Centre for
Cross Border Studies

ACCELERATING GROWTH

PROGRESSING GLOBALLY AMBITIOUS SECTORAL CLUSTERS ON THE ISLAND OF IRELAND

A reflection on Ireland's Department of Enterprise, Trade and Employment's ***S3 for Innovation*** and Northern Ireland's Department for the Economy's ***10X Economy*** through the lens of the European Panorama of Clusters and Industrial Change

Niall O'Donnellan, Development Economist

November 2023

Acknowledgements

I am deeply grateful to those who have shared insights, information and leads on the rich diversity of sectors and companies on the island of Ireland. I appreciate our tradition of sectoral development from the 1840s onwards to the present day. In the context of the thought leadership of Michael Porter, I have benefited hugely from the strategic thinking, empirical insights and analytical work of Michael Best, Simone Boswell, John Bradley, Miriam Brown, Leo Clancy, Meabh Conaghan, Michelle Conaghan, Stephen Creaner, Ann Dinnigan, Eleanor Doyle, Rowena Dwyer, Dan Flinter, Orla Flynn, Carol Gibbons, John Hobbs, David Jacobson, Richard K. Lester, Eoin Magennis, Brendan McCormack, Enda McDonnell, John McCarrick, Neil McHugh, Patricia McLister, Garret Murray, John Nugent, Larry O'Connell, Eoin O'Malley, Feargal Ó Móráin, Ciarán Ó hÓgartaigh, Kathleen Quinlan, Frank Ryan, Claire Scott, Sarah Searson, Rosemary Sexton, Kevin Sherry, Julie Sinnamon, Alexa Toomey, Greg Treston and Chris van Egeraat, amongst many others. I have learnt enormously from the insights and depth of knowledge of the sectoral and investment teams at Enterprise Ireland (EI) and Industrial Development Authority (IDA) and the numerous client companies we were privileged to work with over the years.

This reflection could not exist without the sectoral specialisation strategies of Northern Ireland's *10X Economy – Northern Ireland's Decade of Innovation* (May 2021) by the DfE team led by Deputy Secretary Paul Grocott and the Republic of Ireland's *National Smart Specialisation Strategy for Innovation 2022-27* (July 2022) by the DBEI (DETE) team led by Assistant Secretary Declan Hughes.

I also profoundly appreciate the inputs on regional sectoral development by the teams and associates of the Republic's Regional Assemblies, especially the interest in this work by David Minton, Denis Kelly and John Daly of the Northern and Western Regional Assembly Executive. The work of InterTradeIreland, Cluster Centre, and Cluster Research Network has been central in breaking new ground in understanding and advancing sectoral clustering overall on the island of Ireland. As always, I warmly welcome the guidance and support of Anthony Soares and the Centre for Cross Border Studies team. I extend particular thanks to Anthony for the considerable detailed and time-consuming editing needed to progress this document to publication. Thanks also go to Catrina Stark copy editor of Affinitas Communications, and to Paul Eliasberg graphic designer of Trimprint Ltd, in bringing the document to such a high standard of presentation.

Final thanks go to the home team, whose interest, support and presence have enabled this work. Thank you, Nessa, Caoimhín and Dearbhla, David, Eimear and Jack, and of course to recent arrivals Phoebe, Liam and Daphne.

As the author, I am completely and solely responsible for the many specific assessments and judgements made throughout this reflection and for any errors or omissions of fact and imbalances of interpretation that may have occurred. I hope this reflection proves helpful in the broader debate on the economic future of the island of Ireland, its jurisdictions and regions and that any heresies herein can and will be forgiven.

Contents

Part 1: Context and approach

Context

Enterprises always operate in some type of value chain and network, interacting with their customers and end-users, input suppliers and providers of capital, and their workforce and staff. In our interdependent world, global value chains (GVCs) are prevalent. Standards for classifying and comparing such groups of companies or sectors include NACE,[1] which the European Union (EU) uses and SIC,[2] which the United Kingdom (UK) uses. Many companies gather spatially with groups or clusters of companies in the same or similar sectors or with companies from various industries within a zone, city and region. Encouraging such sectoral clustering has long been seen as a tool of economic development (Marshall (1890), Porter (1990)).

In the mid-2010s, Porter and others developed the global standard that applied to the USA for measuring such sectoral clustering and its impact on performance. The European Commission's European Observatory on Clusters and Industrial Change (EOCIC) initiative has evolved and applied this approach to wider Europe. *The European Panorama of Clusters and Industrial Change* (2020 edition) uses a cluster five-star methodology with 2015/17 data in measuring cluster strengths in size, specialisation and productivity, the presence of high-growth SMEs and the presence of innovation leaders across 51 trading/exporting industry sectors.

It identifies 2,950 regional industrial clusters, accounting for 23% of all European employment and 50% of exporting employment. Of those clusters, 198 rank as high-performers, 898 medium-performers, and 1,854 basic-performers.

"Productivity in clusters is much higher than average productivity, corresponding to a 25% above average productivity effect." (p.6)

Currently, on the island of Ireland, there are 41 performing clusters at some level (based on an adaption of the approach of the EOCIC (2020)). Seven clusters are high-performing, fifteen are medium-performing, and nineteen are basic-performing. Of these performing clusters:

- Northern Ireland (NI) has 11 performing clusters (one high-performing);
- Northern and Western Region (NWR) has four performing clusters (one high-performing);
- Eastern and Midland Region (EMR) has 18 performing clusters (three high-performing); and
- Southern Region (SR) is imputed to have eight performing clusters (two high-performing).

Sectoral development

Sectoral development has long been a topic of discussion and reflection within the policy and academic communities on the island of Ireland since the 1840s. In recent years, considerable work has been done throughout Europe on Smart Specialisation Strategies stimulated by the European Commission (EC). In the UK, the Conservative Government's *Levelling Up the United Kingdom* and the Labour Party's *A New Britain* stress sectoral clustering as key to regional balancing.

Northern Ireland's Department for the Economy (DfE) in its *10X Economy: Northern Ireland's Decade of Innovation* (2021) and the Republic of Ireland's Department of Business, Enterprise and Innovation (DBEI)[3] in its *National Smart Specialisation Strategy for Innovation 2022-2027* (2022), along with the three regional assemblies in the Republic and others, have developed much valuable analysis, stakeholder feedback, policy conclusions and proposed strategic actions.

Approach

As input into the sectoral clustering discussions on the island of Ireland, this strategic reflection contributes:

a) A **qualitative gap analysis** for major NACE/SIC sectors in each NUTS 2[4] region on the island of Ireland by examining the sectors' presence, capabilities in higher education, research and innovation, stakeholder feedback and policy priority, and

b) A **progression focus** to identify which sectors can progress to higher performing levels by 2030 (with some building towards being recognised as one of their sector's top five global locations, either as a core hub or critical spoke).

Part 2: One island, two jurisdictions, four regions

Key sectors in each region and jurisdiction

In reflecting on the sectoral capabilities and EOCIC (2020) clusters within each of the regions and jurisdictions on the island of Ireland, there are significant sectoral clustering opportunities in each. Opportunities also exist for synergies and collaborations, further growth across the island, and becoming more recognised as evolving into a location with high-performing (and some as potentially world-class) clusters. The question is whether and how an all-island perspective brings more remarkable growth to the overall sector and how, within the sector, the whole becomes more significant than the sum of its parts.

For each region and jurisdiction, a triad of potentially high-performing and medium-performing sectors to be realised by 2030 has been identified (Figure 1).

Figure 1: Summary of potential sectoral clusters 2030 priorities at region levels

	1	2	3	4
Level for 2030	**NORTHERN IRELAND (NI - UK)**	**NORTHERN & WESTERN REGION (NWR - ROI)**	**EASTERN & MIDLAND REGION (EMR - ROI)**	**SOUTHERN REGION (SR - ROI)**
High	Biopharma / Diagnostics (eHealth aged) Production technology engineering IT cyber and digital business services	Medical devices (eHealth aged) Production technology engineering Digital business & financial services and IT applications	Information technology Financial, insurance and business services Biopharma / MedTech	IT cyber, digital business and financial services Biopharmaceuticals Food processing
Medium	Financial services / FinTech Food processing Hospitality & tourism / Creatives	Biopharmaceuticals Food processing Hospitality & tourism / Creatives	Production technology engineering Distribution, eCommerce / Transport & logistics Hospitality & tourism / Creatives	Transport & logistics Hospitality & tourism / Creatives Production technology engineering
Low / Basic	Construction products & services Electricity power generation & transmission Education & care services	Construction products & services Electricity power generation & transmission Education & care services	Food processing Electricity power generation & transmission Paper & packaging, Printed services and Fired materials Education & care services	Construction products & services Electricity power generation & transmission Education & care services

Part 3: All-island perspective

Key sectors at an all-island level

In seeking alignment and potential for synergies across Ireland, three sectors are suggested as clusters aiming for high-performing by 2030 at an all-island level and within the regions and jurisdictions. They should also seek to be recognised by 2030 as building towards becoming one of the top global locations in the sector as a core hub or critical spoke.

Three high-performing sectoral clusters at all-island level

The **life sciences** broad cluster on the island of Ireland has a strong presence in all regions. It is already recognised globally, with pharmaceuticals and chemical production in the Southern Region (SR), MedTech and pharma in the Northern and Western Region (NWR), diagnostics and biopharmaceuticals in Northern Ireland (NI) and biopharma and pharma in the Eastern and Midlands Region (EMR). There is also an emerging eHealth opportunity - for records and processes in EMR and SR and for ageing at home/in community services for NI and NWR.

The **information technology** and related activities broad cluster on the island is also strongly present in all regions and recognised globally, within EMR with MNC strategic business services and an IT start-up ecosystem in Dublin especially, in NI with IT cyber and related grouping in

Belfast and beyond, in SR similarly with IT cyber and related digital business services grouping in Cork City and beyond, and in NWR with digital business services in Mayo/Sligo/Leitrim/Donegal, financial services and FinTech in Donegal, and information technology/software verticals applications as well as business and financial services in Galway City and its environs.

The **production technology engineering** and related sectors as a broad cluster is strongly present in all regions on the island of Ireland, especially in Antrim, Belfast, Tyrone, etc. in NI, with sustainable transport, aerospace, construction, energy, and related materials handling, etc. throughout adjacent NWR with toolmaking, materials handling (Monaghan), cranes, etc., in SR with Limerick autos and aerospace, etc. and in EMR with automotives in Midlands, microprocessor chips (Intel) in Leixlip and aerospace services in North Dublin/Louth.

Three medium-performing (at least) sectoral clusters at all-island level

Agrifood, food processing and manufacturing, and **livestock processing** as a cluster is present in all four regions. NI has dairy, beef, sheep, chickens, pigs, and food & drink (whiskey) products. NWR has dairy, sheep, etc., food products, and fish (Killybegs). In EMR, there are consumer foods, beef processing, equine (Kildare) and fish (Howth and Clogherhead). In SR, dairy has a solid presence along with fish (Cork and Kerry) and a rich range of food products, etc. Overall, the aim is a world-leading Sustainable Food System (SFS) based on the island's "own distinctive food system", of which "the core of … agrifood output will continue to be grass-based livestock production wherein lies [our] natural competitive advantage."[5]

Financial services, along with **insurance services**, as a cluster is present in all four regions, with a strong presence, particularly in Dublin (with International Financial Services Centre (IFSC), etc.) and Louth, Kilkenny, etc., NI in Belfast and Derry/Londonderry, NWR in Donegal and elsewhere, and SR in Cork, Kerry (Fexco), and Wexford.

The **hospitality & tourism and related creatives industry** (music, performing arts, etc.) sector as a broad cluster is present in all four regions. In EMR, most overseas tourists come to Dublin for film, theatre, nightlife, etc. In NI, intense scenery, golf, historical and other attractions and a strong film industry (e.g. Game of Thrones) attract many tourists. Meanwhile, NWR and SR offer scenery, music, golf, etc.

Three other potentially performing sectors

Three other sectors have been identified as potentially ranking across the island as (at least) basic/low-performing internationally (within EOCIC (2020) rankings) by 2030.

Construction products and services, with associated **environmental services** and **non-metallic mining** (quarries), are well regarded internationally and present in all four regions on the island of Ireland, especially in NI and EMR.

There is also a significant and vital emerging opportunity for the whole island of Ireland in **offshore wind electricity generation and transmission** that needs developing and exploiting.

Education and care services (including childcare, aged care and healthcare) have deep capabilities throughout the island and international recognition (e.g. nursing schools are highly ranked academically; the island is only one of three locations worldwide with competitive entry for primary school teaching; and is home to a leading global learning platform)[6] that needs to be systematically nurtured and fostered in a modern competitive economy.

All of these sectors (Figure 2) can be systematically assessed, prioritised, developed and invested in on an all-island basis to maximise the mutual synergies, benefits and impacts and to progress their cluster rankings, global profile and leadership and so reinforce their strengths in each of the regions and jurisdictions on the island. All sectors within each region should aim to become recognised internationally as best-in-class in some aspects of practice and process within their global sector.

Figure 2: Overall island of Ireland sectoral priorities by 2030

RANKING AIM (EOCIC) BY 2030	BROAD SECTOR
High	Life sciences Software/Digital business services Production engineering
Medium	Agrifood Financial services Hospitality and creatives
Low / Basic	Construction products Energy/Environment Education and care services

All sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, it is also critical that the specific sectoral skills, experience, expertise and platforms, more general technological, digital, lean and sustainability capabilities and broader inclusive leadership and organisation abilities are all nourished and invested in to underpin the island of Ireland, its two jurisdictions and all its four regions as an adaptive learning community and system at a multiple of levels.

Global end-user experience

In seeking to progress to higher levels of performance for key sectors across the island of Ireland, it is necessary to start at the end-point: the global end-users' experience of what is provided by the sectors. That entails detailed discussion in each sector of what is available now and what is emerging. It also requires consideration of what might be a highly positive experience in each sector of meeting the needs of end-users of the sector's outputs throughout the globe.

That becomes the vision of what will drive global perceptions of the relative strength of the sectors here. Based on this reflection, the tentative outlines of such directions and focus are presented (Figure 3) as one input of many into the sectoral discussions. The key to progression is continuing to evolve through rapid learning, inclusive and sustainable vehicles and practical pathways that implement systems for generating outstanding global end-user experiences.

Figure 3: Global end-user experience of key sectoral clusters on the island of Ireland by 2030

SECTOR	HIGHLY POSITIVE EXPERIENCE IN RESPONDING TO THE NEEDS OF END-USERS
Agrifood Core Known for: **Nutrition**	Producing high-quality, healthy food and drink from traceable, digitalised and sustainable **grassland production** systems.
Life sciences Core known for: **Health**	Making excellent components/tools and combining delivery within **intelligent health** services.
Engineering Core known for: **Mobility**	Making sophisticated, sustainable **mobile structures within intelligent systems**.
Construction Core known for: **Shelter**	Building physical structures **at scale** sustainably and rapidly **to high standards**.
Energy Core known for: **Fuel**	Powering connected grids through massive **offshore wind** and other renewables.
Software Core known for: **Feedback**	Coding creatively for **cyber-security platforms, vertical applications** and **related software platforms**.
Business services Core known for: **Help**	Sourcing very **responsive digitalised service systems** in both urban and rural locations.
Financial services Core known for: **Time**	Applying **digital to finance** for security, regulations, efficiencies, access and new models.
Hospitality Core known for: **Connection**	Ensuring a relaxing journey within a place of highly **welcoming and interesting people, encounters** and **surroundings**.
Creatives Core known for: **Expression**	Sharing deep, **insightful storytelling** across many forms of expression.
Education & care services Core known for: **Nurture**	Realising personalised responses to individual needs through high-quality services delivered by profoundly committed staff and intelligent learning systems.

Underpinning these individual sectoral ambitions is a sectoral template and fundamental 'omega' vision of global recognition for the island of Ireland as **"producing user-driven innovative, digitalised and sustainable products and services that are connected and embedded within human-centric, values-based, intelligent, data-rich, adaptive learning systems."**

Building regional synergies and global linkages

Developing key clusters on an all-island basis and leveraging our scale, proximity, and synergies implies nurturing strategic intensive linkages within clusters in all four regions and with key global clusters. Being globally ambitious entails engaging with and spending time in the top global clusters in a sector, mixing with the best quality and most experienced people in various roles, and continuously learning from and - progressively - sharing with them.

Many current and potential linkages and synergies are identified in nine key sectors, both between regions and on the island of Ireland, and with strong sectoral clusters in Great Britain, wider Europe, the Americas, Asia and Africa. Strengthening and leveraging them is critical for sectoral development at regional, jurisdiction and all-island levels.

Joint investment projects

Developing joint investment projects will facilitate realising the synergies and learning from best practices. Figure 4 suggests several illustrative collaborative projects for consideration. There is already considerable experience in Interreg, PEACE, shared-island HEI research projects, etc., that can guide us in choosing and organising such joint projects. The Tourism Ireland campaign to selected global markets to leverage the regional/jurisdiction brands of *Wild Atlantic Way*, *Giant Spirit*, *Hidden Heartlands*, *Ancient East* and *Dublin* is an excellent example of how such joint projects can help accelerate growth in all regions and jurisdictions across the island. Overall, InterTradeIreland has a crucial role in progressing such collaborative projects.

Figure 4: Illustrative joint projects for island-wide progression of key sectoral clusters

LEVEL AIMED FOR BY 2030		TECHNOLOGY AND SCIENCE	GLOBAL LINKAGES/OTHER
HIGH	Life sciences	High-level professorships across hubs (diagnostics, MedTech, bio-pharma, pharma production) Major research programme for the eHealth industry (aged services, data)	Joint learning mission to Boston and Cleveland
	Engineering	Major research programme on applied science for mobile structures (transport, handling, platforms, etc.) Major joint research and development programme for industrial chip manufacture and design	Joint learning missions to world-leading clusters e.g. West Midlands, Stuttgart/Freiburg, Shenzhen, etc. Joint celebration of engineering/wider manufacturing (May)
	IT/Software	Focused research programmes for key segments (cyber, consumer engagement, wearables/sportstech, energy-saving, EdTech, etc.) Major investment in an island-wide network of quantum computing facilities High-level professorships in areas underpinning sector on the island of Ireland	Joint learning missions to world-leading clusters, e.g. Silicon Valley
MEDIUM+	Agrifood	Major research hub and spoke centre for next-generation food tech (plant meats, insects, hydroponics, etc.)	Joint learning missions to Italian, French and Indian artisan food production systems / cultures
	Financial services	FinTech research programme on key technologies (blockchain, legacy process conversion, mobile finance, etc.) and new options for money exchange, etc.	Joint learning mission to New York for next-generation finance (Columbia Business School)
	Hospitality / Creatives	Shared innovation services for commercialising IP for creatives and linked joint research programme	NWxW digital / creatives festival (wider NW and NWR/NI)
LOW / BASIC+	Construction	Research programme into scaling with high standards construction (modular housing, etc.) within budgets, time and benefits	
	Energy plus	Research programme for smart cities (led by Belfast and Dublin)	Joint learning mission to east coast England, Scotland and Jutland
	Other sectors	Joint Research and Innovation Transport and Logistics Centre	

Strategic levers of sectoral change

The seven levers of sectoral development are:

1. Building shared visions and pathways through sectoral development frameworks.
2. Using collaborative clustering as a tool for sectoral growth.
3. Shaping technology competencies for key sectors.
4. Embedding higher and further education in key sectoral clusters.
5. Leveraging the regional structure and experience.
6. Specifying indicative sector-specific investment priorities.
7. Nurturing an innovative and inclusive economic system at all levels for a world-class general business environment.

Conclusion

The conclusions in this reflection are offered for intensive consultations with key stakeholders at all levels and as a basis for accelerating growth within the two jurisdictions and four regions throughout the island. As one sectoral report put it so well, "if the various actors in the ... sector were connected better, the sector could be world-class, a force to be reckoned with ... there is a need for greater joined-upness here."[7] There is a range and complexity of stakeholders and a multiplicity of objectives, priorities and constraints, as well as the realities of different cross-border needs and powers, that must be understood and addressed.

The prizes in exploring opportunities for synergies, resilience and mutual benefit that is of 'joined-upness' are:

a) Sectoral clusters with higher performance, productivity and incomes; and

b) Greater global recognition of the deep sectoral capabilities on the island of Ireland.

As was once said in a somewhat different context: "Laat ambitie brand uw verstand" ("Let ambition fire thy mind")!

Part 1

Context and approach

1. Introduction

Developing specific sectoral capabilities and experience is vital to building a regional economy as the seedbed for and embodiment of various business structures leading to higher productivity, employment and incomes. This reflection develops an all-island framework and suggests some key alignments. The perspective and framework can be useful for setting priorities for investments at regional, sectoral, department, agency, HEI/FET, jurisdiction and all-island cross-border levels. Key steps in the reflection are:

- Chapter 2 examines concepts of GVCs/networks and spatial sectoral clusters, related issues of cluster mapping HEI/cluster engagement, strengthening international linkages, and so on.
- Chapter 3 outlines the approach of:
    a) Using a range of information to classify activities into NACE/SIC categories and NUTS 2 region categories;
    b) Examining various analyses of clustering on the island, government-led consultation on sectoral opportunities and constraints at regional level, international academic subject rankings, listings of various research and innovation centres, etc., and lists of clusters; and
    c) Assessing both presence, potential and priority of various clusters, and their research and innovation capability, and then developing a process of cluster prioritising.
- Chapters 4, 5, 6, and 7 look at each of the four regions on the island for sectoral assessment, sectoral ambition, HEI/FET cluster links and investment indicative priorities to drive progression.
- Chapter 8 combines the four regional analyses into an all-island synthesis and looks at the potential for step-change in clusters' performance and for building further island-wide and overseas linkages.
- Chapter 9 considers the policy actions for key strategic levers (sectoral planning, collaborative clustering, shaping technology for key sectors, HEI/FET focuses, leveraging regional structure, putting elements of an innovative and inclusive economy in place, and specifying investment priorities).
- Chapter 10 outlines some possible steps to progress discussions and this reflection.

The reflection begins in the Northern and Western Region (NWR - ROI), where our work and contribution are rooted, widening it to adjacent and neighbouring Northern Ireland (NI - UK), and then taking in the Eastern and Midland Region (EMR - ROI) and – closest to the rest of Europe – the Southern Region (SR - ROI). A feature of this island of Ireland upon which we all live and work is a shared international border between two jurisdictions (in common with 30% of the people who live and work in border regions in the European Union).

2.1 The concepts of Global Value Chain and regional sectoral clustering

Statistical coding of companies into sectors (NACE/SIC)

Individuals and companies can be classified into sectors based on common end-users or processes. Standards for classifying and comparing such groups of companies and sectors include NACE[8] (Figure 5), used in the EU, and SIC,[9] used in the UK, and are the main international statistical classifications for measuring and comparing sectoral data.

Figure 5: Sector categories and codes (NACE, ROI)

MANUFACTURING +		CONSTRUCTION +	RETAIL / WHOLESALE+ TRANSPORT	ACCOMMODATION + FOOD SERVICE	SERVICES (PRIVATE, NON-FINANCIAL)
B MINING 5k C **MANUFACTURING 239k**		D ELECTRICITY 10k E WATER 11k F **CONSTRUCTION 158k**	G **RETAIL WHSALE 390k** H **TRANSPORT 109k**	I **ACCOMMODATION AND FOOD SERVICE 223k**	J **INFOR+ COMM 119k** L REAL ESTATE 33k M **PROF/TECH 171k** N **ADMIN SERV 167k**
C10 FOOD PRODUCTS 52k C101 MEAT 22k C102 FISH 2k C105 DAIRY 9K C108 OTHER FOODS 8k (C11 BEVERAGES)	C24 BASIC METAL 4k C25 FAB. METAL 17k C26 COMPUTER 15k C27 ELECTRICAL 5k C28 MACH EQUIP 10k	F41 CONSTRUCTION OF BUILDINGS 43k F42 CIVIL ENG. 11k F43 SPECIALISED CONSTRUCTION 106k	G45 TRADE MOTOR 39k G46 WHSALE 114k G47 RETAIL 238k	I55 ACCOMMOD. 72k I56 FOOD SERVICES 151k	(J58 PUBLISHING) J59 MOTION PICT/TV/VIDEO 9k J61 TELECOMMS ? J62 COMP. PROG 68k J63 INFOR SERVICES 4K
C16 WOOD PRODS 6k C17 PAPER PRODS 3k C18 PRINTING 6k C22 RUBBER/PLASTIC 10k C23 OTHER NON METALIC MINERAL PRDS 10k C31 FURNITURE PRS 5k	C29 MOTORVECH 4k C33 REPAIRSMEQ 3k		H49 LAND TRANS 59k H51 AIR TRANSPORT H52 WAREH 19k		M69 LEGAL/ACC. 53k M70 MAN. CONS. 43k M71 ARCH/ENG. 36k
C20 CHEMICAL PRODS 7k C21 PHARMA PRODS 15k (C32 OTHER MAN) C325 MEDICAL DEVICES 23k					(N82 BUSINESS SUPPORTS) N822 CALL CENTRE 9k

Note: NACE and SIC codes at the level examined are the same numbers, e.g. Food products are NACE C10 and SIC C10.

