



**LIVERPOOL  
CITY REGION**  
COMBINED AUTHORITY

**METROMAYOR**  
LIVERPOOL CITY REGION

# LIVERPOOL CITY REGION+

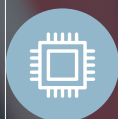
**SCIENCE & INNOVATION AUDIT REFRESH 2022**



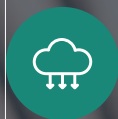
**INFECTION PREVENTION  
& CONTROL**



**MATERIALS  
CHEMISTRY**



**AI SOLUTIONS**



**NET ZERO  
& MARITIME**



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## Foreword by the Mayor of the Liverpool City Region

As Mayor, establishing our city region as one of the most attractive places in the country – and the world - for businesses to innovate and invest is one of my top priorities.

In the five years since I was first elected, the journey to realising that ambition has been made much easier by the enviable foundations we're building on.

Our existing world-leading strengths in Infectious Disease Control, Materials Chemistry Innovation, and Artificial Intelligence have gone from strength to strength. In the five years before the pandemic struck, we attracted over £2 billion of innovation investment.

With a further £3 billion pipeline of new projects still to unlock, it is safe to say that our region has a bright future ahead.

I am incredibly proud of how much we have achieved so far, but I want to go even further – to place us at the forefront of global innovation. That means taking advantage of our strengths, turning potential into profitable businesses, and creating better-paid, greener jobs.

From Mersey Tidal Power, harnessing the power of our river to generate clean, predictable energy, to partnerships with globally significant companies to decarbonise and revolutionise polluting industries, the Liverpool City Region has all the assets, capabilities – and political will – to be a leader of the Green Industrial Revolution.

I want to put our area at the vanguard of some of the industries of tomorrow - creating more opportunities for our people, and natural environment, to flourish. Afterall, our people are our greatest asset - you won't find a resource like them in them anywhere in the world.

My role, therefore, is to ensure they get the opportunities they deserve to unleash their full potential.

By establishing ourselves as a hotbed of innovation and new technology now, we will be able to create thousands of high-skilled, well-paid jobs, businesses, entrepreneurs, and opportunities for years to come.

I truly believe that we have the capacity, and the potential, to be the country's innovation engine – and we are putting our money where our mouth is to get there. Over the next few years, we will be investing 5% of our GVA in research and development – almost double the government's national targets.

We aren't in competition with places like the Golden Triangle because there is really nowhere else like us. We're on our way to building our own innovation powerhouse right here in the Liverpool City Region.

It's a lofty ambition – but I believe if anyone is capable of achieving it, it's the Liverpool City Region.



**Steve Rotheram**  
Mayor of the Liverpool City Region

A handwritten signature of Steve Rotheram in black ink. The signature is written in a cursive, flowing style and is followed by a period.

## Executive Summary

The original LCR+ Science and Innovation Audit (SIA) published in September 2017 played a pivotal role in defining and driving our City Region's innovation priorities and actions. It did so by evidencing three science-based areas where we had distinctive world-leading capabilities: (now retitled) *Infection Prevention & Control, Materials Chemistry, and AI Solutions & Emerging Technologies*.

In the five years since, the innovation landscape of the Liverpool City Region (LCR) has been dramatically transformed. This is thanks to the exceptional efforts, collaboration, partnership, and leadership of the Mayor and Combined Authority, industry, universities, Science & Technology Facilities Council (STFC), other Research & Technology Organisations, NHS, business bodies, the third sector, and passionate individuals.

As a result, Innovation is now a top priority for the City Region and its devolution agenda. This exponential progress is reflected in: (a) the LCR's headline ambition to invest 5% of GVA in R&D per annum by 2030 – nearly double the UK target; (b) the numbers: £2billion innovation infrastructure investment, £1billion live projects, a £3billion projects pipeline, and £4+billion Mersey Tidal Power scheme in development.

With the benefit of hindsight, we therefore view **2017 as an inflection point** that focused LCR stakeholders on systematically maximising our distinctive competitive innovation strengths. Liverpool was already a Capital of Culture, and we have begun to see and actively pursue the LCR's emergence as a Capital of Innovation in specific fields.

But the past 5 years have also brought significant global and national changes - Brexit, COVID-19, Net Zero imperatives, Levelling Up, and a renewed Government-led prioritisation on place-based innovation and clusters, all of which present challenges and opportunities.

Against this backdrop, a decision was made in 2021 to update the original SIA. The intention was to provide robust, refreshed evidence of our distinctive world-leading innovation specialisms, in order to:

- Inform forward LCR innovation and wider policy and strategy development;
- Steer the development and prioritisation of innovation projects and funding;
- Provide a framework for achieving the headline 5% R&D investment target;
- Highlight how the LCR can contribute to the UK government's levelling-up, internationalisation, productivity and growth ambitions.
- Underpin advocacy for greater innovation devolution and investment.

This document delivers that intent, drawing together the findings of a six-month programme of evidence review, partner consultation, and co-creative thinking. The three-fold emphasis of the 2017 SIA remains, but adds *Net Zero & Maritime* as an emerging capability, as also set out in the "3+1" focus of the LCR Innovation Prospectus launched in April 2022.

The aspiration is that this refreshed SIA will be seen as another *inflection point* on the LCR's place-based innovation journey. One that not only realises our projects, opportunities and headline target, but also embeds **a culture of innovation** across all aspects of our City Region, reigniting the pioneer spirit – ambitious – visionary – relentless – inclusive – that motivates all innovators. One that translates what we have created in the past 5 years into near-term social and economic benefits, and ensures we redouble our efforts to make innovation a crucial foundation of LCR's long-term future.



## Socio-economic Context

Relative to 2017, our economic activity levels are up, unemployment levels down, and residents' earnings have increased in line with North West averages. Critically, however, productivity in our City Region remains sub-par, and despite growing numbers of students and increasing skill levels, we have a relatively low share of science and technology professionals, and low R&D expenditure by our SMEs. Driving up productivity is therefore an absolute imperative coming out of this SIA refresh.

## Established Capability: Infection Prevention & Control

Globally, there has been an even greater focus on infection prevention and control globally since 2017, in part directly linked to the COVID-19 pandemic. LCR's long-established research excellence in this sphere is reflected in recent REF 2021 scores, in particular the Liverpool School of Tropical Medicine's (LSTM) ranking 2<sup>nd</sup> in the UK for impact. LSTM and the University of Liverpool (UoL) have also continued to deliver global and national impact via life-saving prevention and diagnostic interventions for malaria, HIV, emerging infectious diseases, and COVID-19.

LCR has the UK's greatest concentration of translational public R&D in infectious diseases in the UK, and with Cheshire and Warrington draws in £2 billion of funding a year. The LSTM-led iiCON programme has delivered exceptional performance within less than 2 years – over £200 million investment, 12 products brought to market, 5 billion units deployed. iiCON is now the UK's established Northern hub for the validation of COVID-19 vaccines and diagnostics. Together with the wider asset base, notably at UoL and via the Civic Data Cooperative and Combined Intelligence for Population Health Action, this enabled LCR to lead national trials and be a key actor in the UK fight against COVID-19.

Significant pipeline investments will strengthen further our value-added in these capabilities, building crossovers with *Materials Chemistry* (Medical-Glass Manufacturing Centre and the High Potential Opportunity in LCR vaccine manufacturing led by the Department for international Trade) and *AI Solutions* (Innovation Liverpool, Pandemic Institute and iiCON Phase 1b and Phase 2) to combat infectious diseases and poor health.

## Established Capability: Materials Chemistry

Our distinct capability in Materials Chemistry is founded on exceptional partnership between the University of Liverpool and industry, most notably Unilever, whose global R&D HQ remains in the LCR, where its team generated more than half the company's 524 global patents in 2021.

The associated 'Liverpool Model' for open innovation is enshrined in the Materials Innovation Factory that officially opened in 2018. The MIF has generated nearly £100million investment, and over and above being a world-leader in computer- and robotics enabled materials discovery and design, is also at the global forefront of lab automation. Its focus is now broadening to address other challenges, notably net zero.

Beyond the MIF and Unilever's Advanced Manufacturing Centre - which houses fully digitised replicas of its other large scale facilities around the world, new arrivals include the Manufacturing Technology Centre, and a first North West base for the Centre for Process Innovation's (CPI). These are underpinned by UoL's research excellence, ranked 3<sup>rd</sup> in the UK for delivering world class impact, and 7<sup>th</sup> overall in REF2021.

Looking forward, pipeline projects including the National Packaging Innovation Centre, and MIF's 'Labs of the Future', positioning LCR as an international centre of excellence in digital innovation for the advanced materials and chemistry sectors.

## **Established Capability: AI Solutions & Emerging Technologies**

Our excellence in digital technology and innovation extends beyond *'High Performance and Cognitive Computing'* highlighted in 2017's SIA, with major capabilities in quantum computing, robotics, immersive technology and digital health.

The single most significant development since the original SIA has been the launch of the £210million Hartree National Centre for Digital Innovation in 2021. This landmark investment in the STFC Hartree Centre has created the UK's de facto AI solutions centre, consolidated the partnership with IBM and its Global Research Lab co-located at Sci-Tech Daresbury, and enhanced their already world-leading AI capabilities.

Other important additions to the LCR asset base include one of the world's most advanced quantum simulators – the Atos Quantum Learning Machine, installed at the STFC Hartree Centre in 2019 - plus UoL's Digital Innovation Facility, launched in 2022, a sister site to the Virtual Engineering Centre, and facilitating both research and industry-HEI collaboration in the application and integration of advanced digital technologies.

There has also been significant investment in digital infrastructure, with the £30million 212km gigabit-capable LCR connect fibre backhaul network due to complete in 2023, and the DCMS-backed Liverpool 5G- Europe's largest 5G mm wave mesh network, delivering health and social care use cases.

REF 2021 confirmed our universities' standing in Computer Science and Informatics, with UoL ranking 5th in the UK in terms of world-leading (4\*) research outputs, and 80% of LJMU's research outputs judged to be world-leading or internationally excellent (4\*/3\*).

The pervasive and ever-increasing application of AI and emerging technologies make for innumerable crossovers with the other established capabilities.

## **Emerging Capability: Net Zero & Maritime**

This refreshed SIA highlights Net Zero & Maritime as a new, emerging capability. The rationale is three-fold: (a) the global imperative to achieve net zero, and LCR's own 2040 target; (b) the LCR's natural coastal assets; (c) the strength of our maritime cluster, combined with our primary west-facing UK port and 2021 Freeport designation; (d) the scale and innovative nature of associated projects and industry investment.

The primary live projects are Glass Futures – an industry-led global centre of excellence for glass innovation and wider industrial decarbonisation campus – and the first phase of HyNet North West, the UK's leading hydrogen cluster seeking to mainstream hydrogen to power energy intensive industries. Both projects delivered world firsts in 2021, notably hydrogen fuel switching at Pilkington and Unilever to run on 100% hydrogen.

This capability has the largest scale investment profile of all. The ambitious £5-14billion Mersey Tidal Power aims to create 5,000 new jobs and produce 1-6TWh of predictable renewable low carbon energy each years. The £5+billion future phase of HyNet is intended to cut carbon emissions by 10 million tonnes a year by 2030 and create 75,000 by 2035. Meanwhile there is also £billions of further planned investment in offshore wind in Liverpool Bay.

The size of both these programmes present major R&D opportunities for the LCR and UK as a whole, linked to delivering the innovative technical solutions required to make them happen. The LCR will need to significantly up its game in terms of research focus and excellence to maximise these benefits. Delivering both the skilled individuals required to fill these new jobs, and the scale of investment required, are also major challenges.

## Renewed Ambitions

The SIA refresh has meant revised ambitions, as set out below.

### LCR Innovation Ecosystem:

- *LCR to be a recognised national exemplar of place-based innovation by achieving its target of investing 5% of GVA in R&D per annum by 2030 and directly contributing to the delivery of UK Levelling Up, Net Zero, and productivity challenges.*

### Infection Prevention & Control

- *Increase the R&D spend on infection therapeutics from the current baseline of £2 billion per annum to £3 billion by 2030.*
- *In so doing, enhance LCR's position as an international centre of excellence in preventing and treating infectious diseases and develop capabilities in digitally enabled personalised diagnosis and treatment, stimulating further regional development and inward investment.*
- *Support development of a cluster of anchor and high growth companies to take advantage of increasing global market opportunities in infection through building deeper organisational partnerships. Establish the region, through the iiCON partnership, as the national lead for tackling AMR.*
- *Share the successful Consortium model across the other areas of activity to synergise further cluster development.*

### Materials Chemistry

- *Exploit LCR's world class materials chemistry knowledge leadership and accelerated 'Open-innovation' capabilities to provide transformational opportunities to mature UK sectors to (i) move to renewable energy sources and (ii) re-engineer materials value chains so that the carbon which is embedded in common products and commodities comes from renewable sources rather than petrochemicals.*
- *Support the creation in LCR of new high-growth industry clusters in sustainable packaging and hydrogen production.*
- *Become a recognised global leader in the application of digital technologies (including mobile robotics, lab automation and AI) to drive a revolution in the scale and pace of innovation in the advanced chemical materials sector.*

### AI Solutions & Emerging Technologies

- *Become a recognised global leader in the application of AI solutions & emerging technologies.*
- *Establish a world class digital technologies cluster that unlocks and diffuses new innovation-led productivity and economic growth impacts for UK businesses across established and emerging growth sectors UK.*

### Net Zero & Maritime

- *To develop and deliver world-leading tidal, hydrogen and industrial decarbonisation solutions in order to achieve Net Zero across the LCR by 2040.*

A series of recommendations to help deliver on these revised ambitions is set out in Chapter 7.

In taking forward the projects, programmes and opportunities highlighted in this refreshed SIA, the LCR welcomes the opportunity to talk and work with complementary partners, organisations and assets across the UK and beyond...



# 1 Introduction

## 15 second briefing . . .

The original BEIS-commissioned 2017 LCR+ Science & Innovation Audit (SIA) focused the City Region's innovation and wider economic development policies, priorities and actions on the three distinctive, world-leading capabilities it evidenced.

But the world has changed profoundly since 2017, just as the Liverpool City Region's place-based innovation outlook and programme have exponentially progressed, whereby a formal refresh of the original SIA was required.

This document delivers that intent, pulling together the findings of a six-month programme of evidence review, partner consultation, and co-creative thinking.

The three-fold "smart specialisation" focus of the 2017 SIA remains, but new areas of innovation are now considered, notably Net Zero & Maritime as an emerging capability = 3 + 1.

This refreshed SIA is intended to underpin the realisation of the City Region's headline ambition to invest 5% of GVA in R&D per annum by 2030, and the LCR looks forward to partnering with the best of the best wherever they may be in order to deliver on this and provide solutions that benefit of the UK as a whole.

## Purpose

- 1.1 This refreshed Science and Innovation Audit (SIA) of the Liverpool City Region (LCR) was produced by Steer Economic Development (Steer-ED), supported by Arthur D. Little (ADL) and DMS Research and Consulting (DMS), for the Liverpool City Region Combined Authority (CA), and five core partners: Liverpool John Moores University (LJMU), The Liverpool School of Tropical Medicine (LSTM), The Science and Technology Facilities Council Daresbury Campus (Daresbury), and The University of Liverpool (UoL).
- 1.2 The work to develop the refreshed SIA was undertaken between January and June 2022, with its interim findings playing a critical role in framing the LCR's *Innovation Prospectus*, launched by the Mayor in late April 2022.
- 1.3 This builds on the BEIS-commissioned SIA published in September 2017, which has been directly instrumental in both prioritising the City Region's substantive, distinctive, world-leading innovation assets and capabilities, and in ensuring that innovation threads through all subsequent LCR economic strategies and programmes.
- 1.4 Five years on, with relentless ongoing market and technology change, new government policies and models of innovation emerging, plus major progress with driving forward all aspects of the LCR's innovation agenda, there was a clear need to update the original SIA and ensure its innovation priorities remained valid, coherent, and comprehensive.
- 1.5 This 'refresh' is accordingly intended to provide **robust, current evidence of our distinctive world-leading innovation specialisms, for five primary purposes:**
  - Inform forward LCR **innovation and wider policy and strategy development;**
  - Steer the **development and prioritisation of innovation projects and funding requirements;**

- Provide a **framework for achieving the headline target of investing 5% of LCR's Gross Value Added (GVA) per annum in R&D by 2030**
  - Highlight how the **LCR can credibly contribute to the UK government's levelling-up, internationalisation, productivity and growth imperatives.**
  - Underpin **communications and lobbying efforts for greater innovation devolution and investment.**
- 1.6 In tandem with the SIA refresh, the CA and partners also commissioned Steer-ED to operationalise existing LCR Innovation Board thinking emanating from "Project Boom"<sup>1</sup> around how to scale established and emerging innovation assets into sustainable growth clusters, as a central plank of forward LCR innovation investment prioritisation and strategy delivery. A separate report and dedicated framework for quantitatively and qualitatively assessing the performance and maturity of assets has been produced. This work has also directly informed the SIA refresh.
- 1.7 Against this background, this refreshed SIA reviews our socio-economic progress since 2017 within the wider UK context, assesses our achievement with regard to the LCR's established world-leading capabilities, highlights our new and emerging strengths in Net Zero and Maritime, and recommends actions to advance and maximise our innovation efforts and impact yet further.
- 1.8 As with the original SIA, this document has been co-developed with core and wider partners across industry, academic and the public sector, using their diverse knowledge and insights to shape, drive, and focus the work. A premium has been placed on partner involvement and engagement, working to build both '*head and heart*' commitment to pushing-on our City Region's innovation agenda.
- 1.9 This refreshed SIA is already having influence – for example, it has already been used to inform the LCR's first-ever '*Innovation Prospectus*', launched in April 2022 by the City Region's Mayor, which showcases the City Region's large-scale investment opportunities relating to the established and emerging capabilities, set out more fully in the refresh document.
- 1.10 It is also noteworthy that of the 25 Science and Innovation Audits developed across the UK over three rounds between 2016-2019, the LCR is the only place, so far, to have refreshed its SIA.

## Starting point: the 2017 Liverpool City Region+ SIA

- 1.11 SIAs were introduced by the Department for Business, Energy and Industrial Strategy (BEIS) in 2016. They gave places, and their public and private partners, the opportunity to (a) evidence their *existing* world-leading science and innovation capabilities; (b) identify relevant *new potential place-based innovation routeways*; and (c) collate and present this evidence in a comparative format to national government and other potential investors in support of R&D funding requirements.
- 1.12 The SIA approach was, de facto, a policy recognition by BEIS that 'place' matters as much as long-established excellence in unlocking new world-leading innovation

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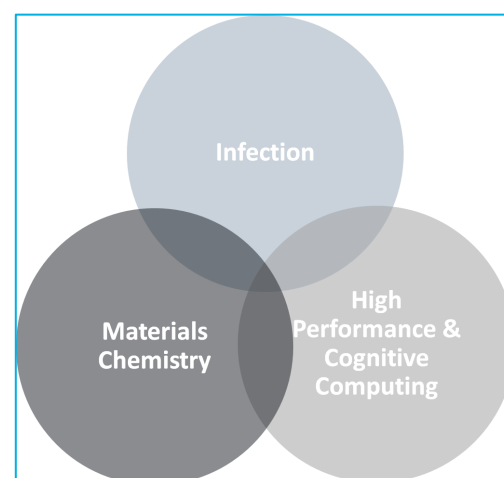
<sup>1</sup> Project Boom was led by LCR CA and involved an industry R&D expert with a record of successful international commercialisation, running an intensive programme focusing on (a) effecting a step change in R&D investment by enhancing and accelerating development of the projects portfolio; (b) radically increasing the translation of science into economic/commercial outputs, and creating new high value jobs for the LCR

solutions and potential across the UK. This approach, together with evidence gathered by the SIAs undertaken, was subsequently codified in the UK's Industrial Strategy.

1.13 Following on from the SIA approach, Government created a first dedicated, place-based public R&D funding stream, in the *Strength in Places Fund*.

1.14 Three world-leading capabilities, summarised in Figure 1-1, were identified in the 2017 LCR+ SIA: *Infection*, *Materials Chemistry*, and *High Performance and Cognitive Computing*. These capabilities were identified using employment and GVA evidence, research impact, assessments of related assets (both hard and soft), and extensive qualitative stakeholder engagement.

Figure 1-1: 2017 LCR+ SIA themes



Source: LCR+ SIA, 2017

1.15 Global market opportunities were also reviewed in depth, which forecasted major growth over the next 20 years in all three focal areas.

1.16 Critically, we did not look at our three world-leading capabilities in isolation, but also how they might cross-over and synergise, and so create new routeways for future innovation and other sectoral sub-specialisms.

1.17 Equally importantly was explicit consideration of which other world-leading institutions, organisations, and assets we could and should partner with in order to maximise the potential of our own competitive strengths and capabilities, hence the LCR+ epithet.

1.18 The most striking testament to the galvanising effect that our 2017 SIA had was that the subsequent LSTM-led iiCON project was one of only six successful projects from about 90 first-round applications for the Strength in Places Fund, and indeed the only one in North West England.

1.19 More generally, the 2017 LCR+ SIA has served as a critical evidence base – most recently enshrined in the Plan for Prosperity, the LCR's long-term innovation-led economic strategy published in March 2022 - demonstrating to industry, investors, and policy makers at all levels the international significance and potential of LCR's distinctive innovation assets, at the same time as helping LCR's innovation actors to focus on rapidly scaling-up R&D in distinctive areas of competitive strength where there is substantive potential, capability and capacity.

## Overview of the 2022 LCR+ SIA refresh

1.20 In refreshing the original 2017 SIA, we sought to:

- Account for the **significant changes in the national and global contexts** – notably Brexit and the COVID-19 Pandemic
- Similarly consider the **very significant developments in the depth and volume of LCR's innovation capabilities and activities**;
- Demonstrate that **LCR has the here-and-now capabilities and ambition** to play a lead national role in place-based innovation and delivering Government priorities;
- **Highlight those innovation actions which will enable LCR to achieve its headline target** of investing 5% of its GVA in R&D annually by 2030;

- **Evidence LCR's potential** to: (a) further develop its three existing world-class capabilities; (b) develop new clusters which have come into view since 2017 via a distinctive asset-based development approach<sup>2</sup>, linking to the renewed national priority<sup>3</sup> being given to clusters and their growth potential;
- Introduce **new large-scale opportunities relating to Net Zero and Maritime**, that are key to LCR achieving net zero by 2040 and contributing to delivering the UK target.

