at Coventry and Wolverhampton Science Parks.
- 4.21 Administrative data from HMRC on two venture capital schemes can be used as a further proxy for the level of investment in the early stage of firms across the area. More specifically: the Enterprise Investment Scheme (EIS) which is designed to help smaller, higher-risk trading companies to raise finance by offering a range of tax reliefs to investors who purchase new shares in those companies; and the Seed Enterprise Investment Scheme (SEIS) which complements EIS and is designed to help small, early-stage companies raise equity finance by offering tax reliefs to individual investors who purchase new shares in those companies.
- 4.22 Data are provided on the number of companies raising funds under the two schemes, and the value of funds raised by region, again covering the broader West Midlands geography. As set out in Table 4-3, encouragingly both the number of firms raising finance and the value of the finance raised though EIS and SEIS has increased over the past three years for which data are available, consistent with the national trend.

Table 4-3: EIS and SEIS data for the West Midlands

	2012-13	2013-14	2014-15
EIS			
Number of companies	105	125	145
Amount raised	29.1	47.4	43.9
SEIS			
Number of companies	55	90	100
Amount raised	3.6	6.7	7.9

Source: Enterprise Investment Scheme and Seed Enterprise Investment Scheme Statistics: October 2016
<https://www.gov.uk/government/statistics/enterprise-investment-scheme-and-seed-enterprise-investment-scheme-statistics-october-2016>

- 4.23 The Midlands Engine Investment Fund, announced in the March 2016 budget, provides an important opportunity for the area to develop the scale and maturity of the venture capital market. The Fund will provide some £250m in total including initially £80m in equity,

alongside £20m in debt funding, £30m for small business loans, and £20m for proof of concept and early stage funds.¹⁸

4.24 Given the long-standing challenge for the UK in spreading private (and public) innovation funding out from its concentration in London and the wider South East, local sources of innovation funding are also crucial. Our businesses have access to a range of finance sources locally across the area. Examples include:

- Finance Birmingham has a comprehensive set of funds available to firms in the Greater Birmingham LEP area but also sometimes to the rest of the West Midlands: this includes grant funding for high tech/early stage companies from £50k up to £500k, and creative firms from £50k to £500k; equity finance in the £250k to £1m space; loan finance from £100k to £1m; and mezzanine finance up to £2m.
- Coventry University Enterprises runs a 'proof of concept' programme, providing grant finance to SMEs based in the Coventry and Warwickshire (and projects within Coventry University and the University of Warwick), to help determine and shape the commercial potential and routes to market of innovative new ideas.
- Mercia Fund Management and the West Midlands Academic Health Science Network have established the SME Innovation Fund to grow spin-outs to improve healthcare services across the NHS, particularly those in line with the WMAHSN's core strategic priorities of: advanced diagnostics, genomics and precision medicine; mental health: recovery, crisis and prevention; long-term conditions; and wellness and the prevention of illness.

4.25 If R&D investment is effective, it often needs to be followed by appropriate investment in the new effective processes (not just products) to give the quality, price, volume and productivity benefits. The MEIF and Finance Birmingham can support to some extent, but there remains a need for funding to move from R&D to real productivity gains.

Innovate UK

4.26 In total, over 400 organisations in our area participated in projects securing Innovate UK funding over 2010-15, equating to grants of £247.5m¹⁹, 8% of the UK total – this is a higher share of Innovate UK funding than our population of firms would suggest (6%), indicating the level of innovation activity across our business base.

Table 4-4: Innovate UK grant funding to organisation based in WM SIA area

	2010	2011	2012	2013	2014	2015	Total
Annual grant (£m)	37.5	59.9	27.9	42.4	35.2	44.6	247.5
% UK total	13%	17%	4%	8%	6%	6%	8%

Source: SQW analysis of Innovate UK funded projects database

4.27 The relatively high share of Innovate UK funding also reflects three further factors:

- A high level of engagement of our knowledge base in innovation activity. Our universities accounted for 12% of Innovate UK grant funding to all academic institutions over 2010-15 (£54m from a total of £465m)²⁰. Warwick University and Birmingham University were ranked third and fourth of all UK institutions in terms of

the scale of Innovate UK funding secured over 2010-15, at £22m and £18m respectively – only Sheffield and Nottingham secured more.

- Our RTO base, with the MTC securing approximately £44m, and Warwick Manufacturing Group HVM Catapult approximately £23m over 2010-15.
- The scale of R&D activity at JLR: JLR secured over £30m in Innovate UK grants over the 2010-15 period; the only businesses that secured more nationally were Rolls-Royce and Airbus.

4.28 Indeed, taken together these four institutions – Warwick University (including Warwick Manufacturing Group), Birmingham University, the MTC and JLR – accounted for 65% of the total Innovate UK grant funding secured by WM SIA institutions over 2010-15.

4.29 Our area has also been particularly successful in attracting funding: for collaborative R&D projects (9% of the UK total); and the Small Business Research Initiative funding, which is aimed at stimulating innovation through supporting public procurement of R&D (10% of UK funding). However, the Innovate UK data demonstrate the need to drive-up greater engagement in innovation across our small and medium sized business base. Over 300 micro/small/medium sized firms in the WM SIA area secured Innovate UK funding over 2010-15 with an aggregate value of over £47m. However, this accounted for just 4.1% of the total Innovate UK funding to firms of this size – compared to 8% of all Innovate UK funding, and our area accounting for 5.2% of micro/small/medium sized firms across the UK.²¹

People and Skills

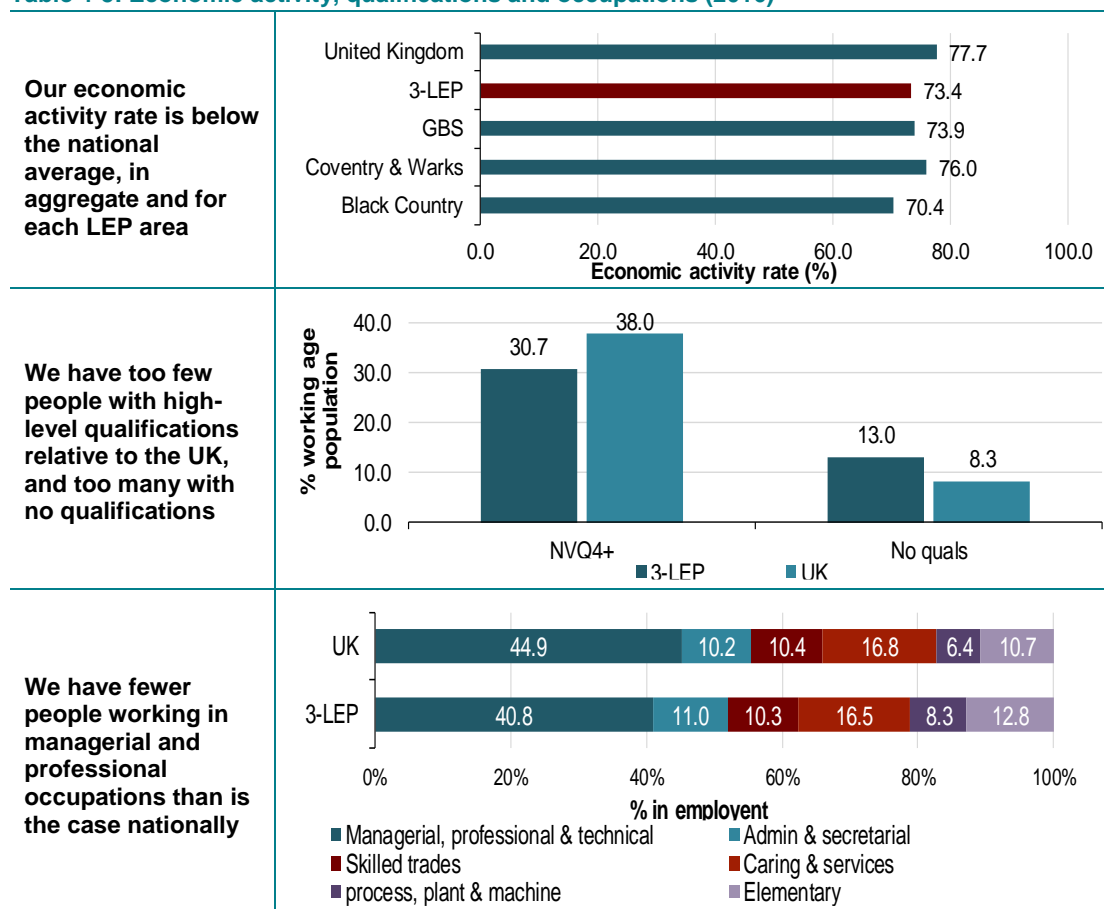
4.30 Our area is home to over 6% of the UK's population and working age population, which gives our businesses a significant pool of labour to draw on. However, we face challenges in relation to economic activity and the skills levels of our population, with the latter reflected in the occupational mix as shown in Table 4-5.

4.31 These wider labour market issues set the context within which action to enhance science and innovation across our region needs to be taken. For example, driving up skills will help attract and retain high quality employers providing high occupational level employment opportunities which in turn will be key to closing the productivity gap.

4.32 Importantly, and as discussed in Section 2, we have a strong base on which to build with 350k employees in 'science and technology' sectors across our area already, and approaching 150,000 students enrolled in our universities which gives us real potential to grow in the future.

4.33 A key factor in retaining our talented labour and attracting new workers is our cultural and quality of life offer. Our diverse and vibrant cities are complemented by the easily accessible countryside in and around our area. This makes our cultural economy a significant part of our ecosystem proposition; there are almost 150k jobs in the cultural economy, generating a GVA of £3,142m.²²

Table 4-5: Economic activity, qualifications and occupations (2016)



Source: SQW analysis of Annual Population Survey data

Networks and Knowledge Exchange

The importance of networks

- 4.34 The fostering and development of collaborative behaviours and networking is core to successful innovation, with ‘open innovation’ models increasingly pervasive, where knowledge, ideas and ingenuity are shared across sectors, institutions, firms and people.
- 4.35 Our area has a long and successful track record of joint working, and this is reflected in a range of effective alliances and formal networks across our area with relevance to the SIA. Further to the West Midlands Combined Authority itself examples include:
- Birmingham Science City, an alliance of public, private and university stakeholders working to stimulate and promote science and technology driven innovation; Birmingham Science City was established in 2006, and is unique in the region, focussing solely on science and innovation and as an independent body. It has persistently had a role in building and maintaining the WM innovation ecosystem through its own thematic working groups; supporting others’ groups including a STEM Engagement Group; holding networking events for innovation leaders in the public and private sector; leading VenturefestWM; and supporting strategic innovation thinking for LEPs and WMCA.

- Medilink West Midlands, providing specialised business support to health technology companies across the region, through personal consultations, site visits, business meetings and events.
- West Midlands Academic Health Science Network (AHSN), that aims to deliver improved healthcare outcomes and create economic growth for the West Midlands and is one of 15 AHSNs across England, established by NHS England; the AHSN includes all NHS organisations, academic and educational institutions, other public bodies, life sciences industry and private sector companies within the West Midlands as ‘standard members’, with NHS trusts and academic institutions part of an enhanced membership scheme.
- Birmingham Health Partners (BHP), an alliance between academics at the University of Birmingham and clinicians at University Hospitals, Children’s Hospital and Women’s Hospital NHS Trusts. BHP’s mission is to harness research strengths in the University of Birmingham and NHS to deliver better treatments and care to patients.
- Made in the Midlands, a privately-run peer group for MD’s and CEO’s of Manufacturing and Engineering firms in the Midlands.
- Sustainability West Midlands, a not-for-profit company with members across the business, public and voluntary sectors in the West Midlands that acts as a catalyst for change to support the development of an environmentally sustainable region.

4.36 Universities, businesses, RTOs and networks in our area also work extensively with partners across the wider Midlands region. This includes involvement with the Midlands Engine itself, including engagement in its Innovation Group (Chaired by the Chief Executive of the MTC); Midlands Connect, a collaboration of local authorities, local enterprise partnerships, Network Rail, Highways England, central government and the business community to develop a strategy to improve the connectivity of our region’s key locations; and the Midlands Aerospace Alliance that represents the aerospace industry across the Midlands. The UK Rail Alliance the rail sector’s largest dedicated B2B networking organisation is also based in the WM SIA area in Warwickshire. University networks and collaborations are considered below.

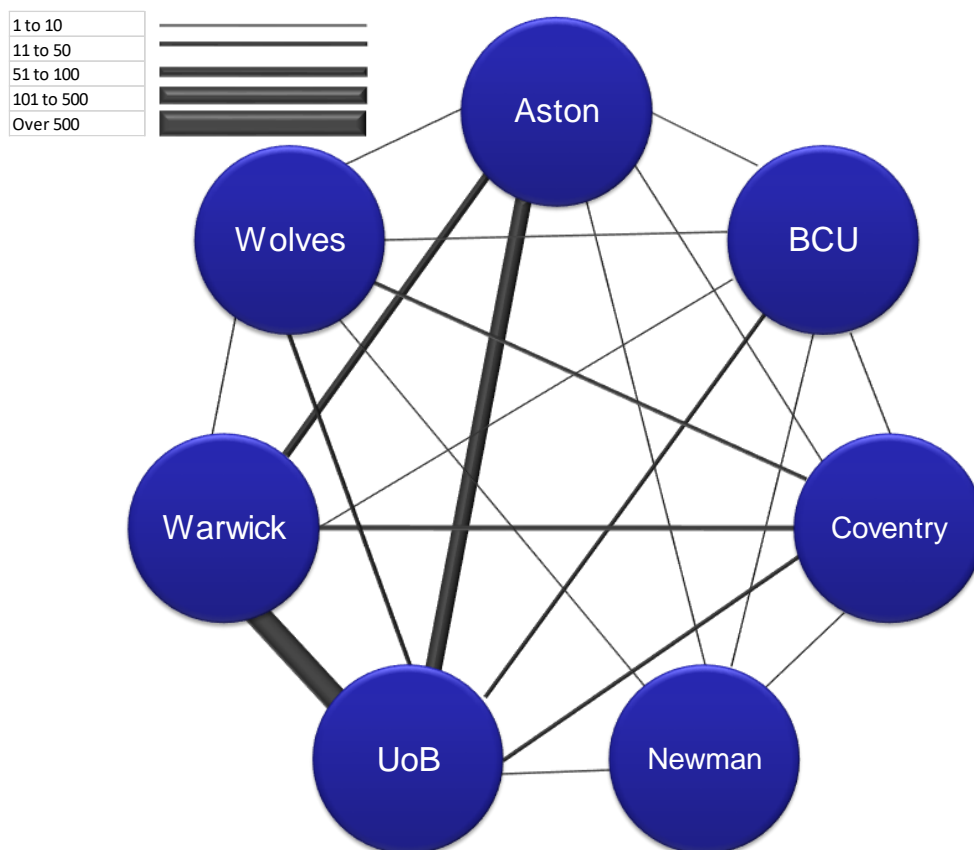
4.37 There are also numerous effective and embedded networks operating at a local level within each LEP-area. These remain important given that innovation continues to happen in places, where personal relationships can be developed, focused around individual innovation districts, universities, science parks, hospitals or major industrial R&D hubs etc.

Evidencing networking in action

4.38 Demonstrating in data effective networking is challenging; however, three sources of evidence are provided below to illustrate the scale and nature of networking and collaboration across the area: data from Sci Val on ‘university-university’ collaboration; wider university partnerships nationally and internationally, including Horizon 2020 funding; and data from Sci Val on ‘university-industry’ collaboration. The case studies at Annex A evidence further collaboration and networking in action; the case studies demonstrate our ability to engage in complex, cross-sector networking and collaboration including examples encompassing the public, private, RTO and university sectors.

4.39 First, on **university-university collaboration**, the scale of collaboration between universities across the area, as indicated by the number of co-authored publications produced over the 2013-15 period is set out in Figure 4-4. Over this period, approaching 1,300 publications were co-authored by institutions in our area, with collaborations between Aston, Warwick and the University of Birmingham particularly common.

Figure 4-4: Co-authored publications between universities in the WM SIA (2013-15)



Source: SQW analysis of Sci Val

4.40 Warwick and the University of Birmingham are also particularly important as sources of co-publications for other institutions across our area. Figure 4-5 sets out the ranking of the number of publications co-authored with other institutions in the area, (where 1 = most co-publications with another institution). The data indicate that:

- The University of Birmingham was the most regular collaborator for co-authored publications for Aston, Birmingham City University, Coventry, and Wolverhampton, and the second most regular for Warwick (after Oxford).
- Warwick University was the second most regular collaborator for Coventry (after Oxford), and the third most regular for the University of Birmingham (after Oxford and Cambridge), and Aston (after Novosibirsk State University in Russia – with which Aston has established a joint research centre for photonics – and UCL).

Figure 4-5: Ranking of number of co-authored publications produced with WM SIA institutions, 2013-15 (1= most co-publications with another institution)

	Aston	BCU	Coventry	Newman	UoB	Warwick	Wolverhampton
<i>Collaborators in WMSIA</i>							
Aston		24	26	15	234	293	32
BCU	156		26	15	411	619	19
Coventry	56	6		3	367	322	5
Newman	429	101	93		1071		54
UoB	1	1	1	6		2	1
Warwick	3	11	2		3		19
Wolverhampton	99	11	11	3	416	619	
<i>Other most regular collaborators</i>	Novosibirsk State University	Lanzhou University	University of Oxford	University of Limerick	University of Oxford	University of Oxford	University of Thessaly
	University College London	De Montfort University	University of Nottingham	Qatar University	University of Cambridge	University of Cambridge	University of the West of England

Source: SQW analysis of Sci Val

4.41 Second, on **university partnerships nationally and internationally**, our universities are widely networked and involved in partnerships and collaboration at regional, national and international levels. At a 'regional' level this includes participation by our institutions in:

- Midlands Innovation, a collaboration of six research-oriented universities including three in our area (Aston, Birmingham, and Warwick) and three in the East Midlands (Leicester, Loughborough, and Nottingham), with the ambition to drive cutting-edge research, innovation and skills development, and build global hubs of research and innovation excellence.
- Midlands Enterprise Universities, a partnership of seven universities, three in our area (Birmingham City, Coventry, and Wolverhampton), and four in the East Midlands (Nottingham Trent, Derby, Lincoln, and De Montfort) with the ambition to drive productivity and growth through skills, innovation and enterprise.
- Two of our Birmingham-based universities (University of Birmingham and Birmingham City University) are partners of the AHRC-funded Midlands3Cities (M3C) Doctoral Training Partnership, alongside institutions in Leicester and Nottingham. M3C provides combined research expertise for the professional and personal development of the next generation of arts and humanities doctoral researchers.

4.42 Our universities are also highly engaged in associations and groups across the spectrum of UK higher education, as summarised below.

Table 4-6: UK university alliances and coalitions

Body	University members
Cathedrals Group	Newman
Guild HE	Newman, University College Birmingham
Million+	Staffordshire, Bedfordshire
Russell Group	Birmingham, Warwick.
University Alliance	Coventry

Source: SQW analysis

4.43 Looking internationally, the Sci Val data indicate that between 2013 and 2015, our institutions co-authored publications with over 2,400 institutions outside of the UK, including over 370 in

the USA, 230 in China, 150 in Germany and 120 in France. Broader evidence on the international links and collaborations across our institutions is set out below.

Table 4-7: International partnerships and activities

Aston University has four international strategic networks: Aston in India (including a collaboration with the Indian Institute of Technology in Ropar); Aston in China and Hong Kong (partners include Beijing University of Technology, Chinese University of Hong Kong, and Shanghai Jiatong University); Erasmus+ Project: Harmony which aims to contribute to the development of comprehensive internationalization strategies (17 partners across the EU and Armenia, Belarus and Russia); and the Erasmus Mundus Project: Unique which aims to support international collaboration and exchange (9 partners across the EU and China, India, Mexico, Namibia and Russia). Aston also has research collaborations, teaching and exchange partnerships with University of Stellenbosch (South Africa), Queensland University of Technology (Australia), University of Florida (USA), University of Sao Paulo (Brazil), Universidad De Sevilla (Spain) and University of Seoul (Korea), and established an International Centre for Photonics with Novosibirsk State University in Russia.

University of Birmingham has identified China, India, Brazil and North America as key strategic regions for focused engagement. In China, the university has multi-faceted collaborations with Guangzhou, and longstanding engagements include high profile partnerships with Chinese government, business and civic society in fields such as health, transport and energy storage. In the USA, the university has a strategic alliance with the University of Illinois at Urbana-Champaign focused on collaborative research and teaching. In India, the university has a permanent office in New Delhi, focused on strengthening existing links and building new partnerships with universities, businesses and governments. In Brazil, the university has extensive collaborative research partnerships, with over 70 academics actively engaged. The University is also a founding member of the global Universities 21 alliance of research universities, and has networks which promote excellence in global engagement via centres such as the China Institute and Africa Hub.

Birmingham City University has a wide range of established partner institutions globally including in Hong Kong, India, Mauritius, Singapore, Sri Lanka, Thailand, the United Arab Emirates, and China. The university Strategic Plan 2020 identifies becoming an international university as one of its key aims in terms of the student body, overseas partnerships and promoting global perspectives in curricula and research. This seeks to build on existing partnerships, including the Birmingham Institute of Fashion and Creative Art, a partnership between Birmingham City University and Wuhan Textile University in Wuhan, China, one of only a handful of such partnerships approved by the Chinese government.