GVCs/networks

Companies transforming inputs into outputs as goods and services and trading and exchanging such outputs are all part of GVCs/networks, with end-users, intermediaries, suppliers of inputs, facilitators and other network participants (Figure 6).

Figure 6: Business value chain/network

Design & R&D	Production	Marketing	Distribution & logistics	Final customer

Note: Adapted from OECD (2013)(a)

> *World trade and production are increasingly structured around 'global value chains' (GVCs). A value chain can be simply defined as the 'full range of activities that firms and workers do to bring a product from its conception to its end use and beyond'.... Typically, a value chain includes the following activities: design, production, marketing, distribution and support to the final consumer. These activities can be performed within the same firm or divided among different firms. The fact that they are increasingly spread over several countries explains why the value chain is regarded as 'global'.*[10]

Regional spatial sectoral clusters

The idea of sectoral clusters is related to the concept of value chains/networks but different**.** Companies will always participate in a value chain/network of trading and exchanging. They participate in global value chains if their inputs or outputs cross international borders. In a small open economy, such as Ireland's, many, if not most, firms (other than enterprises in personal services and related sectors) are involved in GVCs.

In some way, all companies will be located in one or more places, even if linked virtually to other parts of the business and other participants in the value chain. However, not all firms are located alongside other firms in similar or related businesses and are not part of a regional sectoral cluster. They may be co-located with other businesses in various sectors or not close spatially at all. Porter defines such clusters as:

> *... geographic concentrations of interconnected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure. Clusters also often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies, or common inputs. Finally, many clusters include governmental and other institutions — such as universities, standards-setting agencies, think tanks, vocational training providers, and trade associations — that provide specialized training, education, information, research, and technical support.*[11]

Sectoral clusters: Various meanings

Sectoral clustering needs to be defined as it is understood and spoken of in different ways:-

- **Concentration:** Spatial grouping of companies within a GVC, with no connections between individual companies (other than maybe directly as buyers or sellers).
- **Conglomeration:** A group of companies with few close connections between each other and serviced by a range of sector-specific bodies in education, standards, services, etc., and may work together in representing the group's collective needs.
- **Collaboration:** A subset of such companies who closely interact and collaborate on marketing, purchasing, training, strategy thinking, etc.; such clustering may be informal or formal, with a sectoral clustering body, etc.

Such groupings can be valuable levers to grow output, employment, productivity and incomes, warranting public encouragement, guidance/direction and investment.

Underpinning all this is the depth of skills and experience in particular domains and technologies (end-users, processes), alongside more generic business development skills, trust-building communication, team-building, etc. Such capabilities drive business start-ups, growth, scaling, innovation and development, and so productivity and income per person in the region. Such clusters' spread and development can be critical to economic growth.

2.2 Identifying and mapping regional sectoral clusters

Individual firms have always operated within various sectoral GVCs - selling to customers/end-users and buying from suppliers/enablers. They are often gathered together in geographic locations as clusters, which can either be beneficial in sharing specialised resources and capabilities or costly in terms of being inward-looking in their group thinking and competition for limited resources, e.g. land and facilities.

Such clustering has been identified as far back as Marshall (1890) and others, with Porter (1990) being the seminal thinker on clustering in the latter decades. Over the past decade, more systematic and shared definitions and analysis for cluster mapping and performance have occurred in the USA and the EU.

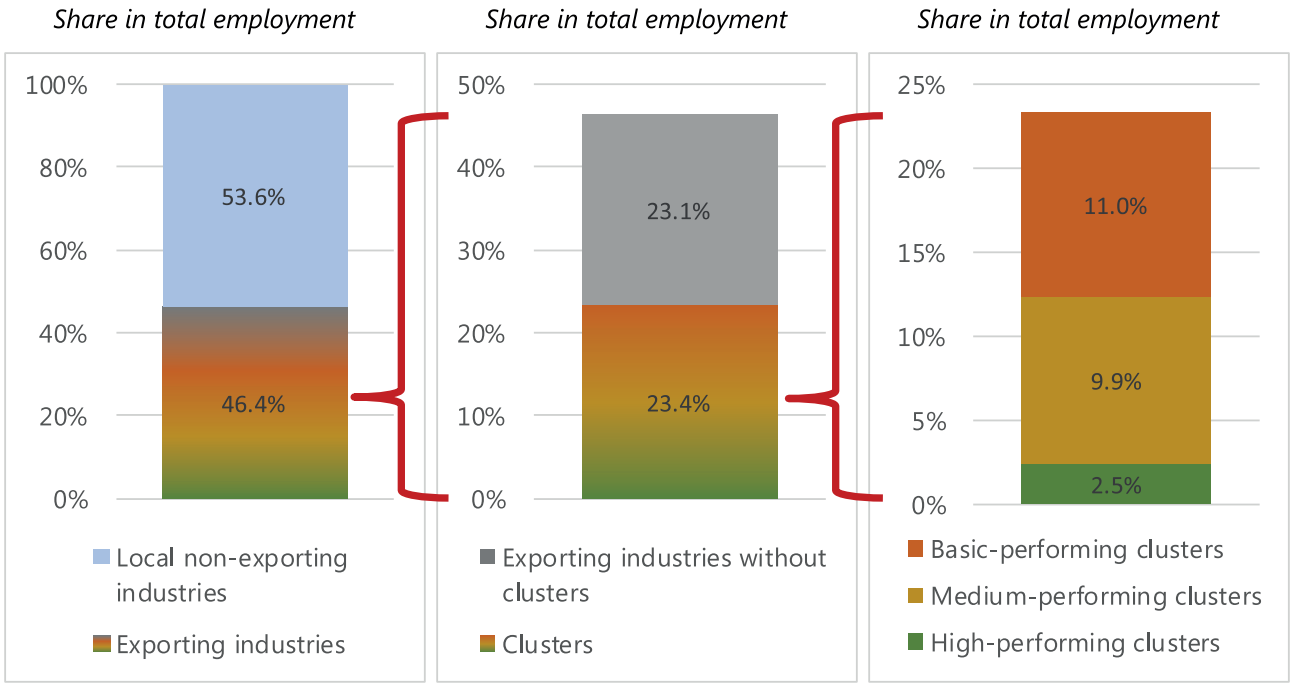
The European Commission's EOCIC initiative has evolved and applied this approach to wider Europe. The *European Panorama of Clusters and Industrial Change* (2020 edition) uses a cluster five-star methodology with 2015/17 data in measuring cluster strengths in size, specialisation and productivity, the presence of high-growth SMEs and the presence of innovation leaders across 51 trading/exporting industry sectors.

It identifies 2,950 regional industrial clusters, accounting for 23% of all European employment and 50% of exporting employment (see Figures 7, 8, 9 and 10). Of those clusters:

- 198 rank as high-performers
- 898 rank as medium-performers
- 1,854 rank as basic-performers

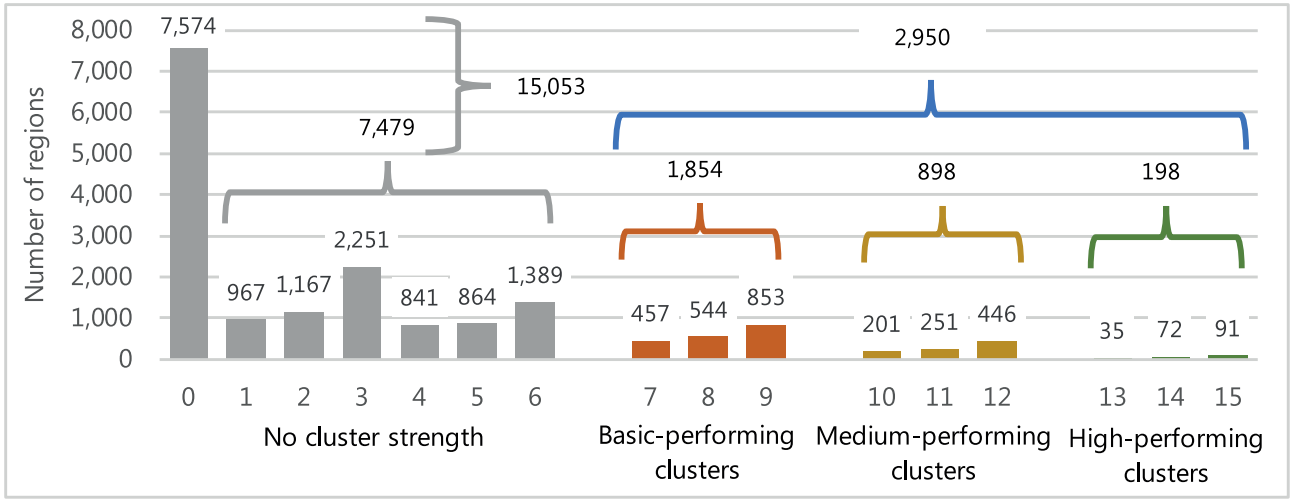
"Productivity in clusters is much higher than average productivity, corresponding to a 25% above average productivity effect."(p.6) It also identifies emerging industries based on close linkages between various sectoral clusters.

Figure 7: Employment Shares (2017): Exporting industries and clusters



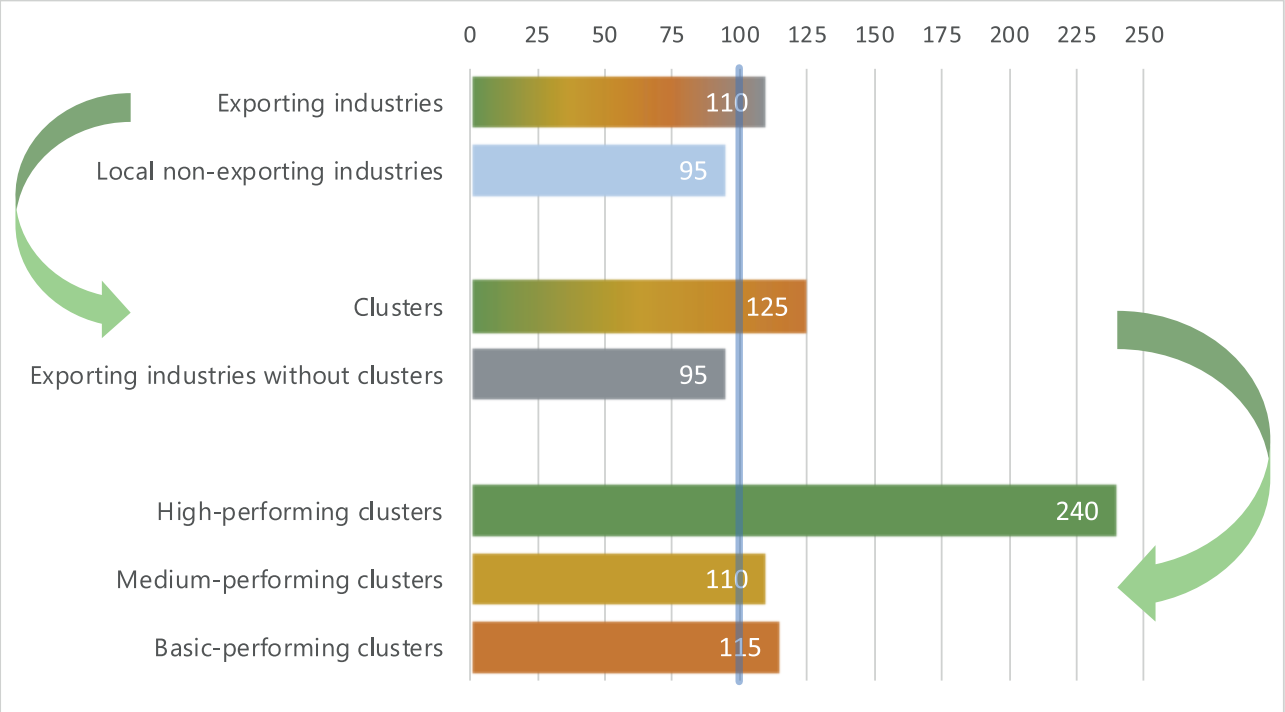
Source: EOCIC (2020) p.14

Figure 8: Strong clusters defined



Source: EOCIC (2020) p.13

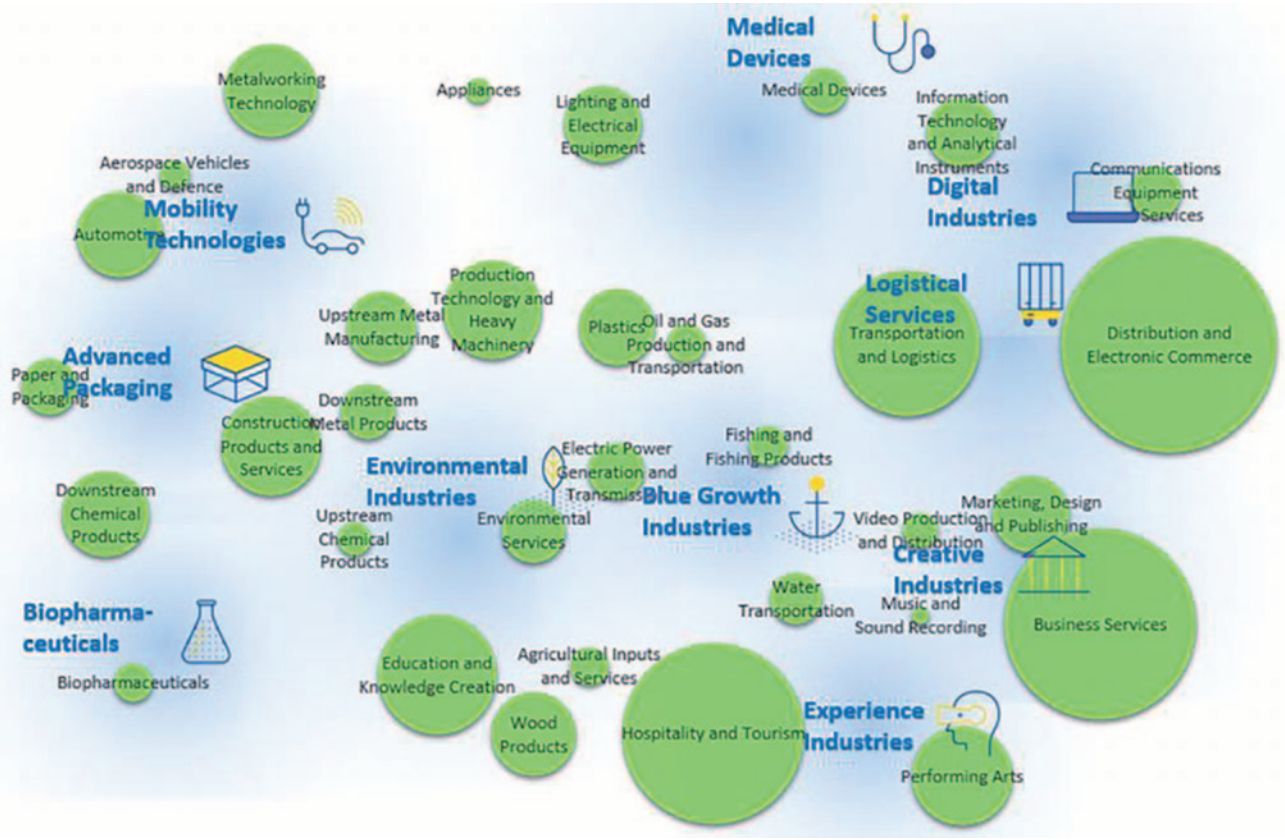
Figure 9: Strong clusters are more productive



Note: Index scores relative to average productivity for all industries (traded and non-traded). The blue line shows average industrial productivity (100%).

Source: EOCIC (2020) p.15

Figure 10: Linkages between emerging industries and sectoral industries



Source: EOCIC (2020) p.35

In their analysis of the "significant advances over recent years in the measurement of clusters" as applied to the USA and Europe, Ketels and Protsiv (2021) conclude that:

> *... regional prosperity is positively and significantly associated with our measure of cluster portfolio strength [even] when accounting for business environment quality. Clusters exist at all stages of economic development, and the specialization in strong clusters is helping locations at all levels of business environment quality to support higher levels of prosperity.*
>
> *... what you export is less important than how well you do in whatever you export.*[12]

2.3 The discussion on sectoral clustering on the island of Ireland

Policy evolution

Sectoral development and planning has been a longstanding tradition on the island of Ireland, going back to the 1840s (Kane's study of Irelands' natural resources.[13]) In the Republic of Ireland, the 1960s Committees on Industrial Opportunities and Progress (CIO and CIP, respectively) and the 1980s/1990s Sectoral Development Committees of the social partnership process all involved comprehensive reviews and widespread participation. The Culliton (1992) Report spurred interest in sectoral clusters as an economic development tool. Later, department-led partnerships developed whole-sector strategies for the food industry and financial services. Similarly, relevant departments and Invest NI focused on key sectoral opportunities in Northern Ireland. Also, the representative industry associations (IBEC, CBI NI, NI Chamber, Chambers Ireland, etc.) have often taken on a sectoral development role and been active with stakeholders at that level (e.g. IMDA (MedTech), NI Manufacturing, etc.).

The recent adoption of sectoral specialisation strategies by DfE and DETE, especially in the context of EU and UK policy frameworks, opens up a new phase of sectoral development and planning on the island. DfE's *10X Economy*, in particular, has become central to policy in Northern Ireland and is referred to as the overarching framework by a range of individual sectoral strategies. DETE's *S3 for Innovation* is heading in that direction also.

Sectoral planning and policy has been much less developed at regional and local level, and the evolution of regional spatial planning has had little reference to sectoral development. The regional enterprise plans of DETE and the regional skills fora of DFHERIS have considerably strengthened the regional perspective and participation. The creation of the regional assemblies in the Republic (with Regional Spatial and Economic Strategies (RSES) and new regional funds available) and the local district councils in Northern Ireland (with the City and Growth Deals) have stimulated stronger interest in regional sectoral development.

There has also been recent support for collaborative clustering between firms working on joint projects and with other stakeholders. In Northern Ireland, Invest NI launched its Collaborative Growth Programme in 2009, which has been operational for over a decade. Enterprise Ireland organised competitive funding pilot schemes for clustering in 2012 and 2018 and the Regional Technology Cluster Fund (RTCF) (for Technology Universities and Institutes of Technology) in 2019.

The creation of InterTradeIreland (ITI) in 1999 led to a strong focus on sectoral clustering at all levels, with the first analysis and mapping of all-island sectoral clusters (ITI, 2015) and

encouragement of the Cluster Centre[14] and the Cluster Research Network (CRN) through its new Synergy Programme.

The CRN, in its *Clustering on the Island of Ireland: A Gap Analysis* (2022), based on a series of workshops with over 100 stakeholders and practitioners in Autumn 2021 supported by ITI, reflected on the experience of the past few decades.

> *On the island of Ireland the idea of clusters becoming a practical policy tool has been slower to gain traction among policy makers than in other advanced economies. The idea was first raised in the Culliton Report (1992) in Ireland and later in Michael Best's 'Innovation and Capabilities' work in Northern Ireland (1999), but scepticism about its application or benefits to the island economy have meant that interventions to assist the development of clusters have been much slower to become mainstreamed as enterprise supports or a key plank of policy. .... A consequence of these doubts has been an ad-hoc approach, both North and South, to embed a culture of clustering, collaboration and coopetition and, in turn, a difficulty in communicating the benefits of a clustering approach to SMEs, universities, local authorities, MNCs and other actors.* (pp.7-8)

Similarly, Doyle and van Egeraat (2018) reflected on the clustering policy experience of the past 30 years.

> *To characterise historical policy development from a cluster perspective, a number of features can be identified. The concept gained some acceptance in policy, but lacks an agreed, consistent or clear definition. Coherence across policy documents is lacking. Networking appears as a preferred operationalisation but implementation has been episodic, at best. Clustering to date has not been applied with its cross-cutting potential, in regional, sectoral or ownership (MNC/indigenous) terms, although recent initiatives are encouraging.*[15]
>
> *Successful industrial cluster policy clearly requires a coordinated and integrated approach involving all relevant government departments and related agencies. .... For industrial policy this means that policymaking should focus on substantial concentrations, incorporating sizeable numbers of firms and workers taking cognisance of network effects.*

They argue, in particular, that sectoral clustering at regional levels is only available for a small number of city regions:

> *... we assert that, in a small country like Ireland, national-level cluster policies will support industrial development and, depending on the industry and activities involved, can benefit many areas, including areas outside the main city-regions. Locally or regionally focused cluster policies and actions are probably suitable for a more limited set of locations – locations that house substantial concentrations of firms, particularly firms involved in research and advanced production activities.*

Hetherington, G., Magennis, E. and Victor, K. (2019), in a review of Cluster Policy in Northern Ireland, concluded that: "More than 80% of the businesses consulted collaborated with other partners, with a focus on business activities such as innovation, purchasing, pooling of skills, etc." (p.5), mostly with customers, to some extent with suppliers and a much lesser extent with competitors or related industries. Firms also collaborated with locally based Higher Education

Institutions (HEIs) for skill development rather than research and innovation. They point to building trust and buy-in as crucial and make a range of recommendations, especially around the role and resourcing of Cluster Management Organisations (CMOs) as central to cluster development.

In overall conclusion, as Bradley (2001) puts it, having reviewed several development frameworks:

> *For small countries like Ireland, sectoral clustering, with its accompanying agglomeration effects, are crucial in generating sustained growth. One can define an industrial cluster as a group of industrial segments that share positive vertical and horizontal linkages.*[16]

Analysis and research evidence

Porter's thinking strongly influenced Ireland's Industrial Policy Group (Culliton) Report (1992). It advocated sectoral clustering as an important objective of industrial policy, leading to a range of studies that examined the presence and potential for clustering in Ireland, as Doyle and Fanning (2007) later summarise.

An initial analysis (O'Donnellan (1994)) concluded that there was a low level of sectoral clustering in Ireland, with only the food, wood and printing sectors appearing as spatially clustered but with little association with various aspects of industrial performance. The conclusion was that small firms might benefit from being part of a spatial cluster, "but at a size of cluster that is considerably bigger than what is generally possible in the Irish Republic."[17] While sector-specific support could be helpful for some emerging clusters at the local/regional level, the policy should focus on building national and international linkages.