1.21 Working closely with a CA-led Steering Group<sup>4</sup> and building on the successful experience of developing the original SIA, the 2022 SIA refresh involved three work streams:

- **Literature and evidence review:** encompassing over 40 documents - including the 2017 SIA's then evidence base, LCR CA's current innovation logic model, the Business Start-Up and Growth Evidence Base, and LCR's innovation project pipeline - and detailed analyses of key socioeconomic indicators, Research Excellence Framework 2021 (REF2021) performance, Knowledge Excellence Framework developments, and local university research funding profiles;
- **Semi-structured consultations** with 60 key consultees (See Appendix B), covering business leaders, policy makers, specialist academics, and leaders in the innovation space (within and outside the LCR). These focussed on understanding the relevance and progress of the theme areas defined in our 2017 SIA, and discussing what new LCR innovation capabilities should be drawn into the refreshed focus; and
- **Development of an asset-based cluster development assessment framework**, to characterise and assess the cluster potential of key assets in LCR. The results of this are detailed in a separate report, which has informed this SIA refresh.

1.22 The main body of the report provides, sequentially, updated evidence on our research and innovation strengths in **three Established Capabilities**, which remain from the 2017 SIA (*Infection Prevention & Control; Materials Chemistry; AI Solutions & Emerging Technologies*<sup>5</sup>). This is then followed by a Section looking at LCR's new **Developing Capabilities** (*in Net Zero and Maritime*), which have potential to support, and be supported, by the three Established Capabilities. A final Section, **Realising Our Ambitions**, summarises the key conclusions from the evidence review and of the synergies between the 3 + 1 Capabilities, together with headline recommendations for delivering the LCR's innovation ambitions going forward.

1.23 To discuss the rationale and process regarding this SIA refresh, plus the LCR's wider innovation priorities, programmes, and opportunities, please contact John Whaling, Innovation & Commercialisation Lead at the LCR Combined Authority, via [john.whaling@liverpoolcityregion-ca.gov.uk](mailto:john.whaling@liverpoolcityregion-ca.gov.uk).

<sup>2</sup> NB. A separate report provide a qualitative and quantitative methodology for reviewing and prioritising live and potential asset-based clusters has been produced, with evidence from that report feeding into this SIA refresh

<sup>3</sup> Hubs of Innovation Playbook

<sup>4</sup> Comprising senior representatives from the LCR CA, LEP, LJMU, LSTM, STFC, UoL.

<sup>5</sup> The nomenclature of both "Infection" and 'High Performance and Cognitive Computing' in 2017's SIA report has been refined, however the focus of the capability area remains the same

## 2 Liverpool City Region Socio-economic Context & Performance

### 15 second briefing . . .

- LCR's economic activity levels are up and unemployment levels down since 2017
- Employment in 2020 was 651,000 (up 1.7% since 2017)
- Residents' earnings have increased in line with those for the North West region
- But LCR's productivity has decreased since 2017, and is falling further behind the UK average
- There are very positive long-term trends in the skill levels of LCR residents
- Enrolled students increased to over 63k in 2020/21 (up by 13% since 2016/17)
- LCR still has a relatively low share of science and technology professionals
- REF 2021 results were positive in key defined LCR capabilities.

### Changes since 2017

#### Absolute Change

- 2.1 The LCR **population** increased to 1.564 million in 2020 (+1.3% since 2017)<sup>6</sup>. Population growth was highest for those aged 65+ (+3.5%) and those aged 0-15 (+2.4%), while the working age population of 16-64 year olds was broadly flat (+0.3%).
- 2.2 The **economic activity** rate for residents aged 16-64 increased to 77.1% in 2021 (+3.5% since 2017) and the **unemployment** rate reduced to 4.6% in 2021 (-0.5% since 2017)<sup>7</sup>. Total **employment** in LCR increased to 651,000 in 2020 (+1.7% since 2017)<sup>8</sup>.
- 2.3 The **nominal earnings** of LCR residents increased in line with the average for the North West. At 2021, the median gross pay for full time LCR workers was £29.6k p.a. (+11.4% in nominal terms since 2017)<sup>9</sup>.
- 2.4 While these are positive developments for the LCR, average **productivity** levels have decreased over the same period. LCR's indexed (to 2018=100) real GVA per hour worked was 93.9 in 2019 (down from a peak of 107.1 in 2010). LCR is also falling further behind the UK average productivity level: indexed (to UK=100) nominal smoothed GVA per hour worked was 86.2 by 2019 (down from a peak of 95.1 in 2009)<sup>10</sup>. Combined with the increases in total hours worked, the decrease in average productivity has led to an **overall GVA** that has been broadly flat in real terms for more than a decade<sup>11</sup>: LCR's total GVA of £32.85 billion in 2019 (in 2018 prices) was just 0.16% higher than in 2017 and 3.7% higher than in 2006.

<sup>6</sup> Source: ONS Mid-Year Population Estimates

<sup>7</sup> Source: Annual Population Survey

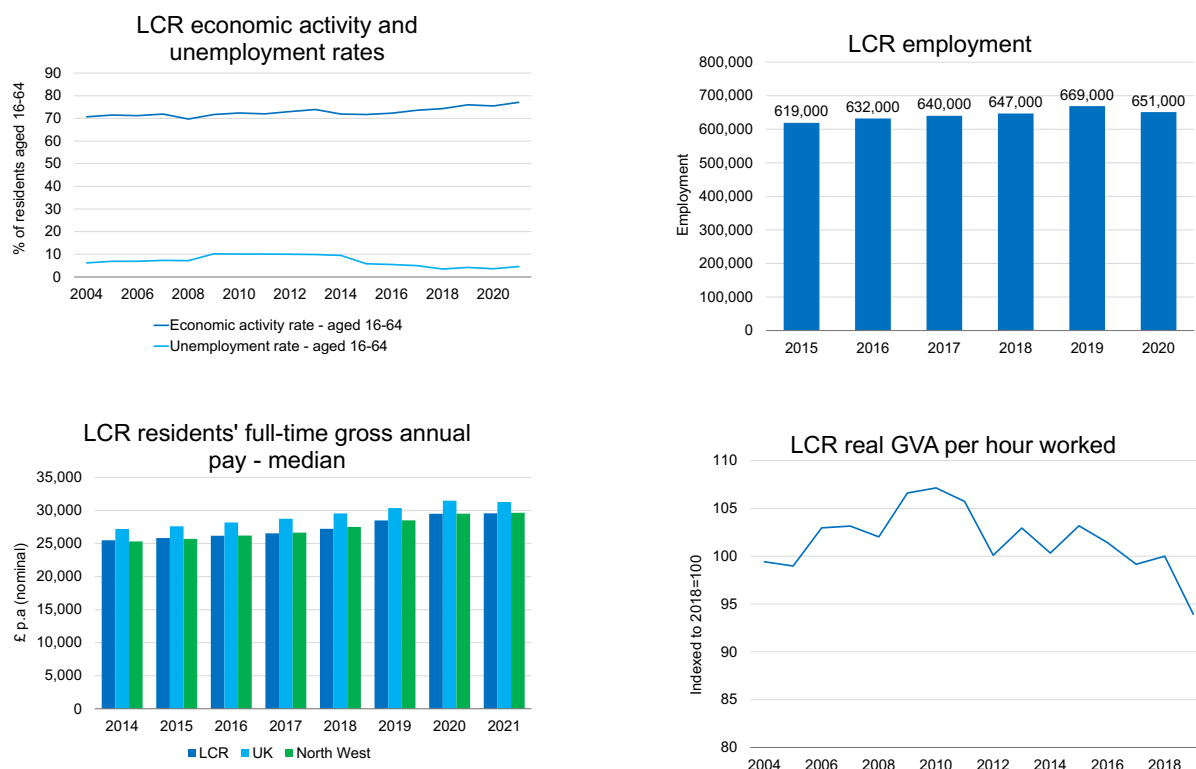
<sup>8</sup> Source: Business Register and Employment Survey

<sup>9</sup> Source: Annual Survey of Hours and Earnings

<sup>10</sup> Source: ONS Sub-regional productivity: labour productivity indices by City Region

<sup>11</sup> Source: ONS Regional gross value added (balanced) by industry: city and enterprise regions



**Figure 2-1: Time series for selected socio-economic indicators**

Sources: Annual Population Survey; Business Register and Employment Survey; Annual Survey of Hours and Earnings; ONS Sub-regional productivity: labour productivity indices by City Region.

## Relative Change

- 2.5 Absolute measures of socioeconomic performance matter, but so do relative ones. Accordingly, the table below compares LCR against England's other LEP areas for selected socio-economic metrics. Although LCR has one of the lowest population growth rates of the 38 LEP areas, the proportion of the population who are of working age is one of the highest. Substantial progress has been made in improving LCR's employment rate ranking since 2017, but this has been accompanied by a reduction in LCR's performance on productivity. This indicates a pressing need to create more high value jobs.

**Table 2-1: LCR's rank amongst LEPs for selected socio-economic metrics**

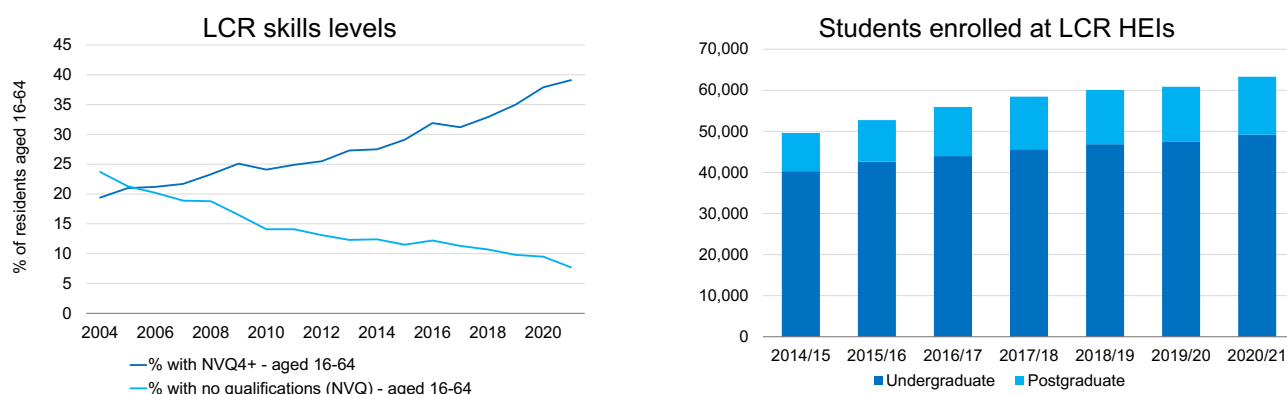
Metric	LCR latest	LCR rank of 38 LEPS – 2017	LCR rank of 38 LEPS - latest	Change in LCR rank
Population growth over last 5 years	2.3%	32	32	0
% population aged 16-64	62.6%	8	8	0
% residents aged 16-64 in employment	73.6%	36	28	8
Nominal smoothed GVA per hour worked index (UK=100)	86.2	23	27	4

Sources: ONS Mid-Year Population Estimates; Annual Population Survey; Annual Survey of Hours and Earnings; ONS Sub-regional productivity: labour productivity indices by economic enterprise region.

## LCR's Innovation Ecosystem

- 2.6 The headwinds to LCR's productivity highlighted above make the need to boost innovation, and to ensure that this translates into new, higher value economic activity, even greater now than in 2017.
- 2.7 Encouragingly, there are very positive long terms trends in one of the key enablers for innovation: the **skill levels** of LCR residents. The proportion of residents aged 16-64 with NVQ4+ (degree level) skills increased to 39.1% in 2021 (+7.9pp since 2017), and the proportion with no qualifications decreased to 7.7% (-3.6pp since 2017)<sup>12</sup>.
- 2.8 Skills are being boosted by the substantial and growing **Higher Education Institution (HEI) presence** in the City Region, centred on Knowledge Quarter Liverpool (KQ Liverpool), a 450-acre innovation district covering over half of Liverpool City Centre.
- 2.9 Across the five HEIs (University of Liverpool, Liverpool School of Tropical Medicine, Liverpool John Moores University, Liverpool Hope University, and Liverpool Institute for Performing Arts), the number of enrolled students increased to 63,295 in 2020/21 (up by 13% since 2016/17). Within this there was particularly strong growth in enrolled postgraduates, which increased to 14,135 in 2020/21 (up by 18% since 2016/17)<sup>13</sup>.
- 2.10 In terms of overall expenditures on R&D, there is a less positive picture. Statistics on **Gross Expenditure on Research and Development (GERD)** show that the City Region's share of UK expenditure on R&D was broadly flat at about 2% over the decade to 2018, while the North West's share has been decreasing: down to 7.7% in 2019 (-1.1pp since 2017, and -3.0pp since 2011)<sup>14</sup>. One other research metric available at the LCR level is **Horizon 2020** funding<sup>15</sup>. Building up from 2014, this peaked at EUR21.8 million in 2016, and reduced to EUR12.8 million by 2020.
- Looking at the proportion of those in employment who are **science, research, engineering and technology professionals (SOC21)**, the data show that this was 6.8% for LCR in 2021 (ranking 23<sup>rd</sup> out of the 38 LEPs on this metric)<sup>16</sup>.

Figure 2-2: Selected innovation ecosystem indicators



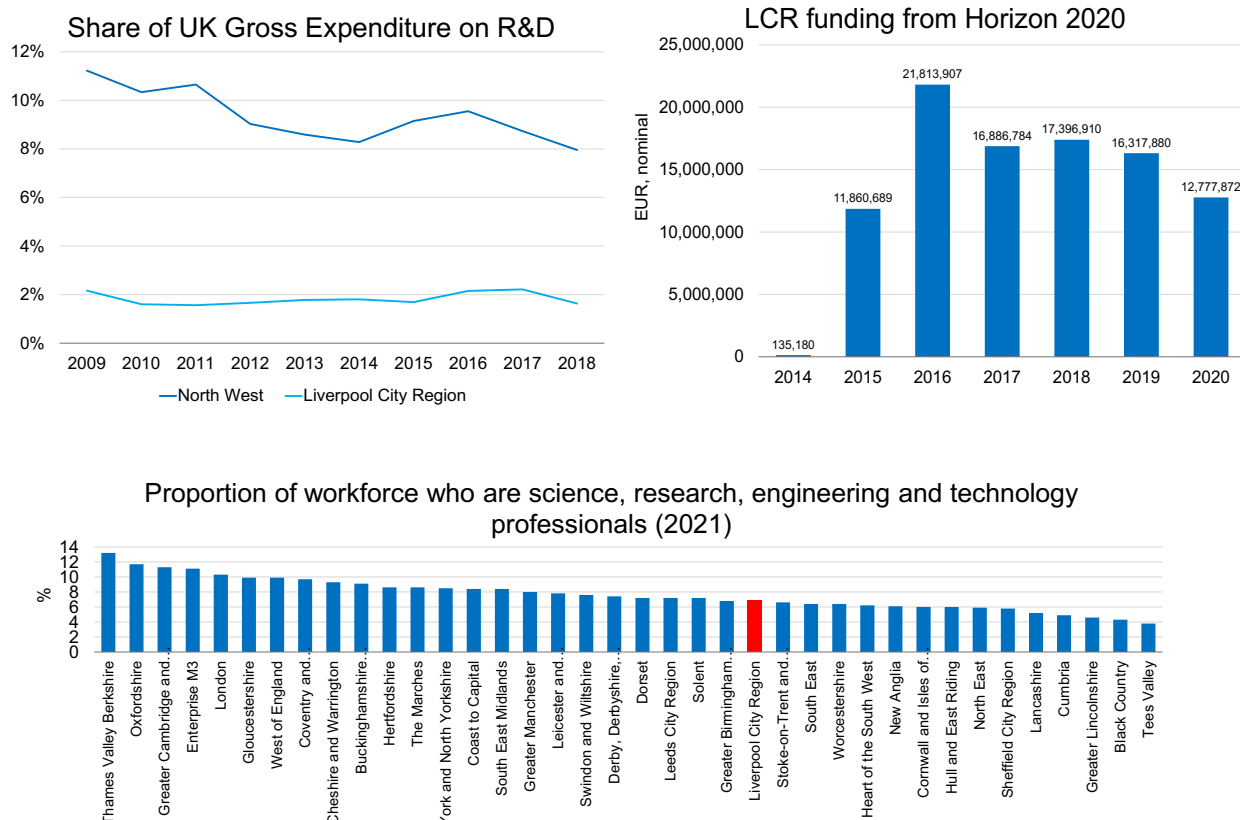
<sup>12</sup> Source: Annual Population Survey

<sup>13</sup> Source: HESA HE student enrolments by HE provider 2014/15 to 2020/21

<sup>14</sup> Source: Eurostat and ONS Gross domestic expenditure on research and development, by region, UK

<sup>15</sup> Source: Cordis via BEIS/Nesta Research & Development spatial data tool

<sup>16</sup> Source: Annual Population Survey



Sources: Annual Population Survey; HESA HE student enrolments by HE provider 2014/15 to 2020/21; ONS Gross domestic expenditure on research and development, by region, UK; Cordis via BEIS/Nesta Research & Development spatial data tool.

2.12 In terms of the **excellence of university research**, the recently released REF 2021 results are broadly very positive for LCR. As shown in the table below of LCR universities' rankings by overall Research Power (RP) and Grade Point Average (GPA)<sup>17</sup>, both UoL and LSTM have improved markedly their overall GPA rankings since REF 2014, and both LJMU and LSTM have improved their Research Power rankings.

Table 2-2: Headline overall rankings in REF 2021 for LCR universities<sup>17</sup>

HEI	RP rank 2021	Change in RP rank since 2014	GPA rank 2021	Change in GPA rank since 2014
LSTM	110	↑ 4	12	↑ 12
UoL	19	→ 0	25	↑ 8
LJMU	46	↑ 16	82	↓ 20
LHU	97	→ 0	110	↓ 3

Source: LCRCA analysis of REF 2021 results

<sup>17</sup> This follows the Times Higher Education methodology for calculating these metrics: GPA is calculated by multiplying its percentage of 4\* research by 4, its percentage of 3\* research by 3, its percentage of 2\* research by 2 and its percentage of 1\* research by 1; those figures are added together and then divided by 100 to give a score between 0 and 4. Research Power is calculated by multiplying the institution's GPA by the total number of full-time equivalent staff submitted, and then scaling that figure such that the highest score in the ranking is 1,000. This is an attempt to produce an easily comparable score that considers volume as well as GPA, reflecting the view that excellence is, to some extent, a function of scale as well as quality.

## LCR Sectoral Specialisms

- 2.13 As outlined in Chapter 1, a key element of the SIA approach is identifying specific areas of research excellence on which places can build out innovation capabilities.
- 2.14 An analysis of the recent **REF 2021** results is given in Figure 2-3. For each LCR university, it provides two different ranks amongst the submissions for each unit of assessment (UoA): by overall Grade Point Average, and by overall Research Power. The green shaded cells highlight those rankings which fall in the top quartile of submissions.
- 2.15 Relating these results back to the specialisms identified in the 2017 SIA:
- **Infection (now Infection Prevention & Control):** supported by the high rankings for LSTM in clinical medicine (GPA), and for UoL in Agriculture, Food & Veterinary Sciences, plus UoL in Public Health, Health Services Research & Primary Care (GPA and Research Power), plus UoL in Psychology, Psychiatry & Neuroscience (GPA and Research Power). LCR has an internationally rare combination of research strengths across medical, tropical, veterinary, behavioural and fundamental biological understanding of infection – a critical mass of expertise for infection-related innovation that could be even further aligned to maximise UK/global impact.
  - **Materials Chemistry:** specialism supported by the high rankings for UoL in Chemistry (GPA & Research Power).
  - **High Performance & Cognitive Computing (now AI Solutions & Emerging Technologies):** UoL was the strongest LCR university in the Computer Science and Informatics UoA, but its overall GPA ranking fell from 10<sup>th</sup> in REF 2014 to 29<sup>th</sup> in REF 2021 (outside the top quartile of submissions). Looking into the breakdown of scores by the Output/Impact/Environment profiles, UoL achieved a very high GPA ranking for Outputs (5<sup>th</sup>).
- 2.16 REF 2021 highlighted important LCR HEI research strengths a number of other areas which have potential to help support innovative activity and economic growth:
- Archaeology (UoL)
  - Communication, Cultural & Media Studies (UoL)
  - Business and Management Studies (UoL)
  - Engineering (UoL)
  - English Language and Literature (UoL)
  - Environmental Studies (UoL)
  - Law (UoL)
  - Modern Languages and Linguistics (UoL)
  - Social Work and Social Policy (UoL)
  - Sport and Exercise Sciences, Leisure & Tourism (LJMU).

**Figure 2-3: LCR university rankings in REF 2021 for overall Grade Point Average and Research Power, by unit of assessment (green shading highlights results in the top 25% of submissions)**

	The University of Liverpool		Liverpool School of Tropical Medicine		Liverpool John Moores University		Total UK submissions
	GPA rank	Research Power rank	GPA rank	Research Power rank	GPA rank	Research Power rank	
1 Clinical Medicine	24	10	6	25			31
2 Public Health, Health Services and Primary Care	10	14	21	23			33
3 Allied Health Professions, Dentistry, Nursing and					72	27	91
4 Psychology, Psychiatry and Neuroscience	13	10			69	37	93
6 Agriculture, Food and Veterinary Sciences	3	4					25
7 Earth Systems and Environmental Sciences	21	23			38	13	40
8 Chemistry	7	11					41
9 Physics	16	20			17	32	44
10 Mathematical Sciences	37	19					54
11 Computer Science and Informatics	29	25			54	30	90
12 Engineering	17	29			35	40	89
13 Architecture, Built Environment and Planning	11	16			31	21	38
14 Geography and Environmental Studies	31	12					56
15 Archaeology	17	4					24
17 Business and Management Studies	17	11			95	72	108
18 Law	23	13			64	54	69
19 Politics and International Studies	34	34					56
20 Social Work and Social Policy	15	24			73	43	76
23 Education					63	34	83
24 Sport and Exercise Sciences, Leisure and Tourism					13	3	61
26 Modern Languages and Linguistics	8	23					47
27 English Language and Literature	17	20			36	44	92
28 History	25	31			72	55	81
30 Philosophy	20	20					35
32 Art and Design: History, Practice and Theory					49	35	86
33 Music, Drama, Dance, Performing Arts, Film and Screen	42	35					84
34 Communication, Cultural and Media Studies, Library and Information Management	13	15			55	21	58

Source: Steer-ED analysis of REF 2021 results



2.17 Turning to the **business base**, analysed by 2-digit SIC code (Table 2-3 and Table 2-4), it is evident that the LCR has relatively high location quotients for employment (LQE)<sup>18</sup> in the established capabilities identified in 2017 SIA: the Manufacture of Chemicals & Chemical Products (relevant to Materials Chemistry), and Human Health Activities (relevant to Infection Prevention & Control) - which has also seen strong growth in recent years. Computer Programming, Consultancy & Related Activities (relevant to AI Solutions and Emerging Technologies) has seen reasonably strong growth, although its LQ is still low at 0.50, highlighting potential for expansion.