University College Birmingham is engaged in a number of transnational projects, including EUGANGS, a collaborative research project with organisations in seven European states investigating the skills required by those working with, or affected by, gangs and gang culture in local areas; the La MANCHE focused on the modernisation of higher education in Armenia, Ukraine, Belarus, Georgia and Moldova; Trans CSR a collaborative research project involving organisations in five European states focused on Corporate Social Responsibility skills across the European tourism industry; and WelDest a collaborative research project with higher education institutions in Finland, Germany and Austria considering how destinations can be developed into health and well-being destinations.

Coventry University: The university has offices in China, Kenya, Nigeria and Pakistan, and over 70 academic partner institutions globally in China, Malaysia, the UAE, Turkey, Ghana, Brazil and many other countries. The university is also home to a new Confucius Institute that aims to promote Chinese language and culture (the first of its kind in the West Midlands), created in partnership with Jiangxi University of Finance and Economics (JUFE).

Newman University: The university has established partnerships with a number of institutions international including exchange agreements with Aichi University in Japan, the Hong Kong Institute of Higher Education, SungKonghoe University in South Korea and Newman University, Wichita USA.

University of Warwick has been working with Monash University in Melbourne, Australia since 2009 and together they launched the Monash Warwick Alliance in 2012. This aims to undertake research on globally relevant problems and produce graduates with a global education. The partnership includes the China, India, Malaysia and South Africa campuses of Monash University, and the two Universities' sites in Italy (Warwick has had a base in Venice for more than 40 years). Warwick is a partner in the Centre for Urban Science and Progress (CUSP), based at New York University, one of America's leading higher education institutions. CUSP is an applied science research institute which aims to address the needs of cities worldwide and educate the next generation of engineers in how to apply that research. Other partners include The City University of New York, Carnegie Mellon University (both USA), University of Toronto (Canada) and the Indian Institute of Technology (Mumbai, India). Warwick is also a partner in CARTA (Consortium for Advanced Research Training in Africa), an initiative of 13 African universities and research institutes and 8 northern partners that aims to develop and deliver an innovative model for doctoral training in sub-Saharan Africa and to strengthen the capacity of institutions to conduct and lead internationally-competitive research.

University of Wolverhampton has established partnerships with teaching organisations globally, providing partner institutions with preparatory courses, taught programmes, research and professional development programmes and consultancy. Examples include a 30-year partnership with Yunnan Agricultural University (YAU) in China, a research partnership with the Canadian Institute for Cybersecurity (CIC) at the University of New Brunswick focused on cybersecurity, and the university has five international Regional Offices and Educational Advisors in over 40 countries.

Source: University websites

- 4.44 Engagement in Horizon 2020, the EU Framework Programme for Research and Innovation for 2014-2020, provides further evidence of international collaboration, with all projects involving multinational collaboration. Data from December 2016 indicate a high level of engagement of our HEIs, with Birmingham and Warwick both in the top ten UK HEIs in terms of the scale of funding secured from the EC for Horizon 2020 projects, with over €50m in funding, and Aston with a further €15m. Data for all HEIs involved in Horizon 2020 projects (at the end of December 2016) are set out below.

Table 4-8: Horizon 2020 engagement by our HEIs (by December 2016)

Institution	Value of EC contribution (€m)	Number of project participations
University of Birmingham	52.2	113
University of Warwick	51.6	85
Aston University	15.2	45
University of Wolverhampton	1.1	5
Coventry University	3.5	12

Source: CORDIS - EU research projects under Horizon 2020 (2014-2020)

- 4.45 In total, 80 innovation-active organisations across our area have been involved in Horizon 2020 projects, summarised by organisation type in Table 4-9. Together, organisations based in the WM SIA area (including HEIs, RTOS and firms) have secured Horizon 2020 funding to date of over €161m, equal to 5% of the UK total, and 7% if London is excluded. Universities account for around three-quarters of this €161m EC contributions, with private sector firms accounting for a fifth. Notable examples of organisations participating in Horizon 2020 projects outside of our universities include:

- The MTC, which has been involved in nine projects, with EU funding of €5m;
- EXERGY Ltd a research-based SME specializing in energy efficiency, renewable energy, built environment and sustainable development based at Coventry University Technology Park that has been involved in eight projects, with EU funding of €3.9m;
- ALLINEA, a software firm supporting high performance computing based at Warwick Technology Park, which has been involved in five projects, with EU funding of €2.5m.

Table 4-9: Horizon 2020 engagement by recipient type (by December 2016)

	Number of organisations	Value of EC contribution (€m)	Number of project participations
HEI	5	123.5	260
Private	64	28.7	93
RTO	2	5.2	10
Public	2	1.7	11
Health	2	1	3
Other	5	1.7	7

Source: CORDIS - EU research projects under Horizon 2020 (2014-2020)

- 4.46 Third, on **university-industrial collaboration**, we have analysed data from Sci Val which records collaborations between universities and industry that have led to co-authored publications. The Sci Val data indicate that over the 2013-15 period, our universities co-authored publications with 165 separate industrial partners, leading to over 900 co-authored publications. The number of industrial partners that universities worked with leading to co-authored publications is set out below; note, some firms had collaborations with more than one of our universities, so the total number of 'engagements' is higher than 165.
- 4.47 The data highlight the significant industrial collaboration leading to research outputs of Birmingham and Warwick, collaborating with over 110 and 80 industrial partners respectively.

Table 4-10: Number of industrial partners leading to co-authored publication (2013-15)²³

	UK	Non-UK	Total
Aston University	8	28	36
Birmingham City University	3	2	5
Coventry University	2	7	9
University of Birmingham	19	93	112
University of Warwick	15	69	84
University of Wolverhampton	1	2	3

Source: SQW analysis of Sci Val data

- 4.48 Firms that engaged in academic collaborations leading to a high number of co-authored publications included major UK-based R&D intensive advanced manufacturing firms such as Rolls-Royce and Jaguar Land Rover; 'big pharma' firms including AstraZeneca, Novartis, GlaxoSmithKline, Pfizer, Bristol-Myers Squibb; IT and technology firms including IBM, Microsoft, and Siemens; and many others including Bayer, Unilever and Johnson Matthey Plc.
- 4.49 It is important to recognise that the data set out above focus on the number of collaborations, not their quality or impact. However, the data reveal how our different universities are engaged extensively in industrial collaboration activity, both in the UK and internationally.

Knowledge exchange

- 4.50 Collaboration between our university base and industry is one way in which our institutions seek to commercialise and transfer their knowledge to support economic growth. Other evidence on the nature of knowledge exchange includes our universities supporting over 100 **Knowledge Transfer Partnerships (KTPs)** over the 2010-15 period, 8% of all delivered across the UK, and involving six of our universities. Wolverhampton and Aston were the universities responsible for the most KTPs delivered in the region over this period (30 and 25 respectively). Wolverhampton and Aston were some of the UK's most active universities in KTPs, ranked 9 and 11 respectively out of 167 institutions. Our universities also work with industry in many other ways, including industry sponsored PhDs and doctoral training centres.
- 4.51 Our universities are highly active in supporting the commercialisation of research via the creation of **spin-outs, collaborative research, licencing, and other forms of Intellectual Property**. Data from the Higher Education-Business Community Interaction (HE-BCI) survey

for 2015/16 indicate there were over 60 spin-offs from our universities which were active and had survived three years in 2015/16 (covering spin-offs with a university ownership, and spin-offs where the university does not hold equity), accounting for 6% across the UK. The majority emerged from the Birmingham University (26) and Warwick University (20), with both institutions in the top 20 of all UK institutions in terms of the number of active spin-offs. The HE-BCI survey data also reveal more than 320 active graduate start-ups from universities in our area, with 170 from Coventry University alone; the institution had the sixth highest number of graduate start-ups from across over 160 UK institutions.

- 4.52 Our institutions secured income of over £210m in 2015/16 from collaborative research, contract research, consultancy, regeneration and development programmes and Intellectual Property (including licencing, the sale of shares in spin-offs and other forms of IP), set out in Table 4-11. The universities deliver knowledge exchange in different ways, in some cases such as Warwick University focusing on collaborative and contract research, in others on consultancy and business services and regeneration and development programmes. For example, Aston University places a particular focus on supporting the growth of new start-ups and SMEs via the Aston Centre for Growth that delivers a range of programmes for entrepreneurs and small business leaders. This includes the Goldman Sachs 10,000 Small Businesses programme that has supported over 200 firms from the Midlands area. Aston's work with firms builds on the knowledge being developed by the Enterprise Research Centre, a collaboration between Aston and Warwick Business Schools, whose principal aim is to understand what drives SME Growth and productivity and to inform regional/national policymaking.

Table 4-11: University income from forms of commercial research and IP in 2015/16 (£k)

University	Collaborative research income	Contract research income	Consultancy and business services	Regen and development programmes	Intellectual Property
Aston University	8,226	2,928	352	1,494	4
Birmingham City University	200	467	496	600	294
Coventry University	19,389	646	4,436	606	11
Newman University	665	0	12	0	0
University of Birmingham	12,428	49,096	6,617	27,260	752
University of Warwick	24,880	26,856	2,497	1,198	663
University of Wolverhampton	1,853	501	7,247	8,335	2
<i>Total WM SIA</i>	<i>67,641</i>	<i>80,494</i>	<i>21,657</i>	<i>39,493</i>	<i>1,726</i>
<i>WM SIA % UK</i>	<i>5%</i>	<i>6%</i>	<i>5%</i>	<i>24%</i>	<i>1%</i>

Source: HE-BCI survey 2015/16

- 4.53 It is important to recognise that the data vary by year: for example, Coventry University reported income from regeneration and development programmes in 2014/15 of £5.7m, compared to around £600k in 2015/16, reflecting funding cycles. It is also worth noting that

ERDF plays an important role in the regeneration and development funding: across 2014/15 and 2015/16, ERDF funding accounted for over a quarter (29%) of regeneration and development funding secured by our institutions reported in the HE-BCI survey. There will be a major funding gap in the ability of our HEIs to engage with business (particularly SMEs) post-Brexit, unless an appropriate replacement funding stream is made available.

- 4.54 Our area also plays a key role in management and enterprise education in the UK with a number of high ranking and prestigious business schools. Warwick Business School and Birmingham Business School are both ranked in the Financial Times Top 90 European Graduate Business Schools (at number 22 and 73 respectively in 2016²⁴), and Aston Business School was one of the first to be awarded the Small Business Charter in 2014, and one of only 4 to have been awarded gold status. Coventry University Business School and Wolverhampton Business School have also been awarded Small Business Charter status.
- 4.55 All six of our business schools – Aston Business School, Birmingham City Business School, University of Birmingham Business School, Coventry University Business School, Warwick Business School and Wolverhampton Business School – are members of the Chartered Association of Business Schools (CABS). Notably, data from the CABS indicated that the University of Warwick received the *highest* level of research income of all UK business schools over the period 2013/14 and 2015/16, with research income of £14.9m, above business schools including Imperial College, Manchester, Oxford and London Business school. Aston Business school was ranked 14th in terms of research income, at £4.2m²⁵.

Policy and regulation

- 4.56 The policy and regulatory framework is a key underpinning factor in supporting innovation activity. While we can and do, seek to inform national policy and regulation, including through engaging with the Innovate UK, Intellectual Property Office, BEIS and department for International Trade officers in our area, these are principally the responsibility of Government and its agencies. However, partners across the WM SIA area are responsible for setting the local policy agenda, responding to the national landscape, and as the devolution to the cities and regions of the UK is accelerated, we have a major opportunity to develop a policy environment that is conducive to innovation.
- 4.57 Core to our approach is placing science and innovation at the heart of individual and shared strategic priorities and agendas. This is reflected in the Strategic Economic Plan for the West Midlands Combined Authority, where innovation is identified as one of three cross-cutting principles – alongside productivity and public service reform – that feature across action plans in different policy domains. A key priority identified is to increase the number of businesses adopting innovation and investing in R&D, building on existing programmes and identifying and nurturing companies pursuing emerging technologies.

In turn, local Strategic Economic Plans in the Black Country, Coventry and Warwickshire, and Greater Birmingham and Solihull have a consistent focus on promoting innovation at both strategic levels and through the development of projects and programmes to support local businesses to innovate and engage with the knowledge and research base.

Local innovation community perspectives

“The West Midlands’ innovation ecosystem will play a crucial role in increasing productivity and reforming public services, with the recommendations of the Midlands Engine Science and Innovation Audit informing the WMCA’s approach. The West Midlands is home to some of the most innovative businesses in the UK, with an excellent infrastructure supporting innovation and R&D, drawing on the skills and resources of its universities, science parks and research institutes. The WMCA’s Strategic Economic Plan recognises the opportunity to extend the use of this infrastructure to more businesses, building on current success that will further help drive our economic growth and position the West Midlands as the most ambitious and innovative region in the country.”

Martin Reeves – Chief Executive, WMCA

Reflecting on the innovation ecosystem

- 4.58 The data and evidence summarised above indicate that in many ways our innovation ecosystem is working well and is highly successful. We have a well-developed set of networks and relationships, and a longstanding policy commitment that provides fertile ground for supporting and embedding innovation behaviours across our business base. We also have a very strong asset base in both science and innovation. Four specific assets appear to be particularly important, as ‘anchors’ both responsible for, and supporting, much of the best science and innovation across our area: Warwick University (including Warwick Manufacturing Group); the University of Birmingham; the Manufacturing Technology Centre; and Jaguar Land Rover. These institutions are unequivocally nationally and internationally significant science and innovation assets; notably, Birmingham University and Warwick University were both recently ranked in Europe’s 100 most innovative universities by Reuters²⁶. They act as important cornerstones of our innovation ecosystem, including accounting for approximately two-thirds of all Innovate UK funding into the area over the 2010-15 period.
- 4.59 However, the evidence reviewed as part of this SIA process suggests that we also face considerable challenges in relation to developing and maintaining our innovation ecosystem. Our ability to secure funding from the public and private sectors could be improved, and we need to drive higher levels of knowledge exchange and investment in innovation if we are to address the area’s stubborn and persistent productivity deficit. Our skills deficit is also a major challenge, with too few people with high-level qualifications, too many with no qualifications, and in turn an occupational mix that contains an under-representation of employment in managerial and professional occupations relative to the national picture.
- 4.60 This mixed picture – in many cases very positive, but in some cases, less so – is reflected in analysis on local innovation undertaken by the Enterprise Research Centre, and qualitative feedback from partners and stakeholders engaged in the development of this audit report.

The evidence on local innovation ...

- 4.61 Research conducted by the Enterprise Research Centre on local innovation across England from 2015 demonstrates the mixed story in terms of our innovation performance. The data are now somewhat dated, as they draw on the UK Innovation Survey with firms covering the

2010-2012 period. However, the data represent the most up to date consistent analysis of the relative level of innovation across the country, and provides a helpful summary depiction of both our 'position' nationally, and our areas of strength and challenge.

- 4.62 Out of 45 areas nationally (covering LEPs in England, sub-regions in Scotland and Wales, and Northern Ireland) our areas ranked 14th (Coventry and Warwickshire), 16th (Black Country) and 28th (Greater Birmingham and Solihull) in terms of overall innovation: good, particularly for Coventry and Warwickshire and the Black Country, but not as good as it should be, given the scale and quality of our asset base, and our rich manufacturing tradition, built on developing new products and 'smart' ways of working.
- 4.63 However, this aggregate data story masks considerable variation across different forms of innovation, as shown in the table below. When it comes to 'collaboration' (a metric based on the percentage of firms in any local economic area which were collaborating for innovation during the period 2010 to 2012), two of our LEP areas were in the top 10 nationally, and Greater Birmingham and Solihull ranked fourth nationally in terms of the level of 'new to market' innovation (a metric based on the percentage of firms which were innovating that reported introducing new to the market innovations - products or services – over 2010-12).
- 4.64 Capitalising more fully on our niche areas of excellence, and addressing key gaps or weaknesses in our innovation offer needs to be a core focus of our policy response.

Table 4-12: Ranking of WM SIA LEPs in different forms of innovation (out of 45, 1= high)

	Black Country	Coventry & Warwickshire	GBSLEP
Product/service	17	24	25
New to market	13	23	4
Process	19	23	27
Strategy/marketing	34	17	29
R&D	8	11	33
Collaboration	5	9	32
Overall	16	14	28

Source: Benchmarking Local Innovation, ERC & EEN, 2015

... and current stakeholder perspectives

- 4.65 Through workshops and consultations, around 100 stakeholders involved in science, innovation and local economic development across our three LEP areas were engaged in the SIA. This provides a significant qualitative evidence base on the way in which the innovation ecosystem is 'working' practically on the ground across our geography.
- 4.66 Consistent with the evidence presented above, the stakeholder feedback indicates a mixed picture. Parts of the ecosystem are seen to be operating well, but there are also areas where there is significant scope to enhance our offer to firms. In a functional economy as large and diverse as the WM SIA this is not unexpected, and stakeholders will be involved in different stages of the innovation process, leading to different experiences and perspectives. However, what is notable is that there was limited consistency in the feedback; some elements of the ecosystem were described as both enablers and inhibitors of innovation in the WM SIA area. The key themes identified in the feedback are summarised below.

Table 4-13: Evidence from stakeholders on key innovation enablers and barriers

Partnership working ...	
<i>Enabler</i>	<ul style="list-style-type: none"> Strong partnership working is embedded across the area – both formally via established networks/groups and informally via personal relationships – notably, between the HEIs and LEPs across the area
<i>Barrier</i>	<ul style="list-style-type: none"> Engagement of HEIs – they are regarded as key collaborators and crucial in embedding partnership activity across the area, but there is scope to enable greater and more consistent engagement across and between institutions
Access to finance ...	
<i>Enabler</i>	<ul style="list-style-type: none"> Presence of some 'regional' sources of early stage finance, including Midven and Mercia venture capital firms ERDF funding has been well utilised by SMEs, and local partners have been effective in making the case for ERDF funding to support business growth and innovation interventions across the area
<i>Barrier</i>	<ul style="list-style-type: none"> A fragmented funding landscape (e.g. three Growth Hubs), and too little private finance available for early stage and knowledge-based firms (reflecting a national trend where VC and other forms of early stage finance to support innovation is concentrated in London and the South east) Relatively, a low level of engagement and success by SMEs in accessing Innovate UK funding, in contrast to the success of some of our major firms, notably JLR
Land and Property ...	
<i>Enabler</i>	<ul style="list-style-type: none"> Well-developed network of incubators, providing both physical space and value-added support, plus a strong supply of large industrial units to support the 'advanced manufacturing' sector across the area
<i>Barrier</i>	<ul style="list-style-type: none"> Feedback of a perceived lack of 'grow on space' for SMEs looking to expand, often emerging from the incubators and accelerators across the area
People and skills ...	
<i>Enabler</i>	<ul style="list-style-type: none"> Skills heritage from the automotive industry, and a diverse and stable population
<i>Barrier</i>	<ul style="list-style-type: none"> Relatively low workforce skills, as reflected in the qualification data, providing businesses with a challenge in recruiting appropriate staff to meet skills needs and demand
Connectivity ...	
<i>Enabler</i>	<ul style="list-style-type: none"> Strategic transport infrastructure – road, rail, airport – providing a strong asset base to attract investment, and enable national and international business connections and linkages
<i>Barrier</i>	<ul style="list-style-type: none"> Transport congestion within the area acting as a barrier to effective supply chain linkages, and cost to business through lost time, issues in attracting high quality staff to the area

Source: SQW analysis of stakeholder feedback

- 4.67 In part, the breadth and variation in the feedback reflects our ambition – with recognition that we can, and must improve all elements of our innovation system to drive faster growth. But it also reflects the need for an increasingly coherent and integrated approach to ecosystem development to ensure that – as far as practical – it is operating effectively for all groups, spatially, thematically and by-sector, with a shared culture of networking and continuous innovation. This SIA process will form an important first step in taking this agenda forward.

5. Enabling Competencies

Summary of key messages

- Manufacturing is changing to incorporate a much broader value chain. The West Midlands is at the forefront of this move towards Advanced Manufacturing and Engineering, both nationally and internationally. The breadth of expertise and excellence in our technology-rich firms provides the area with an integrated package of skills and capacities that span across a wide range of industries and sectors, supported by leading RTOs and universities.
- The increasingly pervasive use of Digital Technology and Data is changing how all sectors and industries across the economy operate. In the West Midlands, many of our globally leading manufacturing firms are using digital capabilities and data analytics to accelerate their R&D activities, improve quality, and reduce costs. Our strengths in this area include: the core 'digital technologies' sector incorporating a significant computer games cluster; strengths in data analytics, data science and smart algorithms, and associated capacity in High Performance Computing; cyber security; and sensor technologies and instrumentation.
- Systems Integration involves research into the development of products, processes and services that enable, and the in-business implementation of, 'whole systems' approaches to a wide range of economic and social activities. This is particularly prominent, and evident in the region, in the areas of transport and energy. Across our private sector we have firms with internationally significant systems integration offers, underpinned by a significant consultancy and technical testing and analysis business base, and the expertise in our RTOs.

Role and purpose

- 5.1 The three Enabling Competencies identified in the WM SIA Framework underpin and support much of the innovation and leading-edge business activity in our area. The competences are found in the research capacity and excellence in our universities, the technical know-how and thought leadership in our research and innovation organisations, and across our business base, from high-growth start-up firms to established innovative multi-nationals. As with the other two core elements of the Framework, they are fundamental to our science and innovation agenda. Without these underpinning and increasingly pervasive areas of expertise, the international competitiveness of our market strengths would be eroded and much of the value of our ecosystem lost.
- 5.2 Whilst not unique to our area, and increasingly important for all advanced knowledge-based economies, the evidence and feedback from stakeholders indicates that in 'Advanced Manufacturing and Engineering', 'Digital Technology and Data', and 'Systems Integration', the West Midlands has a critical mass of existing assets and expertise.