As summarised by Doyle and Fanning (2007),[18] during the mid-1990s, the National Economic and Social Council (NESC) commissioned a series of 'diamond' analyses of individual sectors,[19] which yielded limited evidence of clusters and the absence of a clear competitive advantage. O'Malley and van Egeraat (2000) assessed clustering activity in Irish indigenous industries in general and concluded there was little evidence of clusters. Gallagher, Doyle and O'Leary (2002) carried out a diamond analysis of business or micro-foundations of Irish competitiveness and concluded that a "cluster [was] emerging in software, electronics and telecoms equipment industries [and a] weak cluster in indigenous meat and dairy industries."[20] (p.276)

At the time, examining clustering in three successful clusters (ICT software, ICT hardware and pharmaceuticals), Cassidy, Barry and van Egeraat (2009) concluded: *"MNE presence as well as government FDI-orientated strategy with strong regional and environmental planning objectives proved to be the crucial ingredients of cluster development in Ireland, which is at variance to Porter's concept of cluster dynamics."*[21]

O'Connor, Doyle, and Brosnan (2017) reviewed the clustering literature in Ireland, including a life-cycle approach to the analysis of cluster development dynamics, the European Commission's early version of the new systemic approach to cluster analysis in Europe, and their detailed statistical analysis of the trading sectors in the Republic (35% of employment in 2012). As a result, they conclude that:

> *For Ireland, a number of successful clusters can be identified that have established substantial international positions and are thus well beyond the emergent phase. Cluster emergence in Ireland is linked unequivocally to multinational subsidiary activities."*[22]

They looked at the regional concentration of globally competitive sectors and analysed the NUTS 3 regions' change in regional average wages (2008–12). They apportioned the shift into a wage level effect and a cluster mix effect.[23] They:

> *observed a duality in the results with Dublin, Mid-east, Mid-west and South-west regions displaying both positive mix and level effects … The four other regions exhibited both negative mix and level effects. The level effect represented 39% on average of the variation in average wages across regions and 61% for the cluster mix effect.*
>
> *The stark pattern evident in the two sets of regions points to quite different features at work within similar clusters and of relevance for regional outcomes. …* ***A substantial portion of Irish regional wage variation relates to the cluster mix within regions.*** *[emphasis added].*
>
> *Initiatives focusing on regional economic development require complex programmes that address the more significant issue of how to target transformation from less to more desirable clusters to generate higher wages, and regional prosperity. Such programmes also, although less significantly, require targets to upgrade activities (to increase wages) in those clusters where the regions hold concentrated positions.* (p.277)

This conclusion of O'Connor et al. (2017) – that sector cluster mix matters – differs significantly from that of Ketils and Protsiv (2021), who concluded that sector mix did not matter as an independent variable/driver of regional incomes. Regardless of the broader European conclusion, the data analysis of Babel[24] for the Southern Region in the Republic – which shows a significant difference in sector mix and their technology levels between the three NUTS 2 regions in ROI – has to suggest that such sector mix is a factor in the differences between regional incomes. Such results imply that policy to upgrade the composition of sectors should be an instrument of regional development or, at least, should not be ruled out at this stage. This approach is confirmed by van Egeraat et al. (2023)'s conclusion that "it is the sectoral mix, per se, more than the nationality mix which has the main impact on regional growth performance."[25] (Appendix 3)

2.4 The importance of global linkages for value chain and innovation

The role of international linkages as critical to company and sectoral development within Ireland – and the role of clusters in facilitating such linkages – has been long stressed.

> *Fourth, and most important, Porter's clustering is essentially a mechanism for transmitting market and related information and stimuli faster than otherwise would be the case. In Ireland's case, one major implication of clustering is that 'bridges' to the major international clusters need to be strengthened, over which specific information on market needs, technologies, etc. is rapidly passed onto, and absorbed by, Irish-based firms.* (O'Donnellan 1994)(p.231)

This viewpoint has been reinforced and emphasised by O'Connor et al. (2017):

> *The necessity to connect internationally in supply terms to MNC partners and headquarters, and in demand terms with market networks, counteracts the potential for local absorptive capacity to deteriorate when faced with cluster participants when these are envisaged as operating only in the direct cluster locality.* (p.278)

This is also the implication of the V-LINC mapping of linkages results for the Cork ICT cluster (Byrne, E., Doyle, E. and Hobbs, J. (2021)).

> *Impact measures support the view that superior knowledge originates from beyond the home region as 85% of linkages outside Ireland fall into the high and medium category. Supports for developing additional non-national linkages appear appropriate in this context.* (p.21)

Interestingly, two sectoral studies that look specifically at all-island linkages suggest a pick-and-choose approach to all-island collaboration driven by particular company interests.

A 2020 survey of cyber security shows strong company interest in both jurisdictions in opportunities for collaboration in the form of networking and conferences. It also showed that while 73% of ROI respondents were interested in study visits to NI, only 10% of NI respondents were interested in study visits to ROI, reflecting *" … a difficulty of the current research landscape … [in ROI] … [Overall,] it is obvious … from the reports … that several shared issues are of great importance to members of Cyber Ireland and NI Cyber."*[26] (p.46)

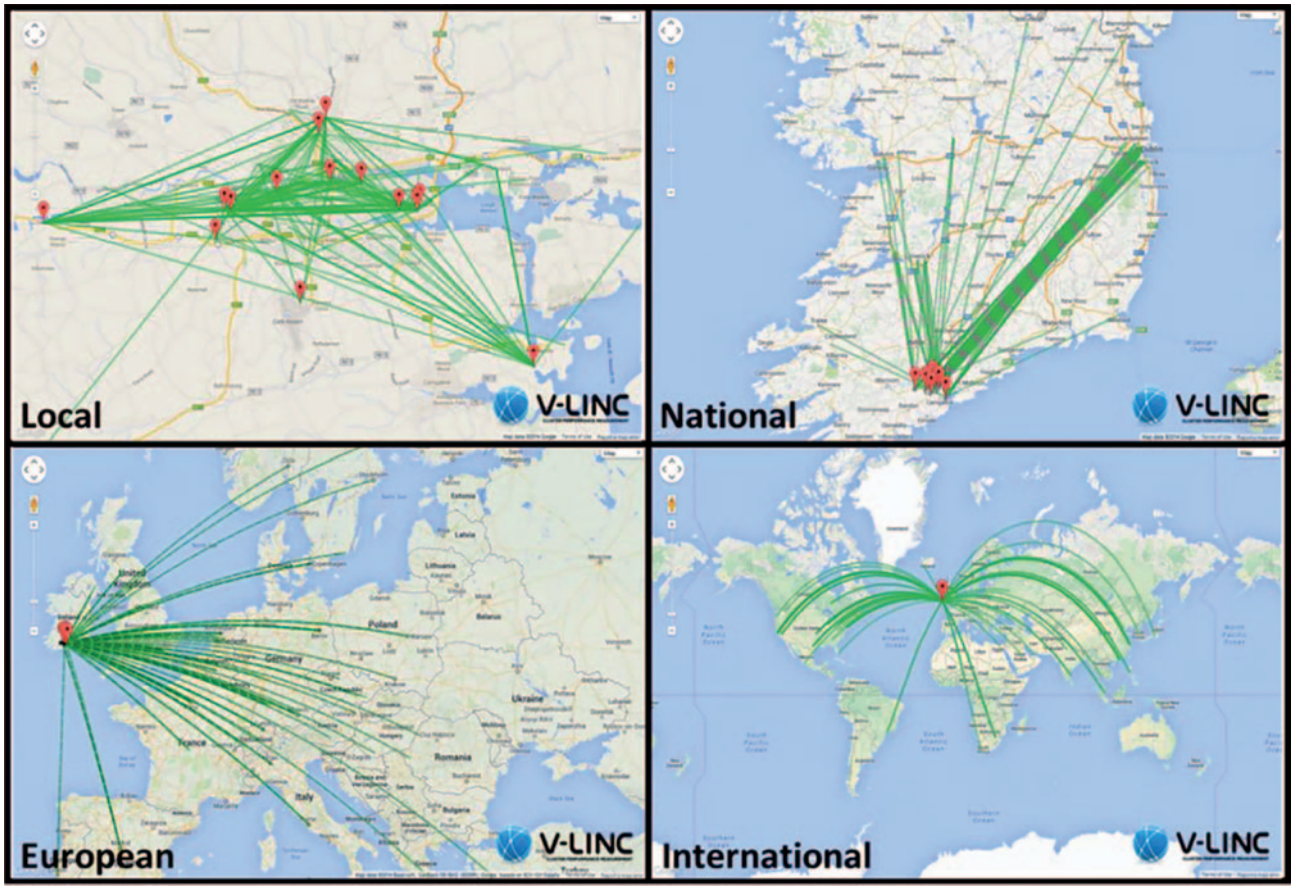
A 2019 survey of 75 companies in three sectors (materials handling, high-tech creatives and immersive technology) concludes that a majority of firms collaborate with customers and, to a lesser extent, their suppliers (which are often located outside of NI), and to a lesser extent with competitors or related industries.

> *Interestingly, the all-island economy is much less present when it comes to collaboration. A small number of consultees – usually successful and keen to gain access to scaled-up businesses – are collaborating on a cross-border basis, notably in animation and gaming, but this is not the norm.*[27] (p.6)

Overall, the consultations reflect a point in time where "firms across the three sectors are still working out not only who to collaborate with, but also to what end." (p.5)

More generally, mapping the linkages within a cluster and with other clusters and locations has been the focus of the work of MTU's V-LINC research group using a specially designed methodology and associated software to map, analyse and evaluate linkages and relationships between different actors within industry clusters and networks to inform policy, develop targeted initiatives and strengthen regional competitiveness. They envisage linkages at local, national, European and international levels. The detail of the survey feedback indicates what types of cluster linkages are present and enable stakeholders to strengthen key features of the cluster (Figure 11). "V-LINC maps reveal which types of intra-regional and extra-regional linkages generate greatest *impact*, given their frequency."[28]

Figure 11: V-LINC cluster mapping: Cork ICT cluster



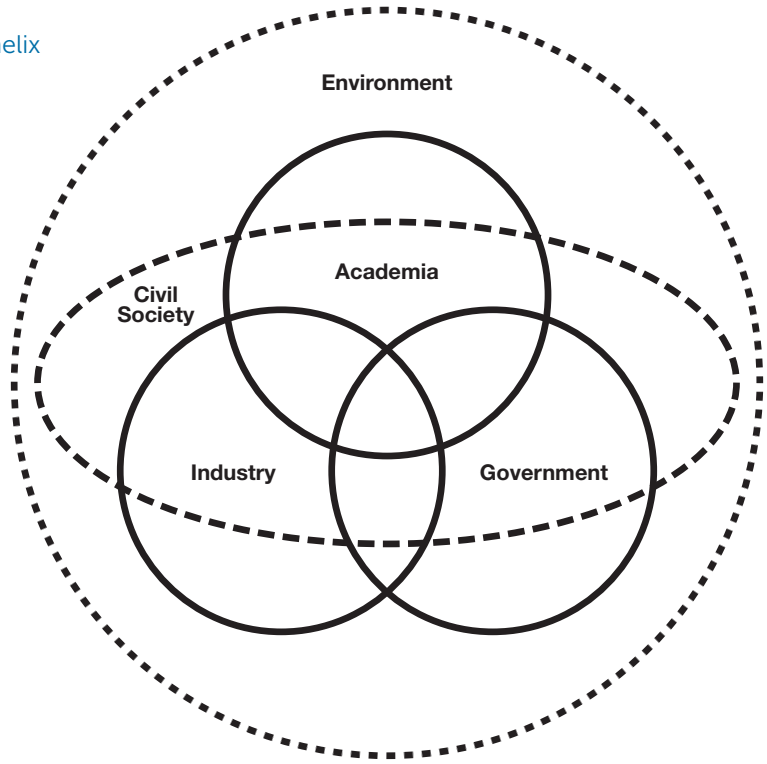
Source: Byrne, E., Doyle, E. and Hobbs, J. (2021)

2.5 The role of higher and further education in sectoral development

HEIs and the quadruple/quintuple helix

The role of HEIs in developing clusters is generally seen as important, if not critical. The quadruple helix of Goddard and Vallance (2013) and others is seen as a framework for identifying key players of companies/industry, government/agencies, HEIs/FETs/other skill developers, and civil society (local communities, development groups, etc.). Adding the environment as a critical factor brings the helix to a quintuple (Figure 12).

Figure 12: Quintuple helix



Source: Wikipedia

MIT's local innovation system (LIS) and higher education institutions (HEIs)

The Massachusetts Institute of Technology (MIT) Industrial Performance Center (IPC) has developed a more specific framework based on a series of international case studies of HEIs and how they interacted with the sectors in their region (Figure 13). This 'outside-in' approach suggested that HEIs adapt and respond to the sectors in their region in ways that vary depending on the sector's development stage (Figure 14). Such sectoral clusters can be categorised as 'established' (undergoing 'conversions' and 'transformations') or 'emerging' (being 'created' or being 'transplants' from outside the region). The HEIs' menu of teaching, research and engagement responses needs to vary by the stage of development within the region of the sector.

> *A key finding is that the university role in local innovation processes depends on what kind of industrial transformation is occurring in the local economy. New industry formation, industry transplantation, industry diversification, and industry upgrading are each associated with a different pattern of technology take-up and with a different set of university contributions.*[29] (p.4)

Overall, ensuring that the HEIs (and FETs) are both aligned and leading the 'quadruple/ quintuple helix' of business, government, community, education and environment in terms of sectoral prioritisation is critical to dynamic economic development at regional, jurisdictional and all-island levels.

Figure 13: University roles in alternative regional innovation

Create new industries	Transplant Industry	Diversify old into related new industry	Upgrade mature industry
Forefront science and engineering research Aggressive technology licencing policies Promote / Assist entrepreneurial businesses (incubator services etc.) Cultivate ties between academic researchers and local entrepreneurs Creating an industry identity: • Participate in standard-setting • Evangelising • Convene conference workshops, entrepreneurs forums etc.	Education / skill development Responsive curricula Technical assistance for sub-contractors, suppliers	Bridging between disconnected actors Filling 'structural holes' Creating an industry identify	Problem-solving for industry through contract research, faculty consulting etc. Education / skill development Global best practice scanning Convening foresight exercises Convening user-supplier forums

Source: Adapted from MIT LIS 2005

Examples of HEIs in Ireland responding to the industries in their region according to the MIT/LIS typology of companies and sectors in their region include:

- **Creating** industries new to their region (e.g. Trinity and computer/software industry 1990s, WIT/SETU and telecoms)
- **Transplanting** industries to region and helping to embed (e.g. University of Galway and MedTech industry)
- **Converting** industry to adjacent sectors (e.g. DCU and software to cloud, Teagasc and monoculture farming to biodiversity)
- **Transforming** mature industries to become more innovative and productive (e.g. UCD and UCC and farming/food industries, ATU and engineering).

Figure 14: HEIs responses vary by stage/type of region's sectors (MIT LIS)

	Create	Transplant	Convert	Transform
Education and Training				
• Under / Post Grad	X	XX	X	XX
• Employee Education		X	XX	XX
• Staff training			XX	XX
• Executive Education			XX	XX
• Industry / other feedback on curricula needs		X	X	X
Research				
• Publications, patents, etc.	X		X	X
• Licensing	XX		X	X
• Contract			XX	XX
• Co-operative / placement	X	X	XX	XX
Engagement				
• Consulting, problemsolving	X		XX	XX
• Access to equipment, space	X	X	X	X
• Venture mentoring, incubators	XX			
• Public spaces and networks (industry identity, forums, foresight, strategy, finance, alumni, connections)	X	X	XX	XX

Source: O'Donnellan (2022)(b)

Best's capability triad

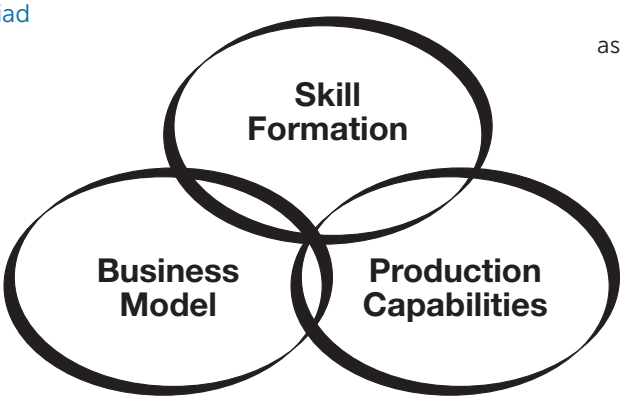
Michael Best's[30] (2018) capability triad of business model, production capability and skill formation integrates key elements of an economy, entering what Porter (1990) calls the 'innovation phase' of development (which succeeds the factor, costs and investment phases).

Bradley (2001) describes the three elements of the capability triad[31] (Figure 15):

> *Best's capability triad is based on the interaction of three core elements: a business model, production capabilities and skill formation ... The business model element of the triad describes how entrepreneurial firms grow, based on the creation of new firms through technology diversification, inter-firm networks based on open systems and regional specialisation based on technological capabilities.*
>
> *The production capabilities element of the triad integrates ideas from operations management and operations strategy into a logical system of production system models that drive home the lesson that competitive strategy and productive systems are bound together. The skill formation element of the triad, in addition to providing a vital direct input into production is what serves to enhance the synergistic interaction of the first two elements: the business model and production capabilities.*

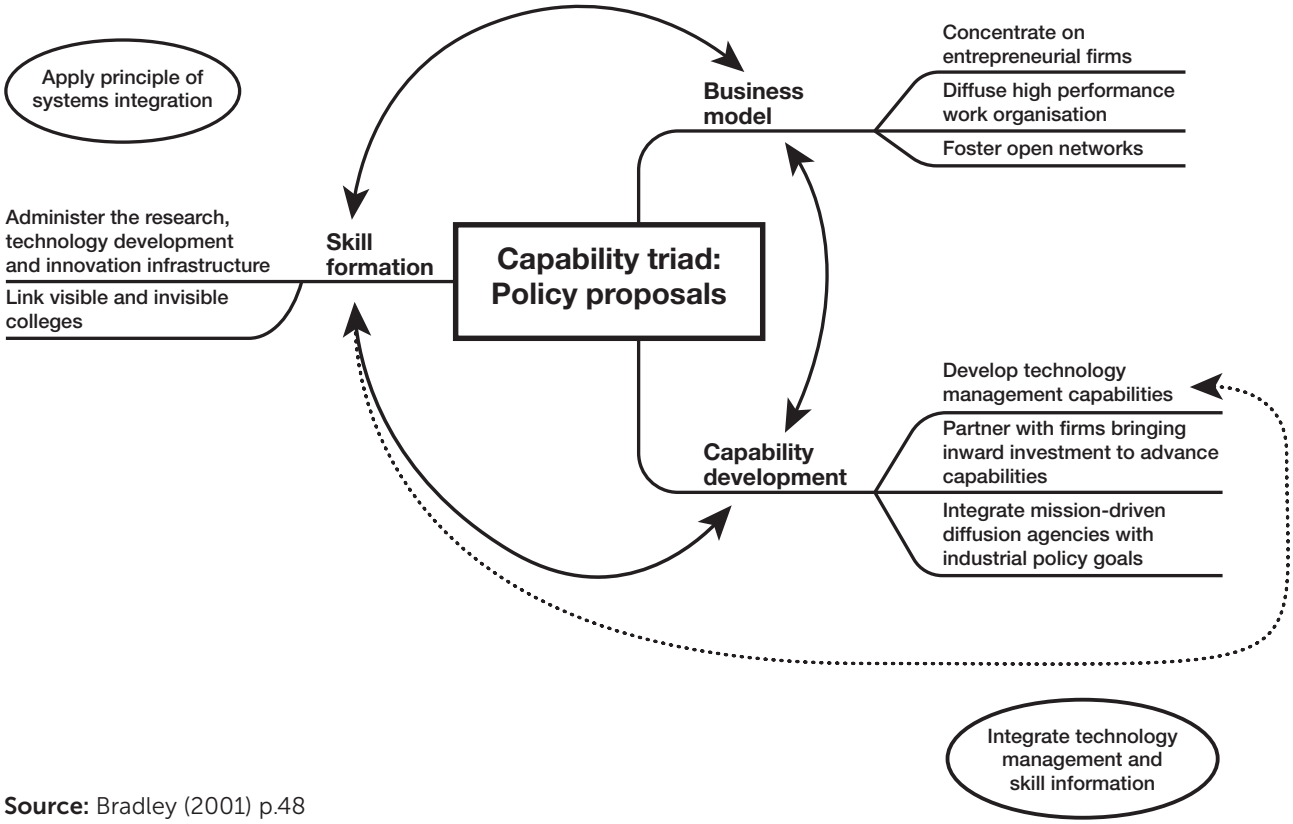
Figure 15: Best's capability triad

Source: From Best (2000) as quoted by Bradley (2001) p.46



There are major policy implications and potential proposals of the capability triad framework as outlined by Bradley (2001) (Figure 16).

Figure 16: Policy proposals linked to the capability triad



Source: Bradley (2001) p.48

> *In order to advance the debate on industrial policy in Ireland, it may be useful to map the essential elements of any policy analysis and recommendations into Best's capability triad framework. Many benefits would flow from such a mapping. The completeness and closure of the strategy would be easier to check. The nature of the required accommodating fiscal, monetary, social and other policies would become more transparent and provide a logical framework for dialogue and debate.*[32]

Overall, Bradley (2012) points to the key challenge facing policy-makers in general and the HEIs' engagement strategies in particular:

> *A daunting aspect of the capability triad is that it treats the scope for public policy as being almost completely and seamlessly blended into the detailed mechanics of change processes that occur within private firms. In this framework, as well as in Porter's diamond, public policy and private entrepreneurial actions do not operate in isolation from each other but need to become mutually reinforcing. … the links between public and private activity are crucial.*[33]

2.6 The policy development of smart specialisation and sectoral clustering

The European Commission has endorsed Smart Specialisation Strategies as a central way to develop regions across Europe.[34] Requirements for a Smart Specialisation Strategy 2021-2027[35] are:

- Up-to-date analysis of bottlenecks for innovation diffusion, including digitalisation.
- Existence of a competent regional/national institution or body responsible for managing the smart specialisation strategy.
- Monitoring and evaluation tools to measure the performance of the objectives of the strategy.
- Functioning of stakeholder co-operation (Entrepreneurial Discovery Process (EDP)).
- Where relevant, actions necessary to improve national or regional research and innovation systems.
- Where relevant, actions to manage industrial transition.

Similarly, in the UK, both the Conservative Government's *Levelling up the United Kingdom* (2022) and the Labour Party's *New Britain* (2022) stress the importance of sectoral clustering as central to regional development and balance. In the ROI, the DBEI's *National Smart Specialisation Strategy for Innovation 2022-2027* involved an inclusive process at national and regional levels to assess sectoral strengths, clustering and potential.

> *The sectoral strengths identified in* [the] *strategy were ascertained from the following sources:*
>
> - *An assessment of IDA Ireland companies in the regions;*
> - *An assessment of Enterprise Ireland investment in the regions;*
> - *An assessment of RD&I resources, including SFI Research Centres, Enterprise Ireland Technology Gateways, Enterprise Ireland and IDA Ireland Technology Centres, and National Institutes for Research and Development;*
> - *An assessment of current cluster activity in the regions;*
> - *CSO trade and employment statistics;*
> - *An analysis of sectoral strengths as identified in the RSESs;*
> - *The views of stakeholders arising from the consultations for the Regional Enterprise Plans;*
> - *The views of stakeholders arising from the consultations for the Smart Specialisation Strategy.*[36]

The policy dialogue has been influenced by substantial submissions on smart specialisation for their regions by the NWRA and the SR, which has also centrally influenced their RSESs. (The EMR appear not to have made such a submission specifically on smart specialisation, but its RSES also entails such thinking.)

Similarly, in Northern Ireland, one of the guiding principles of the DfE (2021) *10X Economy - Northern Ireland's Decade of Innovation* is "Focus on increasing innovation in high value-added areas and priority clusters resulting in higher wages"[37]. Its strategy has developed in an inclusive consultative way at various levels.

> *As a small advanced economy we need to focus on the parts of our economy where we already are or can be global leaders."[38] so that "the outcome of this vision will ultimately see Northern Ireland positioned amongst the elite small advanced economies in the world.[39] Today we are global leaders in cyber security, FinTech and advanced manufacturing.[40]*
>
> *Our five priority clusters ... relate to areas where we have seen the emergence of significant capability and capacity with the potential to drive the economy forward. These technologies and clusters will evolve and change, and policy must keep pace. Whilst these clusters may change ... our commitment to 'tightening an economic strategy from broad sectors to strong or emerging specialisations' will remain.[41]*
>
> *This document represents the first stage in setting out our long-term ambition for Northern Ireland. The vision will be a living document and will be updated and refined based upon emerging developments and arising opportunities.*

2.7 Conclusion on framework

The literature suggests that for regions to develop their overall and per capita incomes, they need to:

a) improve their general business environment;

b) improve the performance of individual clusters and related groups of clusters; and

c) shift activity to higher level income sectoral activities.