**Table 2-3: High point industries in LCR (share of employment > 0.5% and LQ > 1.2)**

Industry	2020 employment	2020 employment share	2020 LQ vs GB
<b>20: Manufacture of chemicals and chemical products</b>	<b>4,000</b>	<b>0.61%</b>	<b>2.32</b>
29: Manufacture of motor vehicles, trailers and semi-trailers	7,000	1.08%	2.03
<b>86: Human health activities</b>	<b>82,000</b>	<b>12.60%</b>	<b>1.54</b>
84: Public administration and defence; compulsory social security	40,000	6.14%	1.40
93: Sports activities and amusement and recreation activities	12,000	1.84%	1.29
38: Waste collection, treatment & disposal activities; materials recovery	3,500	0.54%	1.24
52: Warehousing and support activities for transportation	15,000	2.30%	1.20

Source: Steer-ED analysis of Business Register and Employment Survey

**Table 2-4: High growth industries in LCR (share of employment > 0.5% and employment growth > 10%, 2015-2020)**

Industry	2020 employment	2020 employment share	2020 LQ vs GB	Employment growth 2015-2020
70: Activities of head offices; management consultancy activities	15,000	2.30%	0.91	87.5%
93: Sports activities and amusement and recreation activities	12,000	1.84%	1.29	50.0%
94: Activities of membership organisations	6,000	0.92%	1.15	50.0%
41: Construction of buildings	8,000	1.23%	0.83	33.3%
66: Activities auxiliary to financial services and insurance activities	6,000	0.92%	0.62	33.3%
45: Wholesale and retail trade and repair of motor vehicles and motorcycles	9,000	1.38%	0.77	28.6%
<b>86: Human health activities</b>	<b>82,000</b>	<b>12.60%</b>	<b>1.54</b>	<b>26.2%</b>
68: Real estate activities	13,000	2.00%	1.03	18.2%
69: Legal and accounting activities	20,000	3.07%	1.19	17.6%
38: Waste collection, treatment and disposal activities; materials recovery	3,500	0.54%	1.24	16.7%

<sup>18</sup> Location quotients are ratios that allow an area's distribution of employment by industry, ownership, and size class to be compared to a reference area's distribution. If a specific area has an LQ of 1, then it means its employment density is the same as that of the reference area

Industry	2020 employment	2020 employment share	2020 LQ vs GB	Employment growth 2015-2020
52: Warehousing and support activities for transportation	15,000	2.30%	1.20	15.4%
55: Accommodation	8,000	1.23%	0.89	14.3%
<b>62: Computer programming, consultancy, and related activities</b>	<b>8,000</b>	<b>1.23%</b>	<b>0.50</b>	<b>14.3%</b>
71: Architectural and engineering activities; technical testing and analysis	8,000	1.23%	0.68	14.3%
84: Public administration and defence; compulsory social security	40,000	6.14%	1.40	11.1%
78: Employment activities	20,000	3.07%	1.03	11.1%
64: Financial service activities, except insurance and pension funding	10,000	1.54%	1.00	11.1%

Source: Steer-ED analysis of Business Register and Employment Survey

2.18 Building on these broad metrics, the following three Sections look more closely at three established capabilities in LCR; *Infection Prevention and Control*, *Materials Chemistry*, and *AI Solutions and Emerging Technologies*, followed by a review of developing capabilities in *Net Zero and Maritime*.

### 3 Established Capability: Infection Prevention & Control

#### 15 second briefing . . .

- LCR hosts the largest concentration of translational public sector research, development and innovation into infection in the UK.
- Taken together with Cheshire & Warrington, this is worth £2billion a year.
- The global pandemic has brought unprecedented focus on Infection Prevention & Control since 2017, with global market growth expected to continue at pace.
- REF 2021 scores demonstrate world-leading research capability in LCR, with LSTM ranked 2<sup>nd</sup> in the UK for world class impact, and 88% of UoL's clinical medicine research ranked world class or internationally excellent.
- Measures developed and/or validated by LCR. institutes have delivered global impacts in infectious disease prevention and control, saving millions of lives
- LCR leadership during the COVID-19 pandemic enabled the first lateral flow test and the Oxford-AstraZeneca vaccine to be approved rapidly and effectively
- iiCON is a UK innovation exemplar; within 2 years it has levered more than 10-fold additional investment on the back of £18.6m government funding, and brought 12 products to market, with more than 5 billion units deployed.
- The asset base has also been strengthened by the establishment of the Combined Intelligence for Population Health Action (CIPHA) initiative, and the UK's first health-related Civic Data Cooperative.
- The Department of International trade (DIT) has identified LCR Vaccine Manufacturing as a UK High Potential Opportunity (HPO).
- Pipeline projects – notably the iiCON capacity development and translational facilities, Medical-Glass Manufacturing & Innovation Centre, Pandemic Institute, and Health IN Liverpool - will strengthen the LCR's world-leading capabilities and maximise crossovers with Materials Chemistry and AI Solutions & Emerging Technologies.

#### Context

- 3.1 Since March 2020, R&D in infectious disease has been dominated by the outbreak of COVID-19. However, there are still many endemic infectious diseases and potential for future pandemics, which require prevention, diagnosis, and treatment<sup>19</sup>. These include tuberculosis, measles, malaria, HIV/AIDS, flu, dengue as well as outbreaks of infectious diseases such as Ebola, SARS, and Zika Virus<sup>20</sup>. The latest Global Burden of Disease Study estimated that infectious disease resulted in 8 million deaths per year, and

<sup>19</sup> <https://www.weforum.org/agenda/2020/04/covid-19-infectious-diseases-tuberculosis-measles-malaria/>

<sup>20</sup> <https://www.elsevier.com/connect/infographic-global-research-trends-in-infectious-disease>

caused 420 million disability adjusted life years (DALYs)<sup>21</sup>. In addition, by May 2022, COVID-19 related deaths were over 6 million globally<sup>22</sup>.

### 3.2 Major challenges in addressing infectious disease include:

- **Antimicrobial resistance (AMR)** – remains a dominant threat to global health and prosperity and a G7 priority. The inexorable rise in AMR results from imprecise use of antimicrobial agents, and is further exacerbated by sub-optimal public health measures related to clean water, vaccination and waste disposal. In 2019, AMR was responsible for 0.9 million deaths and associated with 3.6 million deaths worldwide<sup>23</sup>
- **Pandemic preparedness** – COVID-19 has highlighted chronic vulnerabilities in civic systems (health, society, economy, and infrastructure) to massive disruption, from pathogens directly but also from lockdowns, other restrictions, and (market) fear;
- **Climate change** – insect-borne viruses are influenced by ecological changes. Places peripheral to endemic zones may see an increased risk of infectious diseases caused by vectors such as mosquitos<sup>24</sup>. The demand for effective and affordable treatments will continue to increase.

### COVID-19's lasting impacts

- 3.3 COVID-19 catalysed extraordinary innovation, with translation of research into applied diagnostics and treatments being carried out at unprecedented speed<sup>25 26</sup>. COVID-19 also highlighted the importance of other methods of prevention, and underlined the need for governments to invest in agile capacity and capability to detect and respond to new infectious diseases.

The cost of disruption caused by COVID-19 is estimated at over £12.5 trillion. However, the likelihood of future pandemics could be significantly reduced by globally spending £65-£105 billion on R&D and preparation over the next two years, followed by £16-£40 billion annually<sup>27</sup>.

### Global Market size

- 3.5 The global market for infectious disease therapeutics was £57 billion in 2021; estimated to grow to £85 billion by 2026<sup>28</sup>. The diagnostics market was valued at £18 billion in 2020 and expected to reach £32 billion by 2030. Growth of the diagnostics market is driven by the increase in prevalence of infectious diseases such as hepatitis, influenza COVID-19, and HIV, which have increased the demand for point-of-care diagnostic tests<sup>29</sup>.

<sup>21</sup> Global Burden of Disease Study 2019 (GBD 2019) Results

<sup>22</sup> <https://covid19.who.int/table>

<sup>23</sup> [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(21\)02724-0/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)02724-0/fulltext)

<sup>24</sup> <https://www.futureofpersonalhealth.com/vaccine-awareness/the-biggest-problems-we-face-in-fighting-infectious-diseases/#>

<sup>25</sup> ibid

<sup>26</sup> <https://www.futureofpersonalhealth.com/vaccine-awareness/the-biggest-problems-we-face-in-fighting-infectious-diseases/#>

<sup>27</sup> <https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems>

<sup>28</sup> <https://www.globenewswire.com/news-release/2021/12/24/2357713/28124/en/Global-Infectious-Disease-Treatments-Market-Report-2021-Featuring-Abbott-AbbVie-AstraZeneca-Bristol-Myers-Squibb-GlaxoSmithKline-Johnson-Johnson-Novartis-and-Roche.html>

<sup>29</sup> <https://www.alliedmarketresearch.com/infectious-disease-diagnostic-market>

## Research Excellence

- 3.6 The Liverpool School of Tropical Medicine was the world's first institute dedicated to research and teaching in tropical medicine, and together with the University of Liverpool has played an important global role in the research, prevention and control of infection for over a century.
- 3.7 LSTM and UoL have complementary expertise and longstanding partnerships in research themes related to Infection Prevention and Control, and are partners in the LCR's two headline programmes: iiCON (established), and the Pandemic Institute (developing).

**Table 3-1: Infection-related research**

LSTM	UoL
<ul style="list-style-type: none"> <li>Neglected tropical diseases</li> <li>Malaria and vector borne diseases</li> <li>Drug resistance research and management</li> <li>Antimicrobial resistance (AMR) research and the development of new antimicrobial therapeutics for AMR</li> <li>Preclinical pipeline development for therapeutics</li> <li>Disease diagnosis and mass testing</li> <li>Antimicrobial material and biofilm research and development</li> </ul>	<ul style="list-style-type: none"> <li>Prevention and detection of emerging infections, including Zika, and Rotavirus</li> <li>Vaccine development and deployment</li> <li>Antimicrobial resistance (AMR) research and the development of new antimicrobial therapeutics for AMR</li> <li>Application of materials chemistry to disease transmission reduction</li> <li>Systems innovation, leveraging health data (science)</li> <li>Antimicrobial material and biofilm research and development</li> <li>Public health action-research, including two UK Health Security Agency Health Protection Research Units</li> </ul>

Source: Steer-ED document review and consultation with LCR stakeholders

## REF 2021

- 3.8 Our universities' research excellence is reflected in the latest Research Excellence Framework results (REF 2021). Furthermore, the majority of clinical research across LCR is linked to one of the most challenged and busy clusters of NHS organisations in the UK, enabling it to be applied to real health challenges.
- 3.9 Key performance highlights from REF 2021 are highlighted below:
- LSTM showed rapid improvement in its REF GPA ranking 2014-2021, moving up 13 places to sixth of 31 in the UK, with 90% of LSTM's research ranking World Leading and **LSTM scoring 2<sup>nd</sup> overall for impact in the UK<sup>30</sup>**.
  - UoL Clinical Medicine ranked 11<sup>th</sup> in the UK for Research Power, with 100% of impact rated outstanding or very considerable. 88% of research outputs ranked World Leading (4\*) or internationally excellent (3\*).
  - UoL Veterinary School ranked joint top in the UK for 4\* overall research and for its research environment.**
- 3.10 For the next REF (or equivalent), LCR will have two new hospitals (Liverpool University Hospitals NHS Foundation Trust and Clatterbridge Hospital) lending significant additional critical mass to clinical and research facilities in KQ Liverpool. There is considerable scope for investment in the shared NHS and academic environment that can further support the healthcare needs of the City Region's population, with a

<sup>30</sup> Impact in REF is defined as the effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. It forms 25% of the Overall score



significant additional research and innovation pipeline that could be pulled through from this.

## Regional, National, & International Impacts

- 3.11 **LCR hosts the largest concentration of translational public sector research, development and innovation into infection in the UK.**
- 3.12 **Alongside Cheshire and Warrington, this amounts to delivery of £2 billion of infection research and development per year**, two thirds of this is spent in the LCR.
- 3.13 As demonstrated by the REF results, most of this research is World Leading in its impact. Specific examples of regional, national and global impacts in LCR include:
  - **iiCON** – led by LSTM, and includes UoL, LJMU, plus Alderley Park in Cheshire - has a network of 554 global partners, including 241 overseas firms. Other core partners include NHS Trusts, Unilever, Evotec and Infex Therapeutics. Key metrics:
    - Acting as the nationally significant Northern Hub for the Oxford-AstraZeneca COVID-19 vaccine. Datasets generated by iiCON were used for international approval of the vaccine. iiCON validated the first COVID-19 lateral flow test for COVID-19;
    - Cutting edge therapeutic and clinical trial facilities, including securing funding in 2022 for the first Robotic Category 3 Hits to Leads Laboratories;
    - Global impact on applied infection control measures. iiCON led large-scale trials for insecticide treated mosquito nets, which shaped the WHO's recommendations for their use in malaria prevention. 30% of treated mosquito nets in Africa in 2021 used technology trialled by iiCON, with use of PBO-pyrethroid class nets in Uganda helping reduce malaria prevalence by 27%;
    - iiCON over the last 18 months has helped to bring 12 new products to market with 5 billion units already reaching patients/populations; and
    - iiCON has 241 active projects with industry facilitating new product development, is working with 170 SMEs based in the North West and over the last 18 months has created or secured >300 high value jobs, with >100 being new jobs in LCR.
  - **LSTM** has a large portfolio of research funding globally, including £210 million for support tackling TB, HIV/AIDS, malaria, dengue fever and lymphatic filariasis. It is globally influential, acting as the lead institute on 25 international consortia and product development partnerships. Global partners include the World Health Organisation, The Bill and Melinda Gates Foundation, Unilever, AstraZeneca, Pfizer. LSTM also has established trial capability and capacity, with the largest concentration of Category 3 facilities in Europe (26 in LCR), configured to handle high risk biological agents for testing and trials. LSTM has had global impact in validating diagnostics and treatments, including:
    - Treatment: Led the Advancing Cryptococcal Meningitis (CM) Treatment for Africa study, advising WHO recommendations which led to £16 million funding to support 7 African countries to scale up management of CM, saving tens of thousands of lives;
    - Diagnosis: A key partner in the STAR initiative, developing HIV test delivery models in Malawi and Zimbabwe. 4.5 million HIV self-tests were provided through the initiative, with a further 8 million procured by funders; and
    - LSTM is improving the uptake of COVID-19 vaccine in Liverpool, working with Public Health Liverpool (PHL) and the local council to reduce vaccine hesitancy in

several key sectors of the population. The work has been so successful that PHL is looking at extending this to other health areas.

- **UoL** provided local, regional and national leadership for COVID-19 research that resulted in significant advances in molecular epidemiology, new therapeutics and diagnostic development, and gave all patients in the region the potential to be enrolled in nationally prioritised clinical studies. More widely, global impacts include:
  - A UoL-led clinical trial of rotavirus vaccine in Malawi informed a WHO recommendation for the vaccine in Malawi, preventing 1,500 deaths since 2013, and 170,000 deaths in 38 African countries;
  - Dedicated Drug-Drug Interaction (DDI) research and monitoring tools are used by 50,000 users per month in 220 countries. UoL's tools are recommended for use in all HIV clinics in the UK and recognised by the WHO as a world-leading resource.
  - UoL research improved surveillance, diagnosis and management of brain infections, contributing to a 73% reduction in encephalitis treatment time since 2013.
- **CIPHA and the Civic Data Cooperative (CDC)** - established in 2019 by UoL, the CDC is a UK first citizen-involved data system which links the NHS, local authorities (including social care) and citizen-generated data. CDC development was accelerated in response to COVID-19 delivering the Combined Intelligence for Population Health Action (CIPHA) platform in Cheshire and Merseyside. This enabled coordination and evaluation of the world's first open-access, voluntary rapid antigen testing at city-scale, the first reopening of live music events in the Northern Hemisphere, catalysed improved local services and consolidated public and practitioner support for data-sharing that has been difficult to achieve nationally. NHSEI is now expanding CIPHA to cover 20 million of the English population by autumn 2020;

### 3.14 Additional examples of impact include:

- **Vector control:** IVCC is globally the only Product Development Partnership specialising in vector control<sup>31</sup>. It has a £150M portfolio focussing on the development of novel chemistries and affordable products for prevention of malaria and other insect borne disease transmission
- **Inward investment:** iiCON has generated around £45 million of inward investment over the last 18 months. IVCC has a stable turnover of £39.5 million per annum, of which 85% is inward investment, largely from the US;
- **Quality assurance:** LJMU in collaboration with LSTM developed and operationally validated a self-contained sensor platform for insecticide Indoor Residual Spraying quality assurance. It resulted in development of new diagnostic tools and adoption of these in public health, building materials and defence. This is generating £2.5M of inward investment from the Bill and Melinda Gates Foundation; and
- **Pandemic drug testing:** UoL and LSTM are founding partners of the AGILE clinical platform, a new type of study designed for pandemic drug testing which represents a world-first for infectious diseases – capable of testing multiple potential treatments in parallel and speeding up testing by pooling control data across patient groups.

<sup>31</sup> <https://www.ivcc.com/about/>

## Asset Base

We have a growing number of innovation assets supporting innovation in diagnostics, therapeutics, and prevention of infectious diseases and took a leading role in the development of vaccines for multiple infectious diseases and for COVID-19. Key assets in the City Region that currently support reduction of health impacts of infectious disease are presented in Table 3-2, and mapped at Appendix A.

**Table 3-2: Key LCR assets supporting research and innovation in infection**

Asset (alphabetical)	Summary
Alder Hey Children's Hospital	Hospital with 1,000sqm Innovation Centre in its basement aimed at creating individualised pre-emptive interventions and solutions to tackle healthcare inequalities and develop physical, digital, and automated solutions for healthcare. Generated over £12 million funding 2018-21 and has ambitions to develop treatments for 1 billion children worldwide
Civic Data Cooperative	Based at UoL, the UK's first <a href="#">Civic Data Cooperative</a> to organise the efforts of public sector, business and academic organisations in a civic cluster to mobilise residents' data with and for them – leading to multi-award-winning innovations such as the Combined Intelligence for Population Health Action ( <a href="http://www.cipha.nhs.uk">www.cipha.nhs.uk</a> ) platform that underpinned world-first COVID-19 responses such as mass testing and early reopening of mass events.
Infection Innovation Consortium (iiCON)	Consortium of academic, industry and NHS partners operating 10 R&D platforms to overcome roadblocks in infection prevention, control and treatment product development. Generated total funding of £188 million on specific research projects 2018-21. Global network of 489 partners, including 298 industry stakeholders, 40 contract research organisations and 54 laboratories.
Innovative Vector Control Consortium (IVCC)	Facilitates the development of novel and improved public health insecticides and formulations to prevent vector-borne disease transmission. Generated over £110 million funding 2018-21.
Microbiome Centre	Ecological, biological, clinical and veterinary science; work in collaboration with industrial, clinical, and academic partners to accelerate microbiome research.
Nanotherapeutics hub	The Hub builds on local expertise in Nanotherapeutics and leads on the development and standardisation of characterisation techniques, working with partners including American Society for Testing and Materials and The National Measurement Laboratory.
Open innovation Hub for Antimicrobial Surfaces (OPIHAS) and National Biofilms Innovation Centre (NBIC)	OPIHAS is a multi-disciplinary laboratory in the University of Liverpool developing new surfaces, materials processes and technologies to tackle biofilms, antimicrobial resistance and develop advanced biomaterials. It is a core founding partner of NIBIC led by four Universities (Edinburgh, Liverpool, Nottingham and Southampton), and a partnership that has expanded to include 59 associate research institutions, and support from a growing base of >150 small, medium and large companies. NBIC delivered >100 innovation projects, generated £52.5 million funding between 2019-2021 and established an interdisciplinary Doctoral Training Centre in Biofilms Innovation, Technology and Engineering.
Pandemic Institute	A partnership bringing together Liverpool's leading academic institutions, the NHS, City Council, Combined Authority and KQ Liverpool and focusing on pandemic resilience, response, and recovery and translating this into science and technology, business and economics, and policy and impact. Funded by a £10 million philanthropic donation and currently fundraising to £250 million.

Source: Steer-ED document review and consultation with LCR stakeholders

## Funding Developments

3.16 Between 2000-2017, £4.9 billion per annum was invested in infectious disease research in G20 countries<sup>32</sup>. 58% of this funded pre-clinical research, while 28% was targeted at public health research. At the level of individual diseases, HIV/AIDS (40%), TB (7%), malaria (5%) and pneumonia (3%) received the highest levels of investment.

3.17 Past investments into high-threat diseases (e.g. Ebola and coronavirus) were reactive and there is no evidence that investment was guided by pandemic risk<sup>33</sup>. The COVID-19 pandemic has changed this in the short term, with more focus on preventative disease control and should refocus prioritisation of surveillance and response capabilities<sup>34</sup>. LCR's universities and research centres have demonstrated impactful research into this important capability and are well placed to continue to provide leading research solutions to the threat of future pandemics.

### University Funding

3.18 LSTM and UoL sourced £514 million for research related to infection 2018-2022, an increase of £90 million on the preceding five years. In the same period, 138 UoL academics acted as Principal Investigators across 711 infection related research projects, with a total funder contribution of £180 million.

3.19 LSTM has 54 FTE staff working on infection related research and attracted £330 million in funding 2018-2022. Table 3-3 shows a breakdown of funding sources for the two universities combined. It highlights:

- Infection Control related research in LCR is backed strongly by the UK Government and Research Councils, accounting for 28% and 9% of funding respectively;
- Sources of funding have diversified, with a higher percentage of funding coming from industry (16%, including industry in kind funding, up from around 11%); and
- Overseas funding, particularly from governments and sector groups is high, totalling £168 million, 33% of total funding.

**Table 3-3: Funding for infection related academic led research in LCR 2018-2022**

Funding Source	Total (£ million)	Percentage
UK Government/NHS	144	28%
Other Overseas	102	20%
UK Philanthropic	72	14%
Industry in kind	67	13%
Research Councils	47	9%
Philanthropic Overseas	32	6%
EU Government	28	5%
UK Industry	14	3%
EU Other	7	1%
UK Other	1	0%
<b>TOTAL</b>	<b>514</b>	<b>100%</b>

Source: Steer-ED analysis of LJMU, LSTM, and UoL data 2018-2021

<sup>32</sup> [https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(20\)30357-0/fulltext](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(20)30357-0/fulltext)

<sup>33</sup> *ibid*

<sup>34</sup> <https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems>

## Primary Pipeline Projects

3.20 In addition to the academic funded research activity already underway, significant investment in capital pipeline projects is planned in LCR, totalling over £800 million, including:

- **Capacity Workforce Development Centre, LSTM** – Scheduled to open Autumn 2022, will provide industry specific training packages and entrepreneurial service support
- **iiCON Phase 1b and Phase 2** - £94 million capital investment into CAT3 lab space including robotics equipment (1b) and a facility for translational R&D that can support industry R&D needs and rapidly respond to emergent or re-emergent pathogens (2);
- **Innovation Liverpool**– expansion of KQ Liverpool, including the £250 Million Health Innovation Liverpool (HILL) campus development in Paddington Village and a managed innovation pipeline fed by LCR Civic Data Cooperative developing/supporting secure, trustworthy processes for data-intensive innovation with integrated NHS, local authority, public health and administrative data;
- **Medical Glass Manufacturing & Innovation Centre** – Final stage investment being secured for a new commercial £80 million UK production capability to create the specialist borosilicate glass required for vaccine vials that is no longer produced in the UK, alongside Glass Futures pilot plant; and
- **High Potential Opportunity (HPO) in Vaccine Manufacturing** – In spring 2022, the UK Department for International Trade launched a High Potential Opportunity in vaccine manufacturing LCR, directly linked to the LCR's innovation, academic and industrial strengths in vaccine research, manufacture and distribution <sup>35</sup>.