- 5.3 The Enabling Competencies are *not* specific sectors or industries, or individual technical specialisms. Rather, they are cross-cutting and shared capacities across the science and innovation base – including its people, institutions, and partnerships.
- 5.4 Characterising fully the Enabling Competencies is challenging; networks, behaviours and shared knowledge are difficult to capture in secondary data and much of the expertise is found within individual businesses. However, this Section provides a depiction of each of the three competencies in turn, drawing on a range of evidence collected in the SIA process.
- 5.5 Whilst the three Enabling Competencies are distinct, they are also closely related and inter-locking: for example, advanced manufacturing is increasingly being shaped by data and digital applications, and in manufacturing ‘whole systems’ approaches are a core part of the product and process lifecycle. These shared competencies and the strengthening linkages between them, are a defining feature of the West Midlands science and innovation ‘offer’.

Advanced Manufacturing and Engineering

- 5.6 As noted in Section 2, manufacturing and engineering remain an important part of our economy – employing over 200k people: including the spectrum of very large multi-national manufacturing firms like Jaguar Land Rover, 2 Sisters Food Group, Mondelēz International (owners of Cadbury) and IMI, through to established SMEs and new start-ups. Our area also has a strong representation of top consulting engineering organisations including Atkins, Mott MacDonald, Arup, Aecom, URS Scott Wilson, Jacobs, Halcrow, Hyder and Capita Symons.
- 5.7 However, manufacturing is changing rapidly, and the traditional focus on production as reflected in industrial classifications, is becoming outdated. The manufacturing value chain is expanding and manufacturing processes, disciplines and techniques, are being integrated into other industrial sectors - from energy and the process industries, through to construction, medical technology and biotechnology and beyond.
- 5.8 In this context, advanced manufacturing, and the complementary and increasingly coterminous discipline of engineering (be this mechanical, civil, chemical or electrical engineering), incorporates a much broader value chain, stretching from R&D and product design and development, testing and measurement, and on to supplier management, production, after sales services and consumption, followed by recycling, remanufacturing and reuse. This creates new opportunities for value generation, including the ‘servitisation’ of manufacturing, that is firms moving away from simply selling finished products to consumers, to providing an integrated offer of both products and services that deliver value and benefits to customers. A core driver of this change in manufacturing is the concept of ‘Industry 4.0’, or the fourth industrial revolution, which (broadly put) is the increasing use of digital technologies, automation and data exchange in manufacturing technologies.
- 5.9 Industry 4.0 brings together technologies such as cyber physical systems, big data analytics, the Internet of Things and cloud computing into what is known as the ‘smart factory’. This presents challenges and opportunities to manufacturers with implications for business and service models, productivity, supply chain management, and how the role of IT will be embedded into manufacturing processes. The ‘production’ section of the value chain is also undergoing rapid change with the emergence of new technologies and techniques such as advanced materials, additive layer manufacturing, and bio-processing.

- 5.10 The West Midlands is at the forefront of these changes, nationally and internationally. Our area is traditionally viewed as the UK's leading place to manufacture goods, but what we make and how we make them is evolving and must continue to evolve further. Importantly, the breadth of expertise and excellence in our technology-rich firms operating in supply chains locally, nationally and globally provides the area with an integrated package of skills and capacities that span across a wide range of industries and sectors.
- 5.11 The scale and breadth of our advanced manufacturing and engineering business base is set out in Table 5-1 – across a mix of 'traditional' manufacturing disciplines, with a particular focus on metals, machining and manufacture of machinery for use across sectors, and supporting disciplines including testing, analysis and technical consultancy. In these areas, the West Midlands is over-represented relative to the national level in enterprises (with the area accounting for around 5% of all enterprises across the UK), and/or employees.

Table 5-1: Evidence of the advanced manufacturing and engineering business base

	Number of enterprises	Enterprises as % UK (av = 5%)	Employees	Location Quotient
Architectural and engineering activities and related technical consultancy	5,385	6%	27,000	1.0
Other professional, scientific and technical activities not elsewhere classified	2,205	5%	7,250	1.3
Treatment and coating of metals; machining	1,740	11%	15,000	2.0
Technical testing and analysis	310	5%	4,750	1.3
Manufacture of metal forming machinery and machine tools	180	20%	1,850	3.0
Installation of industrial machinery and equipment	160	8%	1,575	1.3
Forging, pressing, stamping and roll-forming of metal; powder metallurgy	145	23%	7,750	6.2
Manufacture of general purpose machinery	115	11%	4,350	1.3
Casting of metals	90	21%	3,175	3.9
Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	80	9%	2,000	1.0

Source: BRES and UK Business Counts

- 5.12 The West Midlands has a range of leading research and translation assets that underpin – and are a core part of – the Advanced Manufacturing and Engineering Enabling Competence. As well as hosting the HQ of the UK's High Value Manufacturing Catapult in Solihull, four centres of excellence in particular are highlighted:

- **Manufacturing Technology Centre:** based in Coventry and part of the High Value Manufacturing Catapult, the MTC provides manufacturing system solutions in partnership with industry (large and small businesses), academia and other translational institutions in the UK and internationally. The MTC focuses on three core technology areas: Assembly Systems; Component Manufacturing Systems; and Data Systems for Manufacturing. The MTC houses over 500 expert staff working on the development of advanced manufacturing solutions.

- **Warwick Manufacturing Group:** part of the University of Warwick, WMG is one of the world's leading research and education groups focused on manufacturing. WMG is also one of the seven Centres of the High Value Manufacturing Catapult, working with business to transfer research to industry, and focused on the global challenge of Low Carbon Mobility and in particular two priorities areas: Lightweight Technologies; and Energy Storage and Management. WMG has over 500 staff working across seven dedicated research and education centres.
 - **Institute for Advanced Manufacturing and Engineering:** a collaboration between Coventry University and Unipart Manufacturing Group, the IAME brings together academia, industry and R&D in a 'live' manufacturing environment, with a focus on R&D and innovative technology development for automotive, aerospace, oil and gas, power generation and rail sectors.
 - **High Temperature Research Centre:** a collaboration between the University of Birmingham and Rolls-Royce, based at Ansty Park in Coventry adjacent to the MTC. The initial focus is on design and manufacturing aspects of investment casting, allowing advanced manufacturing technologies for high temperature materials.
- 5.13 Taken together, these centres engaged in the translation of research and knowledge to commercial development and innovation provide a critical mass of excellence in advanced manufacturing and engineering, working across a very wide range of industries and sectors. They contain some of the most advanced manufacturing equipment in the world, and leading scientists and technicians working with companies from our area, nationally and internationally.
- 5.14 Our university base is also a key element of our strength in Advanced Manufacturing and Engineering. As noted in Section 2, our universities were rated in the Top 10 nationally in a range of engineering/manufacturing units of assessment in the REF 2014. Other key assets include the Midlands Simulation Group at the University of Wolverhampton, focusing on R&D in the area of computer simulation for engineering and related industries; and the Advanced Manufacturing Technology Centre at the University of Birmingham, that carries out research on high value manufacturing and associated knowledge-based technologies (e.g. laser processing, and intelligent robotics). In 2017, Wolverhampton University will open the Elite Centre for Manufacturing Skills (ECMS) a new employer-led training facility for the Black Country, designed to enhance productivity in the region's high value manufacturing sector, based at the University's new Springfield Campus.
- 5.15 Our Universities also host a number of EPSRC centres including the Industrial Doctorate Centre in Formulation Engineering, and Doctoral Training Centre in Structural Metallic Systems for Gas Turbine Applications (both Birmingham), and the Engineering Doctoral Centre in High Value, Low Environmental Impact Manufacturing (Warwick).
- 5.16 This research capacity is demonstrated in the Sci Val data on research quality. The overall FWCI for the '*Engineering*' subject area for our universities was slightly above the UK level. More fine grained data in relevant subject areas and disciplines by our universities is set out in Figure 5-1 below.

Figure 5-1: Sci Val data on subjects and disciplines relevant to the Advanced Manufacturing and Engineering Enabling Competence**Quality: FWCI by subject and discipline over 2013-16 (shaded = above UK average)**

	Aston	BCU	Coventry	Birm	Warwick	W'hmpn
Subjects						
Chemical Engineering						
Engineering						
Materials Science						
Disciplines						
Aerospace Engineering						
Automotive Engineering						
Bioengineering						
Biomaterials						
Biomedical Engineering						
Building and Construction						
Ceramics and Composites						
Civil and Structural Engineering						
Computational Mechanics						
Electrical and Electronic Engineering						
Engineering (miscellaneous)						
Environmental Engineering						
Fuel Technology						
General Chemical Engineering						
Industrial and Manufacturing Engineering						
Materials Chemistry						
Mechanical Engineering						
Mechanics of Materials						
Medical Laboratory Technology						
Metals and Alloys						
Polymers and Plastics						
Surfaces, Coatings and Films						

Scale: scholarly outputs over 2013-16 by discipline

	Aston	BCU	Coventry	Birm	Warwick	W'hmpn
Aerospace Engineering	5		14	29	46	
Automotive Engineering	4		36	89	70	2
Bioengineering	23	4	2	98	232	13
Biomaterials	32		4	87	121	6
Biomedical Engineering	37	9	16	152	273	15
Building and Construction	12	30	40	101	53	28
Ceramics and Composites	11		13	132	131	3
Civil and Structural Engineering	25	27	70	218	91	49
Computational Mechanics			4	23	21	
Electrical and Electronic Engineering	404	24	91	527	537	17
Engineering (miscellaneous)	3	4	2	156	129	1
Environmental Engineering	17	4	27	119	21	10
Fuel Technology	29		14	122	47	2
General Chemical Engineering	63		16	329	150	7
Industrial and Manufacturing Engineering	66	9	75	232	189	21
Materials Chemistry	42		19	235	348	10
Mechanical Engineering	38	6	104	468	342	17
Mechanics of Materials	50		69	366	247	16
Medical Laboratory Technology	1			8	1	
Metals and Alloys	8	1	24	196	150	2
Polymers and Plastics	25		10	64	254	14
Surfaces, Coatings and Films	19		12	163	191	4

Source: Sci Val

- 5.17 Importantly, looking at the skills and capacity of our economy over the long-term, our area also houses three University Technical Colleges squarely in the Advanced Manufacturing and Engineering space: the Aston University Engineering Academy in Birmingham, and WMG Academies for Young Engineers in both Coventry and Solihull.

Digital Technology and Data

- 5.18 The pervasive use and application of Digital Technology and Data is changing how all sectors and industries across the economy operate. The big data revolution, the emergence of energy efficient and high performance computing, as well as the pervasiveness of new digital technologies and developments such as the Internet of Things are transforming the global economy. Encouragingly, we are well-positioned to exploit these opportunities, across our science and research base, and industry.
- 5.19 In the West Midlands, we have seen through the advent of Industry 4.0 thinking how many of our globally leading manufacturing firms, such as Jaguar Land Rover, are using digital capabilities (especially advanced simulation, modelling and visualisation capabilities) and data analytics to accelerate their R&D activities, improve quality, and reduce costs.
- 5.20 More widely, the building blocks of our digital and data Enabling Competency include:
- The **core 'digital technologies' sector**²⁷, with over 40,000 employees across our area, including around 15,000 employees in computer programming/consultancy and over 1,200 in data processing, hosting and related activities. Our area includes a mix of innovative start-ups in the digital space, for example Innovation Birmingham is home to 140 companies, with specialisms including coding, software, digital gaming, and large established firms, for example, the HQ of SCC, Europe's biggest independent IT services business and a leading provider of 'cloud services' to the public and private sectors.
 - As part of this digital technologies sector, a **nationally and internationally important computer games sector**, focused on a relatively small, but expanding digital cluster of gaming firms in Leamington Spa – known as 'Silicon Spa' - with complementary research and innovation expertise at the Serious Games Institute at Coventry University, and other research assets across the area. Recent research²⁸ has identified the strength and potential of the games industry in the West Midlands (with a particular focus on Coventry and Warwickshire), with around 130 games businesses identified, supporting around 3,000-3,500 games industry professionals across the West Midlands; a core of medium sized companies was found to 'anchor' the cluster, including Codemasters, Exient, Ubisoft Leamington (previously Freestyle Games), Playground Games and Radiant Worlds. The research estimated that Coventry & Warwickshire represents about one-fifth of employment and one quarter of GVA directly generated by the UK games sector, and identified the potential for the cluster to take the lead in the developing augmented reality and virtual reality (AR/VR) industry and the major opportunity that exists to apply these technologies to other sectors such as manufacturing, healthcare, logistics and education. The Digital Media Technology Lab at BCU has developed unique AR methods that are being already being taken up by these sectors.
 - **Strengths in data analytics, data science and smart algorithms, and associated capacity in High Performance Computing.** For example, the University of Warwick is home to the Warwick Data Science Institute, and a founding partner in the Alan Turing Institute, the UK's national institute for data science, working in partnership with Cambridge, Edinburgh, Oxford, and UCL. Warwick also partners with Oxford in

the EPSRC & MRC Centre for Doctoral Training in Next Generational Statistical Science (known as OxWaSp), that aims to train the brightest graduate statisticians in the theory, methods and applications of Statistical Science for data intensive environments and large-scale models. Birmingham is also one of only six nodes of the Open Data Institute; ODI Birmingham aims to bring together all of Birmingham's open data and expertise under one roof to better facilitate the use of open data for public benefit, and the Statistical Cybermetrics Research Group at the University of Wolverhampton is one of the UK's leading centres for research on software and methods to exploit Web-based sources for social sciences research, including 'Big Data'. The Midlands Innovation group of universities, which includes the universities of Warwick, Aston and Birmingham University, have also recently been awarded over £3m from the EPSRC to establish HPC Midlands Plus – a centre of excellence in high performance computing (HPC). This builds on the earlier 'MidPlus' Centre of Excellence for Computational Science, Engineering and Mathematics that was established as a joint venture between the universities of Warwick, Birmingham, Nottingham and Queen Mary University of London in 2011.

- **Cyber security**, with leading research assets including the University of Birmingham's Academic Centre of Excellence in Cyber Security Research, the Cyber Security Centre at Warwick University, and the Data and Security Research Hub at Wolverhampton University.
- **Sensor technologies and instrumentation**, with internationally significant scientific research strengths through, for example, the Aston Institute of Photonic Technologies, which has worked with industrial partners including Airbus, BT, and QinetiQ as well as co-authoring over 60 papers with international collaborators, and the UK Quantum Technology Hub for Sensors and Metrology at the University of Birmingham which is working jointly with industry, including e2v and OXEMS, to support the development of smaller, lighter and cheaper components to make quantum devices a commercially viable reality.

- 5.21 More widely our universities and translational centres contain significant expertise in digital technologies and data. The University of Warwick was ranked second nationally in research quality in Computer Science and Informatics, and collectively our universities accounted for 5% of all FTE Category A submissions in this subject area (over 400 submissions).
- 5.22 On Sci Val data, the overall FWCI for the 'Computer Science' subject area for our universities was 1.4, well, above the international average, and only slightly below the UK level of 1.49. More fine grained data in relevant subject areas and disciplines by our universities is set out in Figure 5-2 below

Figure 5-2: Sci Val data on subjects and disciplines relevant to the Digital Technology and Data Enabling Competence**Quality: FWCI by subject and discipline over 2013-16 (shaded = above UK average)**

	Aston	BCU	Coventry	Birm	Warwick	W'hmptn
Subjects						
Computer Science						
Mathematics						
Disciplines						
Artificial Intelligence						
Computational Theory and Mathematics						
Computer Graphics and Computer-Aided Design						
Computer Networks and Communications						
Computer Science (miscellaneous)						
Computer Science Applications						
Computer Vision and Pattern Recognition						
General Computer Science						
Human-Computer Interaction						
Information Systems						
Information Systems and Management						
Signal Processing						
Software						
Statistics, Probability and Uncertainty						

Scale: scholarly outputs over 2013-16 by discipline

	Aston	BCU	Coventry	Birm	Warwick	W'hmptn
Artificial Intelligence	54	35	86	325	129	30
Computational Theory and Mathematics	17	1	18	149	162	3
Computer Graphics and Computer-Aided Design	4	9	37	39	51	14
Computer Networks and Communications	196	46	110	239	261	48
Computer Science (miscellaneous)	6	7	4	24	12	
Computer Science Applications	184	51	142	411	460	95
Computer Vision and Pattern Recognition	14	7	23	101	87	4
General Computer Science	76	30	125	337	251	60
Human-Computer Interaction	21	13	44	166	62	32
Information Systems	66	16	44	102	159	62
Information Systems and Management	43	8	22	46	72	30
Signal Processing	33	12	23	94	122	5
Software	89	50	124	426	268	45
Statistics, Probability and Uncertainty	8		4	26	210	1

Source: Sci Val

Local innovation community perspectives

“The West Midlands’ scale, diversity, connectivity, high quality research institutions, tech incubators and quality of life make it a highly attractive market and location for innovative companies, investors and talent. This is evident in the region’s leading industry base in areas such as low emissions and autonomous vehicles and our fast-growing base of young tech firms. Furthermore, the strong partnerships that exist between industry, academia and the public sector - through initiatives such as the Manufacturing Technology Centre, the Institute of Translational Medicine and Energy Capital – are making a pivotal contribution to UK industrial strategy and consolidating this innovation ecosystem and infrastructure”.

Matthew Rhodes, GBSLEP Board Director

Systems Integration

- 5.23 Systems Integration involves research into the development of products, processes, and services that enable, and the in-business implementation of, ‘whole systems’ approaches to a wide range of economic and social activities. It also covers how these products, processes and services can be better designed, managed and operated, including the intelligent use of data and information to inform decision making. Whole systems thinking and integration is particularly prominent, and evident in the region, in the areas of transport and energy.
- 5.24 In transport, for intelligent and autonomous vehicles to move from the laboratory and test track to the city, requires a complex system of information technology systems, multimodal sensing (ground-based, satellite and aerial), and underpinning modelling and data analytics, to both ensure safety and make the market a viable commercial opportunity. If any one part of this system is not operating effectively, the whole is compromised significantly. WMG is a global leader in this area, undertaking research on the development and commercialisation of effective systems to enable intelligent and autonomous vehicles, and is home to the ‘3xD Simulator’, the only simulator of its kind designed specifically to test real-world robustness and usability of smart, connected and autonomous vehicle technology. WMG is also a participant amongst other West Midlands institutions in the UKCITE project, aiming to create the most advanced environment for testing connected and autonomous vehicles, funded by the Government’s £100 million Intelligent Mobility Fund: our institutions are also involved in two other projects involving Westfields Sportscars in the Black Country, and RDM Autonomous Vehicles based Coventry.
- 5.25 Other examples of Systems Integration capacity, excellence and activity with a transport focus in our area includes:
- Transport for West Midlands (TfWM), the combined transport authority which is focused on working towards an integrated public transport system that is safe and secure. Intelligent mobility is one of the key strategic strands of activity by TfWM, who are working with partners to encourage and harness technology. TfWM has also been working in partnership with public transport operators to deliver ‘smart integrated ticketing’ across different modes and services in the West Midlands: Smart technology has been in use in the West Midlands on buses since 2009, on the Midland Metro since 2014, and at gated rail stations since 2016.
 - The Centre for Mobility and Transport (CMT) at Coventry University hosts a combination of expertise and facilities and is one of the UK’s leading transport research institutes covering the areas of design, autonomous systems and safety.
 - The Energy Systems Integration Laboratory at the University of Birmingham, with a multidisciplinary team tackling fundamental railway engineering problems.
 - Systems integration services to the automotive, aerospace, rail, industrial, and defence engineering sectors at Horiba MIRA in Nuneaton, Warwickshire; this is one of the UK’s largest transport systems R&D companies with a technical team of over 500 staff, including dedicated teams focused on Intelligent Vehicles and Mobility, controls and electronics and safety.

- 5.26 On energy, as the population continues to rise and urbanisation continues, sprawl, traffic congestion, overloaded infrastructure, noise and air pollution will need to be managed in a much more integrated fashion. The headline challenges of decarbonisation, an ageing infrastructure and shifts in societal expectations require a ‘whole systems’ rethink in how energy is generated, stored, supplied, managed and consumed. Thinking and innovation on these issues is being led in the UK by the Energy Systems Catapult, based in Birmingham.
- 5.27 Other examples of Systems Integration activity and excellence in the area include:
- Smart city developments in Birmingham and the Black Country. In the former, ‘Birmingham Smart City’ is focused on working to improve the way services are delivered through the use of digital and smart technologies through a range of projects and interventions, including a ‘smart city demonstrator’ along the Eastern Growth Corridor in Birmingham connecting assets, data, talent, location, and infrastructure, including Birmingham City University, Philips and Telensa. In the Black Country, a strategy has recently been developed, focussing primarily on the Smart Environment theme, covering energy, waste and green infrastructure, and on Smart Mobility. Efforts are underway to connect these two approaches in the context of the WMCA, and Birmingham Smart City was recently ranked thorough independent research as one of the cities in the UK that has the potential to become a leader in smart city development. The research concluded that:

Birmingham has developed an extensive smart cities vision and strategy that it is marrying with its digital innovation programme. Its plans to make the East Birmingham area of the city a testbed not only for technology but also for community engagement provide a strong basis for turning that vision into real city improvements.²⁹
 - The Centre for Complexity Science at Warwick University, a leading research centre for understanding ‘how complex systems behave, how to live with them, to control them and to design them well’³⁰; this includes the Centre for Doctoral Training (CFT) in Mathematics for Real-World Systems, one of only three CDTs nationally in complexity science.
- 5.28 Crucially, Systems Integration is also evident across industries and contexts, including integrated manufacturing systems ensuring efficient and high quality product design, development and production. Across our private sector, we have firms with internationally significant systems integration offers, underpinned by a significant consultancy and technical testing and analysis business base, and the expertise in systems integration in our RTOs, including the MTC and WMG.
- 5.29 Reflecting these strengths, the partners are also progressing (under the West Midlands Combined Authority) the Consortium for the Demonstration of Intelligent Systems (CDIS), a network that draws on and builds up existing centres of research and innovation excellence in the development and demonstration of intelligent systems solutions to challenges, with an initial focus on intelligent systems in the Mobility, Health and Energy sectors. A case study in Annex A considers CDIS in further detail.
- 5.30 Capturing Systems Integration in the data on research excellence is challenging; as discussed above, the Enabling Competence is inherently cross-cutting and multi-faceted, involving

thinking across rather than within individual areas. This said, the Sci Val data do help to demonstrate the quality and scale of research in our universities where Systems Integration is important.