The goal of sectoral development is to widen and deepen the existing capabilities and experiences of the GVC/network on the island of Ireland. In doing so, a higher share and level of value-added can be obtained for the economy on the island of Ireland, its jurisdictions and regions, and so increase the incomes of its inhabitants (Figure 17).

Figure 17: Global sectoral business value chain/network: Widening & deepening presence

Policy instruments to develop sectors within a region include:

- **Developing existing companies in the region's existing sectors**
    - Providing financial and advisory support for developing new products, services and processes in current activity and adjacent areas; access to technology and market opportunities; related capability and skill development; building cluster networks within the region; doing study visits to specific clusters of best practice, etc. ***Transformation***
    - Changing their business model and target end-users and switching to new (for the region) sectors – again support for new products and related capability development. ***Conversion***
- **Creating or attracting enterprises that are new to the region in existing or new sectors**
    - Stimulating new companies in new sectors to emerge within the region, often from HEI research and developing a new (to the region) sector. ***Creation***
    - Attracting companies new to the region into existing or new sectors by promoting the region's opportunities, providing financial incentives and other supports, and accessing regional and local networks. ***Attraction***

Such company development and attraction/creation are underpinned by developing the region's business environment and infrastructure. Such development can be:

- Sector-specific, e.g. for research, innovation and skills; or
- General and can be physical/access (transport, broadband), financial capital, and human capital (skills, cluster groups, leadership capability, etc.).

To do so involves interacting with a range of quintile stakeholders – within and beyond the region – from industry/business enterprise, academia (HEIs and FETs), government bodies, civil society/communities and environmental stewards. Enterprise industry/business includes large corporates originating on the island of Ireland, large MNC plants/operations, medium-sized enterprises, small- and micro-enterprises, and the self-employed.

Building and focusing alliances within and between these groupings within each of the main sectors and at an overall level through development forums at the various levels is the real – and challenging – work of sectoral development.

In Ireland, several empirical studies have been related to sectoral development and clustering.

Concentration

- InterTrade Ireland (2015), Mapping the Potential for All-Island Sectoral Ecosystems
- European Commission (2020), European Panorama of Clusters and Industrial Change (with clusters identified for the island of Ireland and shown in Figure 18, and summarised in Table 1)
- Enterprise Research Centre (2013), Business Clusters Project 2013
- Van Egeraat, C., Morgenroth E., Kroes R., Curran, D., Gleeson, J. (2016) A measure for identifying substantial geographic concentrations

Conglomeration

- DBEI (ROI) (2022), National Smart Specialisation Strategy for Innovation 2022-2027
- Northern Ireland Government Department for the Economy (May 2021) The 10X Economy – An Economic Vision for a Decade of Innovation

Collaboration

- The Cluster Centre, an all-island network for clusters, cluster initiatives and policy-makers

Figure 18: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A – *"Cluster Strengths across 51 individual exporting industry sectors"*. Company size date is from CSO and NISRA.

Note: Post-2014, Eastern & Southern Regions were divided into Eastern & Midlands Region (with Midlands transferring from pre-2014 Border, Midlands & West Region) and Southern Region. Southern Region clusters are therefore imputed. Medical devices appear only in the original Eastern & Southern Region and not in Border, Midlands and West Region, and so are imputed for Northern & Western Region, which is known to have a significant concentration.

Table 1: Performing sectoral clusters on the island of Ireland

	NI	NWR	EMR	SR	Total
High-performing	1	1	3	2	7
Medium-performing	2	1	8	4	15
Low / Basic-performing	8	2	7	2	19
Total	**11**	**4**	**18**	**8**	**41**

Source: EOCIC (2020)

The approach adopted in this reflection is:

1) **Mapping and analysis of sectoral and regional clustering**

- Allocate companies, clusters, state-funded research centres, and HEIs research institutes, centres, groups, etc., to common sector and region by putting all these into their respective sectoral NACE/SIC category and the four NUTS 2 regions on the island of Ireland.
- Compare the presence in the region of the sector (by NACE/SIC employment in NUTS 2 region) and the policy-maker's intent to focus and prioritise (from ROI DBEI (July 2022) *National Smart Specialisation strategy for Innovation 2022-27* and NI DfE (May 2021) *The 10X Economy – Northern Ireland's Decade of Innovation*.

2) **Do a qualitative gap analysis of aspirations and potential versus capability and investments**

- Compare qualitatively in each of the regions and their sectors:
  - o the presence and intent to build (as above) with
  - o current global rankings of HEI achievement (QS subject rankings),[42] current state investments (DFHERIS, DoE (ROI), DofE (NI), DBEI, DfE, HEA, SOLAS, SFI, EI, INI, etc.), existing clustering initiatives, etc.
- Make qualitative judgements on potential gaps as priorities for investment in that region's innovative capability.
- Also, qualitatively, identify possible linkages in the capacities of key sectors for that region with other regions within the four NUTS 2 regions on the island of Ireland and with broader EU, UK/GB and global centres of expertise and capability.

3) **Focus on how clusters can progress to the next level of performance (towards, at some stage, the top 5 in the world, either as a core hub or critical spoke)**
    - Examine the hierarchy of sectoral clustering in terms of competitive performance:
        - in the EOCIC (2020) European panorama quantitative ranking of clusters;
        - sectors existing levels in each NUTS 2 region; and
        - the sectoral 'industrial' policy goal of achieving greater cluster presence at each level of performance.
    - Discuss and judge the appetite for and focus on progression and specify the levels for progression that need investment, required linkages with regional HEIs and FETS, etc.

Part 2

One island, two jurisdictions, four regions

4. Northern and Western Region (NWR - ROI)

4.1 Summary[43]

The NWR, with a 900k population and 442k employment,[44] has the lowest income per person on the island, with considerable economic and social challenges. The European Commission has downgraded the region to a 'region in transition'. The region is also classified as a 'lagging region' and a 'moderate innovator'[45]. Based on agency-assisted employment trends 2001-2022, the NWR's sub-regions Resistance Index for potential future external shocks is Border (0.75) and West (3.44) (Appendix 3)[46]. Overall, R&D staff by headcount in 2021 is 3,685 (a decrease of 12% on 2017), of which researchers in 2021 total 2,298 (9% of all researchers on the island of Ireland).[47] Enterprise Ireland's HPSU and CSF global start-ups in the region were 23 in 2021 (18% of the Republic's total of 125).[48]

It is a strategic region on the island of Ireland, bordering as it does the Atlantic Ocean and the border between NI and ROI, and with strengthening cross-border collaboration (NWSR,[49] ICBAN,[50] EBR[51]). NWR has two universities – University of Galway, a research-intensive university with a world university ranking within the 301/350 range,[52] and the newly created Atlantic Technology University, building on the strengths of its predecessors. The region also has an extensive FET network of ETBs. Based in Galway, Alison is one of the leading global platforms for Massive Open Online Courses (MOOCs), with over 25 million users worldwide.[53]

Compared to the ROI average, the region has more industry and tourism-related services and fewer information/digital and professional services (Table 2). It has a range of companies across all of the sectors (Figure 20), with 85% of employment in SMEs (65% in small 50 or fewer businesses), compared to the ROI average of 65% (44%).[54] Such income and sectoral/size trends are even greater in the Border NUTS 3 region and adjacent rural counties.

According to the EOCIC (2020) *European Panorama on Clusters and Industrial Change* (Figure 19), the region has only, at most, four clusters (2 high/medium) compared to 11 in NI (3 high/medium) and 18 in Dublin/East (11 high/medium). *Project Ireland 2040*'s population target is a 150k net increase in people living in the region and a 100k net increase in people working there.

Table 2: Sectoral profiles of the island of Ireland (NI 2011, ROI 2016)

	NWR	EMR	SR	ROI	NI
Agriculture	8.1	2.0	7.4	5.0	2.0
Mining	0.0	0.1	0.0	0.0	1.0
Manufacturing	13.2	8.0	14.0	11.0	10.0
Energy / Water	3.0	3.0	3.8	3.8	2.0
Construction	6.3	4.8	5.9	5.0	8.0
Retail / Wholesale	13.0	12.9	12.5	12.5	16.0
Transport	3.1	4.9	3.8	5.0	4.0
Accommodation / Food	6.4	5.8	6.8	6.3	5.0
Information / Comms	3.1	7.8	3.0	5.0	3.0
Financial, etc.	2.5	7.0	2.9	5.0	4.0
Professional Services	4.4	7.5	5.5	6.0	5.0
Administration / Support	3.1	4.4	3.8	3.8	4.0
Public Admin / Defence	6.3	6.4	5.0	6.3	8.0
Education	10.0	9.1	9.7	9.5	9.0
Health / Social Work	15.0	13.8	13.4	13.3	14.0
Personal Services	2.5	2.5	2.5	2.5	5.0
Total Employed	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO Census of Population 2016; NISRA Census of Population 2011

Note: Data are approximations due to use of different classifications (NACE, SIC), different Census years, and omission of ROI category of "Other sectors", rounding, etc. More update sectoral employment data for both ROI (2022) and NI (2021) should be available during 2023

Figure 19: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A

Figure 20: NWR - Examples of companies by sector

Agrifood	Abbott Aurivo Bio-marine Ingredients	Coca-Cola Ireland Grá Chocolates Kepak	Lakeland Dairies Mulrines O'Hehirs
Life sciences	Abbott Abbvie Aerogen Avenue	Aveta Medical Boston Scientific Cerenovus	Medtronic TopChem Pharmaceuticals Univet
Engineering	ATA Combilift E + I Engineering (Vertiv) Inishowen Engineering	Mantis Cranes McHale SL Controls	Thermo King Valeo Ward Automation
Construction	King & Moffatt Building Services Kingspan Group	Masonite O'Reilly Group	Stewart Construction Vision Built

IT Software	Appraisee Blockdaemon Cora	Genesys HID Global May 3 Software Located at Claremorris, Co. Mayo	Octiga Overstock Pipit Global
Digital business	Abtran DeCare Dental	eir Group Forward Emphasis International	Tata Consultancy Services
Financial services / FT	Fidelity	FinTrU	Payslip
Energy and circular	Mercury Renewables	Solar Marine Energy	
Hospitality & tourism	Radisson Hotels	Renvyle House Hotel	Voya Seaweed Baths
Creatives	Daniel O'Donnell Druid	EO Teilifís Enya	Saw Doctors
Other	Alison Inishowen Training Solutions	Portwest	Smyths Toys

4.2 Sectoral assessment

In qualitatively comparing the presence of sectors in the NWR and the sectors considered to be priorities for growth with the range and scale of sectoral capability and experience, several assertions can be made for discussion.

Agriculture (NACE A)

While being amongst the NWR's 'high-level strengths' as a sector, it has only some innovation capability within the region in Teagasc research (Athenry), training and operation services and with some expertise in University of Galway (nutrients) and ATU (Mountbellew). Overall, the sector in the region would benefit from more extensive innovation and advisory services (especially on environment management, etc.) and stronger linkages to access such expertise elsewhere (UCD, UCC, QUB, CAFRE, etc.). The prospects of a veterinary school within ATU, perhaps with cross-border linkages, is a significant development. The sector needs the "potential to develop agri-innovation clusters in the region – pushing convergence between farm, research, technology and commercialisation – with a commitment in the NWR's RSES to support this activity."[55]

Fish and related blue economy

Generating 2,440 jobs in Border NUTS 3 region and 765 in west region,[56] the NWR has three of the top 10 seafood ports in ROI with Killybegs (26% of commercial fishing turnover 2018), Greencastle (11%) and Ros an Mhíl (3%). The region has some sectoral capacity-building (University of Galway, ATU, BIM) in Galway, Killybegs and Greencastle. Forestry has little capacity-building beyond Coillte supports.

Overall, for the NWR as well as other regions on the island, the key question is how to evolve "a sustainable food system (SFS) that is profitable throughout (economic sustainability), has broad-

based benefits for society (social sustainability) and has a positive or neutral impact on the natural environment (environmental sustainability)". Such a green sustainable food system is based on a "...distinctive food system" on the island overall, for which "the core of ... agrifood output will continue to be grass-based livestock production wherein lies [our] natural competitive advantage."[57]

The implications of this goal and vision and actions required need continuous reflection at regional and local levels, as well as at jurisdictional and all-island levels. The potential of 'food diamond' linking key stakeholders within the region to deliver such a goal might be considered.[58]

Mining and quarrying (NACE B)

Quarrying is a key part of the construction value chain in the region. With little regional support for companies in the sector, adjacent Northern Ireland[59] is a world-class cluster of companies for quarrying and quarrying equipment, with which improved linkages may be beneficial.

Food and drink (NACE C10/11)

Likewise, food and drink is strongly present throughout the region. Even with some regional expertise (University of Galway and ATU), the sector is still surprisingly under-supported for research and innovation. The sector in the region likewise needs more inter-regional linkages, with both adjacent sources (CAFREs Loughry Campus, UUs FDBDC, Boyne Valley Group, Co. Meath) and food-related SFI/EI Research Centres (such as Dairy Processing Technology Centre (DPTC) at University of Galway) and UCD, QUB and UCC agricultural and food-related faculties. Greater investment is also needed in the region's innovation capacity for food applications, processes and platforms (e.g. strengthening ATU (Mountbellew), leveraging DPTC, recreating a Food Development Centre in the north-west, support for Killybegs fish food additives, improving linking and supporting of BIA Innovator Campus (Athenry), Monaghan Bio-Connect, Drumshanbo Enterprise Centre, etc.). Specific focus on and support for scaling global food SMEs is also key.

Pharma industry (NACE C20/C21)

Present in the region[60] (mainly in Mayo, Sligo and Galway with 7 IDA large MNCs (Abbvie, etc.) and other enterprises) with both long-standing small molecules production and recent complex biologics manufacturing, the sector can access strong pharma research expertise in University of Galway and education and research/innovation support in ATU. It could have stronger access to ROI SFI/EI centres for industry and adjacent NI industry/academic capabilities (QUB). "Stakeholders ... have expressed the view that more formal co-ordination is needed beyond networking and informal linkages ... in the longterm, the lack of alignment and co-ordination between actors could have a negative influence on the development of the ... regional life sciences ecosystem."[61]

Medical devices (NACE C235)

A strong sectoral cluster[62] with a substantial concentration exists around Galway (Medtronic,[63] Boston Scientific, other FDI supply-chain companies, global start-up and scaling enterprises (Aerogen, etc.)) and a supply chain that extends along the west coast. The cluster intensely focuses on cardio and related MedTech that is well supported with innovative capability (University of Galway, ATU, adjacent DkIT and cluster groups). The region has the greatest concentration of FDI MedTech clients in the Republic (32 MNCs). Nevertheless, to progress to a globally recognised leading and resilient cluster, the ranking of research for mechanical engineering in University of Galway (currently within the top 300-400 levels worldwide) needs to be invested in so that it achieves, over time, a top 100 ranking to root global academic expertise in the region.

A digital health/eHealth subcluster (within MedTech)

With remote monitoring sensors, connected devices, social robotics, etc., digital health is a globally emerging sector and a significant opportunity, with some expertise already within the broad region (ATU Digital Health Cluster, DkIT Wellness Centre). As it is "extremely vulnerable to disruptive technologies and rapidly changing global trends, as well as competition from emerging economies, ... further action is needed to futureproof digital health and ensure a framework is in place to promote [the sector]". Such digital health needs significant investment to grow apace alongside (and use as a test bed) more systematic and intensive community services and supports for the ageing population based on the nursing expertise of the region and beyond.

Production technology engineering and related sectors (NACE C24-30)

A long-standing and robust industry in the NWR, there is a focus on transport vehicles and parts, materials handling/fork trucks, cranes (Manta), vehicle refrigerators (ThermoKing), construction and agricultural machinery, precision engineering in both subcomponents and niche products, tool-making (Co. Sligo) as well as general metal fabrication and engineering services. There is a growing innovation and research capability (ATU (PEM, Wisar, Transcend) and University of Galway expertise) both within the region and in adjacent Derry/Londonderry (DRAC), Dundalk (LMETB Training Centre), etc.). There are also clusters (BORMAC, Donegal Engineering, etc.) and potential linkages especially to NI (both with adjacent Antrim/Tyrone/Fermanagh, engineering cluster and elsewhere) which has deep and strong engineering tradition, capability and expertise.

Further strengthening and intensifying the sector's capability, cohesiveness and depth in the region is essential, alongside greater investment in research and innovation capability in key technologies and applied science. Adopting new technologies is crucial in additive manufacturing (3D printing), embedded sensors, IIoT (Industrial Internet of Things), new composite materials, sustainable manufacturing, MaaS, Industry 4.0., etc. Systematically strengthening the linkages to the NI engineering cluster and expertise in Antrim and elsewhere is central. Other linkages with the Limerick/Shannon cluster (on autonomous autos) as well as overseas best practice clusters in Germany (Stuttgart, Freiburg, etc.), Great Britain (West Midlands) and in the USA and China (Shenzhen) are also important. A greater focus on developing a stronger pipeline of global start-ups and scaling enterprises, especially in the northwest engineering cluster, is needed to progress further.

Wood/furniture (NACE C16, C31)

With good capability and support in the region for its scale (wood products with ATU (Letterfrack, and in Galway, Monaghan (also furniture) etc.), the sector could strengthen more with stronger linkages to NI wood/furniture cluster. Its craft segment, in the main, makes it part of the broader creatives industry, closely linked to the hospitality and tourism trade. Other segments (Masonite, etc.) are selling into the construction industry.

Energy and water production (NACE D, E)

The sector has increasing focus and capability supports within the region (ATU, MI, SEA (AMETS – wave energy) and marine clusters for renewable energy, aquatic resources, bio-energy, etc. One-third of the Republic's installed onshore wind turbines are in the region,[64] and over half of proposed RESS1 onshore wind projects are for the region (Donegal and Mayo, mostly).[65] Offshore wind is a massive opportunity (and necessity to achieve net zero carbon) that needs urgent regional investment, both in overall capacity and innovation and research.[66] However, the pipeline of

proposed projects for the region seems weak, given that the current allocations of offshore wind power initial approvals are almost all for the east coast.[67]

Strong linkages to Belfast's expertise and its unique ability to assemble and construct large fixed platforms, etc., are also key. In the longer run, the development of one or more ports, such as Killybegs, Galway, and Ros an Mhíl, to provide the infrastructure required may occur.[68] Killybegs, in particular, "is well situated to service offshore renewable sites along the west and north-west coast"[69] with natural deep water, significant quay lengths, an existing solid, skilled workforce, and focused shoreside development. Adjacent ports in the broader north-west, such as Greencastle (ROI) and Foyle Port (Derry/Londonderry, NI), may also have substantial roles to play. Growing offshore wind investment may also facilitate housing data centres in NW/W.[70]

Developing means of storage, such as compressed air, batteries, green hydrogen, etc., alongside a much improved island-wide and European grid also seems key. As an encouraging development, in July 2023, Mercury Renewables announced plans to build a £100 million wind-powered green hydrogen plant on the Sligo-Mayo border.[71]

There is also scope to build regional success on the infrastructures and practices of the future; it is vital to seize the opportunity to adopt a circular economy approach. Much less waste generation and reduced energy consumption throughout the region significantly reduce the need for land infill, waste export, and the use of fossil fuels, aligning with the Government of Ireland's target of achieving net zero by 2050.

Construction (NACE F)

Significant in the region, there are opportunities to develop sustainability and offsite modular production as its central capacity, as well as being digital and lean. Regional towns contain significant construction companies and activities (such as Kingscourt (Kingspan, O'Reilly Group), Tubbercurry (offsite Vision Built), Carrick-on-Shannon (Masonite) and Manorhamilton (W8 Innovation Centre for quarrying and construction).

While innovation support for construction in all fairness is present in the region (e.g. University of Galway with civil engineering degrees and research, ATU courses, some PEM inputs, MSLETB Retrofit Centre of Excellence), it has no formal collaborative cluster or globally high-ranking construction engineering courses. Further investment in the region's innovation capacity is needed to progress, as well as the development of a cluster and strong linkages with NI construction cluster and supports (e.g. Enniskillen SWC,[72] etc.) and with Technological University Dublin (TUD) construction expertise. The recent 'ConstructInnovate' announcement in University of Galway as an EI Technology Centre is a significant step in that direction.

Retail/Wholesale (NACE G)

Another significant sector in the region, retail/wholesale has major challenges and opportunities to innovate and scale (eCommerce back-office/centres, post-Brexit distribution). While there is some capability development (ATU courses, Skillnet), there is little innovation support or clustering initiatives. Perhaps retail and transport could be one focus of the proposed EDIH Data2Sustain.[73]

Transport (NACE H)

Similar to retail, transport has some capability development (ATU courses, Skillnet) but little innovation supports or clustering initiatives. The ATU sustainable transport research project may lead to some exciting options.

Accommodation and food service (NACE I)

(including tourist-focused activities)

A significant sector within the region, it has some regional capability (ATU, Failte Ireland, Skillnet) but is without substantial innovation, research centres or clustering. The ATU sustainable tourism (STORY@ATU) is a major development for the region and beyond. Overall, it can be considered that the broad region has a major opportunity to become a global cluster in the experience (tourism/cluster) industry. Brands such as *Wide Atlantic Way*, *Hidden Heartlands*, and *Ancient East* have been successful.

However, the absence of major theme parks indicates insufficient demand or a supply focus on different offer types. Also, there seems to be inadequate facilities and supports within the region for campervans, camping, backpackers and similar tourists that are commonplace on the continent and in the UK. A significant opportunity for outdoor activities and experiences here needs to be seized.

Overall, in 2019, the NWR had 16% of overseas tourists to the island and 23% of tourists from across the island, boosted by 710k tourists from Northern Ireland (see Appendix 5).

What is needed now is a major investment in the region's capacity to develop innovative formats, new offers, skills, clusters, research, etc. and focus on creating a world-class sustainable combined experience/creatives industry cluster. Much stronger linkages need to grow with relevant expertise (e.g. NI's highly–ranked UU hospitality faculty (in the top 200 globally), building on UU involvement already in, e.g. virtual tracking footfall on Donegal tourist sites, etc.), University of Galway (Shannon Catering College), global academic leaders (e.g. Switzerland) and experience and clusters elsewhere (Center Parcs in Longford,[74] France's and other high-performing EOCIC clusters in this sector, etc.).

Information & communications technology (ICT) (NACE J – J58 (Software publishing), J62 (Software development and IT consultancy)

An emerging sector[75] in the region involving ICT software applications and solutions (for HR, ERP, commerce, travel and a range of spheres) and ICT software technology platforms rooted in AI. An initial cluster of start-ups, expansions and transplants is growing, especially around Galway (PorterShed,[76] etc.). (Digital business and financial services are addressed separately). Galway also has 22 IDA IT tech companies, while Mayo/Sligo and Donegal have five apiece.

In particular, Galway has 39 cyber security offices with eight dedicated firms, and Hewlett-Packard's Global Cyber Defence Centre is present in the region.[77] The beginnings of an NW ICT/FinTech cluster is also present.[78] There is also strong innovation capability, especially within University of Galway (computer science faculty, ICGEC, and Insight SFI researchers). Progress requires a distinct focus and shaping through sharper clustering and targeted HEI investment.

Films and videos (NACE J59)

The Connemara Irish language film/TV cluster rooted in its storytelling tradition is active, present, and promoted by Western Development Commission and TG4, supported by Údarás, University of Galway, ATU, IFB and Skillnet. The proposed multi-media virtual production hub for Ballaghderreen, Co. Roscommon, will also add to the industry's ecosystem in the region.[79] Stronger linkages with Belfast (Ulster Studios)/Banbridge (Game of Thrones), Limerick (Troy) and Wicklow (Ardmore), as well as global centres (LA, London, Berlin), are vital. The new games hub in Strandhill

(alongside the surfing hub!) has an opportunity to be a leading gamester's hotspot, while Galway has some games experience in electronic arts and others.[80] Overall, closer links to Pixel Mill in Belfast, games companies in Fermanagh and Derry/Londonderry, Dundalk/Newry, and the Dublin games cluster and to the global hotspots are essential to build.