## Learning from the past 5 years

3.21 The COVID-19 pandemic demonstrated the importance of agility in healthcare systems, enabling rapid response to shocks. Research Institutes in LCR took leading roles in the national COVID-19 response. Prior to the pandemic, the City Region was already developing its Civic Data Cooperative initiative, looking at utilising data and AI to proactively prepare for, identify, and treat infection and chronic diseases.

3.22 There are, however, challenges, which need to be addressed to maximise growth and impact of LCR's Infection Prevention and Control Ecosystem, including:

- **Improved cross-regional links** – LCR has a suitable health ecosystem and population on which to validate diagnostics and treatments. This could be maximised with expanded collaboration outside the City Region, over and above that with Alderley Park via iiCON;
- **Talent pipeline development** – digitalisation of diagnosis, tracking and treatment requires skilled data science engineers. To build a pipeline and benefit City Region residents, this will require scaled-up engagement at school level;
- **Critical mass of quality infrastructure** – need for high-quality lab and managed workspace around assets to support cluster development, with particular demand for additional Category 3 facilities for clinical trials;

<sup>35</sup> At time of writing, the LCR - where Seqirus currently has the UK's largest vaccine manufacturing facility - is one of a small number of global locations being considered for a new industrial-scale manufacturing facility for its next generation vaccines. This would potentially safeguard 800 highly skilled jobs as well as create up to 200 new roles in R&D, manufacturing and fill and finish capabilities. The investment could mean an expansion and retention of the UK's sovereign vaccine manufacturing capability, drive global competitiveness and strengthen public health resilience by bringing innovative new technology to the UK that offers enhanced protection against seasonal flu and boosts pandemic response.



- **Secure income generation** – COVID-19 has impacted philanthropic funding, pulling this away from global initiatives to more local donations.

## Future Direction

3.23 Our ecosystem is well placed to capitalise on the following market opportunities and provide solutions to global challenges, with important economic and societal benefits:

- **Clinical trials and validation** – Demonstrated capabilities during development of vaccines, including for COVID-19, pneumonia, and malaria. iiCON has received funding to develop the first Robotic Category 3 Hits to Leads Laboratories, utilising AI and robotics, which will enable more simultaneous experiments to be run on more parameters;
- **Agile response capabilities in healthcare** - the concept of a ‘Living Lab’<sup>36</sup> was in development in LCR prior to the pandemic. LCR demonstrated the value of this in its pandemic response, e.g. through the Phase III Oxford-AstraZeneca trials conducted;
- **Data and civic AI for health** – utilising ‘Civic AI’ to develop applied and connected diagnostics which can operate at a City Region level, whilst delivering personalised diagnostic and treatment services to patients. Underpinned by the Civic Data Cooperative, Liverpool’s health and care system is well positioned to adopt and test new solutions;
- **Place-based innovation beyond boundaries** – there is good critical mass potential in the North West, with complementary life sciences expertise in Greater Manchester and Cheshire. Cooperation at scale is already starting through iiCON and could build capacity and capability to rival global life sciences hotspots like Israel and Singapore and deliver inclusive innovation;
- **AMR and drug resistance** – AMR is a global threat and the UK government’s 20-year plan is behind the curve, requiring increased urgency, leadership, and funding to head off a silent AMR pandemic. The configuration and membership of the iiCON programme and its current integration into international AMR efforts should allow an increasing national leadership role in AMR from the region. The development of preventative products for the threat of AMR is also increasingly important, and both LSTM and UoL are well positioned to provide evidence of need and validation. This requires further government funding support to address market failures around development of ‘last resort’ contingency; and
- **Wider health innovation specialisms**
  - LCR has UK-leading expertise in paediatrics through Alder Hey, which is not only one of the largest and busiest children’s hospitals in Europe but arguably also one of the most innovation-focused health trusts of any kind in the UK.
  - Sports Science: REF21 ranked LJMU’s Sport & Exercise Science 3<sup>rd</sup> in UK for research power and 13<sup>th</sup> overall for research quality, and awarded it 100% 4\* for research environment, reflecting state of the art laboratory facilities.

<sup>36</sup> Living labs and citizen involvement programmes are used to determine use cases, priorities and public service improvements by applying emerging technologies to real world situations for proof of concept and proof of value

## 4 Established Capability: Materials Chemistry

### 5 second briefing . . .

- LCR's capabilities in Materials Chemistry are addressing key global challenges, including net zero, energy transition, health care and hygiene.
- The University of Liverpool's Materials Innovation Factory (MIF) is a world-leader in the computer- and robotics-assisted discovery and design of materials.
- The LCR remains Unilever's global R&D hub and largest R&D facility – of the 524 global patents it registered in 2021, more than half originated from its LCR bases.
- Unilever employs more than 850 scientists in the LCR, including more than 200 with PhDs, and continues to invest in the region as an anchor partner in the MIF and through the Advanced Manufacturing Centre opened in 2018.
- Materials Chemistry in LCR is digitally integrated and exemplified by the 'Liverpool Model' of industry-academic partnership between Unilever and UoL who have been collaborating since 1906.
- UoL's research excellence in Chemistry was demonstrated by its performance in REF 2021, ranking 3<sup>rd</sup> in the UK for the percentage of research rated world class for impact.
- LCR is home to one the UK's largest clusters of chemical companies, while Inovyn is Europe's largest operator of electrolysis.
- National Catapult body Centre for Process Innovation opened its first North West Office in Liverpool in 2022, and is leading on the proposed National Packaging Innovation Centre project.
- MIF's proposed *Labs of the Future* programme will act as a key digital lab innovation hub and cement LCR as a global centre of excellence in digital innovation for the advanced materials and chemistry sectors.

### Context

- 4.1 The 2017 SIA highlighted consistent growth in the Materials Chemistry sector. This growth has continued since with the global lightweight materials market growing from £70 billion to £106 billion 2014-19<sup>37</sup>. The global packaging market itself, a market increasingly visible and crucial to Net Zero goals was valued at £800 billion in 2021<sup>38</sup>. Significant drivers in the Materials Chemistry market include:

- **Net Zero and sustainability:** Global demand for lighter, greener, and stronger material outputs is being driven by businesses as well as governments. Materials Chemistry will provide solutions for:
  - **Energy transition:** development of materials for catalysts, batteries and solar energy

<sup>37</sup>[https://www.researchgate.net/publication/339135787\\_2020\\_Market\\_Analysis\\_of\\_Materials\\_Science\\_and\\_Nanotechnology\\_Conference](https://www.researchgate.net/publication/339135787_2020_Market_Analysis_of_Materials_Science_and_Nanotechnology_Conference)

<sup>38</sup> <https://www.globenewswire.com/news-release/2022/03/18/2405869/0/en/Global-Packaging-Market-Growth-Trends-COVID-19-Impact-and-Forecasts-2022-2027.html>

- **Alternatives to fossil fuels:** replacing crude oil and natural gas as sources of carbon for consumer products;
- **Packaging:** development of biodegradable carbon-based materials for ingredients and packaging<sup>39</sup>;
- **Technology:** digital innovation for chemistry is becoming much more pervasive and could add £22-25 billion value to the sector (2016-2025)<sup>40</sup>. Applications of digital technology to the Materials Chemistry field include:
  - AI to deal with large sets of data, enabling increasingly rapid and automated discovery and testing of new materials
  - Lab automation to increase productivity and data consistency
  - Quantum Computing to enable new forms of rapid, cost effective analysis<sup>41</sup>.
- **Healthcare and COVID-19 lasting impacts:** Material science and chemistry research is key for drug product process development<sup>42</sup>. The requirement for safety critical materials in diagnostics and delivery of treatments and preventative measures continues at a global scale, particularly with increased focus on pandemic preparedness<sup>43</sup>. Research into the application of nanotechnology for drug delivery has developed over the past five years as a potential method to overcome limitations of therapeutics and increase the potential for personalised and precision treatments<sup>44</sup>. In addition, across multiple applications in healthcare, advanced functional surfaces and antimicrobial materials form the first line of defence in medical devices and infection control.

## Research Excellence

- 4.2 UoL's world-leading materials chemistry research is characterised by the Liverpool model' of industry-academia partnership based on 'open by design' access to specialised space and high-throughput facilities. The model also offers access to industry-grade methodologies, digital platforms and academic excellence – all with an emphasis on knowledge-sharing. The model is supported by state-of the-art computing and professional management and business engagement services. The Liverpool model has been perfected over the last two decades, primarily linked to its longstanding partnership with Unilever that culminated in the creation of the Materials Innovation Factory, but now being applied to working with other major companies such as Croda, BASF, and Johnson-Matthey.
- 4.3 The quality of the university's research is evidenced in the high REF scores in Chemistry, detailed below. Table 4-1 lists the ongoing materials chemistry research at UoL.

**Table 4-1: Research themes related to chemistry in UoL**

UoL
New porous materials (including polymers, metal-organic frameworks, porous molecules)

<sup>39</sup> <https://nanocanada.com/5-materials-science-industry-trends-to-look-out-for-in-2021/>

<sup>40</sup> World Economic Forum (2017) Digital Transformation Initiative Chemistry and Advanced Materials Industry

<sup>41</sup> [https://www.accenture.com/\\_acnmedia/PDF-158/Accenture-Digital-Research-And-Development-Chemicals.pdf](https://www.accenture.com/_acnmedia/PDF-158/Accenture-Digital-Research-And-Development-Chemicals.pdf)

<sup>42</sup> ibid

<sup>43</sup> ibid

<sup>44</sup> Mitchell, M.J., Billingsley, M.M., Haley, R.M. et al. Engineering precision nanoparticles for drug delivery. Nat Rev Drug Discov 20, 101–124 (2021)

Nanomaterials for biological and medical applications  
 Unit cell by unit cell assembly of new solids as thin films  
 Polymers for organic electronics  
 Peptide-based materials  
 Synthesis of new oxides for energy applications (fuel cells, photocatalysis)  
 Battery materials and superconductivity  
 Polymer synthesis  
 Nanomaterials synthesis  
 New multifunctional transition metal oxides  
 Molecule-based porous materials for energy-sufficient separation and catalysis  
 Solar fuels – New Materials for Photocatalysis with visible light  
 Advanced antimicrobial surfaces and materials

Source: UoL Materials Chemistry Research<sup>45</sup>

## REF 2021

- 4.4 UoL ranked 7<sup>th</sup> in overall Chemistry research, however 3<sup>rd</sup> in the UK for impact with 87.5% of UoL research in Chemistry rated as (4\*). Outputs and environment were also ranked relatively highly, at ninth and tenth respectively.
- 4.5 UoL's Materials Chemistry capabilities are supported by its engineering research, which ranked sixth in the UK for 4\* impact.
- 4.6 LJMU engineering research also has a strong materials research focus through its Mechanical Engineering & Materials Research Centre (MEMARC). Half of all MEMARC outputs submitted to REF2021 were judged to be world-leading (4\*) and the unit achieved 100% 4\* and 3\* impact.

## Regional, National, & International Impacts

- 4.7 The impact of Materials Chemistry research and innovation in LCR is demonstrated in both the core science of materials discovery and development and in industrial application. Key examples of this impact at regional, national and global level include:
  - **Unilever:** the €52bn company remains a R&D powerhouse and has expanded its research capabilities in recent years to employ more than 850 scientists, of whom more than 200 have PhDs. Its combined assets in Port Sunlight and the Materials Innovation Factory, encompass its global R&D HQ and biggest R&D facility, and are where many of the world's best-known household and hygiene products are developed. In 2021 Unilever made 524 patent applications globally, half of which originated from the Liverpool City Region, more than any other UK-based R&D organisation.
  - **The MIF** is a world leading centre for translational physical science, based on a strategic collaboration between leading industrial innovators and academia. Since its inception in 2014, the total investment in laboratories, scientific equipment, commercial innovation and research activity in the MIF is close to £120 million. This funding is a mix of commercial income and grant funding from highly competitive UKRI and ERC grants. It operates in multiple disciplines (lab automation, robotics, computer science, physics, chemistry, and nanomedicine) and provides open access to more than £20M of high-end scientific facilities. Key achievements of the MIF include:

<sup>45</sup> <https://www.liverpool.ac.uk/chemistry/research/materials-chemistry/research/>

- Acceleration of molecule discovery to product launch, leading to product launches in 2013, 2015, and 2017;
  - Generation of >£450 million per annum 2018-2021 in product sales from materials developed at MIF;
  - Doubling in productivity for industrial scientists at MIF, leading to adoption of its open innovation model by Unilever and collaboration with over 80 companies;
  - Colocation of the large multinational company Croda at MIF, which has opened its Centre of Innovation for Formulation Science on site.
- **Centre for Process Innovation (CPI) and Knowledge Centre for Materials Chemistry (KCMC):** KCMC is hosted by CPI, an independent technology innovation centre and founding member of the UK's High Value Manufacturing Catapult. The KCMC partnership was co-founded by UoL and enables companies to connect and access capabilities and expertise of KCMC partners to meet the research, development and innovation needs of chemistry-using industries. CPI supports the translation of early stage research through product and process scale up and on to commercialisation. This partnership is an exemplar of how the LCR regional innovation ecosystem is connected into wider national infrastructure for supporting key growth sectors of the process and manufacturing industries;
  - **Materials Innovation Translator funding programme:** (£0.5 million from High Value Manufacturing Catapult), enabling flexible project scientist resources to work on industry focussed research projects, including transfer of knowledge from UoL to The STFC Hartree Centre to assist with digitally enabled materials discovery;
  - **NSG Pilkington:** Through the KCMC partnership, NSG is collaborating with UoL, and the Hartree Centre to discover new high performance transparent conducting materials, underpinning the development of the next generation of market leading products;
  - **UoL spinout activity has ramped up since 2017** and includes Liverpool Chiro Chem (chemical tech innovation for pharma sector), Tandem Nano (solid drug nanoparticle technology), CageCapture (air purification), Polymer Mimetics (biodegradable ingredients for products), Meta Additive (additive manufacturing), Gearu (mobile robotics for chemical lab work) and Thiotech (materials for capturing hazardous waste and precious materials).

## Our Asset Base

- 4.8 The LCR has an established nationally and internationally significant Materials Chemistry ecosystem, focused around UoL's research excellence and partnerships with innovation-intensive global businesses, notably CPI, Croda, Johnson Matthey, NSG, and Unilever. Current investment in Materials Chemistry projects in LCR totals over £130m.
- 4.9 The key assets which support research and innovation in Materials Chemistry in LCR are presented in Table 4-2, with all assets mapped at Appendix A.

**Table 4-2: Key LCR assets supporting research and innovation in Materials Chemistry**

Asset name	Summary
Unilever Global R&D HQ & Advanced Manufacturing Centre	Unilever has a proud history of Research and Development in the Liverpool City Region, with Lever Brothers founding its first laboratory at Port Sunlight, in 1911, to design soap.  Building on its global R&D HQ, existing manufacturing capability, and founding investment in the MIF, in 2018 Unilever opened its Advanced Manufacturing Centre (AMC) at Port Sunlight - part funded by the UK's Regional Growth Fund - and the largest of its type in Unilever. It houses fully digitised replicas of large-scale manufacturing facilities around the



Asset name	Summary
Manufacturing Centre	Sunlight - part funded by the UK's Regional Growth Fund - and the largest of its type in Unilever. It houses fully digitised replicas of large-scale manufacturing facilities around the world, including advanced packaging technology. This enables rapid translation from laboratory scale to full manufacturing scale, often without the need to interrupt factory production and generates the data to build 'digital twins' of existing and future production processes. The AMC combined with the Materials Innovation Factory, keeps Unilever globally competitive by harnessing digitalisation and Artificial Intelligence to accelerate innovation.
Materials Innovation Factory (MIF)	The Materials Innovation Factory, located in the heart of KQ Liverpool is an £81 million, 11,600m <sup>2</sup> state of the art facility for research and computer aided innovation in materials chemistry and formulation. It is part of the University of Liverpool, and houses approximately 200 FTE academic staff. In addition, another 80-100 FTE of staff from industrial partners, including Unilever, work in the facility. £49.2m funding was generated between 2019-2021.
Digital Manufacturing Accelerator (DMA)	Operated by the Manufacturing Technology Centre, a Research & Technology Centre and national Catapult, the DMA based at SciTech Daresbury brings together research and industry in focused activities to empower businesses, increase productivity through innovation and integrate regional assets and infrastructure to increase the value proposition and asset capitalisation. DMA generated £11.5 million funding between 2019-2021.
Open innovation Hub for Antimicrobial Surfaces (OPIHAS) and National Biofilms Innovation Centre (NBIC)	OPIHAS is a multi-disciplinary laboratory in the University of Liverpool developing new surfaces, materials processes and technologies to tackle biofilms, antimicrobial resistance and develop advanced biomaterials. It is a core founding partner of NIBIC led by four Universities (Edinburgh, Liverpool, Nottingham and Southampton), and a partnership that has expanded to include 59 associate research institutions, and support from a growing base of >150 small, medium and large companies. NBIC delivered >100 innovation projects, generated £52.5 million funding between 2019-2021 and established an interdisciplinary Doctoral Training Centre in Biofilms Innovation, Technology and Engineering.
Croda UK Biotechnology Lab	Global speciality chemicals firm Croda located its UK biotechnology laboratory at SciTech Daresbury in 2020 to be close to its existing manufacturing base in Widnes to further develop supply chain capabilities across its biotechnology specialist laboratories. and give rise to future generations of sustainable products. Croda also operates a Centre of Innovation for Formulation Science at the MIF.
Knowledge Centre for Materials Chemistry (KCMC) Partnership	KCMC is a leading organisation for knowledge transfer between academia and industry, driving globally competitive innovation that is underpinned by materials chemistry. Partners include UoL, the University of Manchester, University of Southampton, STFC Hartree Centre, NSG, and CPI.
Sustainable Packaging Hub - CPI	CPI's new hub at Liverpool Science Park in KQ Liverpool - its first base in the North West - provides space for partnership development with universities, local government, industry, and SMEs. The hub received seed funding from the LCR CA, and is a forerunner to a £60 million National Packaging Innovation Centre which has the potential to create 2,000 new R&D jobs.
NSG Pilkington	Global glass manufacturer of glass with multiple presence in LCR, plus global R&D facility just over the Lancashire border, collaborating with UoL and The Hartree Centre through the KCMC partnership on discovery of transparent conducting materials.

Source: Steer-ED document review and consultation with LCR stakeholders

## Funding Developments

### University Funding

4.10 Across funding sources, UoL and LJMU received £74 million for research related to materials chemistry between 2018-2022. Key observations are that:

- The vast majority of this funding came from Research Councils, including UKRI, showing the national significance of Materials Chemistry research in LCR;



- EU government funding is significant, at 10%. Although the share has dropped from 15% in 2017, the actual amount of funding has increased, indicating strong international collaboration; and
- UK Industry funding has remained relatively constant since 2017, showing continued significant collaboration between academia and industry in LCR.

Figure 4-1: Funding for Materials Chemistry related academic led research in LCR 2018-2022

Funding Source	Total (£ million)	Percentage
Research Councils	53	72%
EU Govt	7	10%
UK Other	3	4%
UK Industry	3	4%
UK Govt	3	4%
Other Overseas	2	3%
UK Philanthropic	1	2%
EU Other	1	2%
Philanthropic Overseas	0	0%
Industry in kind	0	0%
TOTAL	74	100%

Source: LJMU, UoL

## Our Key Pipeline Projects

4.11 Alongside the significant live projects in LCR, funding provided for pipeline projects in LCR totals over £113 million. Key pipeline projects include those tackling **digitally enabled** discovery, development and commercialisation of new materials:

- **MIF Labs of the Future:** Based on a deep engagement with key commercial partners and funding bodies, this comprises a >£30 million co-investment in six new platforms, designed to transform innovation in the Advanced Chemical materials sector (chemicals, pharmaceuticals, rubber and plastics manufacturing) which has a UK turnover of £87 billion, with £27 billion GVA. These platforms are: (1) Transforming Chemical Lab Operations, (2) Building MIF Capacity, (3) Centre for Autonomous Pharma Process Chemistry, (4) Lab of the Future Accelerator, (5) Accelerated Functional Materials Realisation, and (6) Future Lab Workforce. The six platforms will be led by MIF, its sister institute at UoL, the DIF, and commercial partners. The investment could stimulate the creation of 1,000 new high-value jobs in Liverpool City Region (LCR) and its immediate neighbourhood in the North-West, with a similar number created with partners across the UK. This will create a strategic UK innovation asset, which will directly address UK national priorities e.g. applied and interdisciplinary innovation in advanced materials for clean growth. It will also make Liverpool City Region an internationally identifiable centre of excellence in digital innovation and R&D for the Advanced Materials and Chemistry sectors.
- **Gearu / mobile robotic Chemistry** – A set of collaborative projects between MIF, Gearu Ltd, and significant government and commercial end-users to invent, commercialise (both scale up and scale out) robotics and AI enabled lab automation technologies. These projects will develop hardware and software that is needed to automate synthetic chemistry and formulation processes and will support training in organic synthesis and robotic technologies;

- **EuPRAXIA centre of excellence in advanced plasma accelerator application beamlines** - the Liverpool/STFC Daresbury Laboratory will perform mission-critical R&D, prototyping, testing, and construction tasks;
- **Relativistic Ultra-fast Electron Diffraction and Imaging Facility (RUEDI)** – UoL has been awarded £1.4 million funding through EPSRC to begin to scope and develop a £30million globally unique materials science facility at STFC Daresbury Laboratory that will permit the direct observation of atomic/electronic motions directing the chemistry of materials. This will have applications in the fields of personalised medicine; energy storage, grid and transportation; renewable energy generation, transformation, and advanced manufacturing; and materials operating under extreme conditions.

4.12 Additionally, a new **Prosperity Partnership** was announced in 2021, which is an £8.8 million EPSRC funded collaboration between the University of Liverpool, Unilever and the University of Oxford. It aims to reduce the carbon footprint of consumer products such as shampoo and laundry detergent through improved chemical production, with ambitions to transform the global chemical supply chain and help the UK achieve Net Zero by 2050.