Figure 5-3: Sci Val data on subjects and disciplines relevant to the Systems Integration Enabling Competence

Quality: FWCI by subject and discipline over 2013-16 (shaded = above UK average)

	Aston	BCU	Coventry	Birm	Warwick	W'hmpn
Subjects						
Decision Sciences						
Disciplines						
Control and Systems Engineering						
General Decision Sciences						
Management Science and Operations Research						
Safety, Risk, Reliability and Quality						
Pollution						
Renewable Energy, Sustainability and the Environment						

Scale: scholarly outputs over 2013-16 by discipline

	Aston	BCU	Coventry	Birm	Warwick	W'hmpn
Control and Systems Engineering	58	17	86	203	148	18
General Decision Sciences	19	5	3	14	59	4
Management Science and Operations Research	72	7	35	41	121	38
Safety, Risk, Reliability and Quality	7	10	22	96	65	23
Pollution	23	2	19	154	47	8
Renewable Energy, Sustainability and the Environment	39	8	46	179	97	7

Source: Sci Val

Local innovation community perspectives

“The West Midlands is uniquely positioned to play a key role in delivering the UK’s industrial strategy and in enhancing our global competitiveness. Our Higher Education innovation and research assets combined with the unique business base of the region provide a significant starting point for driving further growth throughout our economy.”

John Latham, Vice-Chancellor, Coventry University

6. Market Strengths

Summary of key messages

- The West Midlands contains a critical mass of globally competitive businesses, and technically specialist SMEs, operating within and across a range of transport-related industries. Our Next Generation Transport excellence reflects two major existing industrial strengths: the automotive sector and the aerospace sector, and their increasingly shared and reinforcing supply-chains. Significant opportunities for growth are provided by the next generation of rail technology, and links to the Midlands motorsport cluster centred in and around Silverstone.
- The Sustainable Construction Market Strength is grounded in the significant construction industry across the WM SIA area. Our Market Strength is particularly focused around the R&D and commercial deployment by industry of energy efficient and lower carbon building technologies, across commercial and residential construction and infrastructure, leveraging the scale and quality of our education, research and technology transfer base.
- The Energy Storage and Systems Market Strength draws on the excellence across the WM SIA's research base including its universities and innovation assets, and focuses on two related areas: Energy Storage (the development of a range of technologies including batteries (materials and chemistry), and hydrogen storage) and Energy Systems (the development, deployment and use of intelligence to integrate the actions of all the components in the energy system).
- Technologies for Better Health focusses on medical technologies, covering the R&D, design and production of devices, diagnostics, (including in-vitro diagnostics), and software as a medical device. The Market Strength also covers the potential growth opportunity from the application and commercialisation of research strengths in translational medicine, and the accelerated access to new drugs, treatments and health technologies. This has a particular spatial opportunity around Birmingham's developing Life Sciences Campus.

Role and purpose

- 6.1 The WM SIA has identified four evidence-based Market Strengths. The four areas vary in their scope, scale, and maturity. However, they are all areas where as a functional economy across our three LEP geographies, we have distinctive strengths and genuine competitive advantage from our science and innovation base. Importantly, these are also areas where, informed by a headline review of market and technology drivers of change and associated foresight materials, there are considerable economic growth opportunities going forward.
- 6.2 To be clear, the four Market Strengths identified are *not* the only areas that are important for our economy, or where sustained investment and action is required to drive economic growth. Rather, they represent market areas that provide significant opportunities to unlock faster

productivity gains and exploit fully the excellence that we have evidenced across our science and innovation base.

- 6.3 For each Market Strength, this section provides: an overview of the scope and competitive advantage of the WM SIA area; a summary of the scale and concentration of activity across the business base; and a synthesis of the supporting assets and science/research base. The evidence is packaged using a consistent overall structure, with broadly consistent data, but with some flexibility to reflect the different scope of each Market Strength and its underpinning data and evidence base.

Next Generation Transport

Scope

- 6.4 The West Midlands contains a critical mass of globally competitive businesses, and high-technology and technically specialist small and medium sized firms, operating within and across a range of transport-related industries. The Next Generation Transport excellence is grounded principally in two major existing industrial strengths: the automotive sector and the aerospace sector, and their increasingly shared and reinforcing supply-chains. In both automotive and aerospace industries, our business base covers the full spectrum from R&D and design through to production and after sales service, and places us at the leading-edge of 'Next Generation Transport' systems, vehicles and technologies globally.
- 6.5 Two further elements comprise our strength in Next Generation Transport, providing significant opportunities for growth. First, we are very well placed to benefit from significant market opportunities in the next generation of rail technology building on expertise in our research base, the convergence of advanced manufacturing processes and disciplines, and the investment from HS2. Second, the Midlands motorsport cluster centred in and around Silverstone stretches into our area, via individual businesses, supply-chain linkages, and innovation partnerships and relationships. This cluster is characterised by the development of products and services across the 'high performance area', with cluster firms playing a key role as first-adopters of new product and process innovations, which can then be embraced by wider transport industries including aerospace, automotive, rail, and other non-transport applications. Our role in the cluster includes Aston Martin's HQ and global engineering consultancy Ricardo's Midlands Technical Centre (both in Warwickshire), the supply chain of the Force India F1 team includes firms based in Coventry and Birmingham, and actors such as JLR, the Warwick Manufacturing Group, the Advanced Propulsion Centre at Warwick, and HORIBA MIRA operate extensively with firms based in the spatial core of the cluster.³¹
- 6.6 Across the four elements of Next Generation Transport, we have well-developed capacities, assets, and expertise in cross-cutting technologies and market development in our business base and research and technology institution in areas including:
- Advanced digital design, simulation and modelling of products and processes, accelerating the commercialisation and development process and the development and deployment of novel technologies.
 - The application of advanced materials and manufacturing processes such as composites and additive layer manufacturing to exploit fully the materials and

processes most effectively, drawing on research in both our own institutes and from elsewhere.

- Digital manufacturing, supply chain and service management including the use of big data, effective supply chain management, intelligent automation and assembly, machining and condition monitoring.
- Manufacturing metrology, metal precision manufacturing, responsive manufacturing, and advanced robotics.
- Low emissions vehicles, though R&D on batteries, fuel cells and energy storage, powertrains, and light-weighting.

Scale and concentration of activity

- 6.7 The West Midlands is one of the UK's leading areas for manufacturing in transport, across the value chain from R&D and design through to production and post-sales servicing. Taking into account both direct manufacturing and a range of supporting disciplines, the secondary data indicate there are approaching 65,000 employees in Next Generation Transport, and over 3,600 firms (see Table 6-1). The employment LQ of 2.2 reflects our high levels of specialisation in this area, driven particularly by the automotive sector.

Table 6-1: Employment (2015) and enterprise (2016) in core and supporting sectors in Next Generation Transport

	Employment	LQ	Enterprises	% UK (av = 5%)
Aerospace				
303: Manufacture of air and spacecraft and related machinery	4,500	0.9	20	3%
Automotive				
291: Manufacture of motor vehicles	27,000	5.7	80	9%
29201: Manufacture of bodies (coachwork) for motor vehicles (except caravans)	900	1.8	35	8%
29310: Manufacture of electrical and electronic equipment for motor vehicles	600	3.3	25	16%
29320: Manufacture of other parts and accessories for motor vehicles	16,000	4.6	190	17%
Rail				
302: Manufacture of railway locomotives and rolling stock	250	1.2	10	9%
Supporting				
71121: Engineering design activities for industrial process and production	4,500	1.3	1,335	10%
71122: Engineering related scientific and technical consulting activities	3,000	0.6	715	4%
71200: Technical testing and analysis	5,000	1.3	310	5%
741: Specialised design activities	3,000	1.0	920	4%
Total	64,750	2.2	3,640	6%

Source: SQW analysis of BRES data and UK Business Counts

- 6.8 The automotive sector alone supports around 45,000 employees directly. The business base includes major production plants for cars (BMW at Hams Hall, Warwickshire, JLR in the Black Country and Solihull, and MG Motors at Longbridge), and commercial vehicles (Dennis Eagle in Warwick and London Taxi Company in Coventry). Importantly, London Taxi Company recently opened a £300m plant in Coventry dedicated solely to the production of range-extended electric vehicles, including a light-weighting R&D centre. Our area also accounts for 17% of all firms in GB in the highly specialised 'Manufacture of other parts and accessories for motor vehicles' sector, demonstrating the breadth and scale of the automotive supply-chain across the West Midlands.
- 6.9 By comparison, the scale of the aerospace manufacturing sector appears to be somewhat more modest, at around 4,500 employees and 20 enterprises. This includes some internationally significant aerospace firms including UTC Aerospace Systems (in Wolverhampton), focused on wing and engine actuation, and heat exchangers; Moog Aircraft Group (also in Wolverhampton at I54) focused on wing actuation, helicopter rotor actuation; Meggitt (in Coventry) focused on wheel and brake, fluid conveyance, heat exchangers; and Rolls-Royce, (in Birmingham) focused on engine control systems and mechanical parts, defence engine repair and overhaul.³²
- 6.10 However, feedback and further evidence provided by local partners in the development of the WM SIA indicates that the level of employment supported by aerospace is likely to be significantly higher in practice than the SIC data suggest. For example:
- There is an extensive network of small, medium and large firms supplying goods and services to aerospace OEMs, including Rolls-Royce's manufacturing sites in the adjacent East Midlands. For example, the large number of firms in metal-related industries, machining and materials identified in the Advanced Manufacturing Enabling Competence in Section 5 will be supplying the aerospace sector.
 - The Midlands Aerospace Alliance reports that it has 160 members in the area covered by the WM SIA, containing manufacturing and service firms operating within, but that may not be recorded as being part of, the aerospace sector in official statistics.
- 6.11 Similar issues also apply in relation to our automotive and rail sectors; particularly given the increasing role of digital- and service-based application in Next Generation Transport. The 'supporting' sectors set out in Table 6-1 are particularly important in this context, including 'technical testing and analysis', and 'engineering design for industrial process and production', which together support approaching 10,000 jobs and over 16,000 enterprises across the WM SIA area. Notably, the WM SIA area accounts for 10% of all 'engineering design for industrial process and production' enterprises across the country (versus 5% of the business base as a whole).
- 6.12 These industries form a key component in transport supply chains and offer services and expertise to enable the region to exploit fully the opportunities from the research base and R&D intensive major firms that characterise our Next Generation Transport Market Strength. The table below shows some of these strategic supply chain companies and major manufacturers with operations in our area.

Table 6-2: Strategic next generation transport companies in the WM SIA area

Black Country	Coventry & Warwickshire	Greater Birm & Solihull
<ul style="list-style-type: none"> • Casting PLC • Hadley Industries • Moog • Steel and Alloy Processing • UTC Aerospace • ZF Lemforder 	<ul style="list-style-type: none"> • Antolin Interiors • Aston Martin • BMW • Brose • Comau • Covpress • Dana UK Axle • Delphi Diesel Systems • Dennis Eagle • International Automotive Components Group • JLR • Lear • Meggitt Aircraft Braking Systems • PSA Peugeot Citroen Group • Ricardo • Tata Technologies • The London Taxi Company • Unipart Eberspacher Exhaust Systems 	<ul style="list-style-type: none"> • Doncasters Group • GKN • Goodyear Dunlop Tyres • Meggitt Control Systems • MG • Pirelli UK Tyres • SAI Automotive Fradley • Timet UK • Titan Europe • TRW • UTC Aerospace • Wabtec Rail

Source: <https://westmidlandscombinedauthority.org.uk/media/1208/wmca-strategic-companies-june-2016.pdf>

Local innovation community perspectives

“The West Midlands is home to a vibrant, significant and growing cluster of more than 200 aerospace companies. At the top of our food chain, global competitors UTC Aerospace Systems, Moog Aircraft Group and Meggitt design and make flight and engine actuation controls and braking systems combining mechanical, hydraulic, electrical and electronic technologies for the biggest Airbus, Boeing and Bombardier aircraft and giant Rolls-Royce aero engines. At the base of the supply chain the UK’s aircraft grade nickel alloys, aluminium and titanium are made in the West Midlands. And of course between these lies our wide and cross-cutting engineering and manufacturing network often serving aerospace and a host of other markets.”

Andrew Mair, Chief Executive, Midlands Aerospace Alliance

Supporting assets and research base

- 6.14 Next Generation Transport is underpinned by a nationally (and internationally) competitive asset and research base. The key RTOs have been described in Section 5 in relation to the Advanced Manufacturing and Engineering Enabling Competence – specifically, the Manufacturing Technology Centre, Warwick Manufacturing Group, and Institute for Advanced Manufacturing and Engineering. Each of these RTOs has specialisms in transport, particularly around the development of innovative products, processes and services in automotive and aerospace.
- 6.15 Other key innovation assets in Next Generation Transport in the WM SIA area include:

- The Advanced Propulsion Centre (APC) Hub, based at the University of Warwick, a global centre of excellence for low carbon powertrain development and production; Warwick also houses one of the APC's 'spokes' focused on Electrical Energy Storage.
 - The Birmingham Centre for Rail Research and Education at the University of Birmingham: this contains over 130 academics, researchers and professional staff focused on research and thought leadership in the rail industry.
 - A Rolls-Royce University Technology Centre in Materials in Birmingham.
- 6.16 The recent BEIS sponsored research into accelerators and incubators identified a new accelerator programme in Birmingham explicitly focussed on the rail industry. The London Midland Labs Accelerator will support innovative tech start-ups in the mobility space across a 12 week period and offers direct access to the train operator London Midland on top of other benefits commonly associated with accelerators such as mentoring and technical support.
- 6.17 Three major developments which are coming on stream in the near future are also important
- The National Automotive Innovation Centre (NAIC) at the University of Warwick, which will open 2017; developed through a partnership with JLR and Tata Motors European Technical Centre (as well as support from the Higher Education Funding Council England) this will bring academic and industrial R&D teams together using state-of-the-art equipment and facilities to develop breakthrough designs, technologies and processes in automotive engineering. A case study in Annex A considers the Centre in further detail.
 - The National Transport Design Centre in Coventry due to open in May 2017 will focus on education in transport design, research projects in collaboration with industry, and support for the high-value manufacturing sector and its supply chain to improve design capability.
 - Birmingham (the base for HS2) will be one of the two campuses (alongside Doncaster) of the National College for High Speed Rail, due to open in autumn 2017. The campus will focus on education in civil engineering and command, control and communications.

Further evidencing the Market Strength in Next Generation Transport

SciVal data

- 6.18 The Figure below sets out the disciplines related to Next Generation Transport where the Field Weighted Citation Impact (FWCI, see Table 6-3) average for the universities in the WM SIA outperforms the UK average and the global average respectively. The disciplines cover the full range of sectors, technologies and processes that underpin the Market Strength.

Table 6-3: Research strengths in Next Generation Transport

3-LEP FWCI average above UK	3-LEP FWCI average above global
<ul style="list-style-type: none"> • Energy Engineering and Power Technology • Fuel Technology • Industrial and Manufacturing Engineering • Polymers and Plastics • Transportation³³ • Safety, Risk, Reliability and Quality 	<ul style="list-style-type: none"> • Aerospace Engineering • Automotive Engineering • Ceramics and Composites • Computer Graphics and Computer-Aided Design • Electrical and Electronic Engineering • Materials Chemistry • Mechanical Engineering • Mechanics of Materials • Metals and Alloys • Surfaces, Coatings and Films • Control and Systems Engineering

Source: SQW analysis of SciVal data Note: UK average above global average in all cases

Innovate UK funding

- 6.19 Institutions within the WM SIA area have been very successful in securing competitive funding from Innovate UK in its 'Transport' budget area, demonstrating the quality and potential of our area in undertaking innovation activity in this space. Over the 2010-15 period, WM SIA institutions secured nearly a quarter (24%) of the total grant value offered by Innovate UK in this budget area, securing grants worth over £60m from over 150 individual projects. Projects within the 'Low carbon and electric vehicles' programme accounted for half of this grant funding, with significant funding also secured for projects focused on autonomous vehicles and APC projects.
- 6.20 Two institutions were particularly important in securing this level of grant: Jaguar Land Rover and Warwick University, which together were responsible for around half of the total grant funding secured from Innovate UK in 'Transport' over the 2010-15 period.

Table 6-4: Innovate UK grant offer in Transport budget area

Project activity area	Value (£m)	% funding secured
Low carbon and electric vehicles	30.3	50%
Advanced Propulsion Centre projects	13.1	22%
Autonomous vehicles	7.3	12%
Aerospace (including ATI projects)	2.5	4%
Rail innovation	1.1	2%
Other	6.4	10%

Source: Innovate UK

Sustainable Construction

Scope

- 6.21 The Sustainable Construction Market Strength is grounded in the significant construction industry across the WM SIA area; identified by the WMCA as a transformational sector which

is fundamental to increasing growth and delivering against local strategic priorities. In the context of the construction sector in the round, our Market Strength is particularly focused around the R&D and commercial deployment by industry of energy efficient and lower carbon building technologies, across commercial and residential construction and infrastructure, leveraging the scale and quality of our education, research and technology transfer base.

- 6.22 Across our business base and in our RTOs and research base, we have technical expertise and practical know-how across key technology and market drivers in construction. These include building information modelling (BIM) technologies, off-site manufacture, modular construction, building materials and technologies, and zero-carbon building and efficiency measures. Given the policy imperative at international, national and local levels to deliver more environmentally friendly products, and the resulting regulatory and legislative agenda, demand for lower carbon construction and/or refurbishment products and services will be a major growth opportunity going forward that we are very well placed to respond to. Recent analysis of the broader low carbon sector in our area identified particular strengths in low carbon building materials, technologies, planning and design, building management systems, and climate adaptation risk management.³⁴
- 6.23 The following sub-section highlights the scale of employment in this area and our strategically important construction businesses.

Scale and concentration of activity

- 6.24 The Sustainable Construction Market Strength covers a significant proportion of the economy of the WM SIA area. Taking into account both 'core' construction industries (including the construction of residential and non-residential building, infrastructure construction and supporting trades), and the 'supporting' industries (of architectural activities, quantity surveying activities, and other engineering activities³⁵), the Market Strength supports employment of approaching 114k, with over 18,500 enterprises as shown in Table 6-5.
- 6.25 Across this broad range of economic activity, the LQ of the WM SIA area is 1.1, and somewhat higher for core construction industries including 'Construction of residential and non-residential buildings' (1.3) and 'other specialised construction activities', which includes construction activities requiring specialised skill or equipment.

Table 6-5: Employment (2015) and enterprise (2016) in core and supporting sectors in Sustainable Construction

	Employment	LQ	Enterprises	% UK (av = 5%)
Construction activities				
Development of building projects	1,750	0.4	1,645	4.9%
Construction of residential and non-residential buildings	26,000	1.3	2,210	4.5%
Construction of roads and railways	2,000	0.6	255	5.1%
Construction of utility projects	225	0.2	60	5.4%
Construction of other civil engineering projects	4,500	0.6	805	5.0%
Demolition and site preparation	5,000	3.4	235	5.3%
Electrical, plumbing and other construction installation activities	25,000	1.1	4,405	5.3%
Building completion and finishing	14,000	1.1	3,820	5.4%
Other specialised construction activities n.e.c.	15,000	1.6	1,545	5.2%
Related professional activities				
Architectural activities	3,500	0.7	650	4.3%
Quantity surveying activities	1,500	1.3	325	5.3%
Other engineering activities	15,250	1.0	2,695	5.6%
Total	113,725	1.1	18,650	5.2%

Source: SQW analysis of BRES data

- 6.26 Looking beyond these headline data, an important characteristic of the Sustainable Construction Market Strength is the presence of a number of globally significant firms with their HQs or major facilities in our area, including the HQ in Wolverhampton of Carillion, the UK's second largest construction firm.³⁶ The table below sets out a range of other strategically important construction firms based within the area across housing, commercial development and infrastructure; these firms are augmented by the major engineering consultancies noted above across the area (see Table 6-6).

