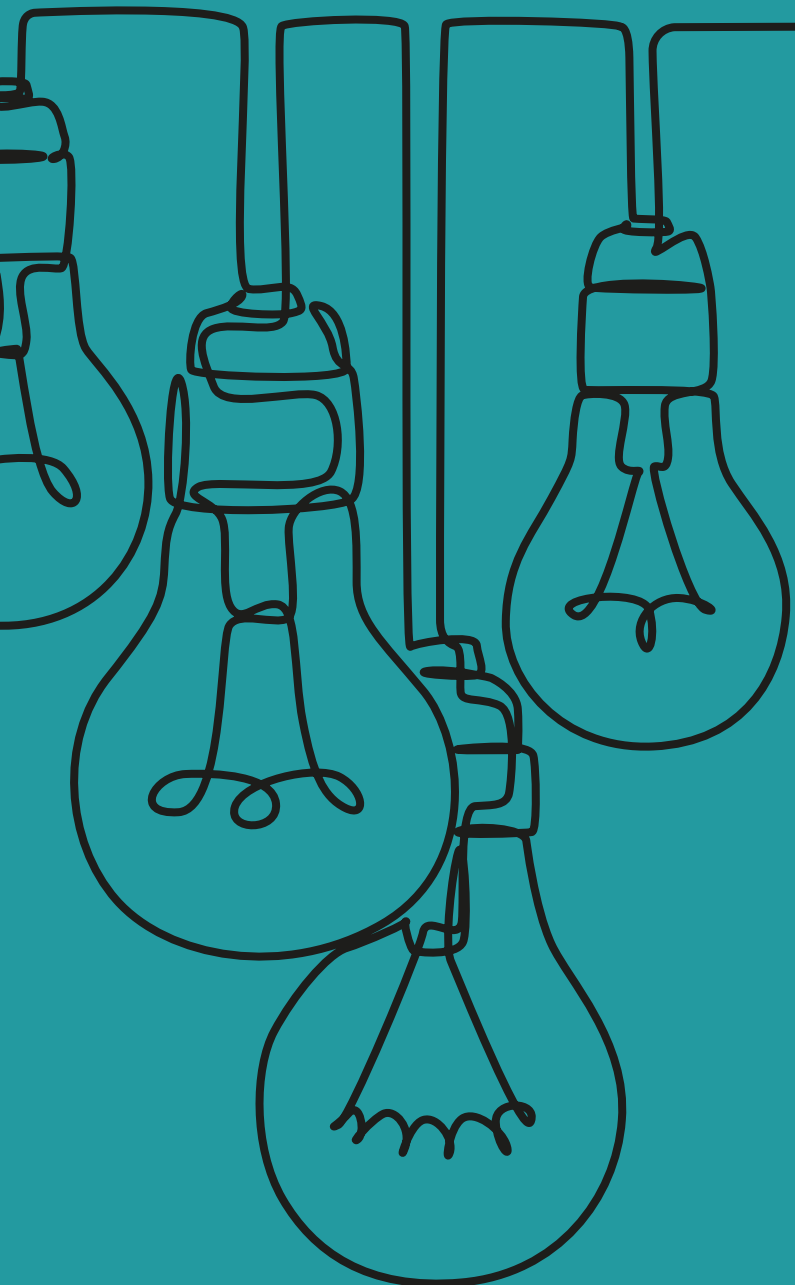# WALES INNOVATES: CREATING A STRONGER, FAIRER, GREENER WALES – PRIORITY THEMES AND STRENGTHS ANALYSIS

To provide an informed focus for the Innovation Strategy an initial number of thematic areas were identified based on current academic research activity. A further exercise was undertaken to identify priorities within these themes based on an analysis of the Welsh academic and industry strengths with the aim of highlighting those which align across academic research and business capability and capacity to exploit. The methodology for this analysis is detailed below and resulted in the following matrix.

Methodology

The recent Research Excellence Framework (REF) 2021 data was used as a key component of determining the relative strengths of the research undertaken in Welsh Universities.

What is the REF?

The REF is the UK's system for assessing the quality of research in UK higher education institutions.

The REF was first carried out in 2014, replacing the previous Research Assessment Exercise. The REF is undertaken by the four UK higher education funding bodies: Research England, the Scottish Funding Council (SFC), the Higher Education Funding Council for Wales (HEFCW), and the Department for the Economy, Northern Ireland (DfE).

How is the REF carried out?

The REF is a process of expert review, carried out by expert panels for each of the 34 subject-based units of assessment (UOAs), under the guidance of four main panels. Expert panels are made up of senior academics, international members, and research users.

For each submission, three distinct elements are assessed: the quality of outputs (e.g. publications, performances, and exhibitions), their impact beyond academia, and the environment that supports research.

The full submissions from every university in the UK and the results are publicly available and fully downloadable via the REF2021 website.

This data was used to populate columns, "REF2021 Outputs" and "REF2021 Unit of Assessment Research Income Location Quotient", in the matrix.