## Learning from the past five years

4.13 Key lessons to observe since 2017 include the following:

- **The success of MIF:** this university-industry partnership asset, has been an unqualified success in all regards, not least in delivering huge turnover value to industry via a unique open innovation model that has been shown to increase R&D productivity by a factor of 2-10. The opportunity is to apply this approach to scale up other LCR assets.
- **Restructuring of Supply Chains:** Brexit, COVID-19, and global political tensions have all adversely impacted the resilience of supply chains critical to scaling up production of new materials and products and sourcing of raw materials. In tandem, net zero and decarbonisation imperatives have also heightened the need for simpler, smaller, more local national and local supply chains.
- **De-risking support:** Some of the best projects have started from impact accelerator funding, which is pivotal for initiating larger projects. This discretionary funding is very important to supporting high-risk but potentially transformational projects associated with new material discovery and development;
- **Skills demand:** On the academic side, it is relatively easy to recruit PhD chemists but difficult to recruit engineers with robotic experience. There is also a skills shortage in AI and biotech. Chemistry graduates are of high quality, but retention is difficult as the majority are students from overseas. Larger companies face fewer issues with recruitment due to their 'pull' factor. Reskilling to build a pipeline of talent in emerging technologies such as nanotechnology, robotics and data science is important to stay at the forefront of Materials Chemistry as automated labs become more pervasive;
- **Communication:** the image of LCR nationally and internationally as an innovative place needs to be broadcast more effectively, with a focus on a small number of specific strengths, including digitally enabled materials R&D, materials commercialisation, and packaging materials;
- **Innovation diffusion and adoption:** is a major challenge outside the large companies. Most innovative activity in Materials Chemistry is undertaken by academia and a small number of large companies. University spinouts historically struggle to know where to start or even what they need to do to innovate.

Consideration of how catapults and public sector can tackle this issue more systematically is important.

## Future Direction

4.14 Materials Chemistry will play a vital role in the move away from fossil fuel use for electricity generation and the development of low/zero carbon and sustainable products. Specific areas which, based on our, world leading capabilities and innovative R&D models, LCR is well placed to lead on include:

- **Addressing the challenge of embedded carbon:** in 2020, 85% of the carbon embedded in chemicals and products in homes, food and drink, infrastructure, transport and energy, was from fossil-based sources<sup>46</sup>. Of this, 65% was from polymers and rubber. As demand for consumable goods continues to increase, the need to reduce embedded carbon and find new source materials will become increasingly important. LCR's research excellence and AI capabilities mean that it could be central to national and international efforts to discover and enable the transition to more sustainable alternatives to polymers;
- **Packaging and the circular economy:** LCR is well placed to address challenges regarding the lifecycle of polymers and derived products. Repurposing and biodegradability of products, packaging, and components is becoming increasingly important for governments, businesses and individuals. The National Packaging Innovation Centre and Prosperity Partnership will be a key research institutes for discovery and development of new materials and methods of packaging to address this, alongside industrial expertise in biotechnology and electrochemical catalysts;
- **Lab automation:** Lab automation can simultaneously improve the reproducibility, traceability, reliability, and intensity of lab operations. The University of Liverpool hosts an Autonomous Chemistry Lab as part of MIF that has 10 FTE of academic researchers working on next generation robotics for chemical lab automation. LCR has super and quantum-computing capabilities at The STFC Hartree Centre and has trialled a robotic infection control lab at iiCON, demonstrating wider transferability of automation that can increase lab process efficiency by 2-10 times. The newly opened Digital Innovation Facility will act as a further catalyst in the development of automated laboratory technology including digital framework architectures;
- **Batteries and energy production:** related to embedded carbon and low-carbon energy production, battery technology will help enable the switch from non-renewable energy sources to more intermittent renewables, however the components still contain embedded carbon. The Prosperity Partnership (UoL, Unilever, and Oxford University) will contribute to discovery and development of new materials which can be applicable to battery manufacture, through research into sustainable organic materials;
- **Personal utilities:** demand for smart utilities for homes and offices will increase, meaning there will be demand for suitable materials for incorporating sensors. Utilities, devices and buildings will become increasingly connected through internet of things, requiring cheap, robust, sustainable materials;
- **Healthcare and safety critical applications:** CPI and NSG have strengths in this area and there is high demand from end users (notably hospitals such as Alder Hey) for anti-viral surfaces and "smart" materials and diagnostic devices with medical accreditation. There is potential here for collaboration between producers and end-users based in LCR to collaborate on testing and validation of devices;

<sup>46</sup> <https://biooekonomie.de/en/service/analyses-statistics/nova-institut-2021-turning-tap-fossil-carbon>

- **Expanding Connections:** Nearby centres of excellence, including the Advanced Manufacturing Research Centre in Lancashire and Sheffield and planned Advanced Machinery and Productivity Institute in Greater Manchester offer opportunities for collaboration and alignment of strategies; and
- **Capitalising on Mersey Tidal and Freeport R&D** opportunities, particularly relating to new tidal power solutions and decarbonising the maritime industry, for example, in the manufacture of innovations with advanced materials such as corrosion resistant turbines, diagnostics and antimicrobial healthcare equipment.

## 5 Established Capability: AI Solutions & Emerging Technologies

### 15 second briefing . . .

- Digital technologies and adoption have continued to advance at an exponential rate since 2017, further accelerated by the global pandemic.
- STFC Hartree Centre at Sci-Tech Daresbury houses arguably the world's most powerful supercomputer dedicated to solving industrial problems.
- 2021 saw the next phase of development with the approval of the £210million Hartree National centre for Digital Innovation as the UK's de facto business-focused AI diffusion and solutions centre, and consolidated IBM's Global Research Lab presence in the LCR.
- Daresbury also now hosts the Atos Quantum Learning Machine, one of the highest performing quantum simulators in the world.
- Other new assets include the University of Liverpool's Digital Innovation Facility – sister to the Virtual Engineering Centre, the joint UoL-LJMU Centre for Doctoral Training for Innovation in Data Intensive Science, also opened in 2022, and the UK's first Civic Data Cooperative.
- REF2021 confirmed LCR research excellence in Computer Science and Informatics, with UoL ranking 5<sup>th</sup> in the UK in terms of world-leading (4\*) research outputs, and 80% of LJMU's research outputs judged to be world-leading or internationally excellent (4\*/3\*).
- LCR's capabilities now extend beyond AI and High Performance Computing to quantum computing, robotics, immersive technology and digital health.
- Re. digital infrastructure, DCMS-backed Liverpool 5G is delivering community health and social care services using the largest 5G mm wave mesh network in Europe, while the LCR Connect 212km gigabit-capable fibre backhaul network across the City Region will be completed in 2023.

### Context

5.1 Innovations in digital technologies have continued to advance at pace since the last SIA in 2017, and this has brought substantial economic growth. Tech Nation estimates<sup>47</sup> that the number of digital economy jobs in the UK has grown from 2.69 million in 2017 to 4.7 million in 2022. Examples of recent technology progress include the following:

- **Artificial intelligence** has become vastly more powerful and pervasive, from smartphones recognising faces and emotions, sophisticated health chatbots as at Alder Hey Children's Hospital, to frontier scientific discovery (e.g. protein structure prediction). Machine learning models have also become considerably larger, more complex and accurate, with Google noting that *'just in the last couple of years models*

<sup>47</sup> Source: [A Decade of UK Tech](#), Tech Nation, May 2022

*in the language domain have grown from billions of parameters trained on tens of billions of tokens of data (e.g., the 11B parameter T5 model), to hundreds of billions or trillions of parameters trained on trillions of tokens of data’<sup>48</sup>.*

- **In High performance computing**, the world’s most powerful supercomputer is now capable of more than 1,000 petaflops compared to 93 in 2017<sup>49</sup>. Quantum computing is an emerging technology with the potential to outperform classical computers at certain tasks, and which saw VC investment of more than £800 million in 2021.<sup>50</sup>
- **Internet of Things** –the worldwide installed base of IoT connected IoT devices has doubled from 6.1 billion at the end of 2017 to 12.2 billion in May 2022<sup>51</sup>.
- **Immersive technology** – virtual reality and augmented reality are increasingly being integrated into a wide variety of situations, from visitor attractions to remote assistance and training in smart factories, using devices such as Microsoft’s HoloLens headset. The rebranding of the Facebook parent company to Meta, and Zuckerberg’s vision of the metaverse, brought a surge of popular interest in immersive technology. In the film and TV sector, virtual production (in which computer-generated imagery is used as a backdrop for a set) was boosted by the difficulties caused by the pandemic for location-based filming.

5.2 Additionally, COVID-19 enforced lockdowns have dramatically accelerated the digital transformations of huge numbers of businesses – forcing them to rapidly to adopt new collaborative working tools in order to be enable effective and efficient remote-working, and/or to expand their online capabilities in order to reach customers, while also spanning healthcare, education and virtually every other facet of life, including a radical decentralisation of clinical trials<sup>52</sup>.

5.3 LCR is not world-class across *all* areas of digital technology, however, does have specific areas of competitive strength, where there is scope to supporting innovation and economic growth at UK and international levels, as well as the LCR’s own sectors.

## Research Excellence

- 5.4 Although not subject to the REF, the STFC Hartree Centre and Scientific Computing Department has a cohort of 300 experts engaged in tackling real-world R&D challenges, which adds significant depth to the region’s capability.
- 5.5 This is complemented by the colocation of 100 IBM Research staff at the Hartree Centre, with plans to increase this presence substantially in the next few years. In addition, IBM Research can leverage their global network of thousands of scientists and specialists, to meet the needs of specific projects.
- 5.6 Three of our universities entered submissions to REF 2021 in the Computer Science and Informatics unit of assessment: UoL (40.75 FTE staff submitted), LJMU (42 FTEs) and LHU (13.5 FTEs).

<sup>48</sup> Source: [Google AI Blog](#), January 2022

<sup>49</sup> Source: [Top 500](#). 1 petaflops = 1 thousand trillion floating point operations per second

<sup>50</sup> Source: [Pitchbook](#), September 2021

<sup>51</sup> Source: [IoT Analytics](#), May 2022

<sup>52</sup> See, for example, [How Did Clinical Trials Move at the Speed of COVID?](#)



**Table 5-1: Main computing research themes/expertise at UoL and LJMU (Source: HEI websites)**

UoL Main research themes/expertise	UoL continued	LJMU Main research themes/expertise
Algorithms and networks Artificial Intelligence Economics and computation Logical methods in computer science Big Data Data Analysis and Simulation Systems verification and validation Next generation of Telecom Robotics	<ul style="list-style-type: none"> <li>Natural Language Processing</li> <li>Autonomous Systems</li> <li>Health Data Science (including Biostatistics, Digital Health and Health Informatics)</li> <li>Bioinformatics</li> <li>Geographic Data Science (including Urban Analytics)</li> <li>Consumers and Retail</li> </ul> Digital Skills and Inequality	<ul style="list-style-type: none"> <li>Network and information security</li> <li>Networking and distributed systems</li> <li>Computer games technology</li> <li>Applied computing</li> <li>Critical infrastructure protection</li> </ul> e-Healthcare

## REF 2021

- 5.7 The REF 2021 results in Computer Science and Informatics were on the whole positive for LCR's universities. UoL and LJMU improved to improve their overall Research Power rankings, with LJMU advancing 45 places up the rankings by this measure. This is largely reflective of the total FTEs included in LCR's submissions increasing from 40.7 in REF 2014 to 96.25 in REF 2021.
- 5.8 UoL ranked 5th in the UK for world leading (4\*) research outputs, with 100% of UoL's research environment rated as world leading (4\*) or internationally excellent (3\*)
- 5.9 80% of LJMU's Computer Science research outputs were judged to be world-leading or internationally excellent (4\*/3\*).
- 5.10 High performance computing is a fundamental component of LJMU's Astrophysics Research Institute submission to Physics, ranked 1st in the UK for research impact (100% 4\* and 3\*) and 5th in the UK for 4\* quality research outputs.
- 5.11 In terms of the percentage of the submissions assessed to be world-leading (4\*) by the Overall score, UoL achieved 52% in REF 2021 (vs 35% in REF 2014), LJMU achieved 11% in REF 2021 (vs 0% in REF 2014).

## Regional, National, & International Impacts

- 5.12 Examples of LCR's research capabilities in digital tech translating into impacts at regional, national and international levels include the following:
- The STFC **Hartree Centre** at Sci-Tech Daresbury is part of the Science and Technology Facilities Council (STFC), one of Europe's largest research organisations, which operates other top UK science assets. It was established in 2012 to help the UK stay at the forefront of computational science and digital innovation. In 2015, it secured a further £115.5m of government funding to become the UK Centre of Excellence in Cognitive Systems and Big Data. That levered a £200m investment by IBM involving access to its global IP - including the Watson AI platform - plus the onsite expertise of 50 staff to create a new global IBM research lab. Today is home to possibly the world's most powerful supercomputer facilities dedicated to applying high performance computing and AI to solve real world challenges. Integral to its success is a unique global collaboration with IBM

Research. A wealth of case studies can be found at:

[www.hartree.stfc.ac.uk/Pages/Case%20Studies.aspx](http://www.hartree.stfc.ac.uk/Pages/Case%20Studies.aspx)

- **LCR 4.0** supported over 300 LCR SMEs to realise the potential of digital transformation in manufacturing, supporting the creation of 955 jobs and £31 million GVA. Led by UoL's Virtual Engineering Centre (with partners STFC, LJMU, Hartree Centre, Sensor City and the Growth Platform), this ERDF-funded initiative was the UK's leading sub-national industrial digitalisation programme and led to the NW Made Smarter national pilot programme, that in December 2021 was scaled out into a £147million national challenge fund.
- The University of Liverpool's **Virtual Engineering Centre (VEC)** is one of the UK's leading digital engineering impact centres for industrial and commercial applications, having been established in 2010, by the University of Liverpool, BAE Systems and the National Nuclear Laboratory. It supports large companies in exploiting cutting-edge digital technologies – for example, with Bentley Motors (in the introduction and development of Virtual Reality technologies for enhancing their product development process), Airbus (with the Hartree Centre, applying state-of-the art AI and data visualisation to support their product development process), and OPTIS (showcasing products and capabilities through the VR visualisation facilities, supporting co-design of new immersive design products);
- Recent projects at UoL's multi-disciplinary **Centre for Architecture and the Visual Arts (CAVA)** include the mixed reality prototype for St Georges Hall's The History Whisperer visitor attraction; and in 2020 CAVA secured more than £500k funding to develop an immersive Shaun the Sheep experience in China for Aardman, through a UK-China Research-Industry Creative Partnerships grant;
- UoL **robotics technology spin-outs** in recent years include Gearu – AI-powered autonomous mobile robots addressing R&D challenges in sectors such as materials, chemicals, and catalysis, which made the cover of Nature magazine in Summer 2020, and Robotiz3d - advanced detection and repair systems in autonomous robotic platforms for automated road maintenance. This builds on a significant industry base, including ABB's UK HQ and robotics/automation R&D lab at Daresbury, plus CNC Robotics;
- LJMU has developed and applied innovative AI techniques, including machine learning and neural networks, in **Sport and Exercise Sciences** to predict movement and loading in the musculoskeletal system, physical activity assessment in children, football performance analytics, identification of risk factors in osteoarthritis and cardiovascular imaging.
- The LCR **Civic Data Cooperative** model of mobilising civic data for digital innovation had world-leading impacts in COVID-19 responses, including a multi-award-winning combined NHS, local government, and public health intelligence system for 2.7m population deployed in 90 days;
- Beyond the established digital and creative cluster in the Baltic Triangle, there is a growing immersive technology nucleus of internationally significant SMEs, notably vTime which is at the forefront of creating the metaverse. In parallel, **LJMU's LIVE Lab** is complemented by UK-leading digital retail and user experience pioneer Very Group.

## Our Asset Base

- 5.13 Innovation assets in AI Solutions and Emerging Technologies include the following, with a full list of assets presented in Appendix A:

**Table 5-2: Key LCR assets supporting research and innovation in digital technology**

Asset name	Summary
STFC Hartree Centre & Hartree National Centre for Digital Innovation	<p>The Hartree Centre at Daresbury helps UK businesses and organisations of any size to explore and adopt supercomputing, data analytics and artificial intelligence (AI) technologies for enhanced productivity, smarter innovation and economic growth. The centre's facilities include three supercomputers, an Atos Quantum Learning Machine (the UK's first quantum computing simulation environment) and a Visual Computing Suite. The Hartree Centre's facilities also include Europe's largest cryogenic cooling bath: important for quantum computing.</p> <p>The Hartree National Centre for Digital Innovation is a new collaborative programme between STFC Hartree Centre and IBM Research enabling businesses to acquire the skills, knowledge and technical capability required to adopt digital technologies like supercomputing, data analytics, artificial intelligence (AI) and quantum computing. As part of this programme the Hartree Centre will be investing in a new supercomputer which will be the first pre-exascale AI -accelerator in the UK focused on industrial challenges.</p>
Alder Hey Innovation	Alder Hey Innovation is the largest, dedicated, purpose built, hospital led innovation centre in the UK. Its ambition is to be the world leader in advancing child health with innovation. Its technical areas of focus include Artificial Intelligence & Data Science, user experience, immersive healthtech & digital therapeutics, all supported and connected by gamified digital platforms development.
Baltic Triangle	Located close to Liverpool City Centre, and voted by The Times as the coolest place to live in the UK, the Baltic Triangle is the LCR's primary digital and creative business cluster.
Centre for Doctoral Training for Innovation in Data Intensive Science	This new joint UoL-LJMU Centre that opened in May 2022 is dedicated to training the scientists of tomorrow in what could become the world's biggest industry. Cutting edge cross-disciplinary research projects and a targeted academic training programme, will complemented by secondments to national and international research partners and industry.
Civic Data Cooperative	The UK's first civic data cooperative model for mobilising residents' data for trustworthy research and innovation uses, including incubation of local businesses in the globally expanding digital health sector. Academic, NHS, local authority, third sector and industry members of the cooperative work to close the data-action gap together, pooling resources to incubate digital innovations while exercising the highest standards of information governance with and for residents.
Digital Innovation Facility	Opened in May 2022, UoL's £12.7 million DIF in KQ Liverpool dedicated to maximising both advanced research and the real-world application of emerging technologies, in an environment that's purpose-built for collaboration. This includes a Mixed Reality Lab containing the latest in virtual reality technology and equipment, an Extreme Environment Lab that simulates real-world hazardous conditions for testing robotics and autonomous systems, and an Immersive Laboratory that focuses on developing sensory technologies in areas of smell and touch for future "Tactile Internet" applications. By co-locating leading academic researchers and commercial partners, the DIF is intended to put the LCR at the forefront of industrial application and integration in the fields of Autonomous Systems, Robotics, Data Analytics and Artificial Intelligence
Digital tech Cluster	Managed by the Science and Technology Facilities Council, the North West digital tech cluster launched in 2021 aims to create 1,000 high-value jobs over the next 10 years, by growing 100 digital tech companies at Sci-Tech Daresbury and a wider network of 300 companies.
LCR Connect	LCR Connect is a £30m joint venture between LCR CA, French company NGE, and ITS Technology Group, delivering a 212km full-fibre, ultrafast, gigabit-capable network infrastructure across the region. It is designed to equip businesses, investors, universities, schools, hospitals, residents and students across the City Region to access next-generation, future-proofed and cloud-enabled technologies.
Liverpool 5G	Co-funded by DCMS, this is currently the largest 5G mm Wave mesh network in Europe, run by a consortium comprising UoL, LJMU, Liverpool City Council, the NHS, and technology companies, and delivering innovative health and social care programmes to some of the UK's most disadvantaged communities.

Asset name	Summary
Manufacturing Technology Centre	The MTC Catapult at Liverpool Science Park in KQ Liverpool provides a high-quality environment for the development and demonstration of new technologies on an industrial scale, supporting skills, productivity and growth. Initiatives include the Digital Manufacturing Accelerator programme.
Virtual Engineering Centre	The VEC, based at Daresbury and Liverpool, sits within UoL's IDEAS (Institute of Digital Engineering and Autonomous Systems) and works to bridge the innovation gap between academic research and new product and process development.

Source: Steer-ED document review and consultation with LCR stakeholders

- 5.14 In terms of the wider business base, key digital tech employers include The Very Group (with significant digital development activity in Speke), IBM Research at Sci-Tech Daresbury, and Sony Interactive Entertainment which has recently re-located to new offices in Liverpool city centre for its PlayStation development activities. Sony is part of a thriving gaming, immersive technology and creative sector in Liverpool, which also includes Ripstone, vTime, Avalanche Studios and Universally Speaking.

## Funding Developments

- 5.15 Total funding awards secured for digital-related research at LCR's universities amounted to £55 million in the period 2018-22. Funding sources for AI Solutions and Emerging Technologies in LCR are more diverse than for High Performance and Cognitive Computing in 2017, showing significant maturation of research. Funding from UK industry rose to 8% from 5% in 2017, which indicates significantly higher levels of applied research.

Table 5-3: Funding for digital related academic led research in LCR 2018-2022

Funding Source	Total (£ million)	Percentage
Research Councils	22	40%
UK Govt	21	38%
UK Industry	4	8%
UK Philanthropic	2	4%
Other Overseas	2	3%
EU Govt	2	3%
UK Other	1	2%
EU Other	1	1%
Philanthropic Overseas	0	0%
Industry in kind	0	0%
<b>TOTAL</b>	<b>55</b>	<b>100%</b>

Source: Steer-ED analysis of UoL and LJMU data

- 5.16 Beyond academic research, funding for live projects in LCR totalling over £310 million. Examples of current funded innovation-related projects include:

- Hartree National Centre for Digital Innovation** – a collaboration between STFC Hartree Centre and IBM Research, involving substantial UKRI funding of £172 million over five years, met with a £38 million in-kind contribution from IBM. Then Science Minister, Amanda Solloway, said: *“Artificial intelligence and quantum computing have the potential to revolutionise everything from the way we travel to the way we shop. They are exactly the kind of fields I want the UK to be leading in, and this new centre in the north west is a big step towards that. Thanks to this fantastic new partnership with IBM, British businesses will have access to the kind of infrastructure and*

*expertise that will help them boost innovation and grow the economy – essential as we build back better from the pandemic”;*

- **Hartree Data Centre** – construction commencing 2022 at Daresbury of a new 33,000 sq. ft supercomputing centre. This dedicated and green/sustainable building will house state-of-the-art computing machines to support the Hartree programme;
- The ERDF-funded **LCA4.0 Start** (supporting LCR SMEs develop their digital strategy) and **LCR4.0 Holistic** (delivering the first City Region-wide digital supply chain ecosystem, cross-linking traditional supply chains and clusters to offer greater business resilience and growth opportunities and facilitate innovation in products and services);
- The **New Robotic Telescope** (NRT) - led by LJMU’s Astrophysics Research Institute, this £24 million project (including £4 million STFC funding) is building world’s largest (4.0m) and fastest (30 seconds to target) robotic telescope; co-located with the current 2.0m Liverpool Telescope (LT) on La Palma. The Astrophysics Research Institute will operate this national facility from their base in Liverpool Science Park; ensuring UK continue to lead the world in robotic time-domain astronomy. NRT will bring opportunities for R&D in control and manufacturing of large precision structures, and in AI for optimal resource scheduling, autonomous operations and self-healing software systems;
- The MTC’s **Digital Manufacturing Accelerator** programme – a £15 million initiative supported by LCRCA.