Table 6-6: Strategic construction companies in the WM SIA area

Black Country	Coventry & Warwickshire	Greater Birm & Solihull
<ul style="list-style-type: none"> A&H Construction and Developments Barhale PLC Construction BriggsAmasco Bullock Carillion Fortel Homeserve Shaylor Group 	<ul style="list-style-type: none"> CEMEX UK Morgan Sindall Saint-Goban Building Distribution Stepnell Holdings 	<ul style="list-style-type: none"> Hill & Smith Holdings Imtech Inviron Interserve Construction Leagro M.V. Kelly Marley Eternit Tarmac Thomas Vale Group

Source: <https://westmidlandscombinedauthority.org.uk/media/1208/wmca-strategic-companies-june-2016.pdf>

Supporting assets and research base

- 6.27 The WM SIA area has a very well developed network of research and innovation assets in Sustainable Construction. As discussed in Section 2, Birmingham University is ranked as one of the top higher education institutions in the UK for Civil and Construction Engineering. It has particular research strengths in structural engineering, including research with industry on novel structural materials, energy-producing structures, renewable energy structures and low and zero-carbon buildings.
- 6.28 The MTC also works extensively with the construction sector. The focus is around four key themes of digital, manufacturing, whole life performance, and skills. The MTC brings significant expertise in modelling, applying the potential for BIM technologies to improve productivity and lower costs due to improved information flow and greater collaboration, and is increasingly seeking to work with the construction industry on the potential for 'construction robots', which are set to be important components of sustainable construction going forward. Reflecting the potential growth in Sustainable Construction, and the potential for sharing processes and expertise between advanced manufacturing and construction, the MTC has recently put together a new team working under the banner of *'Working Together: Transforming Construction'*, to support the sector in meeting the targets set out in the Government's Construction 2025 strategy of reduced costs, faster delivery, lower emissions and increased exports.
- 6.29 More broadly, other complementary assets across the WM SIA area include:
- The Built Environment, Information Systems & Learning Technology Research Centre at the University of Wolverhampton, which researches Engineering, Information Systems, the Built Environment and Sustainability pertaining to people, process, management and education. Specific fields of interest include information systems for management, construction management, retro fit and reclamation, project management, technology mediated training and education, civil engineering, architecture and urban planning
 - The Centre for Environment and Society Research (CESR) at Birmingham City University, which carries out applied research at the interface between the built and natural environment; and the Centre for Low Carbon Research also at Birmingham City University where 'intelligent and sustainable' buildings are a key research focus.
 - The Centre for Low Impact Buildings at Coventry University, which is focused on research in the areas of dynamic performance of buildings, occupant and owner responses, impacts of uncertainty, whole-life decision-making, smart civic structures, and monitoring buildings.
 - Stourbridge College Construction Centre: in September 2016, Stourbridge College opened a newly refurbished £1.5 million Construction Centre, providing state-of-the-art learning facilities in the fields of carpentry and joinery, plumbing, gas and electrical installation, and the Built Environment, which includes construction management and surveying. The centre will increase the number of full-time student places and provides a purpose designed centre of excellence for them to study in.

6.30 Three major developments are also cited that will add substantively to our strength in Sustainable Construction and our ability to maximise its growth potential going forward:

- The University of Wolverhampton's Springfield Campus will seek to position Wolverhampton and the wider Black Country as a national and international hub of excellence for construction and the built environment. The campus is already home to the West Midlands Construction University Technical College (UTC). The regional construction-focussed UTC focuses on modern construction design and build professions and the application of IT in the Built Environment for students from Year 10 to Year 12; the UTC is led by the Construction Industry Training Board. The Springfield Campus will also include an expanded School of Architecture and Built Environment, Built Environment and Climate Change Innovations programme, and the Elite Centre for Manufacturing Skills.
- The National Low Carbon Centre is being established at Stoneleigh Park, backed by HEI partners Aston, Birmingham City, Coventry and Warwick. Focused on the low carbon and energy sectors, it aims to provide a major collaborative platform for research and innovation, knowledge transfer, technology demonstration and deployment, and supply chain exhibitions. Low impact buildings and materials will be one of three core areas of research and innovation for the National Low Carbon Centre, which is also an important emerging asset contributing to the Energy Systems and Storage Market Strength discussed below.
- Reflecting the synergies between our Market Strengths, HS2's national construction headquarters will be based in Birmingham, meaning that the largest infrastructure construction project in Europe will be led and managed from the WM SIA area; alongside the National College for High Speed Rail also to be based on the area (see above). This provides significant Sustainable Construction research, innovation and market opportunities for our area.

Further evidencing the Market Strength in Sustainable Construction

SciVal data

6.31 The Figure below sets out the disciplines related to Sustainable Construction where the average FWCI average for the universities in the WM SIA outperforms the UK average and the global average respectively. The disciplines cover the full range of sectors, technologies and processes that underpin the Market Strength. Importantly, the data indicate that the WM SIA's universities perform above the UK-average in the Buildings and Construction research disciplines, with Coventry and Birmingham universities both performing well-above the UK-average on FWCI in this area.

Table 6-7: Research strengths in Sustainable Construction

3-LEP FWCI average above UK	3-LEP FWCI average above global
<ul style="list-style-type: none"> • Building and Construction • Engineering (miscellaneous) • Environmental Engineering • Renewable Energy, Sustainability and the Environment³⁷ 	<ul style="list-style-type: none"> • Architecture • Civil and Structural Engineering • Geography, Planning and Development • Pollution • Surfaces, Coatings and Films • Urban Studies

Source: SQW analysis of SciVal data Note: UK average above global average in all cases

Local innovation community perspectives

“The Black Country’s GVA has reached a six year high of 20.2bn, representing 17% of the West Midlands. The LEP supports businesses and industries across the Black Country to increase GVA and the Science and Innovation Audit, commissioned with our LEP partners across the West Midlands and the prime aim is to drive up productivity across the region and thus positively impact on GVA. The report will be used to raise the profile of science and innovation in regional growth; provide an evidence base for funding bids and inform our future strategies, which will inform the continued work of the LEP to uplift GVA. Working with partners the LEP has used funding to support the £100 million development at the former Springfield brewery site in Wolverhampton, to becoming the home of the West Midlands Construction University Technical College, the University’s School of Architecture and Built Environment, and the Elite Centre for Manufacturing Skills, being transformed into Europe’s largest specialist construction and built environment campus; HVM City an innovative, interactive platform which captures our total investment opportunity, has an ambition to support 10,000 plus companies and which can exploit major capital programmes due to be delivered in this country and locally with ambition to Create 25,000 new jobs and create over £1bn GVA uplift. At Hadley Industries we have ourselves utilised science and innovation across our production methods and developed an innovative process that could be applied to roll formed steel - UltraSTEEL® - with modern technology combining with traditional craftsmanship to improve already high standards of quality, and make roll forming even more versatile, dependable, productive and efficient.”

Stewart Towe CBE, DL - Group Chairman, Hadley Industries

Innovate UK funding

- 6.32 Our institutions have been successful in securing competitive funding from Innovate UK in areas related to Sustainable Construction. Over the 2010-15 period, our institutions secured approximately £4m in grant funding for innovation projects, equal to 4% of the total across the UK as shown in Table 6-8. The Low Impact Buildings grants included 30 projects in which 25 institutions from across the WM SIA were involved including Aston University, Birmingham City University, Coventry University, and University of Warwick, Encraft, a Leamington-based consulting engineering firm focused on energy efficiency and low carbon buildings, and Carillion.

Table 6-8: Innovate UK funding in Sustainable Construction

Budget holder	Value (£m)	Proportion of UK total
Low Impact Buildings'	3.1	3%
Buildings	0.8	7%
Total	3.9	4%

Source: Innovation UK

Energy Storage and Systems

Scope

- 6.33 The Energy Storage and Systems Market Strength draws on the excellence across the WM SIA's research base including its universities and innovation assets, and focuses on two related areas:
- Energy storage, which covers the development of a range of technologies including batteries (materials and chemistry), and hydrogen storage. Energy storage relates to the decarbonisation of transport systems through electric vehicles and integration with solar systems and grid level storage to complement intermittent renewable energy sources. In the domestic sector, where heat currently accounts for over 40% of the UK's energy demand, significant innovation opportunities exist in designing and delivering low-carbon energy services to consumers that use Energy Storage as part of the answer.
 - Energy Systems, which focuses on the development, deployment and use of intelligence to integrate the actions of all the components in the energy system. Innovation opportunities to exploit smart energy systems exist principally at the 'system edge' (in the 'last mile' of supply), adjacent to the point of use and 'behind the meter' in the consumer's home or premises. Underpinning R&D and industrial activities relates to the use of sensors and controls, the collation and use of data including the architectures which will enable them to be deployed effectively, power systems, and modelling and simulation capabilities to analyse system behaviour under change.
- 6.34 The Market Strength in Energy Storage and Systems also draws on, and is underpinned by, the significant core energy industry across the area, including some of the UK's leading energy supply businesses, and new market entrants focused on innovation in the provision of energy to consumers and businesses. These are identified in Table 6-9 below.
- 6.35 The existing strength and future potential of the WM SIA area in energy is reflected in the development of the 'Energy Capital', launched in early-2017 that is focused on promoting energy innovation across the West Midlands. Focused on the significant energy needs of a population of over four million, living in 1.7 million homes, Energy Capital has two objectives: to ensure the vibrant and growing economy of the West Midlands is supported by a competitive, flexible and secure modern energy system providing low cost, clean and efficient power to its industries and people; and to make the West Midlands the most attractive location to develop and build an innovative, smart energy technology company in the world.

Scale and concentration of activity

- 6.36 The Energy Capital development estimates that there are 10,000 'energy related' companies operating across the WM SIA area: not all of these firms will be involved directly in Energy Storage and Systems, however, this industry base provides the underpinning skills-base and industrial capacity within which innovation and R&D in energy in the area is being delivered.
- 6.37 The Table below sets out data on the number of employees, LQs and number of enterprises with direct relevance to the Market Strength; the energy sector is (like others) challenging to define precisely, explaining the slight difference in terms of the scale of the business base to the estimate from Energy Capital (this may also be explained by the fact that the data presented are for enterprises, not individual business units).
- 6.38 A high LQ is evident for the 'core' Energy sector of 'Electricity, gas, steam and air conditioning supply', based on around 11,000 employees across the WM SIA (including 5,000 in the Black Country).

Table 6-9: Employment (2015) and enterprise (2016) in core and supporting sectors in Energy Storage and Systems

	Employment	LQ	Enterprises	% UK (av = 5%)
Core Energy industries				
Manufacture of coke and refined petroleum products	225	0.5	5	4.8%
Manufacture of other organic basic chemicals	500	0.9	-	-
Manufacture of batteries and accumulators	50	0.4	5	8.3%
Manufacture of electric lighting equipment	1,250	1.5	145	3.4%
Electricity, gas, steam and air conditioning supply	11,000	1.4	5	4.8%
Water collection, treatment and supply	3,500	1.7	10	11.1%
Waste collection, treatment and disposal activities; materials recovery	7,000	0.9	60	7.4%
Remediation activities and other waste management services	900	2.5	-	-
Test drilling and boring	125	1.4	10	11.1%
Supporting industries				
Engineering activities and related technical consultancy	23,000	1.0	4,740	6.1%
Technical testing and analysis	5,000	1.3	310	5.1%
Specialised design activities	3,000	1.0	2,205	4.9%
Other professional, scientific and technical activities n.e.c.	8,000	1.2	4,740	6.1%
Total	63,550	1.0	8,870	5.5%

Source: SQW analysis of BRES data

- 6.39 The high LQ for 'Electricity, gas, steam and air conditioning supply' reflects the presence in the area of some of the largest and most important energy firms in the UK, including National Grid, E.ON UK, Worcester Bosch and npower, as well as some of the newest and most innovative, such as First Utility and Co-operative Energy, both based in Warwickshire. Further examples of strategic energy companies across the area include Baxi Heating, and GE Power Conversion.

Supporting assets and research base

- 6.40 The scale of the energy sector is an important foundation for our Energy Storage and Energy Systems Market Strength. However, given the science-rich nature of this area, and the early-stage of much of the technology which is not yet fully commercialised, as important is the range of research and innovation assets. Two assets of national significance are key here.
- 6.41 First, the Energy Systems Catapult, which is based in Birmingham, and is leading on the UK's innovation in the development and commercial exploitation of smart systems in an energy context. The Catapult is currently executing innovation projects focused on delivery of smart heat services to domestic consumers, and provides networked links to other Catapults holding enabling capabilities for 'smart infrastructure' (Transport, Digital, Future Cities and Satellite Applications). The Catapult is working to address three key gaps in the UK's energy innovation landscape³⁸:
- A whole systems view of the energy landscape to help innovators understand how their product fits into the energy transition and how best to accelerate its exploitation.
 - Expertise in integrated energy systems: to help innovators overcome the systems integration barriers (social, technical and economic) of assimilating their products into a highly complex energy system.
 - Developing, deploying and managing multi-stakeholder, real-world demonstration and scale-up environments designed to accelerate innovation.
- 6.42 Second, The Energy Research Accelerator, a cross-disciplinary energy innovation hub across the Midlands, which brings together capital assets, data and intellectual leadership to foster collaboration between academia and business to accelerate the development of solutions to the global energy challenge. ERA's initial priorities of Geo-Energy Systems, Integrated Energy Systems and Thermal Energy will help deliver the new technologies and behaviours that will open the avenues for its future development and demonstrate the transformative effect the collaboration can have across the energy spectrum. This involves the universities of Aston, Warwick and Birmingham, working alongside with our Midlands Engine partners at Nottingham, Leicester and Loughborough.
- 6.43 More widely, key assets in the WM SIA area include EPSRC Centres for Doctoral Training at the University of Birmingham, one in Carbon Capture and Storage and Cleaner Fossil Fuel Energy, and the other in Fuel Cells and their Fuels; the European Bioenergy Research Institute at the University of Aston; the Willenhall Battery Storage Test Facility; the Energy Innovation Centre at WMG, focused on the development of new battery chemistries from concept through to full proven traction batteries; and the Centre for Cryogenic Energy Storage and Centre for Fuel Cell Research at Birmingham University. Our universities have also been heavily involved

in the SUPERGEN programme, with Aston a partner of the Bio-Energy Hub, and Birmingham and Warwick partners of the Energy Storage Hub.

- 6.44 These research centres are complemented by the Climate-KIC Accelerator programme delivered at iCentrum. This is a two-stage programme where participants attend a 'pitch day' to progress onto the second stage and become eligible for further financial support as well as continued coaching and access to hot-desk space. The programme is led by the Climate-KIC, one of three Knowledge and Innovation Communities (KICs) created by the European Institute of Innovation and Technology (EIT); one of the Climate-KIC's two UK offices is based at the Innovation Birmingham Campus.

Further evidencing the Market Strength in Energy Storage and Systems

SciVal data

- 6.45 The Figure below sets out the disciplines related to Energy Storage and Systems where the average FWCI average for the universities in the WM SIA outperforms the UK average and the global average respectively. The data from Sci Val complement and support fully the findings from the REF 2014 regarding the breadth of energy-related science in our institutions

Table 6-10: Research strengths in Energy Storage and Systems

3-LEP FWCI average above UK	3-LEP FWCI average above global
<ul style="list-style-type: none"> Bioengineering Energy Engineering and Power Technology Energy (miscellaneous) Fuel Technology General Chemical Engineering General Energy Renewable Energy, Sustainability and the Environment³⁹ 	<ul style="list-style-type: none"> Biomaterials Electrical and Electronic Engineering Nuclear Energy and Engineering

Source: SQW analysis of SciVal data Note: UK average above global average in all cases except Energy (miscellaneous)

Innovate UK funding

- 6.46 Institutions within the WM SIA area have secured approximately £7m of competitive funding from Innovate UK in areas related to Energy Storage and Systems over the 2010-15 period, specifically within the 'Energy' and 'Sustainability' budget areas. This accounts for 4% of the total across the UK.
- 6.47 However, this data underestimates significantly the scale of innovation investment in Energy Storage and Systems as it does not include the £180m Energy Research Accelerator (ERA), which includes £60m Government capital investment; £100m of co-finance from private companies; and £20m from the Midlands Innovation universities, including Warwick, Birmingham and Aston. Further, given the focus of the Market Strength on early-stage research, it is also notable that Warwick, Birmingham and Aston universities collectively account for 20% of all EPSRC's current portfolio of grants in the 'Energy Storage' research theme, some c.£13m in research grants, with Warwick and Birmingham both in the top five recipients.

Technologies for Better Health

Scope

- 6.48 The Market Strength has a focus on medical technologies, covering the R&D, design and production of devices, diagnostics, (including in-vitro diagnostics), and software as a medical device. This includes technologies developed for trauma, but with wider applications.
- 6.49 The Market Strength also covers the economic growth opportunity from the application and commercialisation of research strengths in translational medicine from our clinical and research base, and the accelerated access to new drugs, treatments and health technologies: institutions in our area play an important role supporting national and international pharma firms through the innovation process from discovery through clinical trials and into adoption.
- 6.50 Whilst evident across the WM SIA area, with medical technology firms in all three LEP areas (see table 6-11 below), and important clinical and medical health research access across our geography, the Technologies for Better Health Market Strength also has a particular spatial (and community) concentration around Birmingham's developing Life Sciences Campus in Edgbaston.
- 6.51 This draws on a critical mass of complementary high quality clinical and research assets including leading national clinical trials and experimental medicine facilities, with a long-term strategic ambition to develop Birmingham as an internationally leading life sciences cluster. This will be based on leveraging the existing range of assets in the Edgbaston area including the QE2 Hospital (including the Royal Centre for Defence Medicine), Birmingham Women's Hospital, Birmingham Children's Hospital, the University Medical School, the largest Wellcome Trust Clinical Research Facility in the UK, assets including the Advanced Therapies Facility, Human Biomaterials Resource Centre, and NIHR Trauma Research Centre, the Institute of Translational Medicine, and Birmingham Research Park, including the BioHub. Multidisciplinary research expertise spanning from biology, medicine and maths/engineering to social sciences, law and ethics complements and works in collaboration with clinical expertise in patient data and informatics, genomics and surgery.
- 6.52 Work has also been undertaken to bring forward a new Life Sciences Park as part of the integrated University-NHS campus in Edgbaston, directly adjacent to the University of Birmingham, University Hospitals Birmingham and Birmingham Women's Hospital. This site is capable of supporting over 400,000sq ft of commercially-focused space bringing together academic and clinical capabilities with industry opportunities, significantly increasing the region's capacity to drive accelerated access to, and adoption of, devices and diagnostics and novel interventions (e.g. rehabilitation) - acting as an "integrator" of assets and expertise rather than a traditional "incubator".

Scale and concentration of activity

- 6.53 Our area is a national leader in medical-technology business activity. Using SIC codes to define the medical technologies sector(s) is particularly problematic as the sector cuts across parts of a number of different SIC codes. This said, BRES data indicates some 3,000 employees in the tightly focused 'Manufacture of medical and dental instruments and supplies' SIC code, with a LQ of over 1.2, suggesting a high level of specialisation. Further, national data indicate

there were 135 enterprises in this SIC code in 2016, accounting for 7% of the total across Great Britain.

- 6.54 However, a broader perspective in the scale of current business activity in Technologies for Better Health is provided by the Office of Life Sciences' (OLS) 'Strength and Opportunity' 2015 dataset. This suggests there are 295 'core' medical technologies businesses in the WM SIA, and a further 79 associated 'service and supply' businesses; representing 11% and 8% of the UK totals respectively. The table below draws out the ten detailed sub-sectors where the WM SIA area had the highest relative share of UK companies, illustrating our specific areas of strength, including such Dental and maxillofacial technology, Ophthalmic Devices and Infection Control.

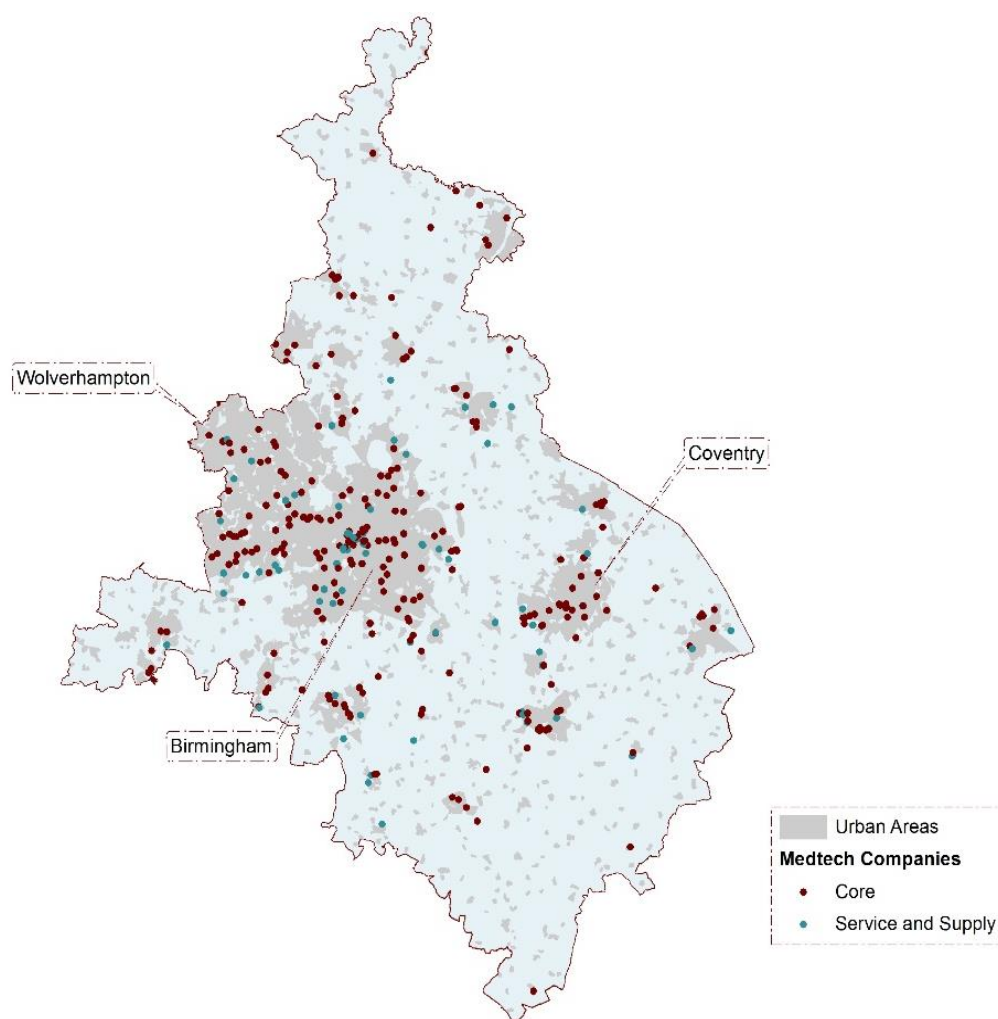
Table 6-11: Top 10 segments by share of UK companies (2015)

	No. companies	Share of UK companies in given segment
Dental and maxillofacial technology	36	26.3%
Ophthalmic Devices/Equipment	17	19.3%
Infection Control	20	17.7%
Assistive Technology	50	14.3%
Contract design*	10	14.3%
Anaesthetic and respiratory technology	11	14.1%
Mobility Access	18	11.8%
Wound Care and Management	13	11.4%
Orthopaedic Devices	16	10.6%
Single use technology n.e.c.	23	10.5%

Source: SQW analysis of OLS data. Note that Contract design is applicable to Medical Technology and Biopharmaceutical

- 6.55 The distribution of these businesses throughout the WM SIA area is shown in
- 6.56 Figure 6-1. Whilst these businesses are spread throughout our geography, there are particular concentrations in Birmingham, reflecting the complementary presence of incubator facilities (and incubation services) at the Birmingham Biohub, leading research at the University of Birmingham, and clinical excellence at the adjacent University Hospitals Birmingham/Birmingham Women's & Children's Hospital sites. This is the concentration of medical technology and life sciences businesses that the strategic focus to develop the area is seeking to exploit and maximise going forward.