Financial services (NACE K)

General banking in the region is shrinking as Ulster Bank, etc., exits the market, even with the remaining banks, credit unions and An Post. With over 15 IDA larger financial services operations as well as smaller Irish-owned companies, financial services are present in Galway (Fidelity), Donegal (FinTrU) and elsewhere (as well as in adjacent Louth) as spinoffs to Dublin and Belfast financial centres and further afield. Skills development (with ATU) and innovation can be strengthened (in RegTech and FinTech in particular), as can linkages with main centres of Dublin (IFSC, etc.) and Belfast (see FAB facility in QUB), etc., as well as global centres of London, Paris, Frankfurt, New York and Shanghai (general digital services are addressed separately).

Professional and technical services (NACE M)

The professional and technical services level has tended to be responsive to regional employment levels, but remote working gives access to wider opportunities and technology transfer. Skills development is strong within both University of Galway and ATU. The recent growth of remote working facilities is encouraging. Investment in design expertise in the region (perhaps in a dedicated centre) is key for developing a range of product and service sectors.

Environmental consulting services (part of NACE 70)

Central across various industries and to the vision of a region underpinned by sustainability, rich skill and innovation capacity (ATU CRU, many courses, summer programmes, some centres) has been developed. Still, it requires more significant investment and linkages (e.g., NI expertise) to be considered a globally recognised central capability under-pinning regional growth.

Digital business (Administration) services (NACE J63 (Data processing), N822 (Call centres), etc.)

There is a strong presence in Sligo/Mayo/Donegal (call centres, data processing, digital back-office services, etc.) and Donegal (financial services/call centres, etc.), and such digital business services represent a major opportunity for income and job growth in the region. Investment in an innovation centre and cluster(s) specifically around this opportunity, as well as linkages to the urban centres of origin of these businesses, etc., back-office services (Dublin, Belfast, Cork, London, New York, Bangalore, and elsewhere), is an important next step.

Cultural and leisure (NACE R)

Strongly present in the region with nearly 3,000 established and new entities over the West/Atlantic Economic Corridor (AEC).[81] The region has deep innovation capability in University of Galway (drama centre, etc.[82]) and all three ATU colleges. The adjacent Louth DkIT also strongly focuses on the creatives industry. Eight industry-standard studios/facilities are also in development in the wider AEC.

Further HEI and FET investments might be in advisory, education and training services for cultural enterprises building on the work of the WDC.[83] There also needs to be research on and support for creating and commercialising Intellectual Property within the cultural industry and further investment in studio facility infrastructure.

The cultural industry is also part of the experience industry, as are accommodation & food services and film & TV sectors. Combined, it is a preeminent opportunity for the region, which needs much more investment in an innovation and research network and greater linkages (with NI QUB performing arts, UU hospitality and NI creative and hospitality industries and to the top EOCIC (2020) clusters in France and elsewhere; as well as with Dublin, Belfast, London, New York and Texas (Austin)). HEI cross-border projects for the creative industries can significantly help here. The sector can scale systematically as a sustainable, socially valued, commercialisable and digitalised sector.

Hospitality and tourism (NACE I, NACE R)

Grounded in the creative/cultural industries, hospitality & tourism is based on the region's rich resources of music, dance, literature, visuals, films, crafts, etc., with commercially developed IP and content. The question is: Can there be a step-change to some form of NWxW ecosystem (similar to that of the famed SXSW in Austin, Texas)?[84]

Other sectors (NACE O, P, Q, S)

Other sectors include health (major opportunity for expanding senior services and offers) and public administration (which needs internal resourcing for regional economic planning and regional strategy and leadership, particularly in rural towns). The ageing demographics of the region and the development of community health services, both public and private, offer an opportunity to become a test bed for a range of aged services innovations, including eHealth. The regional networking of arts centres, especially in the north-west and cross-border, would also broaden the impact of arts and culture on education, urban/rural community development, health/wellbeing and young people.

Figures 21, 22 and 23 summarise the sectoral assessment for NWR.

Figure 21: Sectoral assessment NWR (1)

Sectoral assessment Northern and Western region 1

Sectors (NACE)	Presence (H/M/L - E)	Capability (H/M/L)	Gaps to address?	Linkages to build?
A Agriculture +	H	M Teagasc	More innovation help	With UCD
C Manufacturing	H P			
Food	H P	M University of Galway, ATU expertise, FDC closed, Also BIM	SME food clusters? Emerging foodtech?	With Boyne Valley (Co Louth), Caffrey Co Armagh); with SFI/EI Centres
Chemical/Pharma	H P	M University of Galway pharma No cluster group	Innovation services Cluster group needed?	With Queen UB, NI pharma With Cork + and US NJ
Medical devices	H+ P E E-health	H University of Galway ATU, (DkIT)	Boost University of Galway Mec. Eng + root global academics Invest in ehealth	With German and Boston Clusters
Engineering	H P (Ad. Man.) E Marine	M Range of supports Bormac as key	Invest more in core technologies Develop global start-up/scaling system NW+	Expertise in Dublin and Belfast(QUB+),clusters in Antrim/Tyrone+, West Midlands, Stuttgart, Frieburg, Shenzhen etc.
Other Man.	M Wood/Furniture	H ATU, cluster		With NI wood cluster

Figure 22: Sectoral assessment NWR (2)

Sectoral assessment Northern and Western region 2

Sectors (NACE)	Presence (H/M/L - E)	Capability (H/M/L)	Gaps to address?	Linkages to build?
D Electricity E Water	H E - Blue economy, renewables, sustainability/climate	M - ATU Killybegs, Marine cluster, (DkIT water centre)	Offshore wind (nb (Killybegs) - major opportunity - need investment+ expertise	Links to Belfast Harbour expertise; involve with Foyle Port; Wicklow project
F Construction	H E Sustainability	M Many ATU courses; no centres (PEM some)	Build sustainable construction centre (*Construct Innovate*!)	Links with SWC sustainable construction, and with TUD cluster
G Retail/wholesale	H E E-Commerce	L Some ATU courses; no centres;	Innovation services, a focus of digital hub?	Links to ???
H Transport	H	M ATU skill provision No centre	Ditto?	Link with Wrights Co Antrim for sustainable transport
I Accommodation+ Food service	H	L Some ATU courses; Bord Failte Little re innovation	Develop innovative formats as well as sk clusters, research	Links with UU Hospitality research; also with French, Finish clusters
J Information and Communications (Software etc.)	H esp Galway city P	H University of Galway +	Need for distinctive strength/USP? (Applications?)	SV California, NY, Colorado, London, EU?
Films etc.	H Galway P	H TG4 etc.,Sligo games	Skills development	Limerick/Wicklow clusters NI clusters and centre

Figure 23: Sectoral assessment NWR (3)

Sectoral assessment Northern and Western region 3

Sectors (NACE)	Presence (H/M/L - E)	Capability (H/M/L)	Gaps to address?	Industry Linkages to build?
K Financial services	M - Donegal, Galway (Louth)	L Some University of Galway, ATU, (DkIT) courses	Innovation services, fintech prospects	With Belfast, Dublin,New York, London, Frankfurt
M Professional and Tech. services	H	H University of Galway, ATU	Open access + tech transfer	Links with Dublin, Belfast, Cork and global centres
Environmental	M	M ATU	Need to invest more	Links with NI groupings
N Digital Business (Administration) Services	H Esp. backoffice and call centres E - remote working	L	Remote working opportunity needs major investment and promotion - big innovation and research centre, initially within digital hub	Links with Dublin, Belfast and Cork as well as international centres (as sources of such projects)
R Cultural and Leisure	H	H University of Galway (literature, digital drama etc,) ATU(performance, arts, Crew)	Strategic thinking about tourism in region; research + innovation network: Digital creatives NorthXNWest, IP resource	Close links to UU Tourism/Hospitality and to Queens Performing Arts; links to top French entertainment clusters
L, O, P, Q ,S, T	M range of services	H Both HEIs		Links to rest of EU critical

4.3 Sectoral ambition

Feedback from stakeholder consultations (DBEI, 2022)

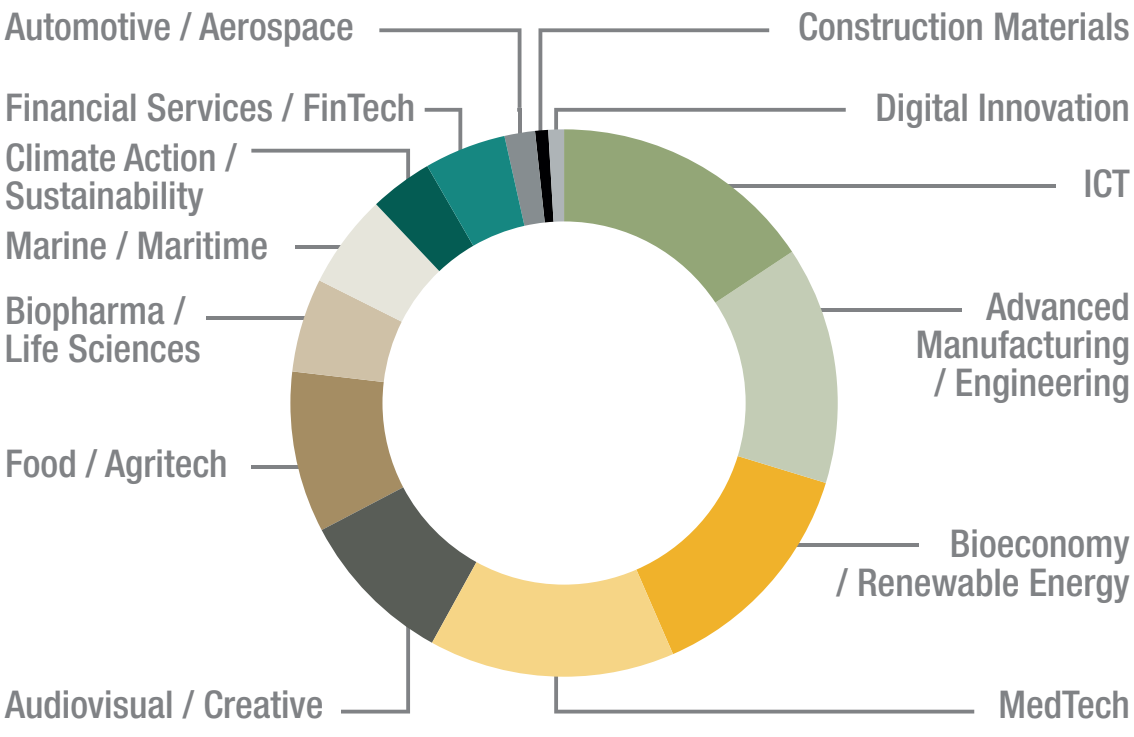
Stakeholders were asked to identify the existing sectoral strengths and emerging areas of opportunity in the NWR. … to assist stakeholders, several sectors were identified based on regional data from the DETE enterprise agencies. These were divided between existing and emerging sectors. Stakeholders were asked whether they agreed with the sectors identified by DETE and whether … further sectors needed to be identified. The sectors presented to stakeholders were MedTech, life sciences, ICT, food/AgriTech, marine, financial services, climate action/sustainability, manufacturing, and audiovisual/creative.

Based on consultation findings and the economic analysis of the region undertaken. The identified areas of sectoral strength and potential opportunity are:

- *Advanced manufacturing and engineering*
- *Audiovisual/creative*
- *Marine and blue economy*
- *Renewable energy, climate change mitigation and sustainability*
- *Agrifood and AgriTech*
- *ICT and ICT services*
- *Life sciences, MedTech and medical devices.*[85]

Figure 24 summarises stakeholder feedback

Figure 24: Identified sectoral strengths and opportunities for the NWR



Towards key sectors

All sectors in NWR can and should increase incomes, employment, productivity and exports by progressing innovation, digitalisation, lean and sustainability through investing in and improving their capability development and innovation services.

However, it is important to prioritise sectors that can progress through the Euro-cluster medium and high levels and become globally recognised as key clusters in growing industries, cascading income and job opportunities throughout the sectoral networks and hierarchies.

Currently, **medical devices** are the one high-performing cluster imputed to be present in the north and west, according to the EOCIC (2020) methodology.[86]

Communication equipment and services is the only medium-performing cluster.

Biopharmaceuticals and **lighting/electrical equipment** are the two basic-performing clusters. The NWR has four performing clusters, the lowest of any NUTS 2 region on the island.

While other sectors and individual companies may be competitive internationally, there is not a critical mass in the region to reach the stage of an internationally performing cluster as classified and measured within the EOCIC (2020) rankings framework.

Clusters to progress and promote over the next seven years to 2030 could include:

Three high-performing clusters

- Maintaining and indeed improving the **medical devices** cluster as high-performing to reinforce its status as one of the top global locations (potentially within the top 5) for the industry (currently a high-performing cluster).
- Nurturing a **digital health** sub-cluster alongside developing more systematic community services and supports for the ageing population based on the nursing expertise of the region and beyond.
- Progressing **production technology engineering** (agricultural, warehouse, transport, etc.) - which has been rooted in the region for decades - to a high-performing cluster. Currently, **communications equipment** and **services** are already medium-performing, respectively, and **lighting and electrical equipment** are already basic-performing clusters within the region (currently, the overall cluster is not performing at relative international critical mass in this region, within the EOCIC (2020) rankings framework).
- Progressing to high-performing level **digital business services** of call centres, data-processing, etc. and related **financial and insurance services**, alongside **information technology** for some key vertical software applications. For this to happen, it is critical to avail much more than at present of the game-changers that are remote working and improved broadband to attract mobile back-office opportunities (currently, the cluster is not performing at relative international critical mass in this region within the EOCIC (2020) rankings framework).

Three medium-performing clusters

- Promoting to medium-performing **bio-pharmaceuticals** cluster (currently basic-performing).
- Progressing systematically to medium-performing initially the broad **food processing** and **manufacturing, fishing & farming** sector as a sustainable food system (SFS) (including some new food platforms such as hydroponics, plant-based 'meats', etc.) (currently, the cluster is not performing at relative international critical mass in this region, within the EOCIC (2020) rankings framework).
- Scaling systematically to the medium-performing level initially a sustainable and digitalised **hospitality & tourism**, grounded in the **creatives/cultural industries** (based on the region-rich resources of music, dance, literature, visuals, films, crafts, etc., with IP and content being commercially developed) as a form of NWxW ecosystem (currently, the overall cluster is not performing at relative international critical mass in this region, within the EOCIC (2020) rankings framework).

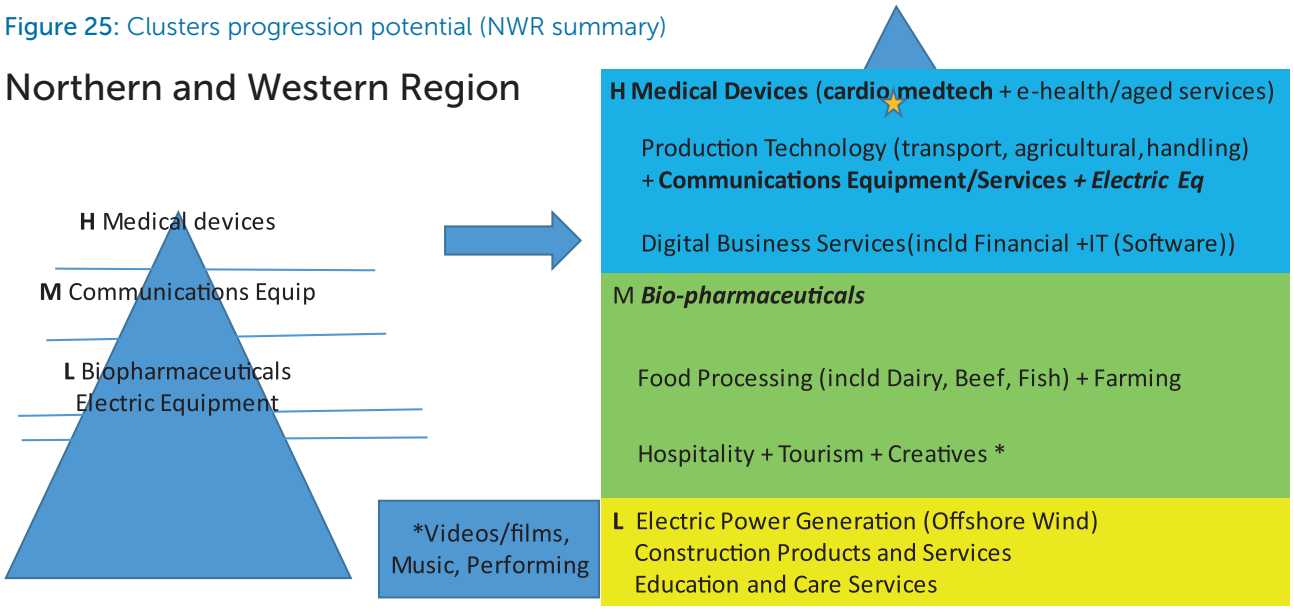
Other basic-performing clusters

- Developing as basic-performing the **construction products & services** sector which is widespread in the region and with some international companies.
- Developing as initially basic-performing **electricity power generation & transmission** to urgently realise the emerging opportunities of renewables, and especially in offshore wind electricity generation and circular economy opportunities (currently, the cluster is not performing at relative international critical mass in this region, within the EOCIC (2020) rankings framework).
- Developing further the **education & care services** sector is a significant opportunity and resource to progress economic and social development within the region.

In summary (Figure 25), the broad clustering goal for the NWR to 2030 could be to progress from having four performing clusters (one high-performing) to having at least nine performing clusters (three high-performing). At least one cluster could be building towards becoming recognised as one of the world's top five locations for that industry, as either a core hub or a critical spoke. All sectors should aim to become recognised globally as best-in-class in some aspects of practice and process within their sector. Such a goal and its pathway to achievement need intensive discussion within the region and beyond, as it is a considerable challenge for all stakeholders.

As stated, all sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, nourishing and investing the region's specific sectoral skills, expertise and platforms, more general technological, digital, lean and sustainability capabilities and broader inclusive leadership and organisation abilities will be critical to underpin NWR as an adaptive learning community and system at multiple levels.

Figure 25: Clusters progression potential (NWR summary)



Note: **bold** is current ranking, ***bold italic*** is promotion, and no bold is currently not ranked within the EOCIC (2022) rankings framework.

4.4 Sectoral development actions

Linking HEIs/FETs and the key sectors

The contribution to sectoral development of the HEIs in the region and the extensive network of ETBs is crucial. Focusing on the key sectors is vital, similar to the MIT Local Innovation System. The MIT/LIS approach can be applied to the NWR (Figure 26).

Figure 26: Sectoral development and HEI/FET interaction in NWR (MIT LIS)

	EXISTING INDUSTRIES		EMERGING INDUSTRIES	
Performance levels 2030 Aim	**CONVERT**	**TRANSFORM**	**CREATE**	**TRANSPLANT**
High-performing +		Medical devices	(New MedTech) (eHealth aged / related wearables)	
		Production technology engineering	(New EngTech)	
			(IT analytics / Software development)	Digital business, Financial services, IT applications
Medium-performing +		Biopharmaceuticals		
	(Sustainable farming)	Food processing	(New food formats)	
	(Creatives – Commercial IP)	Hospitality & Tourism / Creatives		
Low-performing	(Construction: Scaling with standards)	Construction products & services Education & care services		Electricity PGT

Note: In brackets () is the subsector part of the broader sector.

Specifying indicative investment priorities

Following a range of suggested actions at the sectoral level, some indicative investment priorities can be identified and assessed as to costs and benefits (Figure 27).

Figure 27: Indicative sectoral investment priorities in NWR

Sector	Need	Priority
Agriculture / food	Agri-innovation clusters New food platforms research	Medium
Pharmaceuticals	Cluster to coordinate	Medium
Medical devices	Higher academic and more interdisciplinary expertise (University of Galway)	High
Electricity (offshore wind)	Expertise for opportunity	High
Construction	Sustainable innovation service	Medium
Retail/Transport	Potentially, one of EDIH's focuses	Medium
Accommodation / Tourism	New development centre for experience / creatives industries (strategic planning, research new experiences / formats and innovation services)	High
Digital (incl. financial & insurance) businesses / Administration & ICT (software)	Digital back-office / call centre, etc., research and innovation centre to drive growth and attraction to the region ICT research: some key areas (nb. FinTech)	High
Creatives / Cultural industry	New development centre for experience/creatives industries (see above)	High

5. Northern Ireland (NI - UK)

5.1 Summary

Within the jurisdiction of the UK, NI is a distinct region on the island of Ireland with a population of 1.9m and employment of 870k.[87] NI has been classified as a 'strong innovator' within Europe,[88] while as a region, it has been amongst the lower-income regions in the UK.[89] Overall R&D staff by headcount in 2021 was 18,580 (an increase of 22% on 2018 (published) and 32% on 2017 (imputed), of which researchers in 2021 total 8,063 (33% of all researchers on the island of Ireland).[90] From 1998 to 2020, its economy has significantly improved, with "average GDP per capital having increased from £13,391 to £25,575, one of the largest improvements of any UK region."[91]

Overall, NI has a range and depth of sectors, companies and expertise in enabling technologies building on over two centuries of experience in industrialisation (Table 3). It has a strong urban centre around Belfast and other urban centres in Derry/Londonderry, Lisburn, Armagh, Lurgan, Ballymena, Omagh, Newry, Enniskillen, Bangor, etc. It has two influential universities (QUB, a Russell Group University ranking 197 in world university rankings 2023 and a rising new university star, Ulster University) and with a depth of research and innovation in key areas. It also has an extensive FET network of further education colleges. For NI, EOCIC (2020) ranks 11 clusters as performing (Figure 28). NI has a range of companies across all sectors (Figure 29).

The Department for the Economy (2021) *10X Economy: Northern Ireland's Decade of Innovation* strategy lays out a sectoral focus and development framework, leading to 25,000 new and replacement jobs.

Table 3: Sectoral profiles of the island of Ireland (NI 2011, ROI 2016)

	NWR	EMR	SR	ROI	NI
Agriculture	8.1	2.0	7.4	5.0	2.0
Mining	0.0	0.1	0.0	0.0	1.0
Manufacturing	13.2	8.0	14.0	11.0	10.0
Energy / Water	3.0	3.0	3.8	3.8	2.0
Construction	6.3	4.8	5.9	5.0	8.0
Retail / Wholesale	13.0	12.9	12.5	12.5	16.0
Transport	3.1	4.9	3.8	5.0	4.0
Accommodation / Food	6.4	5.8	6.8	6.3	5.0
Information / Comms	3.1	7.8	3.0	5.0	3.0
Financial, etc.	2.5	7.0	2.9	5.0	4.0
Professional Services	4.4	7.5	5.5	6.0	5.0
Administration / Support	3.1	4.4	3.8	3.8	4.0
Public Admin / Defence	6.3	6.4	5.0	6.3	8.0
Education	10.0	9.1	9.7	9.5	9.0
Health / Social Work	15.0	13.8	13.4	13.3	14.0
Personal Services	2.5	2.5	2.5	2.5	5.0
Total Employed	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO Census of Population 2016; NISRA Census of Population 2011

Note: Data are approximations due to use of different classifications (NACE, SIC), different Census years, and omission of ROI category of "Other sectors", rounding, etc. More update sectoral employment data for both ROI (2022) and NI (2021) should be available during 2023

Figure 28: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A

Figure 29: NI – Examples of companies by sector

Agrifood	Bushmills Dale Farm Fane Valley	Foyle Food Group Moy Park Chicken McConnell's Irish Whisky	Tayto Group Spence's Home Bakery
Life sciences	Almac Group Axial3D B-Secur	Diaceutics Norbrook	Randox Teva
Engineering	Artemis Technologies Caterpillar Harland & Wolff Powerscreen	Resonate Testing Seagate Spirit AeroSystems	Telestack Thompson Aero Seating Wright Bus
Construction	Clarke Group Kilwaughter	Mannok Holdings	Tracey Brothers
IT Software	Anomali BT SilverSky	Kainos MetaCompliance Rapid7	Salt Secure Communications STATSports Texthelp

Digital business	Aflac NI Allstate NI Capita	First Derivative Firstsource	PwC Teleperformance
Financial services / FT	Asset Reality Citi Group	Danske Bank FinTrU	Ulster Bank
Energy and circular	B9 Energy Belfast Harbour	CATAGEN Frylite Solutions	North Channel Wind
Hospitality & tourism	Hastings Hotels McKeever Hotels	Mount Charles	Titanic
Creatives	Game of Thrones Studio Tour Getty Music	Studio Ulster Sugar Projects	Paul Brady Van Morrison
Other	CET CryoSpas	Uform	

5.2 Sectoral assessment

Agriculture/Food & drink (SIC A, C10/11)

"Northern Ireland has a large agricultural industry that is successfully evolving to meet changing customer demands, and there is high potential for innovation and technologies such as artificial intelligence to this industry."[92] Key areas are dairy, beef, sheep/lamb, chickens and pigs and their processing both in NI itself (Moy Park (Pilgrim Pride)), Foyle Foods, Dale Farm, etc., as well as some larger food corporates Kerry (cheese products, Portadown, etc.) and in the ROI (mainly in the NWR, e.g. Lakeland, Aurivo, etc.).