#### 5.17 Pipeline projects include:

- **Digital Innovation Accelerator** - dedicated support on the Daresbury Campus for high-growth and scale-up businesses that are either developing or deploying transformative digital technologies, building on the growing Digital Tech Cluster ecosystem around the Hartree Centre.
- **Littlewoods Studios** - transforming Liverpool into one of Europe’s premier TV and Film hubs, building on its status as the most filmed UK city outside London, and comprising 85,000 sq. ft of studio and ancillary space for Twickenham Film Studios, 75,000 sq. ft of education space for LJMU to deliver a sector-leading Entertainment Technology Centre to ensure local young people develop high-level skills to work in the film industry, a further 95,000 sq. ft of flexible employment space for creative industries.

## Learning from the past five years

#### 5.18 Key learning points from the last five years include the following:

- LCR’s **excellence in the digital tech arena now goes wider** than the AI and High Performance Computing areas identified out in the last SIA. In particular, quantum, robotics, digital health and immersive technology are key strengths which are not captured by the AI/HPC tag, hence the revised nomenclature;
- The **LCR is a UK leader in industrial digitalisation**, thanks to LCR 4.0 which demonstrated how well-designed and resourced projects and programmes can have substantial impact in facilitating innovation in LCR’s business base.
- Notwithstanding the major potential future impacts of the Civic Data Cooperative, **more needs to be done to translate digital tech research excellence into impacts**. The relatively low Impact score for UoL in Computer Science and Informatics in REF 2021 reflects this, as do a low volume of tech spinouts;



- In common with other areas of the UK, **major issues in digital tech skills supply** and recruitment are constraining the growth of LCR's tech businesses, especially SMEs with limited resources;
- **LCR HEIs are demonstrating world-class capabilities in a broader range of subjects**, having achieved a top quartile position Research Power in nine different subject areas in REF 2021, compared with just three in REF 2014. In some cases there is clear scope to combine LCR's subject area strengths with digital technology expertise – e.g. in robotic chemical discovery, law tech, tech for archaeology, mental health tech, sport tech, tech for children's health.

## Future Direction

5.19 IN addition to scaling internationally significant existing assets in Artificial Intelligence and High Performance Computing there are opportunities to develop strengths in:

- **quantum computing** and the presence of Atos in what is a niche growth field;
- **Immersive technology** – drawing on the thriving gaming and creative sectors in Liverpool, as well as the research capabilities in LCR's universities and VEC's 14 years' experience of developing and deploying immersive technology in business.
- **Robotics** –UoL's recent digital tech spin-offs have both involved robotics, adding to a business base that includes established players such as ABB and CNC Robotics. There is considerable potential to apply robotics to other themes identified in this SIA via the established MIF and new Digital Innovation Facility. The LCR also has emerging strengths in drone technology, through UoL's Centre for Autonomous Systems Technology (CAST) and LJMU's Drone Research Group; while the UK Drone Major Group is developing its major shared "Phoenix" platform here;
- **Digital health innovation** – the Civic Data Cooperative has catalysed a cluster of activities in programmable prevention, precision and payment as a value-maximising engine for health systems, which could support AI training/testing for better targeted diagnostics, therapeutics and health system management and create a new 'operating system' for integrated care. In children's health, Alder Hey has the largest, dedicated, hospital-based innovation centre in the UK, with a particular focus on the use of technology linked to its "Alder Hey anywhere" ethos; and there is wider potential for HEI spin-out activities...

5.20 It will also be important to:

- **Continue to ramp up computer science and digitally literate student numbers** (both undergraduate and postgraduate) being educated at LCR's universities – to help counter the significant skills shortages facing the digital tech sector;
- **Actively promote and support other routes into digital employment**, including digital Skills Bootcamps and apprenticeships;
- **Increase translational data science training** where there is high demand for a talent pipeline, for example in health, materials, creative, energy, policy, transport and integrative (e.g. smart cities) domains;
- **Embed entrepreneurship more fully** into LCR's universities (in partnership with NHS and local authority organisations), seeking to **increase the numbers of digital tech spin-offs** (whether university spinouts or graduate start-ups);
- **Link local digital tech businesses more closely with the universities and FE colleges**, to ensure that tech students are sighted on the opportunities available to them within LCR, and to help improve talent retention;
- **Grasp catalytic application domains such as mental health and wellbeing** to bootstrap transferrable digital technology development across academic, public



service and industry partners, swarming around critical problems such as mental health and the UK's new Mental Health Mission; and

- **Ensure that projects to assist businesses with digital transformation are still supported** post ERDF funding availability, continuing the work of highly successful projects like LCR4.0.

## 6 Developing Capability: Net Zero & Maritime

### 15 second briefing . . .

- LCR's three established capabilities have application to Net Zero targets and decarbonisation of Maritime. Strong, industry led innovation, LCR's natural assets, the global net zero imperative, the Freeport designation, and a pipeline of ambitious projects highlight Net Zero and Maritime as a key developing capability.
- Alongside the established capabilities' research excellence in themes vital to addressing Net Zero challenges, research power in Engineering and Geography in LCR's universities increased in REF 2021.
- The primary live projects are Glass Futures – an industry-led global centre of excellence for glass innovation and wider industrial decarbonisation campus – and the first phase of HyNet North West, the UK's leading hydrogen cluster seeking to mainstream hydrogen to power energy intensive industries. Both projects delivered world firsts in 2021, notably hydrogen fuel switching at Pilkington and Unilever to run on 100% hydrogen.
- This capability has the largest scale investment profile of all. The ambitious £5-14billion Mersey Tidal Power aims to create 5,000 new jobs and produce 1-6TWh of predictable renewable low carbon energy each years. The £5+billion future phase of HyNet is intended to cut carbon emissions by 10 million tonnes a year by 2030 and create 75,000 by 2035.
- LCR's innovation in hydrogen power and significant and expanding offshore wind generation capacity position it well to lead on the development of solutions to UK Net Zero challenges, including production and utilisation of Green Hydrogen.
- While the size of these programmes present major R&D opportunities for the LCR and UK, linked to delivering the innovative technical solutions required to make them happen, they also pose serious challenges in terms of the scale of investment required, providing the skilled individuals to fill these new jobs, and the LCR upping its game in terms of research focus and excellence to maximise direct benefits.

### Context

#### Global situation

- 6.1 Achieving Net Zero in places, businesses, and services has become an increasingly imperative global challenge for mitigating climate change and increasing sustainability and resilience<sup>53</sup>, and one the UK Government has ambitions to lead in. The UK was the first major economy to legislate for Net Zero, adapting the Climate Change Act of 2008 to a target of achieving Net Zero by 2050. This was ratified at COP26, hosted in the UK in 2021, which outlined that to ensure the international 1.5-degree target is met, there needs to be global Net Zero<sup>54</sup>.

<sup>53</sup> <https://netzeroclimate.org/what-is-net-zero/#:~:text=To%20go%20net%20zero%20is,zero%20on%20the%20timescale%20needed>.

<sup>54</sup> <https://ukcop26.org/cop26-goals/>

## 6.2 Achieving Net Zero is a complex challenge, which needs to be addressed across sectors. Key considerations on how to achieve Net Zero include:

- **Clean energy:** Replacing coal, and gas and oil-fired power stations with renewable energy sources, such as wind, solar, hydrogen, hydroelectric power and tidal, is the most obvious means to reach Net Zero, with energy production being responsible for 25% of greenhouse gas emissions<sup>55</sup>. The global renewable energy market was valued at \$880 billion in 2020 and is forecast to reach \$2 trillion by 2030<sup>56</sup>.
- **Maritime:** The shipping industry is responsible for 2.5% of global CO<sub>2</sub> emissions<sup>57</sup>. Since 2017, there has been a seismic change in Net Zero ambition for the industry, with the UK Government's Maritime 2050 vision providing clear direction for the Maritime sector for the first time. Emissions from shipping are currently excluded in place-based emissions records and targets, but the UK is the first country to include this in its domestic carbon budget. As shipping is responsible for the transport of 90% of all consumable goods<sup>58</sup>, there is significant opportunity to reduce carbon emissions through improved logistics and retrofit or replacement of shipping fleet components through light-weighting materials and alternative propulsion technology;
- **Other Transport:** Transport as a whole contributes 27% of greenhouse gas emissions<sup>59</sup>. Switching to electric or alternative fuels for transport is therefore critical to reducing emissions and air pollution in the world's major cities<sup>60</sup>. Further to this, behavioural change relating to travel is a key aspect of reducing emissions from transport<sup>61</sup>. The global market for electric vehicles was £246.7 billion in 2020 and is anticipated to grow to £1,318.22 billion by 2028<sup>62</sup>;
- **The Built Environment:** Buildings use approximately 35% of global energy (including construction)<sup>63</sup>, with 35% of this energy consumption coming from heating, ventilation and air conditioning, and 11% from appliances<sup>64</sup>. A key challenge in reducing energy consumption in buildings is in provision of suitable insulation, and smart, low energy use appliances. This is particularly challenging in the UK, where significant numbers of old buildings require retrofitting to ensure Net Zero targets are met<sup>65</sup>. Globally, the retrofit market was £160 billion in 2021, projected to grow to £210 billion in 2028<sup>66</sup>;
- **Industry:** A contributor of 24% of greenhouse gas emissions<sup>67</sup>, decarbonisation of industrial processes is critical in achieving Net Zero targets, and relies on private sector investment. Digitalisation, consideration of the circular economy, carbon

<sup>55</sup> <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

<sup>56</sup> <https://www.alliedmarketresearch.com/renewable-energy-market>

<sup>57</sup> <https://www.ukri.org/news/shipping-industry-reduces-carbon-emissions-with-space-technology/#:~:text=The%20shipping%20industry%20is%20responsible,the%20world's%20total%20CO2%20emissions.>

<sup>58</sup> *ibid*

<sup>59</sup> <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

<sup>60</sup> <https://news.un.org/en/story/2020/12/1078612>

<sup>61</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1033990/net-zero-strategy-beis.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf)

<sup>62</sup> <https://www.globenewswire.com/news-release/2021/12/09/2348920/0/en/At-24-3-CAGR-Electric-Vehicles-Market-Size-2021-2028-to-Reach-USD-1-318-22-Billion.html>

<sup>63</sup> 2020 Global Status Report for Buildings and Construction

<sup>64</sup> <https://www.energy.gov/sites/prod/files/2017/03/f34/qtr-2015-chapter5.pdf>

<sup>65</sup> [https://www.arup.com/expertise/services/buildings/building-retrofit?gclid=CjwKCAjwtaVBhBkEiwAsr7-c5gonnb5ezMx3VK3jJnHCZiMQoBrWRMntVdp8uqAnGaiYldjxLVoxoCiysQAvD\\_BwE](https://www.arup.com/expertise/services/buildings/building-retrofit?gclid=CjwKCAjwtaVBhBkEiwAsr7-c5gonnb5ezMx3VK3jJnHCZiMQoBrWRMntVdp8uqAnGaiYldjxLVoxoCiysQAvD_BwE)

<sup>66</sup> <https://www.fortunebusinessinsights.com/energy-retrofit-systems-market-106331>

<sup>67</sup> <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

capture and storage, and utilisation of sustainable materials are key tools to reduce emissions; and

- **Agriculture:** Contributing to 11% of greenhouse gas emissions<sup>68</sup>, decarbonising agriculture will require innovation into methane capture and use, alternative fertilisers, use of alternative fuels for machinery<sup>69</sup>, and even adoption of alternate sources of food to those which are most polluting (e.g. beef)<sup>70</sup>.

## LCR Context

- 6.3 In LCR, globally significant Net Zero initiatives are underway or in the pipeline, including HyNet<sup>71</sup>, the Mersey Tidal Power project, Glass Futures, and ambitious Freeport proposals. Delivering these will be essential for the City Region to reach Net Zero by 2040, ten years before the UK government target.
- 6.4 LCR Pathways to Net Zero sets out in detail how the City Region aims to achieve this goal. Within the City Region, all six local authorities have declared a climate emergency, however an estimated £45 billion of investment is needed over the next 20 years to deliver on these carbon reduction goals.
- 6.5 Progress is being made in LCR to make changes to homes, neighbourhoods, journeys, and workplaces. Carbon emissions in LCR reduced by 40% 2005-2021, but in order to reach the 2040 target, carbon emissions need to be reduced faster, with significant investment and commitment from government.
- 6.6 LCR's world leading expertise Materials Chemistry, AI Solutions and Emerging Technologies, and Infection Prevention & Control capabilities all have significant roles to play in decarbonising transport, industry, energy production and domestic sectors. LCR's physical geography and maritime activity also position it well to develop, test and deliver renewable energy and maritime solutions.

## Research Excellence

- 6.7 LJMU and UoL have complementary expertise in research themes related to Net Zero and Maritime, and both engage actively with businesses in enabling and developing low carbon goods, processes and services. Table 6-1 highlights the research foci of both universities.

**Table 6-1: Research themes related to Net Zero and Maritime in LCR's universities**

Liverpool John Moores University	University of Liverpool
<p>Built Environment, including development and investment of green space</p> <p>Shipping and transport efficiency.</p> <p>Support to enable businesses to create low carbon goods, processes and services</p> <p>Maritime and Mechanical Engineering</p> <p>Triangulation with Net Zero, health &amp; wellbeing, and housing.</p> <p>Design and Operation of large maritime engineering systems</p>	<p>Batteries: Extending battery life, recycling /reusing, next gen. solid state batteries</p> <p>High performance, low-cost solar cells</p> <p>Plasma-catalytic electrification technologies</p> <p>Biomass/plastics waste to fuels and chemicals</p> <p>Next generation nuclear materials</p> <p>Electric vehicle battery monitoring</p> <p>Using solar, wind and ocean power to generate green hydrogen</p> <p>Mass market hydrogen fuelled vehicles</p>

<sup>68</sup> ibid

<sup>69</sup> [Decarbonisation in the Agricultural Sector | SpringerLink](#)

<sup>70</sup> [\(PDF\) Path to 2060: Decarbonizing the Agriculture Industry \(researchgate.net\)](#)

<sup>71</sup> Development of one of Europe's largest industrial decarbonisation clusters

Safety, security and sustainability assessment of port terminals and maritime logistics chains

Design, build, and operation of future nuclear power plants  
Operational efficiency and GHG emission reduction at container ports  
Emission control and sustainable energy in green port development  
Support to enable businesses to create low carbon goods, processes and services

## REF 2021

- 6.8 UoL has shown large improvements in both GPA rank and research power rank for Geography. Alongside this, and as highlighted above, UoL's exceptional research in Chemistry and Engineering have strong crossovers with Net Zero innovation, particularly relating to materials discovery and development for consumables, packaging, and batteries. LCR's universities are well placed to apply their research strengths to provide solutions for Net Zero and decarbonisation challenges.

### Key findings:

- UoL ranked 6th in the UK for outstanding (4\*) impact in Engineering, with 100% of impact rated outstanding or very considerable. 93% of UoL Engineering research outputs rated as world leading (4\*) or internationally excellent (3\*).
- UoL Joint 8th in the UK for world leading (4\*) research environment in Geography, with 100% of research environment rated as world leading (4\*) or internationally excellent (3\*). 87% of UoL Geography research outputs rated as world leading (4\*) or internationally excellent (3\*).
- High quality Engineering research is flourishing at LJMU, with GPA increasing from 2.53 to 3.22 between REF2014 and REF2021 (a rank rise of 28 places [*Times Higher Education data*]). 50% of LJMU's Engineering impact was rated 4\* (100% 4\*/3\*) with 95.8% outputs 4\*/3\*
- With a first time Earth Systems and Environmental Sciences submission, LJMU has highlighted its strengths in protecting and restoring habitats that provide essential ecosystem services; carbon storage is a key example here. 77.2% of outputs are world-leading or internationally excellent (4\*/3\*)

## Regional, National, & International Impacts

- 6.9 Net Zero and Maritime innovation in LCR is strongly led by an innovative and globally connected industry base. Examples of the impact our industries and universities are having in contributing to Net Zero and maritime modernisation include:

- **World firsts in Industrial decarbonisation** through Carbon Capture Utilisation and Storage (CCUS). **HyNet** is one of two government backed Track-1 CCUS clusters. It is set to be the UK's first operationalised hydrogen cluster and will generate 6 GW of hydrogen capacity by 2030, and could have a significant percentage of large-scale carbon generating industrial sources converted to hydrogen by then. As part of the trials, Pilkington at St Helens and Unilever at Port Sunlight were the two plants in the world to convert to 100% hydrogen power for a trial period;
- **Global profile in glass formulation innovation through Glass Futures**, the global centre of excellence for glass R&D, innovation and training, which had substantial representation at COP26 in 2021. Since its establishment in 2020, it has built a global network of world-leading glass producers and hosted industry led trials for resource efficient processing, including a world first trial of a 100% hydrogen fired

commercial float glass furnace. Glass Futures is creating a new glassmaking Pilot Plant facility in St Helens, to provide a Global Centre of Excellence for sustainable manufacture of glass. The facilities will catalyse cluster development, and attract businesses to locate research staff adjacent to the site;

- **Low-carbon business growth** ERDF funded Eco-Innovatory and ECOI-NW (delivered by LJMU and UoL) are enabling SMEs in the LCR and North West region to develop innovative low carbon goods, processes and services through collaborative partnerships with University researchers and access to world leading facilities and resources. These programmes have supported over 700 SMEs, created over 300 jobs, developed more than 120 new low carbon products and services, and added £45 million additional GVA to the low carbon economy in LCR and the North West;
- The **LCR Maritime sector** supports 52,000 jobs and generates £4.2 billion of output through business turnover. The Maritime Super Skills programme, led by LJMU, supported 51 SMEs and created 153 new maritime apprenticeship starts. UoL is partnering in a new Port City Innovation Hub project to support businesses in LCR developing products or services within the maritime sector achieve economic growth;
- **Ambitious City Region wide plans for low carbon transport.** LCR recently secured £750 million of funding to be invested in improving **green transport infrastructure**, expanding the bus and rail networks, and building a network of 600km of walking and cycling routes<sup>72</sup>. Alongside this, the City Region is developing plans for a hydrogen bus fleet as part of our Pathway to Net Zero.

## Our Asset Base

- 6.10 LCR has a growing number of innovation assets supporting innovation in Net Zero and Maritime. Currently, there is £87.5 million of live projects in the capability, including the Glass Futures Pilot Plant and two significant business support initiatives: Low Carbon Eco Inventory and ECO-I North West. Key assets in the City Region that currently support innovation in Net Zero and Maritime are shown in Table 6-2, and mapped at **Error! Reference source not found..** Alongside this, there are a number of significant, global businesses innovating in Net Zero solutions in the City Region, including ABB, Croda, Ineos, Inovyn, NSG Pilkington, Ørsted, and Unilever.

**Table 6-2: Key LCR assets supporting research and innovation in Net Zero and Maritime**

Asset name	Summary
<b>Net Zero</b>	
Burbo Bank Wind Farm	The Burbo Bank Offshore Wind Farm has been fully operational since 2007 and comprises of 25 turbines. The wind farm is run by Ørsted, the largest offshore wind developer in the world. The wind farm has a capacity of 90MW and provides enough power for around 80,000 homes. The project has 45 full time staff and by 2025 is expected to have contributed £70m in GVA to LCR.
Glass Futures	A new and unique £54 million global centre of excellence for glass innovation, including a pilot plant in St. Helens. Glass Futures is aiming to make glass the low carbon material of choice. Glass Futures aims to increase the use of glass throughout society by delivering new resource efficient processes, world class training for the whole supply chain, and new technologies offering greater functionality.
Manufacturing Technology Centre	Aims to support manufacturing and innovation within the region. The Centre is part of the High Value Manufacturing Catapult, supported by Innovate UK. The MTC supports projects working

<sup>72</sup> LCR Pathway to Net Zero



Asset name	Summary
	towards a Net Zero goal, including supporting the Australian company, Fortescue Future Industries in its goal to produce 15 million tonnes of green hydrogen by 2030.
Stephenson Institute for Renewable Energy	The Stephenson Institute for Renewable Energy based at UoL is a specialist energy materials research institute, focusing on the physics and chemistry that will transform the future of energy generation, storage, transmission and efficiency. The Institute comprises of 12 academics, 20 postdoctoral research staff, and 60 PhD students. It has won around £18m of active research funding from UK research councils, the EU, scientific societies and from industry.
<b>Maritime</b>	
Liverpool Institute for Sustainable Coasts and Oceans	The Institute combines the coastal, marine and maritime expertise of Liverpool John Moores University, the National Oceanography Centre and the University of Liverpool. The Institute brings together natural scientists, social scientists, and engineers to meet the challenges of climate change and a loss of biodiversity.
Mersey Maritime	Mersey Maritime is the regional cluster organisation for the maritime industry and wider supply chain in the Liverpool City Region and the Greater North West. The organisation offers networking and collaboration; communication, marketing and signposting; lobbying, representation and championing; business support and development; and innovating maritime.
National Oceanography Centre	The National Oceanography Centre provides world-leading innovative Science and Technology, unlocking knowledge about the oceans. It is in a unique position of having world-leading multi-disciplinary scientific and technical expertise which can help unlock the economic and societal potential of the ocean across a range of industry sectors. The Centre is one of the largest charities in the UK with an annual turnover of over £60m and employs over 600 staff. The Centre has two locations: Liverpool and Southampton.
Port of Liverpool	The port of Liverpool is part of the Peel Ports Group and coordinates and manages the provision of key marine services to shipping operators. Peel Ports have made a commitment to become a Net Zero port operator by 2040 and have invested over £1bn in the last ten years on sustainable infrastructure, with a key investment area being on decreasing operational emissions.
Mersey Multimodal Gateway	The programme will realise the potential for developing a major new rail/road freight handling and logistics park, covering 200 hectares. The programme will support a number of local, regional, and strategic objectives regarding the sustainable movement of goods and materials.
Ocean Gateway in The Wirral	A new port/logistics facility incorporating ship, rail and road access and a multi-modal distribution complex. This is one of 16 Ocean Gateway projects.
Liverpool Logistics, Offshore and Marine (LOOM) Research Institute	A flagship entity at Liverpool John Moores University, LOOM contributes to the modernisation and productivity of the marine and transport industries with world-leading impacts on large maritime engineering systems as evidenced by REF21 outcomes. Its core research capabilities are in the design and operation of large maritime engineering systems (offshore installations, ships and offshore wind farms); the safety, security and sustainability assessment of port terminals and maritime logistics chains; and in the simulation and optimisation of engineering processes and systems such as port terminals and transportation services.