Figure 6-1: Locations of med tech companies in the three-LEP area (2015)



Source: Produced by SQW 2017. Licence 100030994. Contains OS and National Statistics data © Crown copyright [and database right] [2016]. Contains Office for Life Sciences data

6.57 To provide an illustration of the innovation and excellence in our med-tech businesses, the ‘medtech core’ companies with the highest reported levels of turnover and employment in the OLS database for our geography are presented below, together with a short description of their operations in Table 6-12. Demonstrating that our strengths are not confined to this area, Table 6-13 shows strategic companies across the whole of the life sciences industry, including pharmaceuticals, identified by research by the WMCA.

Table 6-12: Largest core medical technologies companies by turnover and employment (2015)

Acedag	<ul style="list-style-type: none"> ACEDAG manufactures a wide range of products and solutions for infection control and the safe disposal and packaging of hazardous materials
Salts Healthcare, Birmingham	<ul style="list-style-type: none"> Salts provides products and services in stoma care, and employs over 500 people, with distributors in 22 countries
Sandvik Medical Solutions	<ul style="list-style-type: none"> Part of Sandvik Materials Technology, their products are in the cardiovascular, diagnostics and sensors; dental; joint reconstruction; spine; surgical tools and instruments; and trauma areas
Smiths Medical International	<ul style="list-style-type: none"> Smiths Medical is a leading global provider of medical devices for the hospital, emergency, home and specialist environments

Source: SQW analysis of OLS data

Table 6-13: Strategic life science companies in the WM SIA area

Black Country	Coventry & Warwickshire	Greater Birm & Solihull
<ul style="list-style-type: none"> C. S. T. Pharma 	<ul style="list-style-type: none"> AAH Pharmaceuticals Alliance Medical Group Barclay Pharmaceuticals Evolution Homecare Services Lloyds Pharmacy Orbit Group 	<ul style="list-style-type: none"> Beiersdorf UK Clinigen Group Embrace Group Halcyon Topco Healthcare At Home Lexon UK

Source: <https://westmidlandscmbinedauthority.org.uk/media/1208/wmca-strategic-companies-june-2016.pdf>

Supporting assets and research base

- 6.58 Recognising that innovation in the Technologies for Better Health market requires academic, business and clinical actors, our businesses leverage key research and clinical assets to support their growth and development. Networks and organisations such as the West Midlands Academic Health Science Network and Birmingham Health Partners are important parts of this support base.
- 6.59 More broadly, the data presented in Section 2 indicated the quality of the academic research conducted in our area: notably, the FWCI of Medicine publications is higher than for any other subject area, and well above the UK-average. This is supported by data from the REF 2014 which ranked the University of Birmingham in the Top 10 for two medical research areas, and Aston in one. Both of these universities have medical schools, as does Warwick. Aston University's School of Pharmacy holds a prestigious Regius Professorship – one of just 12 new Regius professorships announced in 2016, and the only one for Pharmacy; at the same time, Warwick University was awarded a Regius professorship in Manufacturing, adding to the existing Regius professorship in Mathematics at the University.
- 6.60 Further key assets and research centres are summarised in the table below, note that this includes clinical research assets as well as academic research centres.

Table 6-14: Technologies for Better Health research centres

Aston University	<ul style="list-style-type: none"> Aston Brain Centre Aston Research Centre for Healthy Ageing Centre for Vision and Hearing Research Aston Medical Research Institute
Birmingham Health Partners	<ul style="list-style-type: none"> Birmingham Centre for Clinical Trials The UK's largest NIHR/Wellcome Trust Clinical Research Facility West Midlands Genomics Medicine Centre West Midlands Regional Genetics Laboratory Royal Centre for Defence Medicine and The National Institute for Health Research Surgical Reconstruction and Microbiology Research Centre - a national centre for trauma research Institute for Translational Medicine Arthritis Research UK Experimental Arthritis Treatment Centre EPSRC CDT in Physical Sciences for Health NIHR Biomedical Research Centre in Inflammatory Disease MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research

	<ul style="list-style-type: none"> • Cancer Research UK Clinical Trials Unit • Medical Devices Testing and Evaluation Centre (MD-TEC) • Cancer Research UK Centre and Experimental Cancer Medicine Centre • Centre for Precision Spinal Rehabilitation
Warwick University	<ul style="list-style-type: none"> • Institute of Digital Healthcare • Zeeman Institute for Systems Biology & Infectious Disease Epidemiology Research
Wolverhampton University	<ul style="list-style-type: none"> • Centre of Health and Social Care Innovations • Neuro-Oncology Research Centre • Research Institute in Healthcare Science

Source: SQW analysis

- 6.61 Alongside our universities, in particular the teaching of professions allied to medicine at Birmingham City, Coventry and Wolverhampton universities, the Health Futures University Technical Centre in West Bromwich helps to ensure that there is a pipeline of skilled labour to support the growth of the sector. WM SIA partners are also key members of the West Midlands Collaboration for Leadership in Applied Health Research and Care (CLAHRC), a five-year initiative funded by the National Institute of Health Research (NIHR) and matched funds provided by local health and social services. The initiative builds on the successful CLAHRC for Birmingham and Black Country pilot, with a mission to create lasting and effective partnerships across health and social care organisations, universities (Birmingham and Warwick in the WM SIA area, and Keele) to improve service delivery for patient benefit.
- 6.62 There are also supporting assets for our innovative private sector firms including the accelerators and incubators identified by BEIS research:
- The BioHub Birmingham offers a fully serviced biomedical research laboratory to start-ups to help support their growth into more mature businesses able to attract investment. Office space is also provided for the 20+ firms who can be accommodated at any one time.
 - One of the target areas for the Serendip Smart City incubator is digital health. In partnership with the WMAHSN, three challenge areas have been identified: digital tools to support people at risk of mental health crisis; data analytics to support better mental health and care; and improving the lives of people with diabetes through medicine optimisation.
 - A partnership between the Hub Launchpad and PocZero run Birmingham's first health and wellbeing accelerator. The first cohort of 15 ventures have successfully graduated having received training, mentoring and networking connections.

Further evidencing our market strength

- 6.63 The following sub-sections present further evidence to demonstrate our market strength in Technologies for Better Health.

Clinical trials

- 6.64 Data from the NIHR indicates the importance of the WM SIA areas as a location for designing and delivering clinical trials, focused on progressing the next generation of novel drugs and treatments. In 2015/16, University Hospitals Birmingham had 317 studies recruiting participants (ranked 14th in England on number of studies recruiting) and 5,735 study participants (ranked 16th in England on number of study participants), just behind the Heart of England NHS Foundation Trust whose trials had approaching 6,000 participants (15th in England). Our region has the capacity and capability to deliver clinical trials on a large scale and support the acceleration and translation of new treatments.

Table 6-15: Key clinical trials hubs (2015/16)

	Number of studies recruiting		Participants in studies	
	No.	Rank	No.	Rank
Sandwell And West Birmingham Hospitals NHS Trust	112	51	2,513	60
Birmingham Children's Hospital NHS Foundation Trust	103	54=	1,809	82
Heart of England NHS Foundation Trust	167	31	5,989	15
The Royal Wolverhampton NHS Trust	159	34=	1,996	77
The Dudley Group NHS Foundation Trust	92	61	1,358	103
University Hospitals Birmingham NHS Foundation Trust	317	14	5,735	16
Birmingham Women's NHS Foundation Trust	59	100	4,518	24

Source: SQW analysis of NIHR data

- 6.65 Our region also offers proven accelerated clinical trials models. For example, the Birmingham-led Trials Acceleration Programme delivers early phase trials at a pace which has halved average set-up time, reduced per-patient costs and leveraged more than £200 million of novel therapies from industry partners. We also run the largest precision medicine clinical trial in the world (Lung MATRIX), only possible due to the unique combination of trials design and delivery expertise alongside local genotyping capabilities and patient recruitment networks. Evidence indicates that our *“large, diverse and stable population ... offers the relatively high incidence of genetic diversity and diseases”* which means that the impact of a treatment on a diverse population can be studied within the borders of our region.⁴⁰ The model is being extended in the newly opened Institute for Translational Medicine.

SciVal data

- 6.66 The table below areas where the FWCI of publications authored by our universities is above the UK and global average. This highlights the strength of our research in Biomedical Engineering, where the University of Warwick performed very strongly, and Radiological and Ultrasound Technology where both Warwick and Birmingham had high FWCI. Further to the detailed disciplines set out in the Table, the FWCI for the ‘Dentistry’ subject area was well-above the UK-average, owing to high FWCI for Warwick and Birmingham Universities.

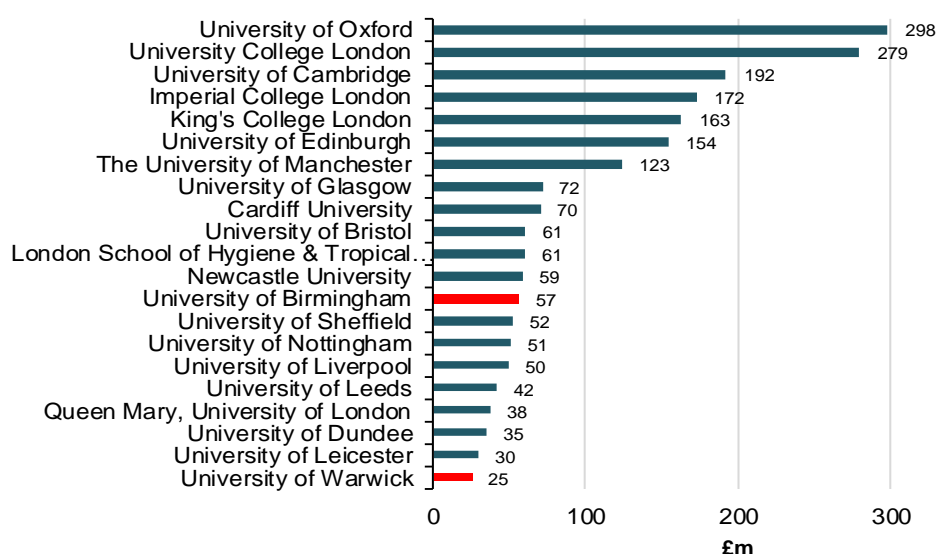
Table 6-16: Research strengths in Technologies for Better Health

3-LEP FWCI average above UK	3-LEP FWCI average above global
<ul style="list-style-type: none"> • Biomedical Engineering • Health Informatics • Radiological and Ultrasound Technology 	<ul style="list-style-type: none"> • Computer Science Applications • Software

Source: SQW analysis of SciVal data

Funding data

- 6.67 Data from Innovate UK show that organisation in our area were awarded £4.2m of grants over 2010-15 in the Healthcare budget area, representing 2% of the UK total, and a further £1m in grants was offered under the Bioscience are budget holder (3% of UK total). Looking at funding for health research more broadly, data from the Medical Research Council (MRC) indicates active funding for grants and fellowships (i.e. funding for on-going projects) of £56m for the University of Birmingham (the 13 highest of UK institutions), £25m for the University of Warwick, and Aston University £1.2m.

Figure 6-2: Active MRC grants and fellowships awards by institution

Source: Medical Research Council Grants and fellowships awarded (as of November 2016)

- 6.68 Funding for health research is also provided by many other charities, philanthropic organisations and public bodies. The UK Clinical Research Collaboration collates data from over 60 funding organisations on relevant funding awards. Excluding MRC funding, the data indicated awards with a combined value of approximately £49m were active in our area in 2014 (the latest available data), 2% the UK total. Organisations in Birmingham accounted for 75% of the total, with organisations in Coventry (including the University of Warwick) accounting for the majority of the remainder. Funders included Cancer Research UK (£12m), the Wellcome Trust (£7m), and British Heart Foundation (£2m).
- 6.69 The data on the proportion of health research funding may appear low. However, it is important to recognise the long-term dominance in UK health research of a small number of institutions (including the so-called 'Golden Triangle') as reflected in the Figure above, which provides clear 'path dependency' challenges for other places (i.e. competitive funding goes to

those places that have the highest quality of research, which is as a result of previous funding rounds). If the funding for institutions in London, East Anglia and the South East is removed, for the UK Clinical Research Collaboration data the WMCA accounts for 7.8%, (compared to 3.1% when these areas are included, as noted above).

6.70 We are addressing this issue both by working closely in partnership with these places – for example the recently established ‘M40 alliance’ between the Universities of Oxford and Birmingham to speed up the development of novel treatments for arthritis, supported by a £7m investment from the Kennedy Trust for Rheumatology Research – and through investing heavily in the infrastructure – hard and soft - in our area, to ensure that we can compete in a competitive funding environment. For example:

- The establishment of the Medical Devices Testing and Evaluation Centre (MD-TEC) between University Hospitals Birmingham NHS Foundation Trust, the University of Birmingham, and Aston University will see a multi-million pound investment in accelerating the translation of novel innovations in the laboratory through to the clinic and commercial exploitation.
- University Hospitals of Coventry and Warwickshire NHS Trust has recently been awarded ‘Clinical Research Facility’ status by the National Institute for Health Research (NIHR), with the NIHR providing £750,000 over the next five years to support research.

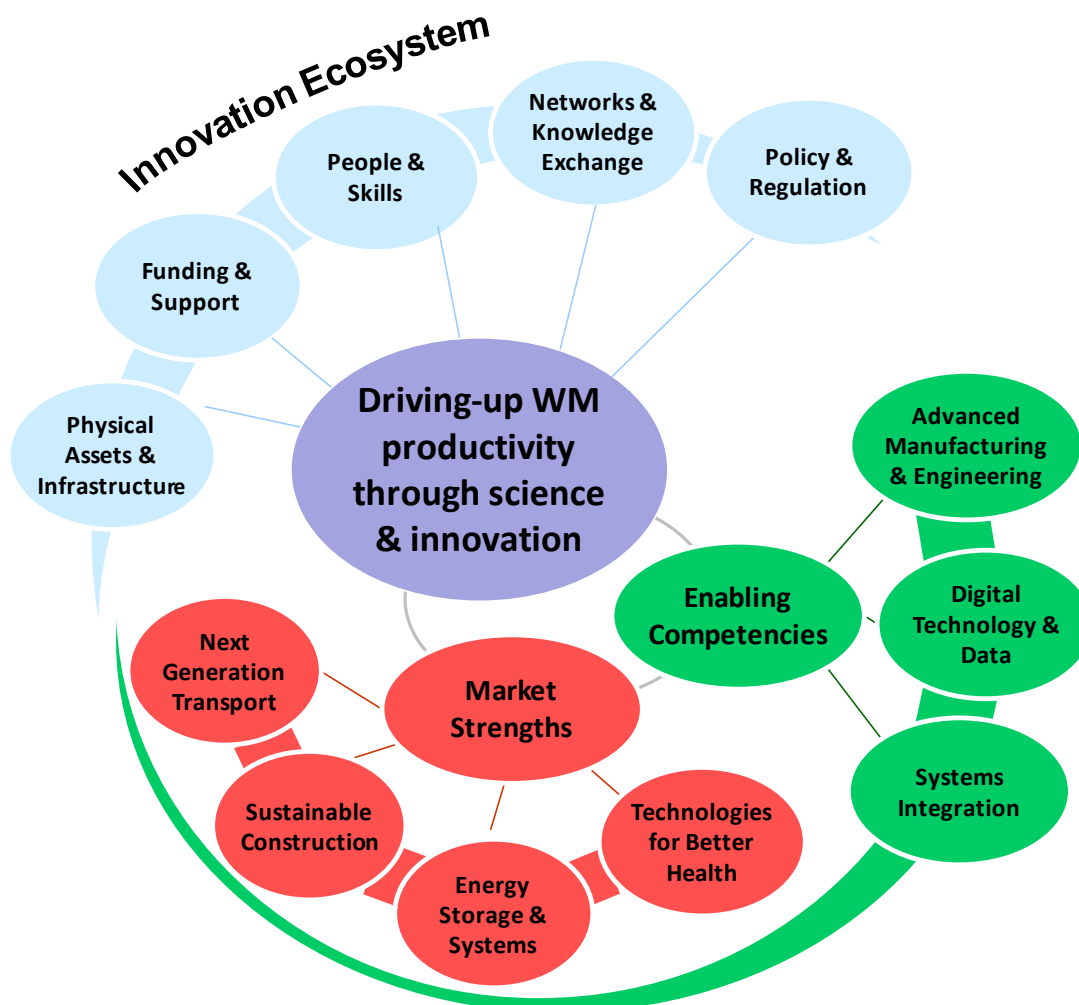
7. Key findings and moving forward

- 7.1 As the single largest functional economic area in England outside of London, and home to some of the country's leading science and innovation assets, the WM SIA area combines both scale and excellence in terms of its science and innovation offer. Building on the Midlands Engine SIA⁴¹, this complementary, more granular and tailored audit was commissioned and funded by the three LEPs associated with the WM Combined Authority (Black Country, Coventry and Warwickshire and Greater Birmingham and Solihull). The purpose of this West Midlands SIA was to identify our science and innovation strengths and areas of potential for the future, to inform decision making, interventions and investments by partners and to strengthen our proposition to potential inward investors and external partners.

Key findings and messages from the SIA

- 7.2 Despite the many strengths of the **West Midlands economy**, productivity performance is persistently well below the national average level. There is no short-term fix, but leveraging our science and innovation excellence to lead to investment in new products and processes and in turn drive-up productivity is a core focus of this SIA process, reflecting the commitment of partners across the area.
- 7.3 The WM SIA area has a strong **Research Landscape** including eight universities. We are also home to two of the UK's strategically important Catapults (in High Value Manufacturing, and Energy Systems), and a critical mass of leading research translation organisations, including in advanced manufacturing, energy and healthcare innovation.
- 7.4 Importantly, whilst we value the contribution of the wide range of science and innovation assets identified in this SIA, we are also confident in recognising the importance of four key innovation system 'anchors' in the context of our SIA Framework: the universities of Birmingham and Warwick (including Warwick Manufacturing Group); the Manufacturing Technology Centre in Coventry; and Jaguar Land Rover. Together, these organisations characterise and embody the excellence in science and the commercialisation of knowledge in our area, and are responsible for much of our nationally and internationally significant science and innovation activity: for example, collectively they accounted for two-thirds of all Innovate UK funding into the WM SIA over 2010-15.
- 7.5 Crucially, the four anchor institutions also play an important role as collaborators with other organisations across the public and private sectors, as well as the research landscape (in the UK and overseas), including our other HEIs, our large and diverse SME base, and wider network of research and technology organisations. The leadership of these anchor institutions will be critical moving forward, but equally, we must also focus on strengthening this wider offer, ensuring that the diversity of our institutions, assets and expertise, is a continuing feature of our expanding and maturing innovation ecosystem.
- 7.6 The following **West Midlands SIA Framework** has been developed to highlight the way that the Innovation Ecosystem, the Enabling Competencies and the Market Strengths identified through this report interact and complement one another. Indeed, it is where the market

strengths and enabling competences converge, supported by a well-developed ecosystem that the best science and innovation in our area happens, as illustrated by case studies (Annex A).



7.7 The evidence collected as part of this SIA process suggests that the various components of our **Innovation Ecosystem** are generally working well and are highly successful. Alongside our very strong asset base in both science and innovation we have a well-developed set of networks and relationships, and a longstanding policy commitment that provides fertile ground for supporting and embedding innovation behaviours across our business base.

7.8 However, continuing to build and maintain the innovation ecosystem is vital as it underpins our ability to exploit our excellent science base to improve productivity and prosperity. The following challenges to developing the innovation ecosystem have been identified:

- The low skills levels in the region is the greatest weakness in the ecosystem
- Our ability to secure funding from the public and private sectors could be improved, including both R&D resources and funds for process scale up or capital investment required to move from R&D to increased productivity
- We need to continue to drive higher levels of knowledge exchange between the universities and business and across technology areas/sectors

- Access to ERDF monies has played an important role in helping us to build our innovation ecosystem. The loss of this source of funding could be very detrimental if no alternative is made available
- We must continue to develop our physical infrastructure to keep up, and anticipate the need for grow-on space as we encourage the growth and development of our innovative businesses
- Maintaining a geographic spread of assets and networks is also important to make it easy for start-ups to find supportive locations and for easy engagement of SMEs with science and innovation bases.

