Executive Summary

In Autumn 2015, the UK Government announced regional Science and Innovation Audits (SIAs) to catalyse a new approach to regional economic development. SIAs enable local consortia to focus on analysing regional strengths and identify mechanisms to realise their potential. The North West Coastal Arc™ (NWCA) Partnership for Clean and Sustainable Growth was formed in 2017 to focus on our strength in science and innovation for Clean and Sustainable Growth. This report presents the results which include broad-ranging analysis of the NWCA Clean and Sustainable Growth Partnership's capabilities, the challenges and the substantial opportunities for future economic growth.

The 2017 UK Industrial Strategy White Paper recognizes that Clean Growth is not simply a challenge but a very significant opportunity to increase productivity, create jobs and scale-up earning power right across the country. In 2014 the global market for low carbon products and processes alone was worth $US3.4 trillion and this is predicted to rise to in excess of $US8 trillion by 2025. In the UK, employment, turnover and GVA in this sector are all growing rapidly (12%, 25% and 28% respectively between 2010 and 2013) and are predicted to grow by 11% per year between 2015 and 2030 – 4 times faster than the rest of the economy. This could deliver between £60 billion and £170 billion of UK export sales by 2030.

This SIA provides the evidence base to demonstrate that the NWCA is exceptionally well-positioned to lead globally in developing both the innovations and the skilled people that will drive forward the economic and environmental benefits of Clean and Sustainable Growth. The NWCA partners share a collective vision of translating world-class research via innovation for Clean and Sustainable Growth to create regional economic value.

We have structured this audit around three prime capabilities in 'science and technology' research and innovation, namely Environmental Industries Technologies & Services, Future Energy Systems and Advanced Manufacturing, Chemicals and Materials. We have also included a fourth 'enabling' capability representing acceleration points for innovation and productivity across each of the prime capabilities. These include co-location of business, support for collaborative research and demonstration capabilities. These complement the technical innovation strengths and act to amplify the translation of research quality into new products and processes for the global market place.

Based on the top 1% of cited publications, the collective research leadership of the partnership is globally leading in Environmental Industries, Technologies and Services, and exceptional in the Agronomy and Crop Science, Plant Science and Waste Management sub-disciplines.

The NWCA's outstanding research excellence in Aerospace Engineering and Materials and Chemistry, particularly Metals & Alloys and Polymers & Plastics is very strong against global comparators. In terms of cross cutting and complementary research capability, the region has outstanding research excellence in Statistics, Probability and Uncertainty, Decision Science, Data Science, Management Science and Management of Technology and Innovation.

Over the course of the audit the underpinning logic chain was developed and refined to link challenges and opportunities with the region's existing activities and assets and ultimately the potential for new assets and activities to drive economic, social and environmental benefits. At the heart of that logic chain (Table 1) are five key opportunities emerging from the collective vision of research and innovation for Clean and Sustainable Growth that has crystallised as partners have worked together to deliver this audit.

The implementation plan defines the mechanisms by which the outcome of this audit will be put into practice. Partners will work together to deliver that plan, and so empower the region as a whole to work collectively to drive forward the economic, social and environmental benefits provided by Clean and Sustainable Growth. The learning, innovation assets and benefits developed as a result of the audit can then be applied across the UK to increase productivity, create good jobs and scale-up earning power right across the country and so maximise the nation's competitiveness in this fast-growing global market.

Five key opportunities emerging from this Science and Innovation Audit

1. Communicating the economic importance of Clean and Sustainable Growth

NWCA partners will work together to use the outcomes of this audit to highlight the immense benefits of Clean and Sustainable Growth for the economy and people, as well as the environment. Communication activities will be an initial priority.

2. Improving connectivity between the region's assets for Clean and Sustainable Growth

The audit has identified specific opportunities for a more 'joined-up' approach to the region's existing research, development, demonstration and co-location facilities. These include research and innovation into hydrogen-based energy systems, below-ground energy resources and 'place-based synergies' focused on the role of NWCA's uplands and coasts supporting the region's urban areas.

To enhance the region's existing assets, an International Centre of Excellence for Clean and Sustainable Growth would act as a gateway for stakeholders to access to the NWCA's existing prime capabilities, targeting the challenges and opportunities at the interaction of the Clean Growth Strategy and 25 Year Environment Plan. The proposed 'Eden Project for the North' offers a unique opportunity to develop new research, development and demonstration capacity, serving the whole of the NWCA partnership, both its research base and business communities, and would be developed alongside public engagement facilities.

3. Enhanced support for connecting business to global markets

The audit has identified the opportunity to take a more coordinated approach to leveraging the international campuses and technology transfer facilities of the region's higher education institutions in order to develop SME internationalisation support programmes across the higher education partners.

4. Training regional talent to support and lead Clean and Sustainable Growth

Consultation with business and other stakeholders highlighted a gap in training at all levels relevant to Clean & Sustainable Growth. Improved integration and connectivity across the region's further education and higher education providers would create a 'skills escalator', for example through a virtual Clean Growth Training Academy.