## Funding Developments

6.11 LJMU and UoL sourced £29million for research related to Net Zero and maritime 2018-2022 Table 6-3 shows a breakdown of funding sources for the two universities combined. It highlights:

- Net zero & maritime related research in LCR is backed strongly by the Research Councils and UK Government, accounting for 39% and 14% of funding respectively; and

- Industry funding is relatively high, at £3 million, accounting for 12% of all funding for Net Zero & Maritime research in LCR, highlighting the importance of industry applied innovation to the capability.

**Table 6-3: Funding for Net Zero and maritime related academic led research in LCR 2018-2022**

Funding Source	Total (£ million)	Percentage
Research Councils	11	39.4%
UK Govt	4	14.5%
UK Other	4	12.1%
UK Industry	3	11.6%
UK Philanthropic	3	10.7%
EU Govt	3	10.5%
Other Overseas	0	0.8%
EU Other	0	0.3%
Philanthropic Overseas	-	-
Industry in kind	-	-
<b>TOTAL</b>	<b>29</b>	<b>100.0%</b>

Source: Steer-ED analysis of UoL and LJMU data 2018-2021

### Key pipeline projects

6.12 The real potential for LCR to deliver significant impact to address regional, national and local challenges relating to clean energy generation, decarbonisation of industry and logistics and decarbonisation in Maritime comes from its pipeline of projects, amounting to £1.1 billion, and between £10-20 billion including the large-scale Mersey Tidal project under development and future investment into HyNet. Key pipeline projects include:

- **Freeport** – One of eight designated Freeports in the UK, the 45km long site aims to contribute £850 million GVA benefits and create 14,000 jobs. The Freeport has a dedicated Innovation Strategy centred around addressing specific challenges: decarbonising port operations and vessels, decarbonising logistics, facilitating “Smart Borders”, and delivering R&D solutions for maritime and clean energy operations;
- **Mersey Tidal** – a £4-14billion capital programme to utilise the high tidal range in Liverpool Bay and the Mersey estuary to reliably generate long-term renewable energy. The scheme could power 1 million homes and deliver up to 30% of energy demand in LCR. This project will require significant public funding and industry investment, but could deliver significant impact on addressing Net Zero and energy supply challenges in the UK;
- **HyNet** - £5 billion future investment into the UK’s leading industrial decarbonisation cluster, to deliver ambitious targets of reducing carbon emissions by 10 million tonnes per annum by 2030;
- **National Packaging Innovation Centre** – capital project which will provide an internationally significant open access innovation facility for large and small businesses, seeking to commercialise new products and processes through the full packaging life cycle and supply chain, from materials discovery to disposal and repurposing. The project has been initiated via seed funding from LCRCA and CPI, with the potential for £60m regional/national government and industry co-investment during its first 5 years; and
- **Industrial Energy Test Centre** – potential Catapult-type hydrogen demonstration and innovation trials facility as a new element of the wider Glass Futures industrial decarbonisation campus;
- **Maritime knowledge/freeport innovation hub** – a £23m capital project that will sit within the wider LCR innovation ecosystem. It will provide a co-location space for

maritime businesses and higher education, to bring together business, research, education and innovation support to help drive new skills, products and services to address challenges in the maritime sector;

- **Burbo Bank Extension** – 40km<sup>2</sup> Extension of the Burbo Bank offshore wind farm, with an estimated generation capacity of up to 250 MW, more than double the capacity of the current Burbo Bank Offshore Wind Farm;
- **HEMISPHERE** – this is set to be an eco-trailblazer for the Liverpool City Region, aiming to be its first operational Net Zero carbon commercial building in the region. HEMISPHERE is a £35 million building which will feature 116,000 sq. ft of innovative Grade A office space for health, education, science and tech occupiers, creating the supply needed for the innovation ecosystem.

## Learning from the past five years

6.13 Our Net Zero and Maritime potential is centred around utilising key geographical and industrial assets to deliver cross-sector innovation which addresses decarbonisation challenges in industry, transport, maritime, and the built environment.

6.14 Key lessons since 2017 include:

- R&D in Net Zero and Maritime is **heavily led by industry**. HyNet was conceived and initiated by business, Glass Futures was developed to provide a solution for businesses looking to innovate, and LCR hosts a large number of industry players innovating in the space<sup>73</sup>. To become a fully established world leading capability, industry R&D needs to be supported with targeted academic research, focused on impact;
- **Hydrogen** production/demonstration is emerging as a real strength in LCR, particularly through HyNet and Glass Futures. It is also a government priority, with a dedicated Hydrogen Strategy released in 2021<sup>74</sup>. However, ‘blue’ hydrogen<sup>75</sup> from captured emissions is not carbon neutral, so R&D needs to be prioritised on the production of ‘green’ hydrogen<sup>76</sup>, as has been trialled at Glass Futures;
- Maritime 2050, the UK government’s vision for the Maritime industry has given a **clear decarbonisation target** – reduction in greenhouse gas emissions by 50% by 2050. Given the previous lack of UK wide strategy for Maritime, this presents an opportunity for LCR to mobilise industry partners and universities through Mersey Maritime to deliver solutions to decarbonisation challenges;
- The influence of the Maritime sector and importance to Net Zero targets has been overlooked until recently, and the industry itself traditionally operates in siloes. Mersey Maritime has a key role to **support and champion the Maritime ecosystem**. It has access to government and can represents the needs of industry in LCR;
- Two **major live projects** (HyNet and Glass Futures) are providing bases for UK and world first developments regarding hydrogen use and glass production. Two **additional major pipeline programmes** (Freeport and Mersey Tidal), provide the opportunity for LCR to demonstrate at scale innovations that will have significant national and international impacts on global challenges including decarbonisation of Maritime, use and production of hydrogen, and new formulations of glass;

<sup>73</sup> including Ørsted, Berobank, Ineos, Inovyn (Net Zero), and Cammell Laird, Peel, Maersk (Maritime)

<sup>74</sup> <https://www.gov.uk/government/publications/uk-hydrogen-strategy>

<sup>75</sup> ‘Blue’ hydrogen: hydrogen produced from captured carbon

<sup>76</sup> ‘Green’ hydrogen: hydrogen produced from electrolysis of water, powered by clean energy

- Despite the potential, **physical demonstration at scale** of innovations in hydrogen and ammonia generation, and of Maritime innovation, have yet to be carried out.
- Consideration must also be made regarding **manufacturing capacity** in the City Region and location of supply chains for raw materials;
- There has been a significant increase in **interdisciplinary research** and growth of research staff in the energy and nuclear technologies since REF2014, as demonstrated by the range of specialisms at LJMU and UoL (Table 6-1). However significantly greater scale and impact is required around these research capabilities.
- Alongside this, the research and innovation excellence demonstrated in LCR's three established capabilities are key solutions providers for achieving Net Zero, particularly in large, polluting sectors such as Maritime, transport, and consumable goods.

## Future Direction

6.15 There are significant Net Zero & Maritime innovation opportunities in emerging fields that the LCR is well placed to take advantage of:

- As **offshore wind generation capacity** increases in the Irish Sea, extra energy generation from this source can be utilised in the City Region to produce green hydrogen. Production facilities will ideally be located next to or efficiently connected to sources of demand;
- The physical situation and industry presence in LCR research present an opportunity to develop **scale-up innovation test bed capacity**. Particular opportunities present themselves in retrofit of buildings (e.g. structural solar), and decarbonisation innovation for Maritime, using a model similar to that deployed at Glass Futures;
- The crossover between **digital and maritime** is emerging currently. 95% of global communications rely on interconnected cables on the sea floor<sup>77</sup>. As digital tech becomes more pervasive, the need to secure, maintain and upgrade these cables will become increasingly important;
- Commercialisation of the large **capacity for captured carbon** in the Irish Sea and neighbouring Cheshire into potential new products in the circular economy is not fully realised, but is a significant opportunity for LCR, given its physical assets.
- **Mersey Tidal** presents a real opportunity for LCR to develop a huge scale project deploying new technological solutions to harness the between 1-6TWh of renewable energy per year over 100 years, with potential to deliver 30% of the City Region's electricity demand.

<sup>77</sup> <https://www.theweek.co.uk/news/technology/955812/undersea-cables-connect-world-subject-concern>

## 7 Realising Our Ambitions

### The 15 second briefing . . .

- This SIA refresh confirms the ongoing importance of the 3 original world-leading capabilities, now titled '*Infection Prevention and Control*', '*Materials Chemistry*' and '*AI Solutions & Emerging Technologies*'.
- A new developing capability has been identified, '*Net Zero & Maritime*' which should now be within the future SIA scope.
- Since 2017, significant synergies across distinctive capabilities have been built; this should be an enhanced ongoing focus as this combination reflects the LCR's unique place-based offer.
- Catalysed by the 2017 SIA, the LCR is an exemplar of innovation place-based collaboration and partnership.
- The LCR has made exponential progress regarding every aspects of its innovation ecosystem, reflected in £2billion innovation infrastructure investment, £1billion live projects, a £3+billion pipeline, and £9+billion in global scale net zero initiatives.
- Innovation is now a LCR and devolution priority, reflected in the headline ambition to invest 5% of GVA in R&D by 2030, nearly double the UK target.
- Focusing on productivity, linking science and technology -based innovation with wider innovation agendas, working with complementary capabilities elsewhere, ensuring the wider components of a successful innovation ecosystem are in place, telling LCR's science-based innovation narrative, and inspiring children and all local residents are all key imperatives for this refreshed SIA.
- Detailed recommendations and renewed ambitions have been identified for the LCR ecosystem as a whole and each of the 3 + 1 capabilities.

- 7.1 Based on the evidence, arguments, and ambitions gathered and tested during the course of this refreshed SIA's development, the key findings and implications are set out in sequence below as The Good News, Issues to Address, and Recommendations.

### The Good News . . .

- 7.2 The key positive conclusions from this refreshed SIA 2022 are as follows:

- **The evidence-based case for maintaining focus on the three distinctive and established world-leading capabilities defined in the 2017's SIA remains strong, and these should still stand.**

We have renamed 2017's '*Infection Control*' capability to be '*Infection Prevention & Control*', in order to reflect more accurately the City Region's experience and competence, not least in the wake of the global COVID-19 pandemic, our response to the UK Government's aspiration's regarding vaccine self-sufficiency, and the pervasive need to ensure pro-active and robust pandemic resilience for the future.

Similarly, '*High Performance & Cognitive Computing*' has been redefined as '*AI Solutions & Emerging Technologies*' to reflect better our current capabilities and future growth potential beyond AI to quantum and other data-intensive industries



such as robotics, immersive technologies, and digital health, recognising the exponential growth in these markets globally and the advent of the 'Metaverse'.

'*Materials Chemistry*' remains unaltered as the other established capability.

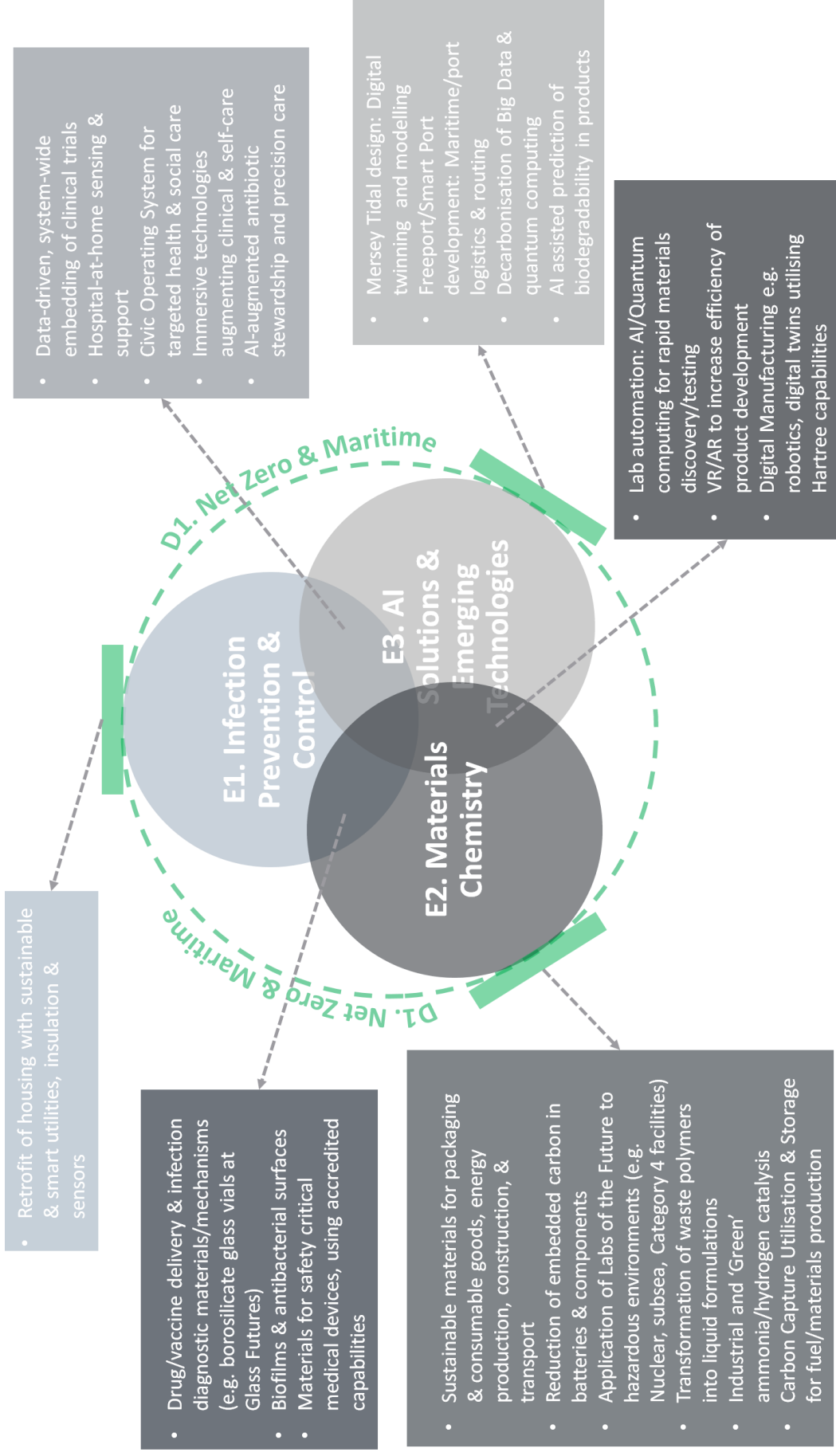
Not only is the case for continuing with these three capabilities convincing, but their inclusion in this SIA refresh will reinforce the smart specialisation focus of our LCR's science-based innovation activity, and help consolidate and enhance their international relevance to leverage the significant investments they are attracting.

- All three have attracted landmark investment in world class assets:
  - The **Infection Innovation Consortium** (iiCON) launched in 2020 has already secured £200 million funding and has a global network of 500 partners, while LSTM's IVCC has also attracted £110 million;
  - The **Materials Innovation Factory** officially opened in 2018 has growing investment now totalling nearly £100million;
  - The £210million **Hartree National Centre for Digital Innovation** confirmed in 2021 included £38million in-kind from IBM.
- Alongside the three validated established capabilities, this refreshed SIA has identified a new **developing capability in Net Zero & Maritime**. This recognises the global imperative to address climate change, and develop sustainable new materials and energy sources. The Maritime element reflects the LCR's natural assets and net zero potential through tidal and offshore power generation, plus our Freeport designation and decarbonisation focus, linked to the key role largest Atlantic-facing port can play in building the resilience of freight-based global supply chains.
- We have **built and applied clear and tangible complementarities between our distinctive capabilities – these combinations are unique to LCR and reflect the importance of "place"**. For example, the MIF's globally transferable applications around AI and robotics powered lab automation for materials discovery, that is now also being applied to infection control; the National Packaging Innovation centre proposal; and the development of a commercial Medical Glass Manufacturing and Innovation Centre to produce borosilicate glass vaccine vials alongside the Glass Futures pilot plant. A fuller depiction of actual and potential synergies across our established and developing capabilities is at Figure 7-1.
- **The LCR innovation-related collaboration and partnership engendered by the 2017 SIA development process has gone from strength to strength**, with demonstrable added value. This applies across all capabilities and in all combinations, from inter-HEI and inter-industry cooperation to greater industry to academic and/or public sector partnership MIF. This stands us in very good stead to realise our translational science-based innovation potential and ambitions across complementary capabilities, plus articulate a much stronger place-based investment offer.
- There has been **exponential progress with all aspects of developing the LCR's innovation ecosystem**, notably:
  - £2billion investment in innovation infrastructure in the 5 years pre-pandemic, predominantly demand-led expansion at Knowledge Quarter Liverpool and SciTech Daresbury.



- Innovative large scale new digital infrastructure: Europe’s largest 5G mm wave mesh network, and the 212km LCR Connect gigabit-capable fibre network that will complete in 2023.
  - Deepened and broadened LCR’s research excellence, as confirmed by enhanced research power scores in REF 2021 in the three established capabilities and developing capability, high scores in impact (e.g. Chemistry, Engineering and Clinical Medicine) and output (e.g. Clinical Medicine and Computer Science and Informatics), and with LSTM’s rating 2<sup>nd</sup> overall in the UK for impact particularly striking;
  - Direct global impact, with Infection Prevention and Control innovation developed and tested by LCR partners, including re COVID-19, saving lives around the world;
  - Developed exceptional new repeatable innovation models, from the manifest success of LSTM’s iiCON platform approach, to the ‘open by design’ Liverpool model so successfully applied at the MIF, to our new approach to developing asset-based innovation clusters;
  - World first trial deployments of hydrogen for industrial fuel switching at Pilkington and Unilever;
  - A series of catalytic investments in dynamising our business ecosystem, including the creation of a dedicated new commercialisation vehicle and seed fund - LYVA Labs, a Future Innovation Fund for near to market innovation during the pandemic succeeded by a High Growth Innovation Fund, and the creation of a new Angel Network and Tech Accelerator.
  - Improved employment and skills levels for 16-64 year olds.
- **The LCR now has a multi-billion-pound portfolio of innovation initiatives:** this spans £1billion in live projects, a £3billion pipeline mainly across our three established capabilities, and £9+ billion covering the large-scale Mersey Tidal and HyNet programmes.
  - **Production of a first ever LCR Innovation Prospectus in April 2022 to promote associated investment opportunities and highlight how the LCR can deliver the UK government’s levelling up and science superpower priorities.**
  - **Enhanced leadership and governance** through evolution of what was the UK’s first ever sub-regional Innovation Board to significantly expand its membership in December 2021, and in 2022 creating 5 member-led squads to drive challenge-focused programme delivery in R&D investment and clusters; net zero innovation; innovation to enterprise; skills and inspiration; comms and lobbying.
  - **The net result is that innovation is now a genuine LCR and devolution priority, as reflected in the headline ambition to invest 5% of GVA in R&D per annum by 2030, nearly double the UK target.**

**Figure 7-1: Key synergies between LCR established (E) and developing (D) capabilities (illustrative, non-exhaustive)**



Source: Steer-ED, 2022

## Key Issues to Address

7.3 Despite the remarkable progress made since 2017's SIA and the science-based applied innovation agenda it defined, the work of this refreshed SIA 2022 identifies a number of critical challenges:

- Our productivity improvement imperative:** whilst key parts of our economy continue to develop and thrive – e.g. increases in employment and earnings, our productivity performance (and therefore our wider competitiveness) has weakened at the same time as technological advances mean an even more inexorable shift to a knowledge-based economy. *We have to address this*; as one of the five drivers of productivity, innovation in all its forms has a vital role to play in redressing this critical challenge, which is why this refreshed SIA matters – innovation is ‘mission-critical’ to the long-term wellbeing of our businesses, people, and places.
- Focused, but porous innovation:** like its 2017 counterpart, this is a (refreshed) science and innovation audit driven by applied science and technology, which must remain its core nature and has always been the focus of the LCR Innovation Board. By the same token, the LCR innovation agenda needs to embrace and integrate the social and inclusive innovation agendas developing in the City Region and beyond in order to create a pervasive and sustainable innovation culture across our place. In other words, the LCR's innovation approach must itself be inclusive and innovative, with this SIA a driving part of that.
- Learning from, and working with neighbouring and wider world-leading places and specialisms:** while the focus has been and remains the LCR itself, the original and ongoing “+” in our SIA title recognises the need to work with the best of the best elsewhere to maximise our own distinctive world-leading capabilities and contribute to UK growth. From materials in Greater Manchester, life sciences in Cheshire, and cyber security in Lancashire, our immediate North West neighbours have distinctive, world-leading assets and capabilities of their own that can complement ours, let alone net zero in the North East, and others across the whole range of 25 UK SIAs. We need to be more proactive in identifying, developing, and sustaining specific linkages to mutual “win-win” benefit in terms of even greater scale and impact. There is also an international dimension to this, most notably the emerging relationship with Busan as an explicit element of the BEIS UK-South Korea innovation twinning programme.
- Ongoing ecosystem and capacity development and investment:** this refreshed SIA highlights the science and technology driving innovation-led growth in the LCR towards 5% R&D investment. Realising this potential ambition however will depend on wider factors, e.g. further investment in infrastructure, skills, diffusion, enterprise support, and access to finance, with the current deficit of top-grade lab space a case in point. It is vital that the CA, Innovation Board and all stakeholders continue to pull all levers in terms of holistic ecosystem development and redress clear gaps or deficiencies, which will take enhanced capacity and investment amid numerous competing demands.
- Telling our story better:** the LCR Innovation Prospectus published in April 2022, and underpinned by the SIA, was an excellent first step in collectively and coherently showcasing the LCR's distinctive world-leading capabilities, UK-leading place-based innovation approach, and large-scale investment opportunities for the first time. However this momentum needs to be sustained by all stakeholders, and a long-term

communications programme delivered to drive public R&D funding and industry/inward investment.

- **Inspiring and informing our own communities:** in order to truly embed a culture of innovation and supply the talent that our world-leading capabilities, innovation project pipeline, and future growth clusters need, it is crucial that we inspire our own children, and inform our business base and residents, about the ideas, discoveries, assets and people in and around the LCR that are changing the world as we speak. Innovation is often viewed as remote, complex and intangible, so we need to invest concerted time, energy and funding to “open the box”, highlight real world impact, explain simply why it is important, and amaze and inspire in the process...

## Recommendations

- 7.4 Informed by the conclusions above, the overarching imperative of the LCR to achieve 5% of GVA as R&D investment by 2030, the challenge of Net Zero, and current policy intents such as the Plan for Prosperity, the table below sets out the key recommendations flowing from this refreshed SIA.