7.9 This SIA audit process has identified three **Enabling Competencies** that characterise our modern knowledge-economy, and where we have both a concentration of assets, and genuine expertise across the private and public sectors:

- **Advanced Manufacturing and Engineering:** reflecting our pervasive leading-edge technical knowledge, and practical know-how in the research and industry base, in designing, validating, producing, and servicing new products and industrial processes. The competence supports a broad and integrated range of sectors and markets – including food and drink manufacturing, automotive, aerospace, rail, electronics, construction, and energy.
- **Digital Technologies and Data:** with strengths in the area’s academic, research and industrial base in exploiting and understanding big data, analytics, simulation and modelling etc. and the use of digital technologies and media in product, process and service development and commercialisation across the full range of markets and sectors.
- **Systems integration:** assets, expertise, and insight in the area’s academic, research and industrial base on how increasingly complex systems – including energy systems, manufacturing processes, service delivery, and logistics – can be better designed, managed and operated, to deliver improved performance and outcomes.

7.10 These Enabling Competencies underpin and support our four specific areas of market strength (see below) where there is existing excellence and major growth opportunities for the future, so they should be supported through continued efforts to develop and impact across our range of market strengths.

7.11 The four **Market Strengths** identified in this SIA range from established world class strengths, to markets in which we are just beginning to realise our full potential, but all have significant scope for on-going development that will increase the productivity of the WM SIA geography:

- **Next Generation Transport:** building on a critical mass of globally competitive businesses, and technically specialist SMEs, operating within and across a range of transport-related industries, with a focus on the automotive and aerospace sectors, and their reinforcing supply-chains. Significant opportunities for growth are provided by the next generation of rail technology, in part through links to HS2, and connections with the Midlands motorsport cluster centred in and around Silverstone.

- **Sustainable Construction:** grounded in the significant construction industry across the area, and the R&D and commercial deployment by industry of energy efficient and lower carbon building technologies, across commercial and residential construction and infrastructure, leveraging the scale and quality of our education, research and technology transfer base. We have the opportunity to buck the trend of construction being one of the UK's least innovative sectors (BEIS Innovation Survey 2015).
- **Energy Storage and Systems:** grounded in scientific excellence across our knowledge base, we have significant potential in the development and commercial application of a range of technologies in energy storage including batteries (materials and chemistry), and hydrogen storage, and in supporting the developing of effective energy systems covering the development, deployment and use of intelligence to integrate the actions of all the components in the energy system.
- **Technologies for Better Health:** focused on developing further our nationally-significant medical technologies sector, covering the R&D, design and production of devices, diagnostics, and software as a medical device; and the growth opportunity from the application and commercialisation of our research strengths in translational medicine, and accelerated access to new drugs, treatments and health technologies, leveraging the opportunity around Birmingham's developing Life Sciences Campus.

Next steps

- 7.12 The WM SIA provides **a wealth of evidence that can and should be used** to: inform policy and guide interventions; stimulate new ideas and explore new collaborations; and strengthen cases to attract investment and external partners. The WM SIA will be widely available so that it can be used by partners across the innovation ecosystem, by the three LEPs, and the WMCA.
- 7.13 **The WM SIA is particularly important for the LEPs and the WMCA** for whom the work was conducted as the findings can help partners deliver on the following core objectives:
- **Closing the productivity gap.** The SIA points in detail to market strengths and enabling competencies where support might have the greatest impact, together with evidence of areas of particular challenge in the underpinning ecosystem. The WM SIA can directly inform the work of the WMCA Productivity and Skills Commission with respect to innovation as one of the five identified drivers of productivity.
 - **In a strong WM innovation ecosystem, the 'weakest link' is a shortage of skilled people.** If we are to fully exploit the market opportunities and enabling competencies identified in this WM SIA, there needs to be a stronger connection of the innovation ecosystem with local skills interventions, further exploration of targeted education and training around the emerging science and innovation opportunities, and capitalisation on scarce skills by focussed innovative capital investment.
 - **Reform of public services across the West Midlands.** The public sector is a critical part of our innovation ecosystem and in some of our market priorities and enabling competencies, partners are already actively engaging with research and innovation agendas. Continued support and collaboration could allow science and innovation to play a significant role in the public sector reform programme, not just improving

efficiencies, but enabling completely new ways of delivering services. The UK Industrial Strategy looks set to place emphasis on stimulating innovation through procurement, including the extension of SBRI and driving changes in public sector procurement practices; this is an opportunity to be exploited in the West Midlands.

- **Delivery of priorities of the WMCA SEP and of the three LEP SEPs.** Innovation is a cross-cutting theme with potential to impact positively on every one of the eight WMCA SEP priorities to a greater or lesser extent. A number of the market strengths and enabling competencies identified in this report relate directly to these priorities. Likewise, innovation features in all three LEP SEPs, so the WM SIA evidence should aid the delivery of a wide range of LEP and WMCA objectives.

7.14 By **grasping the currently favourable national policy context**, there is an exciting opportunity to realise the potential identified in the WM SIA, by taking forward the following with Government and local partners:

- **Raising levels of business R&D investment and its subsequent exploitation is a key strategic imperative for the UK, including the WM SIA area.** In the context of both devolution and the emphasis on innovation and place in the emerging Modern Industrial Strategy, a dialogue with government may be timely around incentives for product and process business innovation. For example, this could include a review of tax incentives; consideration of how in policy terms the WM can focus more on demand-led and productivity-led innovation, including via the extension of SBRI, business-led 'RPIFs' and the Industrial Strategy Challenge Fund; exploration of the industry-led sector deals being developed nationally as part of the Industrial Strategy.
- **Addressing the large number of innovation inactive businesses,** effort is required to increase the inclination or capacity of businesses to innovate. In part this is linked to finance, skills and leadership, but local promotion and brokerage to help business to understand the opportunity from engaging in innovation remains key. The network and knowledge transfer activities that are strong in the WM, therefore need to be maintained and developed further. This will become more challenging with the loss of ERDF funding, unless alternative support is negotiated.
- **Stimulating and steering major collaborative research and innovation projects that realise the potential from our science and innovation base.** A number of the case studies presented in this SIA highlight where significant action is underway across the innovation ecosystem. A continued willingness of local science and innovation partners to develop ambitious, collaborative propositions at scale, will play a key role in developing the innovation platform and performance needed to drive-up our productivity. A particular current opportunity may be to develop proposals for the new Industrial Strategy Challenge Fund. The 'anchor' institutions identified in this SIA have a leadership role to play here, as well as the financial and other support that may flow through the LEPs, the WMCA, wider Midlands Engine and national funding.

7.15 Taking hold of the findings of this SIA, and acting to realise the potential identified will require **strong leadership, and appropriate governance and executive structures**. The 'anchor institutions' and other innovation ecosystem partners all have major roles to play, but the

existing innovation committees (or equivalents) and resources of the LEPs will also be key, as will the proposed WMCA Innovation sub-Board, and the support structures that emerge around it.

- 7.16 The collective challenge will be to **develop and implement a whole range of complementary interventions** designed to strengthen our **Innovation Ecosystem**, exploit our well-evidenced **Market Strengths** and leverage our pervasive **Enabling Competencies**. The prize is a significant one – helping to secure sustainable improvement in our long-term productivity performance.

Annex A: Case Studies

Seven case studies have been developed that showcase excellence in science and innovation across the WM SIA area. Taken together the case studies cover the full breadth of our SIA Framework – identifying how the Market Strengths and Enabling Competencies are realised in practice, working within the Innovation Ecosystem – and span innovation activity by (and across) the private, public and education sectors.

The case studies are

- Birmingham Health Partners
- Simco – an innovative Black Country construction SME
- The National Automotive Innovation Centre, Warwick
- Consortium for the Demonstration of Intelligent Systems (CDIS)
- Disruptive Media Learning Lab, Coventry University
- Developing a Connected and Autonomous Vehicles Environment
- Energy Capital

Birmingham Health Partners: *Accelerating access to world class care and a pipeline of innovative drugs, devices, diagnostics and interventions*

Background and innovation focus

Birmingham Health Partners (BHP) is the clinical-academic accelerator at the heart of Birmingham's Life Sciences Engine. BHP is a strategic alliance between a leading Russell group University, the University of Birmingham (UoB), and two major NHS Foundation Trusts, Birmingham Women's & Children's (BWC) and the Shelford Group University Hospitals Birmingham (UHB). All of the partners are co-located on the Edgbaston campus within a 10 minute walk of each other (see graphic below).



The Framework in action

BHP's mission is to harness research strengths in the University and NHS to deliver better treatments and care to patients. The long-term objectives of BHP are to improve healthcare; contribute to the local economy through job creation and inward investment into the biomedical sector; and increase public engagement and education about biomedicine and clinical research through increased enrolment into early and late phase clinical trials. Its short term strategic objectives focus on the identification, adoption and spread of innovation and best practice, through the alignment of healthcare delivery, research and training. Across BHP there is a critical mass of specialist facilities, research centres and supporting assets (see the table below and BHP's website for details: <http://www.birminghamhealthpartners.co.uk>).

- Advanced Therapies Facility
- Birmingham Dental Hospital and School of Dentistry
- Birmingham University Imaging Centre (BUIC)
- Cancer Research UK Clinical Trials Unit (CRCTU)
- Cancer Research UK Birmingham Centre
- Centre for Clinical Haematology
- Centre for Computational Biology
- Centre for Human Brain Health (Under construction)
- Centre for Patient Reported Outcome Research (CPROR)
- Centre for Rare Diseases
- Centre for Translational Inflammation Research
- Clinical Immunology Service
- Global Digital Exemplar
- Health Services Management Centre
- Henry Wellcome Nuclear Magnetic Resonance Facility
- Human Biomaterials Resource Centre (HBRC)
- Institute of Translational Medicine (ITM)
- NHS Blood and Transplant Service (NHSBT)
- NIHR Biomedical Research Centre (BRC) in Inflammatory Diseases
- NIHR Experimental Cancer Medicine Centre
- NIHR Liver Biomedical Research Unit
- NIHR Surgical Reconstruction and Microbiology Research Centre
- NIHR Trauma Management Healthcare Technology Co-operative
- NIHR/Wellcome Trust Birmingham Clinical Research Facility
- Phenome Centre Birmingham
- The BioHub Birmingham
- Tommy's National Centre for Miscarriage Research
- University Medical Practice
- West Midlands Regional Genetics Laboratory
- West Midlands NHS Genomic Medicine Centre

The BHP agenda and WM SIA Framework are very well aligned. Perhaps most obviously, this is evident through the **Technologies for Better Health Market Strength** area, which specifically recognises the scale and significance of the opportunity at the developing life sciences campus in Edgbaston. However, BHP's work cuts across and reinforces many other important elements of the SIA Framework too. For example, there is a very strong "fit" with two of the SIA Enabling Competencies in particular. The West Midlands' rich **Engineering and Manufacturing heritage** plays a key role in supporting the med-tech sector locally. Similarly, the area's specialist skills, kit and associated capabilities around **Digital Technologies and Big Data** have supported BHP's ambitions to develop highly competitive informatics and e-health offers. However, it is arguably **the SIA Innovation Ecosystem** that will determine the extent to which BHP can deliver on its full potential in terms of driving innovation and maximising economic impact. As the cohort of life science companies on-site grows and clustering behaviours become more embedded, it will be essential that a "whole system" view is adopted by BHP and wider partners. The most successful life science clusters in the UK, in the Golden Triangle and elsewhere, have created environments which are conducive to increasingly open innovation, business growth and development. All of the prerequisite ingredients for success are in place, whether that be access to finance, specialist support, attractive premises, good transport links, superfast broadband, a good supply of highly skilled workers, a supportive policy and regulatory landscape, and a very strong culture of networking.

Key relationships and collaborations

BHP functions as an integrated portal for industry, academic and third sector collaborations within the West Midlands, bringing together state of the art research, training and clinical facilities with access to a large ethnically diverse and stable population. Discoveries and expertise from multidisciplinary research programmes that span bioengineering, physical, computing, social and life sciences can be rapidly translated into clinical and commercial benefit through a comprehensive translational infrastructure. This includes significant clinical trials expertise, with one of the largest trials portfolios in Europe and national leadership of paediatric cancer trials; a state of the art

Advanced Therapies Facility and Human Tissue Biorepository; the largest national NIHR Clinical Research Facility, incorporating both paediatric and adult studies; and the UK's largest regional genetics diagnostic service and Genomic Medicine Centre. The co-location is further enhanced by UHB's cutting edge clinical digital systems, which are integrated with the University's expertise in the Centre for Computational Biology (CCB) to facilitate granular level informatics and comprehensively stratified patient cohorts.

The recent opening of the £24m **Institute of Translational Medicine (ITM)** greatly increases BHP's capacity to drive **accelerated access to and adoption of drugs, devices and diagnostics** by bringing together patient cohorts, clinicians, clinical trials, informatics and stratified medicine expertise in one integrated facility. Together with the co-located BioHub (which offers specialist start-up and grow-on office/lab space and tailored support for innovative life science firms), it provides a powerful engine to drive innovation with regional, national and international industry partners as well as patient, public and third sector collaborators, working with Birmingham City Council and the Greater Birmingham & Solihull LEP.

Looking forward

The main strength and differentiator of BHP is the critical mass of co-located assets of national significance. Looking forward, a number of exciting complementary investments are in the pipeline. For instance, there are plans to relocate the Children's Hospital to the site, thus further strengthening the adjacent **Edgbaston Medical Quarter**, home to many of the region's 550+ medical and life science companies. Additionally, work is underway to expand the highly successful Birmingham Centre for Clinical Haematology (BCCH) at the Queen Elizabeth Hospital Birmingham. The UoB has also recently acquired 10 acres of land at the neighbouring Battery Park site and is bringing forward ambitious proposals for the **Birmingham Life Sciences Park**. It is envisaged that the park will include state-of-the-art research and commercial facilities that will bring together partners in a bid to drive increased innovation and harness the academic, clinical and commercial sectors across the city. The aim is to support R&D to take innovative new healthcare technologies from the early stages of concept to real life application and to create high quality employment opportunities. Birmingham Life Sciences Park will be delivered by BHP.

BHP's vibrant, integrated health sciences community forms one of the largest healthcare campuses in the UK.

Simco – an innovative Black Country construction SME

Background and innovation focus

Simco External Framing Solutions ('Simco') designs, manufactures and installs building facades, such as lightweight steel framing and rainscreen cladding, for the construction industry. Based in the Black County, the Simco group of companies (which also includes Phos Facades) has a national reach, delivering projects for, and securing contracts from clients across the UK. For example, Simco were involved in the design of the aluminium and granite rain screen cladding for the redevelopment of Birmingham New Street Station, and also worked on the control tower at Birmingham Airport

Reflecting major changes and drivers in the construction industry, the Simco group are active innovators, increasingly adopting 'Industry 4.0' principles – focused on the exploitation of automation and the use of data and information in the manufacturing process – in their factories. Simco are also increasingly moving their innovation focus towards the design and delivery of offsite manufactured modular homes, responding to the increasing demand for faster and more efficient housing construction that offsite manufacturing enables. This ongoing work is reflected in Simco's inclusion in the 2017 edition of the London Stock Exchange Group's '1000 Companies to Inspire Britain' report.

The WM SIA Framework in action

The Simco group is an important component of the strength of the WM SIA in the **Sustainable Construction** market area, and demonstrates how the industry is working with other partners across our area with expertise in the **Advanced Manufacturing and Engineering** and **Digital Technology and Data** enabling competencies identified in the WM SIA to seize fully the commercial opportunities in this area.

For example, in early 2016, the Simco group realised that to expand their business in line with their aspirations they needed to become more efficient: this meant becoming smarter when ordering materials to reduce the volume (and cost) of stock, and being leaner and more efficient in their working practices. Conscious of the increasing prevalence of Industry 4.0 thinking in the construction industry, and the growing digitisation of the manufacturing process, the Simco group recognised that having access to real-time information on their production on-site would be crucial in driving down costs and maximising the efficiency of manufacture processes.

Simco therefore approached Warwick Manufacturing Group (WMG) to help achieve their objectives. WMG worked with Simco to design and implement a new system to monitor production in real time using digital technology. At a relatively low cost to implement, this has allowed Simco to track their outputs with more precision and gain greater insight into the costs of production, e.g. on machine downtime, as well as helping to engage their workforce by stimulating communication between all roles. Paul Nicol of Simco commented that this has *"helped transform our manufacturing facility."*

The Simco group also has strong links with Wolverhampton University. Their R&D activity has been supported by a BIG (Business Interface Graduate) PhD student placement, and the firm has attended workshops and networking events held by the Built Environment Climate Change Innovations (BECCI) team at the University.

Looking forward

The Simco group of companies expect to work more closely with the BECCI team at Wolverhampton in the future and are also considering working with WMG again to carry out a six sigma project to further improve their production efficiency.

The group is continuing to develop its offsite modular homes business in response to the identification of a market demand for the faster build of homes and the Government's February 2017 White Paper on Housing. Their Lightweight Steel Frame Modern Methods of Construction (LSF MMC) modular home can be manufactured and assembled off-site, allowing the on-site construction to happen much more quickly than with a traditional build. It also offers the potential to include energy efficient technology and add-ons such as photovoltaic panels at an earlier stage in construction.

National Automotive Innovation Centre, Warwick

Background and innovation focus

The National Automotive Innovation Centre is a flagship development for the UK automotive sector. The Centre will place the UK, and the West Midlands specifically, at the forefront of the generation of ground breaking ideas and technologies in key areas including connectivity, intelligent vehicles, connected and autonomous technologies, and advanced propulsion.

A 33,000 sqm facility located adjacent to Warwick Manufacturing Group (WMG) on the University of Warwick campus in Coventry, the Centre is a visible and prominent example of a public and private sector partnership. It is a joint initiative between Jaguar Land Rover, Tata Motors European Technical Centre, WMG, and the University of Warwick. The Centre also secured UK Government funding of £15m (via the Higher Education Funding Council England), to support the capital project.

The WM SIA Framework in action

The development of the National Automotive Innovation Centre in Coventry, and the commitment of its partners, reflects the existing strength of the West Midlands in **Next Generation Transport**, and the very significant automotive opportunity going forward.

The Centre also embodies fully and comprehensively the expertise and capacity in the West Midlands identified in the enabling competencies of the WM SIA: the Centre will be globally-competitive focused on the application of leading-edge **advanced manufacturing and engineering** processes and expertise in the development of the next generation of low carbon automotive products and services, exploiting **digital technologies and data** in progressing these ideas, and developing and testing the **systems integration** requirements that will enable their roll-out and commercial application.

For example, at the heart of the Centre will be a Virtual Reality Centre, hosting one of the world's most adaptable and advanced driving simulators the '3xD Simulator': this will provide an immersive, simulated environment for smart and connected vehicles which includes full emulation of wireless communications, supporting researchers working on autonomous, smart and connected vehicles.

The Virtual Reality Centre will complement research in a broad range of other areas related to smart and connected vehicles, including driverless vehicles, self-learning vehicles, cloud vehicles and the Human-Machine Interface; and research on the next generation of propulsion systems that are integral to the future competitiveness of the automotive industry, including internal combustion engines, hybrid and electric systems, lightweight vehicle technology and advanced automotive control systems.

Looking forward

When the centre opens in 2018, it will support around a thousand highly-skilled researchers, technologists, and engineers working across a diverse range of technologies

in next generation transport, drawn from across project partners to facilitate and catalyse collaborative R&D.

Jaguar Land Rover will co-locate 600 of its engineers, researchers and technologists to work collaboratively with academics and R&D specialists from across the automotive supply chain.

From day one, the focus will be on supporting industry to accelerate the introduction of exciting new technologies that will keep the West Midlands at the forefront of innovation in the increasingly competitive global automotive industry.

Consortium for the Demonstration of Intelligent Systems (CDIS)

Background and innovation focus

The Consortium for the Demonstration of Intelligent Systems (CDIS) is an innovative and ambitious initiative whose development is being led by Birmingham Science City, on behalf of WMCA Innovation Working Group, to accelerate the exploitation of new products, services, and processes through the demonstration of intelligent systems principles and technologies.

CDIS will develop and apply intelligent/smart systems technology and approaches to solve real and substantial challenges faced by the public and private sectors, leveraging the area's significant innovation assets and institutions working together in an integrated and coordinated way. Ultimately, it is envisaged that CDIS will improve products and services that will increase business competitiveness and productivity, and contribute to the reform of public services. Initially, the focus will be across three areas which reflect local and regional market strengths as identified in the Midlands Engine SIA: mobility, health and energy. CDIS will be funded via the innovation strand of the West Midlands Devolution Deal, with funding to be confirmed in the coming months.

CDIS will include partners across the WMCA region's research and technology base including: the Universities of Aston, Birmingham, Birmingham City, Coventry, Warwick and Wolverhampton; Innovation Birmingham; the Energy Systems Catapult; Transport for West Midlands, Sustainability West Midlands, West Midlands Academic Health Science Network, Birmingham Smart City Alliance, Digital Birmingham and others. It will also involve best-in-class national partners, including the Digital Catapult.

The WM SIA Framework in action

CDIS is a strong example of our expertise and assets in the Enabling Competencies of Digital Technologies and Data, and Systems Integration, and how these competences are maximising our strengths in Next Generation Transport, Technologies for Better Health and Energy Systems and Storage. The CDIS proposals are still being developed however, three examples of potential pilot activities which provide an indication of the sort of work that is expected to be progressed are provided below.

The ***Mobility as a Service*** pilot will integrate different mobility options into one smartphone app. Up to 500 customers involved in the 18-month pilot will be able to access bus, metro, and rail travel, as well as car and cycle hire through the app. The outcomes are expected to be more reliable journey times, fewer poor air quality days, and new business opportunities.