There are opportunities for "locally sourced organic foods" and "applying innovative technologies" (AgriTech, AI). AgriTech/food is a 10X priority cluster and a strong primary sector, with opportunities for growth and innovation and with QUB high in international rankings for agriculture and with "leading-edge research facilities" such as QUB Institute for Global Food Security (IGFS), Agri-Food and Biosciences Institute (AFBI) and College of Agriculture, Food and Rural Enterprise (CAFRE). AFBI and CAFRE are crucial in developing and diffusing innovation (e.g., farm robotics).

Along with the primary sector, the NI food and drink sector (Fane Valley, Tayto, Moy, Bushmills, McConnell's Irish Whisky, etc.) has substantial opportunities, and with supportive research and innovative facilities (UU Food and Drink Business Development Centre, etc.). Innovations in alternative protein, organic, plant-based, vegan and insect-based offers are emerging. Creating a vet school (linked to UU) or "securing guaranteed uplifted places for NI students on GB, ROI or potentially EU vet programmes" would also add to the industry's ecosystem.[93] EOCIC (2020) clusters identified "livestock processing" as a basic-performing cluster for NI.

NI's commercial fishing fleet of over 120 boats (10 metres +) operates mainly from Kilkeel, Portavogie and Ardglass fishing ports, all in Co. Down.[94]

Overall, for NI, the key question is how to deliver green growth through the food diamond model of stakeholders as specified by DAERA.[95] Such a green sustainable food system (SFS) is based on a "...distinctive food system" on the island overall, for which "the core of ... agrifood output will

continue to be grass-based livestock production wherein lies [our] natural competitive advantage."[96]

To address "the disconnect between various actors in the supply chain, we think there is an exciting opportunity to bring together all parts of Northern Ireland agri-food together to deliver on the massive challenges: climate change, biodiversity, the circular economy, anti-microbial resistance, global competitiveness. 'Green Growth' sums up the ambition. ... The NI Diamond model seeks to create an ecosystem in which the NI government, business, society and the knowledge base work together to pool goals, resources, risks, responsibilities and competences in agri-food."[97]

Mining (SIC B)

Quarries and associated machinery to move materials are present throughout the region, with quarrying in particular a key part of the construction value chain. There appears to be little advisory support for companies directly in the sector.

Nevertheless, NI and, in particular, the MSW region (Tyrone, etc.) is "a global leader in the manufacture of tracked mobile stone crushing and gravel screening equipment",[98] with half of the international equipment in this niche subsector produced from NI, the location of the top five companies in the sector.

Pharma (SIC C20, C21)

As a 10X priority cluster, NI, especially in and near Belfast, has "a strong base of market-leading companies to build from, with a significant number of private enterprises associated with diagnostics, and our universities in the top 10 in the UK for bioscience research".[99] Companies include Almac, Northbrook, Teva (R&D operation in Larne), etc. QUB is in the top 200 academic rankings worldwide for medicine, pharma and nursing. EOCIC (2020) identified biopharmaceuticals (medium-performer) and downstream chemical products (low-performer) as clusters for NI.

MedTech (SIC C32500)

"... Northern Ireland excels at diagnostics."[100] NI has particular strength in diagnostics (e.g. Randox, Diaceutics (with DXRX – the world's first diagnostic commercialisation platform), Axial3D (medical imaging), etc., and has potential for personalised medicine: "... opportunity for increased demand to provide remote and digital medical solutions for our ageing population with more complex needs."[101] The achievement of electronically shared medical records in NI by 2025 will help the sector's innovation significantly. Academic support is strong in QUB and UU, with, in particular, NI Connected Health Innovation Centre. QUB is also highly academically ranked in mechanical engineering, key to medical devices.

Engineering (SIC C24-30)

Embracing areas such as "aerospace & defence, automotive, construction, materials handling, electronics, energy, water and consumer products"[102], engineering is a 10X priority cluster developing NI's "... strong manufacturing heritage combined with world-class innovation" and strong academic research, e.g. NI Advanced Composites Centre, etc. "NI is home to five companies with the SC21 Supply Chain Quality System Gold Award out of nine across the UK."[103]

The leading-edge subsectoral focus and special strength/specialisation include transport (Wrightbus, Spirit Aerospace, Artemis Tech), construction handling machines (Powerscreen,

Caterpillar, cluster in MSW), fixed wind platforms construction (Belfast Harbour is currently unique on the island for such operations) and other marine transport and energy operations (e.g. Harland & Wolff's recent contract win for Royal Navy Fleet Solid Support Vehicles).

There are smaller sub-specialisms such as air seating (Thomson in Banbridge with new Dynamic Test Facility), Resonate (space testing) in Newry, etc., as well as rich capability in precision engineering in both subcomponents and niche products, process engineering (tanks, equipment) as well as general metal fabrication and engineering services.

While most of the sector is around Belfast and eastern NI, Derry/Londonderry is also developing with a proposed new Digitalised Robotics and Automation Centre (DRAC), and Tyrone and other border areas have strong engineering capabilities and long-standing traditions as well.

A major nano-technology project of over £60 million value involves Seagate Technologies in Derry/Londonderry and QUB researchers as part of the Smart Nano NI consortium to create nano-photonics devices and establish a supply chain for these devices into healthcare, optical communications and data storage sectors.[104]

Additional investment to drive subsector specialisation may be required; in particular, the 2022 commitment of the High-Value Manufacturing Catapult to make "... meaningful investments in areas across the UK, including expansions in ... Northern Ireland"[105] should be delivered as a priority and as a major centre based in UU or/and QUB. Adopting new technologies will be critical in areas such as additive manufacturing (3D printing), embedded sensors, IIoT (Industry Internet of Things), new composite materials, sustainable manufacturing, MaaS, Industry 4.0., etc.

Greater linkages with the broader engineering sector in the northern half of the island (through Bormac, etc.) would also be useful and of mutual benefit, as well as with similar engineering clusters in, e.g. Great Britain (West Midlands, etc.) and in Germany (e.g. Stuttgart, Freiburg, etc.).

Wood/furniture (SIC C16, C31)

Euro-clusters (EOCIC (2020)) identified these sectors as a basic-performing cluster for NI with high-performing companies such as Uform, etc. There is potential for more links with ATU Letterfrack facilities and Monaghan companies.

Energy and water production (SIC D, E)

Core to providing regional needs and key in "our transition to a greener, more sustainable economy."[106] NI is already gaining offshore wind expertise with a supply chain in Belfast for Robin Rigg offshore wind farms off northwest England.[107] Belfast Harbour D1 is currently unique on the island of Ireland for assembling fixed large platforms. It has a significant opportunity as a central facility and/or expertise to other regions on the island in developing offshore wind power, etc., as well as servicing GB and other locations.[108]

Other NI ports also have the potential to get involved in various aspects of decarbonisation and renewable energy (such as Larne, Harland & Wolff, and, for the wider northwest, Foyle Port[109]). Onshore wind (B9 Energy, Larne[110]), solar and biomass (Dale Farm solar project, Tully plant[111]) projects are also growing in presence, as well as offshore wind proposals (North Channel Wind).[112]

With Wright Bus a world leader in green hydrogen buses and now proposing to set up a green hydrogen plant to power 300 buses, the Hydrogen Training Academy and Hydrogen Test Beds in Ballymena and other projects, Antrim is becoming a hotspot for green hydrogen.[113]

In support of the industry, there is strong academic research in both QUB and UU and various degrees and other courses provided by the two universities and the further education colleges.

There is also scope to build regional success on the infrastructures and practices of the future. The Belfast Carbon Roadmap[114] specifies a clear route to reducing the city's carbon emissions by 80% in 2030 and 100% in 2050. Measures include improving domestic buildings (insulation, heat pumps, heating controls, electrical upgrades), public buildings (fabric improvements), and petrol/diesel car users switching to cycling, walking, EV, electric bus journeys, etc.

Overall, it is vital to seize the opportunity to adopt a circular economy approach. Some strong NI circular economy companies exist, such as Frylite, which provides fresh oils for cooking and collecting waste oil to convert to biodiesel throughout the island. Much less waste generation and reduced energy consumption throughout the region significantly reduce the need for land infill, waste export, and the use of fossil fuels.

Construction (SIC F)

This significant sector actively provides for NI, island-wide, GB, Europe and further afield. With high academic (QUB civil engineering) and other supports (South West College, etc.) and seen by EOCIC (2020) as a basic-performing cluster for NI (especially in Tyrone with related quarrying and quarry machinery high-performing companies[115]), additional investment to drive sustainability, innovation, research and best practice should be of benefit.

Retail/Wholesale (SIC G)

The sector provides for regional consumer needs, with little HEI/other support for innovation.

Transport (SIC H)

The sector provides for regional consumer needs, with significant post-Brexit changes, challenges, and opportunities requiring additional HEI/other support for innovation.

Accommodation and food service (including tourism) (SIC I)

With its brand *Giant Spirit*, NI is highly rated for tourism offers. Lonely Planet ranks NI as "the Best Region in the World to visit in 2018", with golf, culture, landscape, art and literature as significant draws. "Our artists, writers, rich and unique cultural assets, the authenticity of our visitor attractions, the outstanding landscape and warm-hearted hospitality bring more than 3 million people to our shores annually."[116] Belfast is the highest ranked amongst UK cities for business events.[117] In 2019, 167 cruise trips were docked in Northern Ireland ports (62 in 2013).[118] "This growth … has been dominated by the NI tourism 'hotspots' of Titanic Belfast and the Causeway Coast. By contrast, the performance of the tourism sector in MSW has lagged [with] … overall tourism [falling] … from 17% to 14%" between 2013-18, and a 7% fall in total spending.[119] Key opportunities here include the adjacent *Wild Atlantic Way* and *Hidden Heartland*, and the longer-term development of the Ulster Canal.

In 2019, NI had 13% of overseas tourists to the island and 19% of tourists from across the island (see Appendix 5). NI tourism was boosted by 756k tourists from the Republic of Ireland (up 66% since 2016 and a 104% rise in spend). Northern Ireland Tourism seeks to have its share of ROI tourists spend on the island go from 4.5% in 2016 to 7% in 2019 to 10% over the next three years.[120]

The UUs hospitality faculty's high international academic ranking is a major resource for more investment to progress innovation and opportunities for linkages to University of Galway (Shannon

Catering College) and ATU in these areas. Greater academic research for strategic development and more innovative services for spreading best practices and skills would be important to progress the region's international status. Stronger linkages to the *Wild Atlantic Way* brand, especially for the Mid South West, may also be beneficial.

Information & communications technology (ICT) (SIC J – J58 (Software publishing), J62 (Software development and IT consultancy)

A DoE 10X priority cluster (digital, ICT and creatives (DIC) industries) with NI having "recognised world-class strengths in cyber security, … [and] the opportunity to build upon existing success."[121]

> *… cyber security in particular [is] now an established regional strength … a thriving cluster of more than 100 cyber companies, employing over 2,300 people, has grown up around CSIT (Centre for Secure Information Technologies at QUB), and Belfast's 'titanic quarter' has become the focus of a cyber innovation ecosystem with international standing. Northern Ireland is the #1 international investment location for US cyber security firms, and for financial services technology inward investment projects.*[122]

Eighty-six cyber security offices (31 cybersecurity dedicated offices) are present in NI, over 80% in Belfast and over 60% of jobs in US MNCs.[123] Areas include securing networks and cloud environments (with 28% of employees), managing risk, threats, etc., ID authentication, security operations and managed security services and advice. The aim is to grow employment from 2,300 in 2021 to 5,000 by 2030.

In a V-LINC detailed survey[124] and analysis of connections of NI cyber members (10 companies), "numerous linkages between Belfast and London … and numerous connections with North America and Asia" (p.3) are reported. "NI cyber firms report that 86% of output linkages are outside Northern Ireland, of which 23% is destined for the UK, a further 17% for the European marketplace and 46% with international customers." (p.4).

NI is also the location for six co-location data centres, the second highest concentration on the island after Dublin.[125]

The Connected Places Catapult[126] has worked since 2016 with Belfast City Council to create a Smart Belfast Framework and to develop smart city links with Sejong, South Korea.

Overall, Tech Nation[127] reports NI has over 2,000 companies employing over 20,000 people in the broad ICT sector. According to Digital DNA, 54% of NI's top 100 tech companies are headquartered regionally. Examples of companies include Kainos (London-listed 3,000 global jobs), Catagen (QUB spinout for emissions data for autos), BT Ireland Innovation Centre (with UU and INI), Seagate (1,500 jobs), etc.

Belfast now (2021) ranks as 11th in the Top 25 Tech Cities of the Future and is only one of two in the top 15 cities both on the island (along with Dublin (no. 3)) and the UK (along with London (no. 1)).[128]

The sector overall is supported by QUB's internationally high academic ranking for computer science, the strength of QUB's Centre for Secure Information Technology (CSIT) (recognised by approval of a Regius Professorship for Computer Science and Electronics[129]) and the significant Digital Catapult (and associated Ormeau Baths hub),[130] as well as specific cyber security courses from QUB, UU and Belfast Metropolitan cyber academy.

Further development might include ramping up additional investment in academic research and innovation services in selected areas such as cyber security, RegTech and digital twinning, more programmes like Cyber Security Skills Development Platform, stronger linkages to the Dublin information services/software/cyber cluster and the Cork cyber cluster, even closer involvement with key GB centres, and stronger linkages with international global clusters of expertise and capability. The recent announcement of £20 million for research and skills development will significantly strengthen the cyber cluster in NI.[131] Similarly, the recently announced Software Alliance for NI will build on the wider NI sector's momentum. The Software Alliance was launched in March 2023 "to be the central vehicle through which software engineering companies large and small can collectively set the strategic direction for the industry going forward ... [and] lobby on strategy and policy development, initially [on] labour shortages and skill issues."[132] Holding 'First Friday' (a Silicon Valley-type networking event) in Belfast further builds the ecosystem.[133]

Films and videos (SIC J59)

A thriving Oscar-achieving film industry is evolving, building on the success of Game of Thrones and NI as Westeros, and with the Game of Thrones centre in Linen Mill Studios, Banbridge. The new Belfast Harbour/UU Ulster Studios virtual production facilities are of the highest international standard - tier 1 centre of excellence - and will further boost the industry. Pixel Mill is the focal point for games in Belfast, and there is potential for "satellite mini-hubs in Fermanagh, Derry/Londonderry, and Newry."[134] Future Screen NI[135] and Immersive Labs (Ormeau Baths) are also significant developments.

The ambition of NI Screen is for "Northern Ireland to have the strongest screen industry outside of London in the UK and Ireland."[136] More investment may be required for growth, innovation, and stronger links to Wicklow, Limerick, Connemara and Sligo (games) nodes and LA, London, France, etc., as global centres.

Financial services/FinTech[137] (SIC K)

"Belfast is emerging as a key regional hub delivering innovative financial services, [with] ... over 70 FinTech firms providing 7,000 jobs" and "a technological window of opportunity for NI".[138] Derry/Londonderry is also emerging as a place for FinTech (e.g., the former Shirt Factory is now a hub for FinTech and other digital sector firms). Northern Ireland is considered one of six emerging or specialised financial services hubs in the UK, focused on RegTech, InsurTech, wealthtech, and operations technology.[139] Belfast is ranked as 3rd best location for FinTech in the future and the world's number one destination for FinTech development projects.[140] The aim is to grow from over 70 to 100 firms, with a corresponding increase in employment.[141]

There is a range of financial services companies from global corporate subsidiaries such as Statestreet (Belfast), Aflac NI (US F500 sub) (with Belfast hub for tech/cyber with 150 tech staff), Allstate in Derry and Strabane, FinTrU providing regulatory solutions for investment banking, etc. (with 1k people in Belfast, Derry/Londonderry, Dublin, London, Maastricht and New York). About 1 in 4 financial service jobs are technology jobs.

QUB has highly recognised academic rankings in finance, practice trading rooms (as has UU), and the Finance and Artificial intelligence research laB (FAB) for FinTech.[142] Both universities provide courses for new entrants and existing employees. Closer linkages with the Dublin IFSC and related cluster may be beneficial, and access to Donegal's financial/back office cluster for expansions is already proving useful (e.g. FinTrU, etc.). Linkages with London's financial sector are important to development, as are links with New York, Frankfurt, Paris, Shanghai, etc.

Professional and technical services (SIC M)

Strong supply for capabilities to supply regional needs and beyond, with QUB highly ranked for legal, finance, etc. One example is First Derivatives for financial services, data-related technology and consultancy services. Most global/UK business consultancies, e.g., KPMG, have operations in Belfast. The PwC/Google Innovation Lab is an exciting development.

Environmental consulting services (part of SIC M70)

The sector has a presence in NI that can grow to meet climate change needs. There is strong support from high QUB academic rankings in environmental sciences and Southwest College in Enniskillen and other locations.

Digital business (Administration) services (SIC J63 (Data processing), N822 (Call centres), etc.)

This sector is linked to finance, and there is now an active back-office service sector in Belfast, Derry/Londonderry (Allstate), and Newry (Teleperformance (with related UU/SRC course), which could be more developed overall in NI and also proactively promoted for the Mid South West region. Academic and innovation supports seems low and could be strengthened.

Cultural and leisure (SIC I, R combined)

The industry is a DfE 10X priority sector (as part of DIC Industries) with considerable depth and resources, including QUB performing arts being highly internationally ranked. UU's Creative Industries Institute is also key. Further investment in innovation and greater linkages to the cultural clusters of Dublin/EMR, SR and NWR, as well as to the global cultural clusters of London, New York, France, etc., seem important to further build the broader experience/creatives sector.

Other sectors (SIC O, P, Q, S)

With a public sector with considerable expertise and experience in working through the major challenges of a divided society, there is considerable HEI involvement with highly internationally ranked academic knowledge in both QUB and UU. There are also key think tanks, including the Centre for Cross Border Studies[143] (Armagh), Hume Foundation[144] (Derry), Pivotal[145] (Belfast) and Centre for Democracy and Peacebuilding[146] (CDPB) (Belfast). Education is also highly invested in at the third level, with QUB education highly ranked internationally at 198th in the world[147] and with UU progressing significantly in recent years. At the primary level, the island of Ireland is only one of three systems in the world with competitive entry for teachers (along with Finland and Singapore).

Figures 30, 31 and 32 summarise the sectoral assessment for NI.

Figure 30: Sectoral assessment (NI) 1

Sectoral assessment Northern Ireland 1

Sectors (NACE/SIC)	Presence (H/M/L –E)	Capability (H/M/L)	Gaps to address?	Linkages to build further ?
A Agriculture +	H 10X Priority as "Primary food"	H QUB Agriculture (top 200)	Substantial capability already present	With NWR, EMR (more with UCD?) With GB NE Food Valley, France clusters, NZ
B Mining				
C Manufacturing	H 10X Priority "Advanced Man. + Engineering"	H Strong research and support QUB and UU	Substantial capability already – progress	With adjacent and high performing clusters
Food	H 10X priority ECl meat processing	H QUB Agriculture, IGFS, UU Food Dev, Cafre	More to progress innovation diffusion ?	As above for Agriculture
Chemical/Pharma	H 10X Priority ECl biopharma, chem.	H QUB Medicine, Pharma, Nursing	Substantial capability Present	With medtech Galway and pharma Dublin, Cork, NW With Cambridge cluster
Medical devices	H Diagnostics	H QUB Mech. Eng.(100)	Progress diagnostics and ehealth options	As above
Engineering	H 10 Priority Strong in transport, construction etc.	H QUB Eng NI ACE Strong academic support QUB, UU	HVM Catapult deliver major new Centre with UU/QUB Progress Inn. Diffusion	NWR engineering cluster (Bormac), ATU facilities, GB and German clusters
Other Man.	H Wood + Furniture			Access to ATU(Letterfrack)

Figure 31: Sectoral assessment (NI) 2

Sectoral assessment Northern Ireland 2

Sectors (NACE/SIC)	Presence (H/M/L – E)	Capability (H/M/L)	Gaps to address?	Linkages to build further?
D Electricity E Water	H 10X Priority AME "Energy"	H Offshore wind power (Belfast Harbour) Green hydrogen cluster	Substantial capacity and opportunity to be built on further	To GB (Liverpool, Wales) OWP expertise, and Ecl (France?) With N+WR OWP potential
F Construction	H 10X Priority AME "Construction"	H QUB Civil Eng+, SWC		To TUD Construction Centre; University of Galway (Construct Innovate)
G Retail/wholesale				
H Transport				
IAccommodation+ Food service	H 10X Priority "Tourism"	H UU (Hospitality) 100	More investment to progress innovation?	To University of Galway (Shannon), ATU (Story@ATU)
J Information and Communications (Software etc.)	H 10X Priority "ICT" Cyber and other areas	H QUB Computer Science, CSIT	More investment to progress innovation?	To Dublin and Cork clusters
Films etc.	H 10X Priority GoT	Recent centre ABC	More investment to progress innovation?	To Wicklow, Connemara To LA, , London, France

Figure 32: Sectoral assessment (NI) 3

Sectoral assessment Northern Ireland 3

Sectors (NACE/SIC)	Presence (H/M/L – E)	Capability(H/M/L)	Gaps to address?	Linkages to build further?
K Financial services	M 10X Priority Financial Services	H Strong QUB and UU academic support with "trading floors" and Sandbox	Substantial capacity present	With Dublin IFSC+, and N+WR+ (Donegal, Louth) DCU, NCI Financial London, NY, Frankfurt, Paris, Shangai
M Professional and Tech.Serv.	H Present throughout	H QUB		
Environmental services	H	H QUB Environmental services, SWC		
N Admin. Services	H Present	H QUB Finance		
R Cultural and Leisure	H 10X Priority Films, Art, Literature etc.	H QUB Performing Arts UU Creative Industries Institute	More investment to progress innovation?	With N+WR, Dublin cluster, University of Galway, ATU, and London, France, NY
L, O, P, Q, S, T Other	H esp public sector	H QUB academic Support		

5.3 Sectoral ambition

Feedback from stakeholder consultations (DfE, 2021)

Stakeholder feedback and consultations on the NI clusters ready to adopt enabling technologies are summarised here, as in DfE's (2021) *10X Strategy: Northern Ireland's Decade of Innovation* (Figure 33).

Figure 33: NI clusters ready to adopt enabling technologies

Priority 10X clusters ready to adopt enabling technologies	Additional Gross Jobs* potential over 10y	Definitions
Digital, ICT & Creatives	+ 25,000	The processing and communication of information by electronic means, including transmission and display, incorporates cyber security, AI and data analytics, telecom, mobile and data, networks, healthcare IT, smart cities, sports tech, and digital and entertainment media.
AgriTech	+ 10,000	The application of innovation and enabling technologies to build competitive advantage and transition to net zero across the primary and secondary processing sectors, including genomics, traceability of food, advanced packaging, plant and animal health specialisms, and the application of AI to new agricultural methods.
FinTech/Financial services	+ 11,000	Services and technological solutions to the international financial services industry, including banks, insurance companies, and asset management companies.
Advanced manufacturing & engineering	+ 15,000	Advanced manufacturing uses innovative or cutting-edge technologies and methodologies for improved competitiveness in the manufacturing sectors. It embraces aerospace and defence, automotive, construction, materials handling, electronics, energy, water and consumer products companies.
Life & health sciences	+ 3,000	Specialisation in pharmaceutical, diagnostics, connected health, medical devices and biotechnology with a focus on enhancing wellbeing and providing healthcare solutions.