Table 7-2: Key recommendations flowing from this refreshed SIA

Challenge	Recommendation
<b>General ecosystem development</b>	
<b>Productivity improvement imperative</b>	<ul style="list-style-type: none"> <li>• Ensure increasing productivity remains core to the strategic and tactical implementation of this refreshed SIA.</li> <li>• Support and resource the development of identified asset-based innovation clusters.</li> <li>• Secure large-scale government and industry co-investment to deliver on pipeline innovation projects and programmes.</li> <li>• Expand and accelerate the role of LYVA labs in catalysing new challenge-led academic-industry partnerships and projects.</li> </ul>
<b>Focussed, but porous innovation</b>	<ul style="list-style-type: none"> <li>• Proactive engagement to integrate inclusive and social innovation initiatives into the primary LCR innovation agenda.</li> <li>• Scope out feasibility of flagship two-yearly LCR Innovation Index which reports on the breadth and performance of all types of innovation activity</li> </ul>
<b>Learning from, and working with neighbouring and wider world-leading places and specialisms</b>	<ul style="list-style-type: none"> <li>• Engage with other NW sub-regional innovation Boards and leads to identify and action areas of specific synergy</li> <li>• Produce a joined-up NW inward investment offer</li> <li>• Ongoing involvement in NP11 innovation leads, of which LCR was a founder member</li> <li>• Develop national (and if appropriate international) map of potential innovation to help drive forward established and new developing capability proposed by this SIA</li> <li>• Maximise UK Freeport Innovation network linkages</li> <li>• Explore scope for LCR to actively partner in innovation strategies and refresh SIAs developed in other places with complementary capabilities</li> <li>• Develop and deliver an action-focused innovation twinning programme with Busan in South Korea</li> <li>• Consider wider programme of inward/outward innovation partner mission to build and further strengthen international science-based innovation partnership (resources permitting).</li> </ul>

Challenge	Recommendation
Ongoing ecosystem and capacity development and investment	<b>Skills</b> <ul style="list-style-type: none"> <li>• Refresh Innovation Skills for Growth Strategy</li> <li>• Invest in dedicated and specific talent pipeline generation programmes, linking businesses with education providers through Innovation Board led collaboration</li> <li>• Develop centres for workforce development at key research institutes such as the planned Workforce Development Centre at LSTM, linking business/R&amp;D needs to workforce at all qualification levels.</li> </ul> <b>Enterprise (and particular need to increase R&amp;D)</b> <ul style="list-style-type: none"> <li>• Deliver prospective national UKRI Launchpad pilot.</li> <li>• Development and delivery of LYVA labs phases 1-3.</li> <li>• Deliver other business innovation diffusion, culture and access to finance initiatives to link in assets and develop clusters and attract new R&amp;D intensive businesses to the region.</li> <li>• Ensure post-ERDF continuity of successful business support programmes like LCR4.0 and the Low-Carbon Eco-Innovatory.</li> <li>• Support LYVA Labs and LCR Universities in the co-creation of successful R&amp;D focussed spin-outs through availability of funding and support programmes (e.g. training programmes, mentorship and support for entrepreneurs, co-created investor networks etc) and ensuring appropriate incubator space is available for these companies to be housed in the LCR.</li> </ul> <b>Finance for business</b> <ul style="list-style-type: none"> <li>• Develop pipeline projects, including asset-based cluster-related proposals, into compelling investable propositions.</li> <li>• Enhance close coordinated dialogue with government and UKRI.</li> <li>• More extensive coordinated engagement with UK investment community.</li> <li>• Enhanced inward investment campaign.</li> </ul>
	<ul style="list-style-type: none"> <li>• Enhance LCR innovation logic model and metrics, with specific R&amp;D calculation element</li> <li>• Develop comprehensive, coherent and communicable collateral to promote this refreshed SIA – nationally and internationally</li> <li>• Develop programme of study tours to LCR (separately for funders, inward investor/relocators, and science partners) to build wider and deeper understanding of establish and developing SIA capabilities</li> <li>• Work to ensure LCR representation on key UK-level innovation policy development groups</li> <li>• Produce regularised (six monthly) think-piece to central government on relevant current innovation issues</li> <li>• As above, scope out feasibility of flagship two-yearly LCR Innovation Index which reports on the width and performance of innovation activity (science-based, inclusive, social etc) as part defining LCR's approach to innovation in the round.</li> </ul>
	<ul style="list-style-type: none"> <li>• Develop and deliver a comprehensive, dedicated innovation inspiration programme, aimed at primary and secondary schools, business base and wider population to “open the box” on past and present LCR world-changing people and innovations.</li> <li>• Highly visible city centre maker space and engagement hub an explicit element of this.</li> </ul>

## Infection Prevention & Control

Challenge	Recommendation
<b>Expanding cross-regional links</b>	<ul style="list-style-type: none"> <li>• Further expand LCR's health and life science capabilities through collaboration with neighbours (e.g. AMR capabilities at Alderley Park, and precision medicine in Manchester).</li> <li>• Maximise the HPO in vaccine manufacturing.</li> </ul>
<b>Developing a skilled and sustainable talent pipeline optimised for digitalisation of healthcare</b>	<ul style="list-style-type: none"> <li>• Utilise LSTM's Workforce Development Centre and increase university and business engagement with education providers at all levels to ensure clear and visible routeways to attractive and high value careers are developed.</li> <li>• Focus on development of digital skills alongside clinical knowledge.</li> </ul>
<b>Developing a critical mass of quality infrastructure</b>	<ul style="list-style-type: none"> <li>• Creation of high quality labs and managed workspaces around established assets to catalyse cluster development.</li> <li>• Provision of high quality, digitally enabled Category 3 facilities for clinical trials, including automated labs.</li> </ul>
<b>Secure income generation</b>	<ul style="list-style-type: none"> <li>• LSTM and UoL have been successful at developing growing and diverse funding portfolios, but with ERDF funding set to cease and global events impacting philanthropic funding sources, resource needs to be dedicated to continually sourcing new funding streams.</li> </ul>
<b>Materials Chemistry</b>	
<b>Supply chain resilience</b>	<ul style="list-style-type: none"> <li>• Prepare to back spinouts by de-risking new ventures relating to materials development.</li> <li>• Provision of public funding and project scientists</li> <li>• Undertake a supply chain mapping exercise to understand where there are clusters or gaps of businesses supplying priority raw materials and manufacturing capabilities</li> </ul>
<b>Robotic, biotechnology and AI skills</b>	<ul style="list-style-type: none"> <li>• Skills gap assessment and then develop specific routeways from school level up to these high value and high earning careers.</li> <li>• Utilise key assets such as the MIF to a) understand R&amp;D and business skills needs and b) encourage entrepreneurship and cluster development through the open innovation model</li> </ul>
<b>Effective communication of expertise</b>	<ul style="list-style-type: none"> <li>• Articulate nationally and globally LCR's R&amp;D strengths in biotechnology, hydrogen production, sustainable packaging and digitally assisted discovery, development and manufacturing</li> </ul>
<b>Innovation diffusion and adoption</b>	<ul style="list-style-type: none"> <li>• Maximise the cluster potential of LCR's Materials Chemistry assets (MIF, DMA, OPIHAS, Glass Futures) through concerted build of co-located/connected physical lab and workspace infrastructure in a Materials Innovation Zone centred on MIF.</li> <li>• Continue to invest in business development expert resource at key assets to generate and manage industrial pipelines.</li> <li>• Consider development of a challenge specific consortium modelled on the iiCON model led by MIF, and connected to LCR's wider set partners and assets.</li> </ul>
<b>AI Solutions &amp; Emerging Technologies</b>	
<b>Translating LCR's digital tech research excellence into enhanced impact</b>	<ul style="list-style-type: none"> <li>• Embed entrepreneurship more fully into LCR's universities (in partnership with NHS and local authority organisations), seeking to increase the numbers of digital tech spinouts and/or graduate start-ups)</li> <li>• Further well-designed programmes to support digital adoption in SMEs, as evidenced by LCR4.0 and the Made Smarter Pilot.</li> </ul>



Challenge	Recommendation
<b>Digital tech skills supply</b>	<ul style="list-style-type: none"> <li>Continue to ramp up computer science and digitally literate HEI student numbers (both undergraduate and postgraduate)– to help counter the significant skills shortages facing the digital tech sector.</li> <li>Actively promote and support other routes into digital employment, including digital Skills Bootcamps and apprenticeships.</li> <li>Increase translational data science training where there is high demand for a talent pipeline, for example in health, materials, creative, energy, policy, transport and integrative (e.g. smart cities) domains.</li> <li>Grasp catalytic application domains such as mental health and wellbeing to bootstrap transferrable digital technology development across academic, public service and industry partners, swarming around critical problems such as mental health and the UK's new Mental Health Mission.</li> </ul>
<b>Encouraging digital adoption in LCRS SMEs</b>	<ul style="list-style-type: none"> <li>Ensure that projects to assist businesses with digital transformation are still supported post ERDF funding availability, continuing the work of highly successful projects like LCR4.0.</li> <li>Link local digital tech businesses more closely with the universities and FE colleges, to ensure that tech students are sighted on the opportunities available to them within LCR, and to help improve talent retention.</li> </ul>
<b>Net Zero &amp; Maritime</b>	
<b>Largely industry led impacts</b>	<ul style="list-style-type: none"> <li>Develop specific targeted 'challenges' which industry and academia work together to provide innovative solutions to e.g. investigation into use of captured carbon, new propulsion methods for Maritime vessels</li> <li>Deliver Freeport innovation programme collaboratively with universities and industry around its specified innovation challenges</li> <li>Prioritise development of world leading academic research, with particular focus on delivering impact, through Innovation Board activity, such as the recently initiated 'Innovation Squads', targeted at specific challenges and 'problems'</li> </ul>
<b>Resourcing of large-scale pipeline project</b>	<ul style="list-style-type: none"> <li>Highlight solutions developed in the NW as being applicable worldwide to UK and global challenges and lobby government and industry</li> <li>UK R&amp;D Challenge programme to deliver Mersey Tidal Power programme</li> </ul>
<b>Manufacturing capacity and supply chain resilience</b>	<ul style="list-style-type: none"> <li>Asset-based cluster development</li> <li>Undertake a supply chain mapping exercise to understand where there are clusters or gaps of businesses supplying priority raw materials and manufacturing capabilities, and identify key opportunities for reshoring</li> </ul>
<b>Testbed/ demonstration capability</b>	<ul style="list-style-type: none"> <li>Develop structured partnerships to deliver specific test-bed capabilities based on the Glass Futures Model.</li> <li>Consider retrofit, structures solar, maritime propulsion.</li> </ul>

Source: Steer-ED, 2022

## Ambitions

- 7.5 Built on the significant progress in the LCR's three established capabilities and an additional developing capability, we have revisited our ambitions, set in 2017, and framed new ones which will propel the City Region to be a leading actor in transforming UK productivity, achieving the Government's science and innovation superpower aims, and providing real, global and national scale solutions to the UK's biggest challenges. Our new ambitions are in Table 7-3.

Table Error! No text of specified style in document.-1: LCR's Science and Innovation Ambitions

Theme	2017 Ambition	Review	2022 Ambitions
<b>Ecosystem-wide</b>	For the LCR to be a national exemplar of place-based and innovation-driven economic growth that supports the UK Industrial Strategy.	<ul style="list-style-type: none"> <li>Only one of 25 UK SIAs to refresh the original to date</li> <li>Development of bespoke LCR innovation logic model and metrics mapping to ensure innovation addresses LCR challenges and enable effective monitoring and evaluation.</li> <li>Development of a novel scalable asset-based approach to identify, prioritise, develop and scale established and emerging clusters.</li> <li>Production of first ever LCR Innovation Prospectus.</li> <li>Creation of first ever dedicated LCR innovation commercialisation vehicle in LYVA Labs.</li> <li>SIF investment in a number of business ecosystem and dedicated innovation programmes.</li> <li>Expansion of the UK's first sub-regional Innovation Board, and development of challenge focused 'Innovation Squads' led by board members.</li> <li>Demonstrated impact (turnover and efficiency) through practical application of open innovation at MIF, plus repeatable iICON platforms model.</li> <li>Synergistic development of three established capabilities and one developing capability.</li> <li>Major development of new innovation infrastructure at Sci-Tech Daresbury and Knowledge Quarter Liverpool.</li> <li>Prospective designation as national pilot for UKRI Launchpad programme.</li> </ul>	LCR to be a recognised national exemplar of place-based innovation by achieving its target of investing 5% of GVA in R&D per annum by 2030 and directly contributing to the delivery of UK Levelling Up, Net Zero, and productivity challenges.
<b>Infection Prevention &amp; Control</b>	To consolidate the LCR's position as an international centre of excellence in tackling infectious diseases, and create a cluster of anchor and high growth companies to take advantage of global market opportunities in infection.	<ul style="list-style-type: none"> <li>Major iICON success in both investment and delivery of infection control commercialisation</li> <li>Continued world leading impacts delivered tackling infectious disease globally</li> <li>Leading UK pilot role in COVID-19 testing and vaccine validation, which has been capitalised on in development of the Pandemic Institute</li> <li>Development of the Civic Data Cooperative, a world-leading citizen-involved data system for health and social care. Development was accelerated in response to COVID-19, delivering the Combined Intelligence for Population Health Action (CIPHA) platform in Cheshire and Merseyside</li> <li>Growing digitally enabled clinical trials capacity and use of robotic labs in Category 3 testing</li> <li>Significant pipeline work utilising crossovers with Materials Chemistry (Medical-Glass Manufacturing Centre and HPO in Vaccine Manufacturing) and AI Solutions (Innovation Liverpool and iICON Phase 1b and Phase 2) to build synergised ecosystem combatting infection and poor health</li> </ul>	<p>Increase the R&amp;D spend on infection therapeutics from the current baseline of £2 billion per annum to £3 billion by 2030.</p> <p>In so doing, enhance LCR's position as an international centre of excellence in preventing and treating infectious diseases and develop capabilities in digitally enabled personalised diagnosis and treatment, stimulating further regional development and inward investment.</p> <p>Support development of a cluster of anchor and high growth companies to take advantage of increasing global market</p>

Theme	2017 Ambition	Review	2022 Ambitions
			<p>opportunities in infection through building deeper organisational partnerships.</p> <p>Establish the region, through the iiCON partnership, as the national lead for tackling AMR.</p> <p>Share the successful Consortium model across the other areas of activity to synergise further cluster development</p>
Materials Chemistry	<p>To apply the LCR's world class materials chemistry capabilities and commercialisation model to provide transformational opportunities for mature UK sectors, create new high-growth industries, and become a recognised global leader.</p>	<ul style="list-style-type: none"> <li>Enhanced investment and application of Materials Chemistry expertise to discovery, development and commercialisation of innovation through MIF</li> <li>Specific development of globally transferable MIF Labs of the Future approach</li> <li>Concerted focus on implementing the phased growth of new Sustainable Packaging innovation assets through partnership (CPI + UoL + Unilever + Others), in tandem with an ambitious plan for an LCR led UK national centre of excellence in sustainable packaging (in partnership with Unilever)</li> <li>Expanded industrial expertise in biotechnology</li> <li>Glass Futures - unique new global industry led centre of excellence in glass innovation</li> </ul>	<p>Exploit LCR's world class materials chemistry knowledge leadership and accelerated 'Open-Innovation' capabilities to provide transformational opportunities to mature UK sectors to (i) move to renewable energy sources and (ii) re-engineer materials value chains so that the carbon which is embedded in common products and commodities comes from renewable sources rather than petrochemicals.</p> <p>Support the creation in LCR of new high-growth industry clusters in sustainable packaging and hydrogen production.</p> <p>Become a recognised global leader in the application of digital technologies (including mobile robotics, lab automation and AI) to drive a revolution in the scale and pace of innovation in the advanced chemical materials sector.</p>
AI Solutions & Emerging Technologies	<p>To harness the LCR's world-leading High Performance and Cognitive Computing capabilities to accelerate cross-sector growth and productivity, public sector transformation, and develop a world-class</p>	<ul style="list-style-type: none"> <li>£210million Hartree National Centre for Digital Innovation, creating the UK's de facto AI Solutions Centre and consolidating IBM's Global Research Lab</li> <li>Atos Quantum Learning machine at SC-Tech Daresbury is one of the most advanced in the world</li> <li>New UoL Digital Innovation Facility opened in May 2022 – sister to the Virtual Engineering Centre</li> <li>Joint UoL-LJMU Centre for Doctoral Training for Innovation in Data Intensive Science, also opened in 2022</li> </ul>	<p>Become a recognised global leader in the application of AI solutions &amp; emerging technologies.</p> <p>Establish a world class digital technologies cluster that unlocks and diffuses new innovation-led productivity and economic growth impacts for UK businesses across</p>

Theme	2017 Ambition	Review	2022 Ambitions
	data-centric and disruptive digital technologies cluster.	<ul style="list-style-type: none"> <li>The UK's first Civic Data Cooperative.</li> <li>LCR's capabilities now extend beyond AI and High Performance Computing to quantum computing, robotics, immersive technology and digital health.</li> <li>DCMS-backed Liverpool 5G is applying the largest 5G mm wave mesh network in Europe to health and social care use cases</li> <li>LCR Connect 212km gigabit-capable fibre backhaul network across the City Region is in delivery and will complete in 2023.</li> </ul>	established and emerging growth sectors UK.
Net Zero & Maritime	N/A	<ul style="list-style-type: none"> <li>Strong industry led innovation potential in hydrogen production, with world first industrial switching trials being held in the LCR</li> <li>Glass Futures industrial decarbonisation campus in development, extending beyond glass to other foundation industries</li> <li>Opportunity to enhance global impact of environmental research, focused on challenge specific themes (e.g. green hydrogen production, decarbonisation of Maritime, reduction of embedded carbon in products)</li> <li>Freeport designation a big opportunity for innovation in Maritime</li> <li>Advancement of the Mersey Tidal Power programme with potential to have global significance</li> <li>Major opportunities are driven by natural assets and pipeline projects, yet to be delivered</li> </ul>	To develop and deliver world-leading tidal, hydrogen and industrial decarbonisation solutions in order to achieve Net Zero across the LCR by 2040

Source: Steer-ED, 2022



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With close links to other North West, national and global centres of excellence, the city region offers major new investment opportunities for both Government and industry.

## B List of Consultees

Name	Role	Organisation
Adrian Nolan	Lead Officer, Industrial Strategy	Liverpool City Region Combined Authority
Prof. Alex Singleton	Professor of Geographic Information Science	University of Liverpool
Alison Thornber	Head of Grants, Policy and Projects	Liverpool John Moores University
Amanda Lyne	Managing Director	ULEMCo
Amy Farrington	Head of Business Incubation	Science & Technology Facilities Council (STFC)
Andy Hulme	Head of Innovation and Growth	The North West Business Leadership Team
Dr Andy Levers	Executive Director	University of Liverpool
Annette Lewis	Learning and Development Business Partner	AstraZeneca
Anthony Mtimila	Senior Partnerships & Innovation Manager	University of Liverpool
Dr Arun Harish	Strategy Director and General Manager — Electronics	CPI
Ben Heywood	Senior Investment Manager	Liverpool City Region Combined Authority
Charlie Whitford	Director North West & Regions	The Manufacturing Technology Centre
Chris Shirling-Rooke	Chief Executive	Mersey Maritime
Claire Liddy	Executive and Managing Director of Innovation	Alder Hey Children's Hospital
Colin Sinclair	CEO	KQ Liverpool & Sciontec Developments
Damian Kelly	Vice President Innovation & Technology Development	Croda
Daniel Bimpson	Development Specialist	Liverpool City Region Combined Authority
Danielle Carrington	Sector Champion for Professional & Business Services	Liverpool Growth Platform
Gill Wood	Deputy Portfolio Holder for Climate Emergency and Renewable Energy	Liverpool Growth Platform
Dr. Grahame Smith	Mental Health and Innovation Lead	Liverpool John Moores University
Heather Carroll	Business Development Controller	Cogent Skills
Helen Cross	Digital and Creative Champion	Liverpool Growth Platform
Prof. Iain Buchan	Executive Dean of the Institute of Population Health, Chair in Public Health and Clinical Informatics and	University of Liverpool
Iain Taylor	Director	IMT Consulting
Prof. Janet Hemingway	Director of iiCON: Infection Innovation Consortium and Professor of Tropical Medicine	Liverpool School of Tropical Medicine
Jen Rae	Innovation Programmes Lead	The NP11
Joe Darlington	Chief Engineer for Digital Manufacturing	The Manufacturing Technology Centre
John Clarke	Executive Officer	Riverside College
John Conti-Ramsden	Director	Knowledge Centre for Materials Chemistry



Dr. John Grasmeder	Chief Scientist		Victrix
John Leake	Business Development Manager and Chair of the UK Science Park Association (UKSPA)		SciTech Daresbury
John Lucy	Director of Liverpool Freeport		Liverpool City Region Combined Authority
John Whaling	Lead Officer - Innovation & Commercialisation		Liverpool City Region Combined Authority
Dr. Jon Hague	Vice President, Operations and Open Innovation		Unilever
Joseph Howe	Professor and Executive Director: Thornton Energy Research Institute		University of Chester
Prof. Julian Hiscox	Chair in Infection and Global Health		University of Liverpool
Kate Downes	Head of Evidence, Research and Intelligence		Liverpool City Region Combined Authority
Kate McDermott	Investment Executive		Liverpool Growth Platform
Dr. Katherine Robertson	Head of Campus Development		Science & Technology Facilities Council (STFC)
Prof. Keith George	Associate Dean for Scholarship, Research and Knowledge Transfer		Liverpool John Moores University
Mark Knowles	Head of Low Carbon		Liverpool City Region Combined Authority
Mark Proctor	Head of Global Technical Services		AstraZeneca
Martin Land	Project Director - Mersey Tidal Power Project		Liverpool City Region Combined Authority
Mary Murphy	Principal		Riverside College
Massimo Noro	Business Development Director, Science and Technology		Science & Technology Facilities Council (STFC)
Prof. Matt Reed	Strategy Director		University of Liverpool
Prof. Michael Riley	Director Civil Engineering & Built Environment		Liverpool John Moores University
Quincy Quayson	Founder & CEO		Q3 Consultancy
Prof. Raphaela Kane	Pro Vice Chancellor - Faculty of Health		Liverpool John Moores University
Prof. Richard Jones	Vice-President for Regional Innovation and Civic Engagement		The University of Manchester
Richard Katz	CEO and Founding Director		Glass Futures
Rob Tabb	Policy Lead: Employment and Skills		Liverpool City Region Combined Authority
Sarah Jackson	Director of Research, Partnerships and Innovation		University of Liverpool
Simon Reid	Head of Sectors		Liverpool Growth Platform
Dr. Sonja Vujovic	Head of Consultancy & Innovation		University of Liverpool
Dr. Steve McBride	Head of Knowledge Centre for Materials Chemistry		CPI
Steven Heales	Head of Innovation and Science Commercialisation Policy		Greater Manchester Combined Authority
Dr. Su Varma	Academic Director of the R&D Incubator		NSG Pilkington
Prof. William Hope	Dame Sally Davies Chair of AMR Research, Director of Centre of Excellence in Infectious Diseases Research		University of Liverpool



**LIVERPOOL  
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To find out more about innovation assets, programmes and opportunities across the Liverpool City Region:

please visit

[www.liverpoolcityregion-ca.gov.uk/what-we-do/innovation](http://www.liverpoolcityregion-ca.gov.uk/what-we-do/innovation)

or contact

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