The results for the first of these was determined by analysing the submissions for each of the UOA relevant to each of the themes. Over 5,000 entries were analysed, each having an associated title for the publication/paper, categorised by UOA and university. To determine the common themes in the titles a "word cloud" approach was used to identify the top three words, with the highest occurrence, for each theme and relevant UOA(s). The overall top 5 occurring themes are highlighted in yellow.

The results for the second of these was determined by analysis via the calculation of location quotients (LQ). Location quotients compare the relative performance of a location, in this case Wales, compared with the UK. These were calculated from REF2021 submissions results, for each UOA, for number of 3*+ quality full time equivalent researchers, value of, industry income secured and competitively won funding from UKRI, etc. The UOA(s) with positive LQs in each of these are included in the matrix. Where there is no evidence of a "comparative advantage", the UOA(s) with LQs with the potential to be future strengths are highlighted. In one case, where a strength has been identified, additional potential future strengths have also been included.

The same "word cloud" approach was used to identify the common themes in titles of successful UKRI and IUK funding applications made by research organisations (RO) and businesses respectively. These are used to populate the columns "RO UKRI Funding" and "Industry IUK Funding".

The column "Industry Sector (SIC Code) GVA Location Quotient" used the LQ analysis based on the GVA contribution, to the Welsh economy, of industry sectors categorised by SIC codes, relative to UK. A positive LQ demonstrates a Welsh comparative advantage. The sectors relevant to the themes with positive LQs have been included in the matrix. Where "no comparative advantage" was identified support activities for emerging industry strengths have been included.

The next column highlights physical assets, academic and industrial, which provide facilities relevant to the themes and the academic and industry strengths identified.

The final column maps the Welsh Priority Themes to the UK Innovation Strategy "seven technology families of UK strength and opportunity" to highlight where there are common themes and technologies.

Strengths / Themes	Common Themes in Papers and Funding Applications			REF2021 Unit of Assessment Research Income Location Quotient	Industry Sector (SIC Code) GVA Location Quotient	Academic/Industry Assets	Seven technology families of UK strength and opportunity
	REF2021 Outputs	RO UKRI Funding	Industry IUK Funding				
Digital transformation	Quantum Fuzzy Neural	Cyber Quantum	Monitoring Cyber Quantum	No comparative advantage Potential strengths: • Physics • Computer Science and Informatics	• Information and communication	• National Digital Exploitation Centre • Centre for Artificial Intelligence, Robotics and Human-Machine Systems	• AI, Digital and Advanced Computing • Electronics, Photonics and Quantum • Robotics and Smart Machines
Net Zero and decarbonisation	Solar Tidal/Wave Hydrogen	Solar Tidal Waste	Waste Packaging Solar	• Engineering • Earth Systems and Environmental Sciences	• Electricity, gas, water; sewerage and waste management	• SPECIFIC • Centre for Automotive and Power Systems Engineering • Sustainable Building Envelope Centre • H2 Wales Hydrogen Research Centre • Active Building Centre	• Energy and Environment Technologies
Agri tech and rural economy	Genome Crops Livestock	Livestock Soil	Crops Pests	• Agriculture, Food and Veterinary Sciences	No comparative advantage Emerging strengths: AberInnovation	• Institute of Biological, Environmental & Rural Sciences	• Bioinformatics and Genomics • Engineering Biology • Energy and Environment Technologies
Creative industries and media	Digital Art Music	Arts Welsh	No comparative advantage	No comparative advantage Potential strengths: • Computer Science and Informatics • Art and Design: History, Practice and Theory • Music, Drama, Dance, Performing Arts, Film and Screen Studies	No comparative advantage Emerging strengths: Clwstwr	• S4C Headquarters – Yr Egin • The Royal Welsh College of Music & Drama	• AI, Digital and Advanced Computing
Population health and biotech	Cancer Neural/ Brain Genetics	Brain Genetic	Blood Cancer	• Allied Health Professions, Dentistry, Nursing and Pharmacy • Psychology, Psychiatry and Neuroscience	• Manufacture of pharmaceutical products, petroleum, chemicals and rubber, plastic and non-metallic minerals	• Cardiff University Brain Imaging Centre • Institute of Life Sciences	• Bioinformatics and Genomics • Engineering Biology
Materials and manufacturing (including semiconductors)	Perovskite Catalysis Graphene	Semi-conductors Photovoltaics Catalysis	Coatings Graphene Composite	• Engineering Potential additional strengths: • Physics • Chemistry	• Manufacture of pharmaceutical products, petroleum, chemicals and rubber, plastic and non-metallic minerals • Manufacture of machinery and transport equipment • Manufacture of computer, electronic and optical products • Manufacture of basic and fabricated metal products	• Compound Semiconductor Applications Catapult • Advanced Manufacturing Research Centre Cymru • Institute for Innovative Materials, Processing and Numerical Technologies • OpTIC Centre Glyndŵr • TWI • Manufacture Advanced Design Engineering Centre • Dennison Advanced Materials Centre	• Advanced Materials and Manufacturing • Electronics, Photonics and Quantum • Energy and Environment Technologies