Source: Adapted from DfE (2021) p.22

Note: Includes replacement as well as new jobs (not net creation). Source DfE 10X /UU EPC.

Towards key sectors

All sectors in Northern Ireland can and should increase incomes, employment, productivity and exports by progressing innovation, digitalisation, lean and sustainability through investing in and improving their capability development and innovation services.

However, it is important to prioritise sectors that can progress through the EOCIC (2020) cluster framework at medium and high levels to become globally recognised as key clusters in growing industries, cascading income and job opportunities throughout the sectoral networks and hierarchies.

Currently, in NI, **non-metallic minerals (quarries)** is the one high-performing cluster reported to be present, according to the EOCIC (2020) methodology.

Biopharmaceuticals and **small electronic goods** are the only medium-performing clusters. **Life-stock processing**, **construction products and services**, **fired materials**, **furniture**, **wood products**, **environmental services**, **downstream chemical products** and **electric power generation & transmission** are all basic-performing clusters. In all, the NI NUTS 2 region has 11 performing clusters. While other sectors and individual companies may be competitive internationally, there is not a critical mass in the region to reach the stage of an internationally performing cluster as classified and measured within the EOCIC (2020) rankings framework.

Clusters to progress and promote over the next seven years to 2030 could include:

Three high-performing clusters

- Progressing **production technology engineering** (for transport, construction, AgriTech, aerospace, windfarms, small electronic goods, etc.) to high-performing level cluster, building on the region's extensive strengths and engineering tradition that goes back to the early 19th century, and seeking to achieve status as one of the top five global locations for the industry, as either a core hub or a critical spoke.
- Progressing **information technology** (cyber in particular) for key vertical software applications, and in particular FinTech and RegTech (the cluster is not currently performing at relative international critical mass in this region/jurisdiction within the EOCIC (2020) rankings framework.
- Promoting **diagnostics** (medical devices) building on the sector's current strengths and recognised excellence, alongside other life sciences subsectors bio-pharmaceuticals/pharma cluster (currently medium-performing) along with downstream chemical products (currently basic-performing).

Three medium-performing clusters

- Progressing systematically to medium-performing the broad **food processing and manufacturing, fishing & farming** sector as a sustainable food system (SFS)(including some new food platforms such as hydroponics, plant-based 'meats', etc.)(with livestock processing now a basic-performing cluster). Currently, the overall food processing cluster is not performing at relative international critical mass in this region within the EOCIC (2020) rankings framework.

- Progressing to initially medium-performing level, **financial and insurance services**, business services of call centres, data-processing, etc., and related professional services. NI is especially strong in FinTech and RegTech, which is included as part of high-performing IT cyber security and associated segments – in practice, FinTech spans both IT and financial services sectors.
- Progressing systematically to initially medium-performing level a sustainable and digitalised **hospitality and tourism** sector, grounded in the creative/cultural industries (based on the region-rich resources of business events ratings, golf, scenic tours, music, dance, literature, visuals, films, crafts (furniture, wood products, etc.) etc., with IP and content being commercially developed). Currently, the overall cluster is not performing at relative international critical mass in this region within the EOCIC (2020) rankings framework.

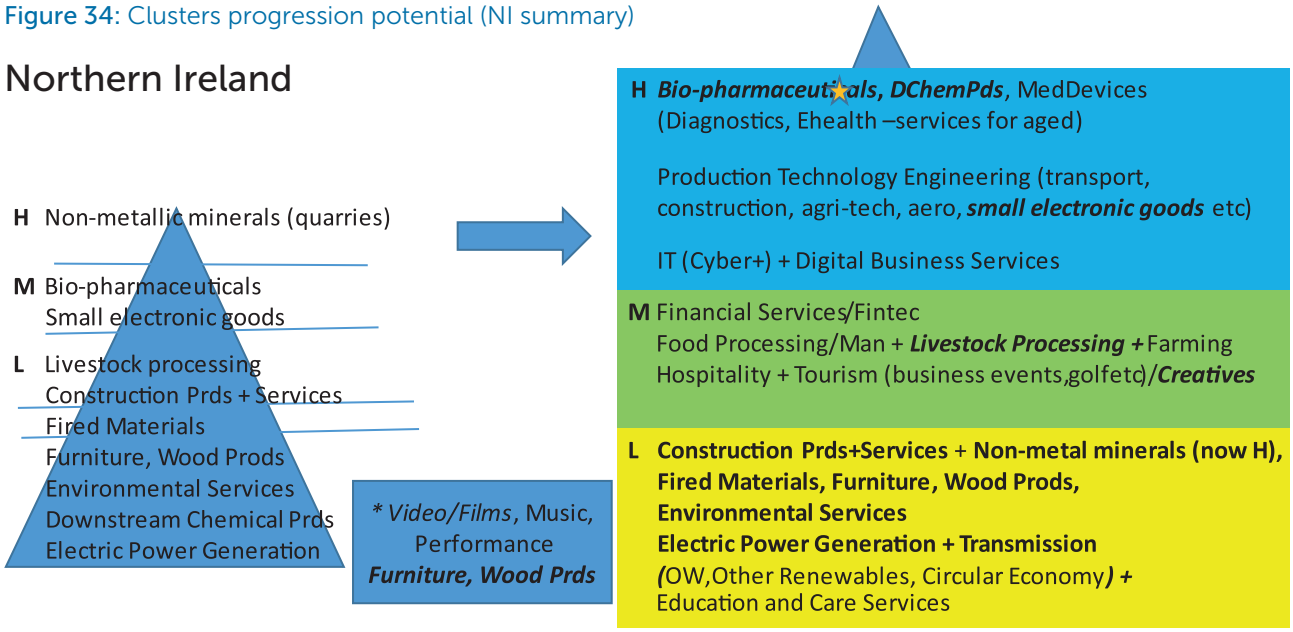
Other basic-performing clusters

- Sustaining as basic–performing **construction products and services** (alongside related clusters such as non-metallic minerals (to be maintained as now a high-performing cluster) and fired materials, furniture, wood products, and environmental services -all currently basic-performing clusters.
- Sustaining at least as a basic-performing cluster **electricity power generation & transmission** to urgently realise the emerging opportunities of renewables and circular economy, especially in offshore wind electricity generation & transmission (alongside Belfast Harbour's unique on-the-island ability to manufacture/assemble the required large fixed platforms).
- Developing further the **education and care services** sector is a major opportunity and resource to progress economic and social development within the region.

In summary (Figure 34), the broad clustering goal for NI to 2030 could be to progress from having 11 performing clusters (one high-performing) to having at least 20 performing clusters within seven broad groups of related clusters (of which three initially at least are high-performing). At least one cluster could be building towards becoming recognised as one of the world's top 5 locations for that industry, as either a core hub or a critical spoke. All sectors should aim to become recognised globally as best-in-class in some aspects of practice and process within their sector. Such a goal and its pathway to achievement need intensive discussion within NI and beyond, as it is a considerable challenge for all stakeholders.

As stated, all sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, it is also critical that the region's specific sectoral skills, expertise and platforms, more general technological, digital, lean and sustainability capabilities and broader inclusive leadership and organisation abilities are all nourished and invested in to underpin NI as an adaptive learning community and system at a multiple of levels.

Figure 34: Clusters progression potential (NI summary)



Note: **bold** is current ranking, ***bold italic*** is promotion, and no bold is currently not ranked within the EOCIC (2022) rankings framework.

5.4 Sectoral development actions

Linking HEIs and FETs and the key sectors

The contribution to sectoral development of QUB and UU and the extensive network of regional colleges is crucial. Focusing on the key sectors is vital, similar to the MIT Local Innovation System. The MIT/LIS approach can be applied to NI (Figure 35).

Figure 35: Sectoral development and HEI/FET interaction in NI (MIT LIS)

	EXISTING INDUSTRIES		EMERGING INDUSTRIES	
Performance levels 2030 Aim	**CONVERT**	**TRANSFORM**	**CREATE**	**TRANSPLANT**
High-performing +		Production technology engineering	(New EngTech)	
		Diagnostics, Medical devices / Biopharma	(New diagnostics) (eHealth aged)	
			(IT cyber, Wearables)	IT cyber, Digital business services
Medium-performing +			(FinTech)	Financial services / FinTech
	(Sustainable farming)	Food processing	(New food formats)	
	(Creatives – Commercial IP)	Hospitality & Tourism / Creatives		
Low-performing	(Construction: Scaling with standards)	Construction products & services Education & care services		Electricity PGT

Note: In brackets () is the subsector part of the broader sector.

Specifying indicative investment priorities

Following the range of potential actions at the sectoral level, some indicative investment priorities can be identified and assessed as to costs and benefits. For various reasons, much of this public investment consideration is already in train (Figure 36).

Figure 36: Indicative clustering investment priorities in NI

Sector	Need	Priority
Medical devices	Focus more academic research on diagnostics (centre) and eHealth services for the elderly	Medium
Electricity (offshore wind)	More expertise for opportunity	High
Construction	Sustainable innovation service	Medium
Retail	Innovation services	Medium
Transport	Innovation services	Medium
Accommodation/Tourism	Greater investment in academic research (centre) and innovation services	Medium
ICT (Cyber)	Major focus on academic research to strengthen the opportunity to be among the top global 5	High
Financial services	Investment in FinTech research	Medium
Creatives/Cultural industry	Films, academic research and innovation services	High
Production engineering	Invest in major NI centre for HVM Catapult	High

6. Eastern and Midland Region (EMR - ROI)

6.1 Summary

Economically, EMR is the largest region on the island of Ireland, with a 2.5m population and 1.3m employment[148] and a great range and depth of sectors present (Table 4). The region has an academic infrastructure of seven universities, four other HEIs and an extensive FET network of ETBs. Trinity has a world university ranking 2023 of 161, UCD and RCSI rank within the 201/250 range, and DCU and MU rank within the 401/500 range.[149] EMR ranks 89th in the EU Regional Competitiveness Index 2019 and is classified as a 'strong innovator'.[150] Based on agency-assisted employment trends 2001-2022, EMR's sub-regions Resistance Index for potential future external shocks is Dublin (9.42), Mid-East (0.89) and Midlands (0.99) (Appendix 3).[151] It has the most performing clusters of all regions on the island (18 performing clusters, with three high-performing)(Figure 37). The region has a range of companies across all sectors (Figure 38). Overall, R&D staff by headcount in 2021 is 22,337 (an increase of 35% on 2017), of which researchers in 2021 total 11,099 (44% of all researchers on the island of Ireland).[152] Enterprise Ireland's HPSU and CSF global start-ups in the region were 77 in 2021 (62% of the Republic's total of 125).[153]

As the administrative centre of ROI, Dublin has the advantages of being the capital of an independent state and a recognised international city.[154] Nevertheless, positioning itself as a competitive global city is challenging, with relatively high pricing levels, major traffic congestion and a significant housing shortage. In the wider region, other urban centres include Maynooth/Leixlip, Athlone, and Dundalk/Drogheda (Co. Louth is adjacent to NWR and was part of the Border NUTS 3 region up to 2014).

The EMR *Regional Spatial and Economic Strategy 2019-31* lays out the opportunities and challenges for the region.[155]

Table 4: Sectoral profiles of the island of Ireland (NI 2011, ROI 2016)

	NWR	EMR	SR	ROI	NI
Agriculture	8.1	2.0	7.4	5.0	2.0
Mining	0.0	0.1	0.0	0.0	1.0
Manufacturing	13.2	8.0	14.0	11.0	10.0
Energy / Water	3.0	3.0	3.8	3.8	2.0
Construction	6.3	4.8	5.9	5.0	8.0
Retail / Wholesale	13.0	12.9	12.5	12.5	16.0
Transport	3.1	4.9	3.8	5.0	4.0
Accommodation / Food	6.4	5.8	6.8	6.3	5.0
Information / Comms	3.1	7.8	3.0	5.0	3.0
Financial, etc.	2.5	7.0	2.9	5.0	4.0
Professional Services	4.4	7.5	5.5	6.0	5.0
Administration / Support	3.1	4.4	3.8	3.8	4.0
Public Admin / Defence	6.3	6.4	5.0	6.3	8.0
Education	10.0	9.1	9.7	9.5	9.0
Health / Social Work	15.0	13.8	13.4	13.3	14.0
Personal Services	2.5	2.5	2.5	2.5	5.0
Total Employed	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO Census of Population 2016; NISRA Census of Population 2011

Note: Data are approximations due to use of different classifications (NACE, SIC), different Census years, and omission of ROI category of "Other sectors", rounding, etc. More update sectoral employment data for both ROI (2022) and NI (2021) should be available during 2023

Figure 37: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A – "Cluster Strengths across 51 individual exporting industry sectors". Company size date is from CSO and NISRA.

Figure 38: EMR – Examples of companies by sector

Agrifood	Boyne Valley FULFIL Guinness Irish Distillers Jacob's Biscuits	Keelings Kerry Group Lir Chocolates Megazyme	O'Brien Fine Foods Panelto Foods Tayto Snacks Teeling Whiskey
Life sciences	3D4Medical AstraZeneca Bimeda Elave Skincare	ICON Iheed MSD Ireland	Pfizer Trulife WuXi Biologics
Engineering	Anord Mardix Ardagh Group Dublin Aerospace	Ericsson Glen Dimplex Grant Engineering	Intel Corporation Marco Beverage Systems Suretank
Construction	Ballymore Cairn	Ecocem Irish Cement	Sisk

IT Software	Continuum	IBM	Version 1
	Cubic Telecom	Integrity360	Ward Solutions
	Ergo	Kitman Labs	Warducks
	Fenergo	Slack	Workday
	HP	Twilio	Workhuman
Digital business	Amazon Ireland	Facebook	Meta
	Buymie	Flutter	Microsoft
	ESW	Google	Oracle
Financial services / FT	AerCap	BNP Paribas	Paypal
	AIB	BNY Mellon	Permanent TSB Group
	ALT 21	Citibank	State Street
	Avolon	Credit Union	Stripe
	Bank of Ireland	Mastercard	Wayflyer
Energy and circular	Bord na Móna	ESB	Hanley Energy
	CoolPlanet	Greencoat Renewables	Mainstream
Hospitality & tourism	Center Parcs (Longford)	Emerald Park	InterContinental
	Dalata Hotel Group	EPIC	The Shelbourne
Creatives	Abbey Theatre	EGG	U2
	Ardmore Studios	Caitríona Balfe	
Other	Aer Lingus	DCC	Penneys
	Arthur Cox	Finline Furniture	Ryanair
	Botany Weaving	KPMG	Smurfit Kappa

6.2 Sectoral assessment

Agriculture/Food/Drink (NACE A, C10/11 Drink)

The region has "a diverse agri-food sector"[156] and a "high-quality agricultural base and multiple RPOs",[157] with beef (Kildare), dairy, equine (Kildare), crops, horticulture (North Dublin), and fishing (Howth, Clogherhead, Arklow) and food (Jacobs, Fulfill, Tayto) and drink (Guinness, Teelings). It has significant research resources in UCD with its high academic global rankings, AgriTech Innovation Centre, related research SFI/EI Centres (MPTC, etc.), and Teagasc research facilities. With strong innovation and research support already in the region, the global expertise of the Kerry Food Research Centre (in Kildare) and further development of the Boyne Food Valley cluster, as well as the TUD Food Innovation Lab, can stimulate consumer food applications and innovation. "With EMR's high-quality agricultural base and multiple RPOs, the region is in a good position to benefit from this global trend (to fortified and functional foods)."[158]

Fish and related blue economy

The sector generates 1,500 commercial fishing-related jobs in EMR[159] with two of the top 10 seafood ports in ROI, at Howth (9% of commercial fishing turnover 2018) and Clogherhead (7%).

Further investment may be needed to reach higher cluster performance rankings and more profound research to benefit the island's primary and secondary processing food industry. Also, the equine industry may benefit from more direct research support and linkages (e.g. with CAFRE, Enniskillen and internationally).

Overall, for the EMR as well as for other regions on the island, the key question is how to evolve "a sustainable food system (SFS) that is profitable throughout (economic sustainability), has broad-based benefits for society (social sustainability) and has a positive or neutral impact on the natural environment (environmental sustainability)". Such a green sustainable food system is based on a "...distinctive food system" on the island overall, for which "the core of ... agrifood output will continue to be grass-based livestock production wherein lies [our] natural competitive advantage".[160]

The implications of this goal and vision and the actions required need continuous reflection at regional and local levels, as well as at jurisdictional and all-island levels.

Pharma/Biopharma/Chemical products (NACE C20/21)

The sector has a substantial concentration[161] in the region, with a strong presence of MNCs (e.g. Pfizer, MSD, etc.), added to by significant recent pharma investment announcements and chemical products in Dublin reaching into the Midlands.[162] Overall, FDI pharma in the EMR represents over 60% of such operations in the Republic (Appendix 4). There is also a range of innovative SMEs providing different products and services. Substantial expertise is available through Trinity and UCD (Nibert, etc.).

MedTech (NACE C325)

Again, significant MNCs, large Irish-origin corporates (ICON), and innovative SMEs and Irish enterprises are present in the region in various MedTech, diagnostics and clinical trials. Dublin and its environs (as well as Athlone) have substantial concentrations of the medical devices industry.[163] There is strong medical-related expertise in Trinity, UCD and RSCI, as well as MU, DCU and DkIT. Diagnostics and clinical trials subsectors are also present, with HSE and HRB resources. eHealth (specifically electronic medical records, processes, and personalised diagnostics) is an emerging subsector that can be further invested in alongside the core MedTech cluster. Greater focus and support will be key for eHealth electronic records and processes from HSE, SFI Insight, etc., and personalised medicine from Trinity, UCD, RSRI Medical Schools, and TUD's MiCRA Biodiodiagnostics Technology Gateway.

Production technology engineering and related subsectors (NACE C24-30)

An extensive engineering sector is present, both as specific sub-clusters such as aerospace services (north Dublin, Louth), semi-conductor chips (West Dublin), vehicles/trailers and parts (Midlands), container tanks (Dundalk) and telecoms (Athlone). Segments include precision engineering in subcomponents and niche products, electrical equipment, process engineering, general metal fabrication, and engineering services.

Substantial supports both in Dublin (SFI Centres I-Form (UCD), Amber (TCD), DCU, etc.) and in Midlands (MU, TUS, IMR, APT, Engenuity cluster) assist the sector, with perhaps more innovative services needed for spreading the opportunity for digitalisation and sustainability. The concentration in the Midlands allows for becoming "known internationally as a centre of excellence in advanced and sustainable manufacturing."[164] Adopting new technologies in additive manufacturing (3D printing), embedded sensors, IIoT (Industry Internet of Things), new composite materials, sustainable manufacturing, MaaS, and Industry 4.0. etc. will be essential.

Encouragement of specific sub-clusters and associated investments would be helpful to further that aim. Deeper linkages with similar clusters on the island (especially in NI, but also NWR and SR) and internationally, such as Great Britain (West Midlands), Germany (Stuttgart, Freiburg, etc.), the USA and China (Shenzhen) could be strengthened.

Wood/furniture (NACE C16, C31)

Sector is extensive in Leinster/Midlands[165] (Navan furniture, Dublin, furniture restoration, etc.) and closer links to Letterfrack and overseas centres of excellence should be encouraged.

Energy and water production (NACE D, E)

Core energy and water production are present here to meet the needs of the island's largest urban concentration, and some major renewables projects (Arklow Offshore, etc.) are in place or being developed. Most of the initial offshore proposals recently approved were on the east coast.[166] Renewables such as offshore wind, tidal energy (e.g., Greenore, Co. Louth has potential, etc.), and green hydrogen (as proposed by Bremore Port, Co. Louth[167]) are major necessities and opportunities in this region. Interestingly, the region – especially Co. Meath – approved over 20 solar projects under RESS1.[168] Geothermal energy is also a growing area of interest.

"There is a notable opportunity for the Midlands to develop significant capacity in the low-carbon economy"[169] in the context of the transition from Bord na Móna peat-fired stations and opportunities for biorefining and bioconversion, and substantial resources have been allocated both within the sub-region and region (SFI Research Centre BiOrbic, UCD etc.).

While Smart Dublin and Smart Docklands are substantial initiatives, the question arises as to whether enough expertise on sustainable cities and energy efficiency, conversion and usage generally is available/being developed for the needs (DkIT in Louth has an energy optimisation and energy storage research group). The experience of Belfast as a smart city is important to tap into.

There is also scope to build regional success on the infrastructures and practices of the future, and it is vital to seize the opportunity to adopt a circular economy approach. Much less waste generation and reduced energy consumption throughout the region significantly reduce the need for land infill, waste export, and the use of fossil fuels.

Construction (NACE F)

Construction in Dublin and the broader region of dwellings, hotels, offices, retrofit/refurbishment, data centres, retail, and infrastructure is strong; Dublin accounts for 30% of new housing completions (over 60% in EMR overall). CIF's Crane Survey had over 80% of cranes in the Republic working in Dublin.[170] Some companies based in the region are strongly internationally competitive (CRH, etc.).

Civil engineering is well supported academically by TCD and UCD as professions, and the recent TUD EI Construction Cluster is an important support, as are linkages with the recently approved University of Galway Construct Innovate Technology Centre. Overall, diffusing best sustainable and digital practices, quality controls and governance and accessing world-class expertise in the global industry could be strengthened.

Retail/wholesale (NACE G)

Dublin is the island's largest retail and wholesale hub and has some major digital online businesses, e.g. ESW, Amazon fulfilment centre, etc. Yet, as an industry overall, there is little focus from an innovation and research perspective (outside of IBEC's Retail Ireland and Skillnet). Some further investment would be useful here.

Transport (NACE H)

Similarly, Dublin, with its airport and seaport, is the critical access point for most of the movement of people and goods to and from the island overall, for example, to GB (London for people, Liverpool for goods, etc.) and to Europe and further afield (people, value-added goods). While civil engineering academic faculties in TCD and UCD provide some support, the question is whether enough expertise is working on sustainable transport systems for a significant conurbation such as Dublin/wider east. With the scale, complexity, interdependence and impact of at least five mega projects - city centre transport integration, metro system, third runway, city-link high-speed rail and port expansion/relocation – the need for systematic and joined-up thinking and big project expertise cannot be overstated.

Accommodation and food service (including tourism) (NACE I)

Dublin and its environs are the major tourism magnet on the island for many reasons. With the most significant number of overseas visitors and a broad and deep range of attractions (shopping, culture, sports, etc.), the opportunity to boost the region's tourism and offer higher quality and impact as part of a broader experience/creatives industry needs to be progressed. Challenges of pricing levels, accommodation availability, transport and access modes, etc., will have to be addressed for that to happen. Outside of Failte Ireland, there is little innovation and academic research support for the industry to develop strategic responses, promote best practices, and build Dublin as a beacon of sustainable tourism. Overall, in 2019, the EMR had 44% of overseas tourists to the island and 23% of tourists from across the island, boosted by Dublin with its status as a major global city and its airport as a gateway to the island (about 70% of flights into the island of Ireland go through Dublin; see Appendix 5).