The ***Homes for the Future*** pilot aims to create a small-scale pilot in c.100 homes by embedding sensors and other technologies during the build phase. New technologies such as li-fi (wi-fi built into lighting), new energy systems and energy harvesting pavements (kinetic walkways) will be explored and exploited, reducing energy demand and usage. The aim is to develop a 'proof of concept community' where new technologies and building methods can be tested and showcased.

The **Digital Innovation in Public Services** (DIPS) pilot recognises the ongoing pressures for Public Services to reduce costs whilst improving quality. The pilot aims to promote greater innovation within and for Public Sector bodies and to create a digital transformation in public services. It aims to do this by developing close working partnerships between innovative digital companies and the traditionally less innovative public sector.

Key relationships and collaborations

The process of collaboratively forming and shaping the CDIS proposal has helped strengthen existing collaborations and built new relationships across the geography. Led by Birmingham Science City, this process has engaged partners across the West Midlands to secure their commitment to the proposal.

An initial workshop held in October 2015 was attended by over 30 representatives from universities, science parks, Catapults, RTOs, companies and sector support organisations to identify key challenges that could be tackled with an intelligent systems approach. Further research and exploration was then undertaken with universities and organisations at the interface between research and the business/user communities such as Centro, Innovation Birmingham and Sustainability West Midlands. A follow-up workshop was held in July 2016 to develop examples of where intelligent systems could be applied to create breakthrough impacts for the region.

This preparatory work to corral and enthuse partners is crucial to the success of CDIS: at the core of the proposed approach is that CDIS will leverage the significant expertise and talent-base in intelligent systems across our existing assets, bringing them together to share experiences, ideas and promote collaborative R&D.

Looking forward

The proposal currently being finalised envisages that CDIS will develop in two phases.

Phase 1 will establish a CDIS 'brokerage system' to manage coordination, networking and business engagement across the wide range of partners. Phase 1 will also support a series of feasibility and pilot studies, as per the examples provided above.

Phase 2 will build on this through the creation of larger, demand-led accelerators which will demonstrate new innovations in 'real-world' situations to encourage the wider uptake of intelligent systems technologies.

CDIS is an ambitious proposal and while it will focus initially on mobility, health and energy, it is envisaged that this will lead to a scalable model with the potential to be rolled-out to other technologies and markets and allow wider geographical involvement over time.

Disruptive Media Learning Lab, Coventry University

Background and innovation focus

The Coventry University Disruptive Media Learning Lab (DMLL) was born out of the University's Media Department in 2013. Keen to improve the Department's standing amongst potential applicants and to offer a 'point of difference', which marked their courses out from competitors, Dr. Shaun Hides and Professor Jonathan Shaw outlined a new 'open learning' strategy to shape their courses, including the use of social media, podcasting and peer-driven community engagement in their Photography and Media degrees.

The approach was highly successful, leading to a move beyond lecture-driven pedagogies across the Media Department – initiating partnerships with Apple and Adobe – and, instigating a rise from the bottom to the top of course league tables. The establishment of the DMLL was an attempt to capitalise the findings of this approach in order to change culture and practices across the wider University, within the community of Coventry and through broader collaborations.

The 'Lab' is a vibrant and energetic space, situated at the heart of the University, on the 3rd floor of the University's Lanchester Library. It includes group study areas with LCD screens, whiteboards and moveable desks and independent areas with 60 computer workstations; 49 iMacs and 11 PCs. Unique features of the space are the 'hill' and the 'grass', which differentiate it from other spaces across the University. Whilst this is central to the DMLL offer, it also acts as a springboard for the support and services, which DMLL's staff offer to partners across the University and beyond.

The DMLL's focus is to experiment with and develop innovative pedagogies. This covers everything from community based learning, through to the use of new and disruptive technologies including virtual reality and processes such as 'game-based and playful' learning to change educational practices and so improve outcomes, as well as being a tool for research.

Although the Lab draws on, and uses, a large amount of cutting-edge technology it sees these merely as tools for facilitation – the real innovation is borne of adopting open innovation processes, design-thinking and addressing the mind-set of academics- these enable changes in approach to teaching and learning which they feel will engage students, cement the place of the University in the community, and help to improve employability. Part of the dividend is in exposing people to new experiences, new cultures and new ideas – this can just as easily be through an international collaboration, or use of a 'business process' such as a SPRINT, which involves interdisciplinary teams, radical process re-design and 'end user' engagement in the project, as through exposure to a new technology.

The WM SIA Framework in action

The DMLL's key contribution to the WM SIA Framework focuses on improving the functionality and productivity of a regularly overlooked input - **People & Skills**. By exposing students to new models of innovation, new business techniques, and offering them opportunities to engage with, and use, cutting edge technologies they ultimately improve the employability and experience of their graduates.

Much of their work also features some form of **collaboration and knowledge transfer** – be this within the local community or with international partners (see below), which expose students to different experiences and help to build the reputation of the WM as both a learning environment, and a user of new techniques and technology in improving business innovation and **systems integration**. These collaborations include ‘blue chip’ academic research institutions including MIT and the Universities of Seville, Cairo and Alexandria.

For example – the Horizon 2020 funded **OpenMed** programme, in which the Lab is helping other Universities in the Mediterranean expand capacity and skills in Open Education and **MUSE**, supporting South America universities to offer access to disabled students through digital media.

The DMLL approach to learning is also offering participants a strong grounding in the use of **Digital Technology & Data** at every point at their learning lifecycle, which gives them a strong grounding in a key enabling competence within the WM SIA Framework, and helps them ‘futureproof’ their employability skills. Many of their projects and approaches have explored the use of technological techniques in ‘unusual’ settings, upping the affinity with digital processes and data management amongst the broader student body.

For example, the DMLL’s **Game Changers** programme, funded by HEFCE, uses a process of design based thinking, to facilitate the use of games and playful activities to develop active participation and engaging learning activities. This includes Game Design Sprints, a ‘Game Changers Open Course’ designed to provide staff and students with the knowledge required to design, prototype, and pitch games through the employment of a design based thinking approach and ‘LEGO Serious Play, a methodology designed to foster creative thinking through teams building metaphors of their organizational identities and experiences using Lego bricks.

More broadly the facilitative, collaborative approach to pedagogies promoted across Coventry University (and amongst local, national and international partners) through the DMLL is offering an insight into the importance and benefits of a key WM strength – **Systems Integration** - to those not undertaking technically focussed courses. By highlighting the opportunities of collaboration and integration, DMLL helps build the ‘problem solving’ mind-set.

Key relationships and collaborations

The DMLL have established over sixty international partners, including universities and a range of small and medium size enterprises (SMEs) from eighteen countries, including Armenia, Belgium, Brazil, Canada, Egypt, France, Greece, Italy, Spain, Malaysia, Morocco, the Netherlands, New Zealand, Romania, Singapore, South Africa, Sweden, Uruguay and the USA.

They are leading the €5.9m Horizon 2020 **BEACONING** programme, with collaborators including Heriot-Watt University, BIBA, Playsoft Group and Geomotion Games. The programme aims to provide a demonstrator which will facilitate, assess and author gamified learning activities, integrating existing educational tools and services of the participating organisations. Focusing on STEM, the cross-subject approach will contextualise learning within real world problem solving and applications, using the

process of filtering and connecting concepts framed under practical, investigative and exploratory scenarios.

Arts Gymnasium, delivered with Coventry's Belgrade Theatre, is an example of working within the community to provide innovation in learning. The project uses arts based community learning to promote health and wellbeing outcomes in the over 50s – particularly those suffering from dementia. Phase one was successful and phase two is due to kick-off with funding from the Esmée Fairbairn Foundations and support from Coventry City Council (Public Health Team, the Dementia unit, Insight Team), Coventry University (Neighbourhood University project), Age UK Coventry, housing organisations, and associated networks.

Looking forward

DMLL has expanded from 8 to 30 academic staff since 2013 and is looking to further build upon the successes from its initial phase and increase its impact across the wider University Group and Higher Education sector. It will also play a leading role in the formation of two new Research Centres in Education and Post-Digital Cultures. Their intention is to work with international partners to remain at the leading edge of learning innovation.

Developing a Connected and Autonomous Vehicles Environment

Background and innovation focus

The Transport Systems Catapult has estimated that the UK Connected and Autonomous Vehicle (CAV) market will create c.3,000 jobs and £4bn GVA per annum by 2025. By building upon an impressive network of existing assets, the West Midlands is in a strong position to operate as the premier location across the UK for the development of CAV technologies. It therefore aims to develop a fully-fledged 'CAV Environment' to create the conditions to introduce connected vehicles that are coming onto the market now, followed by fully autonomous vehicles over time.

The WM SIA Framework in action

Moving from research to development, eventually the exploitation of the CAV Environment will draw together strengths from across the West Midlands innovation ecosystem going beyond the Market Strength of **Next Generation Transport** to include all three Enabling Competencies. **Advanced Manufacturing and Engineering** techniques allied to modelling strengths using **Digital Technologies and Data** will be particularly important at the virtual simulation stage. **Systems integration** is already being applied in the real-world testing where parts of the M40, M42, A45 and A46 have had short-range communication and cellular technologies installed to enable vehicle-to-vehicle and vehicle-to-infrastructure communication.

Illustrating the strengths of the area, West Midlands partners including Jaguar Land Rover, Coventry University and Coventry City Council are already involved in the £7.1m UK CITE project, which aims to develop an advanced CAV test environment on 41 miles of roads around Coventry and Solihull. Building on this, the £19.2m UK AutoDrive project aims to trial CAVs in Coventry and Milton Keynes, with additional WM partners including JLR, RDM Group and the Transport Systems Catapult. These projects are part of a £65m package of on-going projects developed in the last two years (excluding pure research and commercial grant funded or wholly private sector activity) that are based in the West Midlands and/or involving West Midlands companies in developing the CAV environment.

Key relationships and collaborations

Developing a 'CAV Environment' draws on the unique combination of assets offered by the area which include the innovative manufacturing base; a rich pool of entrepreneurs; a thriving community of technology start-ups; a wealth of applied research and development within the academic sector; and the alignment of these opportunities with key public sector objectives for transport as promoted by Transport for West Midlands.

This combination of assets is enhanced by the existing collaborations between the individual innovation actors. This includes the two publically funded projects above which will both deliver activity in the area, as well as projects which will deliver in other parts of the UK. These broader collaborations illustrate the high regard in which our companies

and academic institutions are held. For example, the Insight project, to develop the Heathrow Ultra PODs for on-road use in Greenwich, has participants including Westfield Sportscars, Conigital and Birmingham City University.

Looking forward

The projects cited above will help to both create real world test environments in the region and to develop the CAV technologies needed to trial in these environments. Bringing together both in the West Midlands presents a powerful offer to both companies and investors.

Moving towards real world exploitation will require harnessing the automotive supply chain already based in the area to scale up the production processes and techniques leading to mass production in the region to serve domestic and international demand. If the test environments can successfully demonstrate the application of CAV technologies in real world environments, then the region has the manufacturing capability and automotive heritage to build the next generation of vehicles and enhance its internationally significant status.

Energy Capital

Background and innovation focus

Energy Capital is the smart energy innovation partnership for the West Midlands. It comprises leading academic expertise with ambitious local authorities, diverse businesses, innovators and entrepreneurs.

The objective of Energy Capital is to make the West Midlands one of the most attractive locations globally in which to develop and build an innovative clean energy technology company. It aims to deliver affordable power for industry, develop distributed energy systems that benefit communities and embed low cost generation and storage technologies close to where energy is being used. It seeks to do this by providing a social, political and regulatory context supporting and nurturing the latest innovations; bringing new products, services and business models to the marketplace.

An underpinning assumption is that while wider policy objectives and technological changes leading to energy system transformation are driven externally (often from global or national levels) future energy systems will be increasingly distributed and diverse, and thus can only be created and operate efficiently with strong and confident local leadership – across the city, community and individual district and borough level. Energy Capital will therefore be a highly focused facilitating and support body. It will act as the umbrella under which strategic energy activity across the WMCA will take place, but will not take a project delivery or management role.

The WM SIA Framework in action

Energy Capital is in the early stages of development but seeks to intervene to improve the broad Innovation Ecosystem across the WM, with a focus on building capability and removing barriers to growth in the within an area of market strength identified in the SIA - **Energy Storage and Systems**.

It will do this by developing plans and co-ordinating activities under five broad headings:

- Regulatory and political support – a key theme within the SIA's ecosystem
- Marketing
- Investment and finance – providing **Funding and Support** opportunities to businesses and research institutes
- Supply chain engagement – promoting **Networks and Knowledge Exchange**, especially for SMEs
- Market and technology foresight (Investment Opportunities).
- Skills and learning

At present the partnership is focussing on securing political and regulatory support and ensuing local infrastructure is attractive for innovators, signposting existing opportunities and events which could appeal to local businesses, partners and stakeholders, facilitating collaboration and helping SMEs make linkages. It will build on the regional expertise and research base in both **Advanced Manufacturing** and **Energy Systems Integration**, offering opportunities for collaboration and drawing attention to examples of best practice which highlight innovation and integration within the energy sector.

So far these include: work by Encraft with Beattie Passive, Solihull Metropolitan Borough Council, Solihull Community Housing and Coventry University on retrofitting buildings to reduce energy bills by 85 percent and cut carbon emissions; and work by Aston University, funded by The Engineering and Physical Sciences Research Council, and in partnership with Sheffield and Southampton universities, to develop a £4 million battery near Walsall, offering the perfect facility for testing battery storage technology – a key component in smart energy futures.

Energy Capital will build on this by piloting an **Energy Innovation Zones** designed to provide geographic areas for deploying smart energy solutions in commercially important sites, with the consent of local people and national regulators. These are likely to include the waste/energy cluster at Tyseley Energy Park, which already hosts a waste plant and will be home to a collaboration between the University of Birmingham and the Fraunhofer Institutes, and a regional Energy Skills Academy and the 'HS2 Central' site, which could be used to pilot approaches to use of electric vehicles and smart energy across the region.

Energy Innovation Zones are about ensuring innovation is demand-led and meets local market needs. They will provide the missing link in the UK innovation ecosystem for energy – opportunities to deploy energy innovations commercially and as part of an integrated system at a scale customers can relate to and act as a critical link between pilot demonstration and global market success.

Key relationships and collaborations

Energy Capital is a partnership between the West Midlands Combined Authority, Greater Birmingham and Solihull LEP, Black Country LEP, Coventry & Warwickshire LEP, the local research intensive HEIs (represented by Aston University), Department for Business, Energy & Industrial Strategy, the Energy Systems Catapult and Local Authorities, backed by an Industrial Advisory Group including representatives of Jaguar Land Rover, National Grid, Liberty Group, Western Power Distribution and the National Grid.

Energy Capital's broad Terms of Reference seek to establish the appropriate Innovation Ecosystem and market conditions which allow businesses and research institutes within the region to collaborate and grow local share of the national and international market in Energy Storage and Systems, building on existing enabling capacity across the region in both Advanced Engineering and Energy Systems Integration.

Looking forward

Energy Capital's workplan includes an ambitious programme designed to highlight and augment ongoing work in the region, including:

- Securing stakeholder support and funding for **Energy Innovation Zones**, including relevant system operators and corporates, with success defined as establishment of **Regional Energy Commission** to define EIZ governance and management structures
- Producing a **WMCA energy infrastructure assessment/plan** using local energy data to set the context and opportunities;
- Working with the Local Growth Fund, Innovate UK, British Business Bank and others to ensure **maximum investment in WM energy projects**;
- Creating a **regional Energy Capital investment fund**;
- Connecting SMEs and Community Energy Companies to local and regional energy projects, including through designing and supporting Energy Capital Challenge Events; and
- Encouraging and supporting individual technology special interest groups (SIGs) where demand exists – such as Hydrogen Fuel Cells.

¹ <https://www.midlandsengine.org/wp-content/uploads/2017/02/Midlands-Engine-SIA-Volume-1-Report-01-Nov-1.pdf>

² The Innovation Group would like to thank the University of Birmingham for allowing the research team to access the Sci Val database under their licence for the purpose of this work.

³ A Location Quotient (LQ) of 1 means that the level of employment a sector is equivalent to the average across the UK. An LQ above 1 means that the sector is over-represented in an economy, and under 1 means that the sector is under-represented in an economy.

⁴ Marketing Birmingham, referenced in GBSLEP Employer Skills Action Plan

⁵ Great Britain

⁶ <https://westmidlandscombinedauthority.org.uk/what-we-do/commissions/productivity-and-skills-commission/>

⁷ <https://www.topuniversities.com/university-rankings/world-university-rankings/2016>

⁸ According to the European Association of Research and Technology Organisations, RTOs are 'mission-oriented providers of innovation services to governments and firms, dedicated to improving quality of life and building economic competitiveness'. They are generally non-profit organisations, with revenues re-deployed to fund new innovation cycles (see <http://www.earto.eu/about-rtos.html>)

⁹ Defined as academic staff with a contract of employment of 0.2 FTE or greater and on the payroll of the submitting HEI, and whose primary employment function is to undertake either 'research only' or 'teaching and research.'

¹⁰ The other three units of assessment are Anthropology and Development Studies; Architecture, Built Environment and Planning; and Geography, Environmental Studies and Archaeology.

¹¹ Seven of the eight universities as University College Birmingham is not included in SciVal data

¹² Field-Weighted Citation Impact (FWCI) indicates how the number of citations received by an entity/group's publications compares with the average number of citations received by all other similar publications in the data universe. A FWCI of 1 indicates that the entity/group's publications have been cited exactly as would be expected based on the global average for similar publications; a FWCI of more than 1 indicates that the entity/group's publications have been cited more than would be expected based on the global average for similar publications; a FWCI of less than 1 indicates that the entity/group's publications have been cited less than would be expected based on the global average for similar publications.

¹³ University of Cambridge, Imperial College London, University College London, Kings College London and University of Oxford

¹⁴ The APC has spokes at the Universities of Nottingham (Power Electronics), Loughborough University (London) (Digital Engineering and Test), and Warwick (Energy Storage).

¹⁵ <http://www.the-mtc.org/academic-founders>

¹⁶ Accelerator; Virtual Accelerator; Pre-accelerator; Incubator; Incubator (University Enterprise Zone); Virtual Incubator; Coworking; Coworking space plus; Venture Capital; Active seed / VC; Makerspaces; Other

¹⁷ <http://www.dudley.gov.uk/media/media-releases/january-2017/dy5-dudleys-business-and-innovation-enterprise-zone/>

¹⁸ <http://british-business-bank.co.uk/wp-content/uploads/2016/10/Midlands-Engine-Investment-Fund-Procurement-for-Fund-Management-Services.pdf>

¹⁹ Innovate UK funded projects database. The data uses the 'Grant offered' field

²⁰ This data excludes funding from the High Value Manufacturing Catapult Centre Warwick Manufacturing Group

²¹ Note this data excludes the following RTOs that are classified as 'medium' sized firms in the Innovate UK data: National Renewable Energy Centre Limited, Cell Therapy Catapult Limited, Centre for Process Innovation Limited, Offshore Renewable Energy Catapult, Aircraft Research Association Limited, The Manufacturing Technology Centre Limited (in the SW SIA), High Value Manufacturing Catapult Centre, Energy Systems Catapult Limited.

²² WMCA Strategic Economic Plan Technical Appendix

²³ No co-publication were identified in the data for Newman University

²⁴ <http://rankings.ft.com/exportranking/european-business-school-rankings-2016/pdf>

²⁵ <https://charteredabs.org/wp-content/uploads/2017/03/Chartered-ABS-Research-Income-for-Business-Management.pdf>

²⁶ See <https://www.timeshighereducation.com/student/news/100-most-innovative-universities-europe-2017>

²⁷ As defined by TechNation SIC code definition covering: Manufacture of computers and peripheral equipment; Wired telecommunications activities; Wireless telecommunications activities; Satellite telecommunications activities; Other telecommunications activities; Publishing of computer game; Other software publishing; Computer programming activities; Computer consultancy activities; Computer facilities management activities; Other information technology and computer service activities; Data processing, hosting and related activities; Web portals; and Repair of computers and peripheral equipment

²⁸ Games Industry in Coventry and Warwickshire A Blueprint for Growth (available here <http://ukie.org.uk/sites/default/files/cms/docs/Games%20Industry%20in%20Coventry%20and%20Warwickshire%20-%20A%20Blueprint%20for%20Growth.pdf>)

²⁹ https://www.huawei.eu/sites/default/files/Huawei_UK_Smart_Cities_Report.pdf

³⁰ http://www2.warwick.ac.uk/fac/cross_fac/complexity/about/more/

³¹ <http://silverstone-park.com/hptm-cluster-research/>

³² Information provided by Midlands Aerospace Alliance

³³ Equal to the UK

³⁴ Low Carbon and Climate Change Research Strengths in the West Midlands (<http://www.sustainabilitywestmidlands.org.uk/resources/low-carbon-and-climate-change-research-strengths-in-the-west-midlands/>)

³⁵ This comprises the provision of architectural engineering services, drafting services, building inspection services and surveying and mapping services and the like

³⁶ Top 100 Construction Companies 2016 (<http://www.theconstructionindex.co.uk/market-data/top-100-construction-companies/2016>)

³⁷ Equal to the UK

³⁸ https://www.scribd.com/document/341946831/Energy-Systems-Catapult-2016-Annual-Review#fullscreen&from_embed

³⁹ Equal to the UK

⁴⁰ Silk, G. (2015) The Greater Birmingham Life Sciences Commission: The Silk Report

⁴¹ <https://www.midlandsengine.org/our-five-themes/innovation/>