5. Freedom and flexibility in supporting industrial R&D for Clean and Sustainable Growth, particularly in SMEs

A clear conclusion from the audit is that achieving our aspirations of significantly increased SME R&D for Clean and Sustainable Growth requires funding mechanisms (for example the multiple mechanisms of government investment highlighted in the Clean Growth Strategy) that operate at an appropriate and transformational regional scale across individual LEP boundaries.

This audit has proved the strength of the NWCA partnership and shown a real commitment by each of the organisations involved to create a Strategic Alliance, develop an action plan for the first 12 months and convene an implementation group to drive progress.

Since the formal submission of this SIA in July 2018, the Intergovernmental Panel on Climate Change (IPCC) published a special report[32] on the impacts of global warming of 1.5°C above pre-industrial levels. The report makes clear that limiting warming to 1.5°C would prevent many of the risks associated with a 2°C rise.

The IPCC report states that to limit global warming to1.5°C *"....would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems. These systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options."*

This conclusion of the IPCC report further reinforces a major outcome of this audit in highlighting the urgent need for Clean and Sustainable Growth that addresses the needs of all sectors and industrial systems.

The SIA consortium is led by Lancaster University and includes all the region's LEPs (Cumbria, Lancashire, Cheshire, Liverpool City, Stoke-on-Trent and Staffordshire), the North Wales Economic Ambition Board and the Mersey-Dee Alliance, together with companies of all sizes, and across a wide range of sectors. It brings together the complementary research strengths of ten regional universities, Lancaster, Liverpool (both members of the N8 partnership), Bangor, Chester, Cumbria, Edge Hill, Keele, Liverpool, John Moores (LMJU), University of Central Lancashire (UCLAN) and Wrexham Glyndwr and other national research assets, together with Blackpool and The Fylde College.

Table 1

Logic chain for North West Coastal Arc™ (NWCA) Partnership for Clean and Sustainable Growth Science and Innovation Audit

What are the challenges and opportunities?	What assets does the SIA build on in the region?	What new activities or assets could be developed?	What will these new assets and activities unlock?	What will be the result in the long term?
Industrial Strategy highlights weak UK productivity performance and clean growth as a grand challenge. 25 Year Environment Plan requires significant acceleration of decarbonisation. Misconception of the nature and need for Clean and Sustainable Growth beyond 'low carbon energy'. No integrated national centre of excellence to develop, test and showcase such technologies.	Complementary research strengths across the region. Demonstrable track record of business-driven innovation. Northwest is ranked first for employment in the clean growth sector in England. Unique set of place-based assets.	**A connected ecosystem of research, innovation and demonstration facilities across the NWCA geography.** Creation of an **International Centre of Excellence for Clean and Sustainable Growth** including the expansion of demonstrator facilities.	Increased IP commercialised from wider sectors (e.g. aerospace) used for clean growth applications. NWCA assets and facilities across the geography mutually accessible to researchers, innovators and industry. SMEs/Corporates all linked, to develop new products and services for global marketplace.	Substantial improvements in NWCA economic growth rebalancing relative UK productivity performance. International Centre of Excellence for Clean and Sustainable Growth established as a gateway for business to access NWCA prime capabilities and demonstrator sites. NWCA known as globally leading for Clean & Sustainable Growth through Eco-Innovation.
Skills shortages at all levels associated with clean growth requiring cross-disciplinary skills.	Complementary teaching and training strengths of regional higher education and further education providers.	A new **collaborative Training Academy for Clean & Sustainable Growth** attracting, creating and retaining talent within the NWCA. **Enhanced leadership & entrepreneurial behaviour programmes** enabling start-ups to become scale-ups.	Relevant STEM skills and talent attraction and retention programmes at all levels. Training to enhance leadership driving innovation and entrepreneurialism in SMEs.	World-class student/ research/ industry talent attracted to the NWCA and the 'eco-innovators' of the future retained within the region. New models of shared provision for training across the NWCA, including better collaboration across FE and HE providers and increased engagement with Degree Apprenticeships.
Sub optimal support for overseas expansion and not easily visible.	Universities have extensive and complementary, international partnerships and infrastructure, but this is currently under-utilised to support trade.	**Enhanced and "joined-up" leverage of university's international reach.**	Successful SME internationalisation support programmes across higher education institutions.	NWCA make a significant contribution to increases in UK trade figures through clean growth export opportunities.
Clean growth resources and programmes are fractured i.e. they tend to be project based and targeted around specific physical locations.	Broad-based and successful collaborations across the region have been established despite the current fractured funding models.	**New flexible funding mechanisms** to support SME focused R&D. **National Open Innovation IP Bank for Clean Growth** to support increased commercialisation.	R&D activities operate at appropriate and transformational scale across LEP boundaries. Increased investment in supporting expansion of clean growth and sustainable cross-sector start-up and scale-up SMEs.	New mechanisms secure the enduring success of the NWCA in driving Clean and Sustainable Growth, and the resulting economic, social and environmental benefits.