Information & communications (ICT) (NACE J – J58 (Software publishing), J62 (Software development and IT consultancy)

"ICT is a significant economic sector for Ireland. It has a strong capacity in the EMR, with several globally significant MNCs having their European operational bases in the region... Activity [ranges] from semiconductor manufacturing to software development ... and [is] supported by numerous RPOs."[171] Dublin hosts many well-known large MNCs such as Facebook, Google and others, many of whom are strategic business support services for the EMEA region (e.g. Microsoft has over 3,000 staff in South Dublin, of whom 800 are engineers). Many vibrant Irish enterprises also have software development at their core in various vertical applications (eCommerce, cyber, sports-tech, market analytics, process controls, etc.) and platform development (AI, games, etc.). IDA IT technology operations in Dublin number over 160, which is the biggest share in the Republic

(Appendix). Dublin and its environs contain, by far, the largest substantial concentration of the software industry in ROI.[172]

With 379 (and 100 dedicated) offices, Dublin has 50% of the Republic's cyber security offices and "is home to many of the country's largest tech MNCs and financial services companies with growing cyber security teams, such as Microsoft, Amazon and Zurich. There is a strong base of indigenous SMEs ... such as Integrity 360 and Ward Solutions."[173] Academic and research support for the IT sector in the EMR is substantial in Trinity, UCD, DCU, MU and TUD, and the SFI/EI Centres (Insight, etc.).

The application of AI is a strong opportunity for the region. "However, increasing global competition in AI markets will make it increasingly difficult for the region to defend its strong track record. ... there may be an opportunity to strengthen the network of and relationships between AI research hubs and industry players, as well as presenting a clear and coherent message on the AI offering... ."[174] Another opportunity is ICT for smart grids and smart cities (with a question about the depth of expertise, research, and innovation supports invested in). Also:

> *... further capacity building in semiconductor manufacturing ... the EMR has a long-established presence in the semiconductor industry with representation across the entire value chain and the proven ability to deliver large scale projects across a range of business activities ... [with global] shortages. There is an opportunity for the region to build on its capacity and to engage with opportunities in the EU.*[175]

Most colocation data centres on the island are in Dublin (23 centres).[176] While there are recent constraints on further expansions in Dublin, it does give opportunities for new data centres elsewhere within the region and beyond, assuming energy supply issues can be addressed. (Another estimate puts the total of data centres in Dublin and environs at 77 (of 82 in ROI) – the difference may be counting individual structures.[177])

Dublin is ranked number 3 (2021) after London and Paris in the top 25 Tech Cities for the Future, based on its economic potential (3rd) and FDI performance (3rd).[178] Nevertheless, Dublin ranked less for innovation and attractiveness (7th) and did not rank at all in the top 10 for start-up environment (London, Berlin and Paris are the top three) or for cost-effectiveness (not surprising, especially with the cost/shortage of housing to rent/buy, leading to between 10-30% of jobs offered overseas being turned down). These rankings are all red flags and must be a major cause of concern and focus.

To further progress Dublin to a globally-recognised place for software development, investment in higher academic rankings and a few key subsectors for both platforms and applications (e.g. cyber, sports-tech, etc.) is needed.

Films and videos (NACE J59)

"The audio-visual and creative industry sectors ... are well established with considerable creative industry assets including national broadcasting infrastructure and sizable film studies."[179] Wicklow is one of the island's filmmaking centres, with Ardmore Studios going back some decades and strongly supported by the private sector and Screen Ireland. "Dublin is home to a large number of game development MNCs and indigenous start-ups", while Dublin and elsewhere host a "thriving and prolific animation sector."[180]

For Screen Ireland, "to achieve ambitious growth, a national approach to regional production will be required, co-ordinating a cohesive set of supports and development opportunities"[181] with crew development hubs across the country and working with local authority film offices. Design-based activities, digital creative (games and post-production/visual effects) and content creation across various platforms are all major opportunities for this and other regions. Music publishing and sound recording (as well as creative artists) are strong in Dublin City and its environs.[182]

Financial services (NACE K)

"Within Dublin, the IFSC is critical to the sector [and] home to half of the world's top 50 banks and insurance companies."[183] IDA client companies number over 250 in the region, mainly in Dublin, providing much employment (Appendix 4). There is also a range and depth of Irish-origin enterprises, both as start-ups, scaling, and large companies (Finnego, etc.). Activities include investment management and fund services, investment banking, investment fund and debt listing (Euronext Dublin (previously Irish Stock Exchange) is, since 2018, the global leader for debt fund listings worldwide[184]), trading platforms, corporate treasury operations, insurance and reinsurance and payments.

ROI is the world's leading centre for aircraft leasing. GPA, as a spinout of Aer Lingus, created the industry as a new category, and now over 50% of all leased aircraft worldwide (i.e., a quarter of all global aeroplanes) are handled in Dublin (and Shannon) by companies such as Aercap (the global industry leader). Sustainable finance is steadily increasing, and Dublin already has a cluster of renewable energy infrastructure fund managers.

The region "has a well-established capacity in FinTech, especially in Dublin and along the east coast",[185] with opportunities in RegTech and LegalTech, especially with Dublin as the centre for national banks and regulators and the International Financial Services Centre (IFSC) being a solid base for MNCs.

There are also outlying spokes within the region, such as Dundalk/Drogheda (Coca-Cola Financial Services, Yapstone, etc.). Brexit has motivated several UK-based financial operations to open or increase a presence in Dublin.

While DCU and NCI (located in the IFSC) focus on the sector, the research and innovation investment seems surprisingly low for the sector (e.g., no Sandbox-type incubator in the region). The opportunity for a "digital bridge"[186] between the top global finance MNCs in IFSC and the top global tech MNCs in Silicon Docks, just across the River Liffey, seems too obvious to miss. The Citi Innovation Lab is one such node among several. Overall, the sector could benefit from potential FinTech incubator initiatives involving Central Bank of Ireland (CBI), MNCs and others, as well as some focused research investment, especially in FinTech platforms and applications (e.g. blockchain, paytech, RegTech, InsurTech, etc.) and various forms of sustainable finance, etc.

The aim for the sector overall is that "Ireland will seek to be amongst the top-rated financial centres … at a global and EU level … The sector … has within its grasp the opportunity to be a world leader by 2025 as a location for financial services and as a source of technology and innovation-led solutions."[187]

Professional and technical services (NACE M)

Dublin is the core of most professional services on the island, with management consultancy, architects and engineers, etc., strongly present and stretching into the Midlands and Carlow.[188]

The sector is well-serviced academically by Trinity, UCD, DCU, and Maynooth University**.** More proactive reaching out to such groupings in the other regions, especially to NI (addressing mutual recognition of qualifications in particular) would be mutually beneficial.

Environmental consulting services (part of M70)

Both need and opportunity (including exporting) are substantial. While academic support from Trinity, UCD, DCU, MU, TUD and TUS is high, the question is whether more should be invested in such a key area.

Digital business (Administration) services (NACE J63 (Data processing), N822 (Call centres), etc.)

Dublin City has a substantial concentration of information services activities, office administration, office supports, call centres and other business services, stretching out into the mideast and beyond. Over 155 IDA MNC companies, numerous SMEs, and larger Irish-origin companies are in the region. There are opportunities to develop back-office and remote working outside Dublin City centre, elsewhere within the EMR, and in some subsectors outside the region**.** The research investment and focus seem low for the sector's scale in the region.

Cultural and leisure (NACE R)

Dublin is the hub for many cultural and leisure activities and is strongly supported by Trinity, UCD, DCU, MU, TUD, NCAD, IADT, TUS and DkIT from an academic perspective. It plays a key role in the region's combined experience/creatives Industry.

Other sectors (NACE O, P, Q, S)

Dublin is a globally recognised education knowledge cluster (EOCIC (2020) medium-level cluster). It can be further developed as such, as indeed the HEIs are in the process of doing, both for tertiary (Trinity in top 200 (at 161) and UCD and RCSI in top 201/250[189]), primary (Ireland is one of three locations in the world with competitive teacher entry) and EdTech (with TCD's Learnovate and some interesting EdTech companies).

Dublin is also the centre of administration in the Republic and its door to the rest of the EU. There is strong public policy research and innovation both academically (Trinity, UCD, DCU and MU), as well as a range of public and private leadership development and policy think tanks, etc. (ESRI, NESC, IPA, IMI, IIEA, NERI, TASC, etc.[190]).

Figures 39, 40 and 41 summarise the sectoral assessment in EMR.

Figure 39: Sectoral assessment EMR (1)

Sectoral assessment Eastern and Midland Region 1

Sectors (NACE)	Presence (H/M/L – E) Priority?	Capability (H/M/L)	Gaps to address?	Linkages to build?
A Agriculture +	M Kildare/Meath beef farming North Co. Dublin vegetables+ fruit Kildare equine	H UCD Teagasc	Substantial capability present	
B Mining				
C Manufacturing	Priority			
Food	H Meat-processing (Kildare+);Consumer foods (Louth/Boyne Valley, city suburbs?)	H with EI MTC, UCD TUD for consumer foods? Kerry Group research	More investment in services to progress innovation?	With SR food sector? With French, Italian EOCIC clusters, NorthEast England
Chemical/Pharma	H + Substantial and growing MNC pharma (big + small molecules)	H Lifesciences capability esp. Trinity and UCD (Nibert),SFI/EI	Progress personalised medicine, and more root global academics	With NI diagnostics and SR pharma; with Cambridge etc., German clusters, N.J.
Medical devices	M MNCs/SME/ICON present +	H UCD + Trinity, SFI/EI Centres	E-Heath (records) as need and opportunity	With NI Diagnostics + Galway Med-tech cluster
Engineering	H (Dublin – Intel, aerspace services, Midlands auto), telecoms Athlone	H Trinity + UCD, SFI/EI Centres	Innovative services in Midlands (TUS?)	With NWR, NI engineering With West Midlands, German auto clusters, Detroit Georgia (Evs) others

Figure 40: Sectoral assessment EMR (2)

Sectoral assessment Eastern and Midland Region 2

Sectors (NACE)	Presence (H/M/L-E)	Capability (H/M/L)	Gaps to address?	Linkages to build further?
D Electricity E Water	H core production + Offshore Wind (Arklow)	M Trinity and UCD	Not enough expertise in sustainable cities?	With global cities best sustainable practices (?) OW with NWR/NI/SR
F Construction	M esp. core services	H Trinity, UCD,TUD (Cluster)	More innovative services to diffuse best practice?	With NWR/NI/SR, and Euroclusters
G Retail / wholesale	H Dublin island's retail hub; some digital (EWS)	L little? (Retail Ireland, Skillsnet)	More innovation services and research centre	With leading edge retail researchers (?); NWR/NI/SR
H Transport	H Critical access point L for island; esp for GB	L	Ditto	Ditto
I Accommodation + Food service (Tourism+)	H+ major tourist magnet;	L little research? Bord Failte	More innovation services and research centre ??)	With NWR/NI/SR, and world strategic and research expertise
J Information and Communications (Software etc.)	H ICT MNC EMEA services, and Irish software sub-clusters	H Trinity, UCD, DCU Smart Dublin SFI/EI Centres	Focus on developing a few subclusters ? (applications, platforms) Invest for higher ranking	Ditto
Films etc.	H Wicklow core	M sectoral expertise	Enough commercial training?	With LA, Euroclusters in France

Figure 41: Sectoral assessment EMR (3)
Sectoral assessment Eastern and Midland Region 3

Sectors (NACE)	Presence (H/M/L-E) Priority?	Capability (H/M/L)	Gaps to address?	Industry Linkages to build?
K Financial services	H IFSC+ some fintech	M - Trinity, DCU, UCD, NCI	No research centre? Needs Sandbox (CBI etc.)? More for fintech (blockchain)	NY (CBS), Frankfurt, London, Shangai +
M Professional and Technical services	H Core of areas in Republic	H Trinity, UCD, DCU		With NI, SR, NWR
Environmental services	M Some organisations + expertise	H Trinity, UCD	Given need and export opportunity, more invested?	With global centres of best practice?
N Digital (Administration) Services	H Range of services and call centres	L - little focus?	Potential to back-office out of Dublin City centre to Dublin suburbs, elsewhere within EMR and NWR, NI, SR	With NWR Centres of global expertise in digital backoffice and call centres
R Cultural and Leisure	H core on island for many areas;	H Trinity, UCD, DCU		
L, O, P, Q, S, T Other	H Education Cluster Centre of government services	H Trinity, UCD, DCU, IPA		With global centres of best practice? Links to Brussels and other EU capitals as critical. London vital also.

6.3 Sectoral ambition

Feedback from stakeholder consultations (DBEI, 2022)

As in other regions stakeholders were asked to identify the existing sectoral strengths in the EMR along with the new and emerging areas of opportunity in their region. These were areas which could develop critical mass over the next seven years, creating new enterprises, employment, exports and value added to the regional and Irish economy.

In order to assist stakeholders, several sectors were identified based on regional data from the DETE enterprise agencies. These were divided between existing and emerging sectors. Stakeholders were asked whether they agreed with the sectors identified by DETE and whether any further sectors needed to be identified. The sectors presented to stakeholders were:

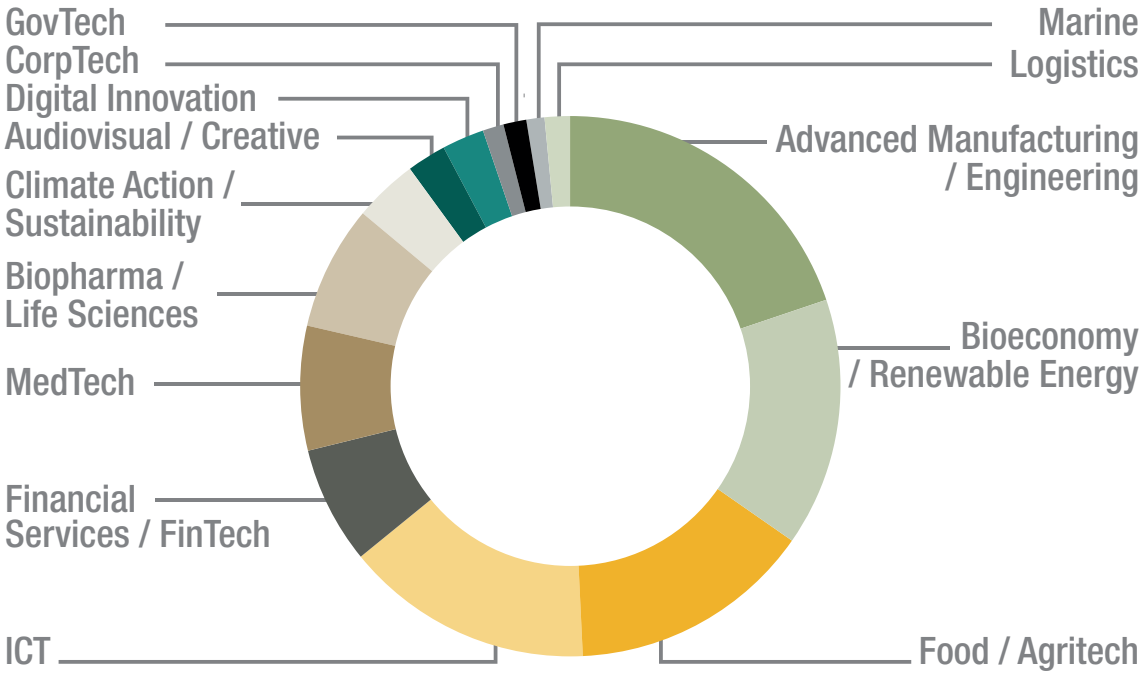
- *ICT;*
- *Biopharma/Life Sciences;*
- *Engineering;*
- *Food/AgriTech*
- *Financial Services/FinTech;*
- *Advanced Manufacturing;*
- *Audiovisual.*

Four sectors comprised over half of all EMR submissions. These were Advanced Manufacturing/Engineering, Bioeconomy/Renewable Energy, Food/AgriTech and ICT. This reflects the focus on the digital and green transitions and ongoing strength in

both nationally and internationally in these areas. Other sectors of interest included Financial Services/FinTech, Biopharma, MedTech, Audiovisual/Creative and Marine. As in other regions retail and tourism are excluded. An overview of the sectors referenced in consultation is presented in Figure [42].

There are a wide range of sectors of scale in the EMR. However, the main sectors with high employment and innovation capability are advanced manufacturing, audiovisual/creative, bioeconomy/renewable energy, biopharma and life sciences, financial service/FinTech, food/AgriTech, ICT and marine/maritime.[191]

Figure 42: Identified sectoral strengths and opportunities for the EMR



EMR: Towards key sectors

All sectors in the EMR region can and should increase incomes, employment, productivity and exports by progressing innovation, digitalisation, lean and sustainability through investing in and improving their capability development and innovation services.

However, it is important to prioritise sectors that can progress through the Euro-cluster medium and high levels and become globally recognised as key clusters in growing industries, cascading income and job opportunities throughout the sectoral networks and hierarchies.

In the EMR, high-performing clusters are **information technology** and **insurance services**. Medium-performing clusters are **business services**, **financial services**, **education knowledge**, **communication equipment & services**, **transportation & logistics**, **distribution and eCommerce**, **vulcanising/fired materials** and **printing services**. Basic-performing clusters are **hospitality & tourism**, **video production & distribution**, **jewellery & precious metals**, **appliances**, and **paper & packaging**.

The EMR region has 18 performing clusters (three of which are high-performing clusters), the highest of any NUTS 2 region on the island.

While other sectors and individual companies may be competitive internationally, there is not a critical mass in the region to reach the stage of an internationally performing cluster as classified and measured within the EOCIC (2020) rankings framework.

Clusters to progress and promote over the next seven years to 2030 could include:

Three high-performing clusters

- Maintaining and indeed improving the **information technology cluster** (with particular strengths as MNCs strategic business services for EMEA, and also associated IT start-up and scaling ecosystem for mainly vertical software applications, such as sporttech, FinTech, eHealth (e-records and processes), operations processes software, etc.) as high-performing.
- Promoting the **bio-pharmaceutical/pharma industry and related MedTech** (especially for developing eHealth records and processes) to build its status in the direction of one of the top five global locations for the industry as either a core hub or a critical spoke.
- Promoting to high-performing level the related clusters of **financial, insurance, and business services** (especially international financial and legal expertise)(currently all medium-performing).

Three medium-performing clusters

- Progressing to medium-performing level **production technology engineering** and related sectors (computer products and services (telecoms)(now medium-performance), appliances (now low-performing), computer chip production, aerospace services, auto parts and services). However, the overall cluster is not performing at relative international critical mass in this region within the EOCIC (2022) rankings framework.
- Maintaining and sustaining medium-performing **distribution, eCommerce, and transportation & logistics clusters**.
- Promoting to medium-performing initially the **hospitality & tourism cluster, alongside creatives** (based on the region's rich resources of video/film production, music, performance arts (literature, dance, visuals, etc.) and crafts (jewellery)) with IP and content being commercially developed)(which are now either low-performing or not at critical mass of performing cluster); and also alongside strengthening **education knowledge** (tertiary, primary and EdTech (now already medium-performing).

Other basic-performing regional clusters

- Promoting to basic-performing level initially the **broad food processing & manufacturing**, fishing, equine & farming sector as a sustainable food system (SFS) (including the livestock processing sector as well as some new food platforms such as hydroponics, plant-based 'meats', etc.). Currently, a cluster not performing at relative critical mass in this region.
- Developing as initially basic-performing **electricity power generation & transmission** to urgently realise the emerging opportunities of renewables, especially in offshore wind electricity generation and circular economy opportunities

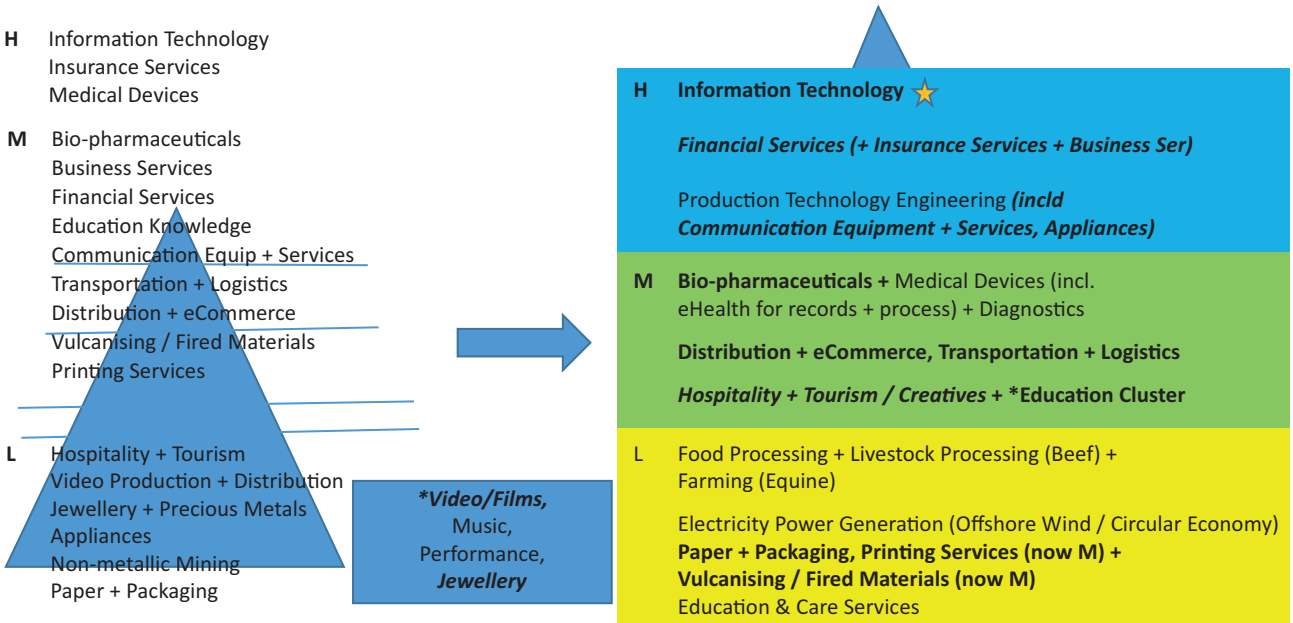
- Maintaining and sustaining at least basic-performing **paper & packaging, printing services and vulcanised/fired materials** (the latter two are currently medium-performing).
- Developing further the **education & care services sector** is a major opportunity and resource to progress economic and social development within the region.

In summary (Figure 43), the broad clustering goal for the EMR region to 2030 could be to progress from having 18 performing clusters (three high-performing) to having at least 21 performing clusters in 8 groups of related clusters (three high-performing). At least one cluster could be building towards becoming recognised as one of the world's top 5 locations for that industry, as either a core hub or a critical spoke. All sectors should aim to become recognised globally as best-in-class in some aspects of practice and process within their sector. Such a goal and its pathway to achievement need intensive discussion within the region and beyond, as it is a considerable challenge for all stakeholders.

As stated, all sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, it is also critical that the region's specific sectoral skills, expertise and platforms, more general technological, digital, lean and sustainability capabilities and wider inclusive leadership and organisation abilities are all nourished and invested in to underpin the EMR as a learning community and system at a multiple of levels.

Figure 43: Clusters progression potential (EMR summary)

Eastern and Midland Region



Note: **bold** is current ranking, ***bold italic*** is promotion, and no bold is currently not ranked within the EOCIC (2022) rankings framework.

6.4 Sectoral development actions

Linking HEIs and FETs and the key sectors

The contribution to sectoral development of the HEIs in the region and the extensive network of ETBs is crucial. Focusing on the key sectors is vital, similar to the MIT Local Innovation System. The MIT/LIS approach can be applied to the EMR (Figure 44).

Figure 44: Sectoral development and HEI/FET interaction in EMR (MIT LIS)

	EXISTING INDUSTRIES		EMERGING INDUSTRIES	
Performance levels 2030 Aim	**CONVERT**	**TRANSFORM**	**CREATE**	**TRANSPLANT**
High-performing +		Biopharma / MedTech	(eHealth records)	
		IT, Digital business services, IT cyber / vertical app	(IT Software, Cyber, Wearables, etc.)	(IT, Digital business services/software)
		Financial, Insurance & Business services	(FinTech (Blockchain))	
Medium-performing +		Production technology engineering	(New EngTech)	
	Distribution, eCommerce	Transport & Logistics		
	(Creatives – Commercial IP)	Hospitality & tourism / Creatives		
Low-performing	(Sustainable farming)	Food processing	(New food formats)	
	(Construction: Scaling with standards)	Construction products & services		
		Education & care services		Electricity PGT
		Paper & packaging Printed services Fired materials		

Note: In brackets () is the subsector part of the broader sector.

Specifying indicative investment priorities

Following the range of suggested actions at the sectoral level, some indicative investment priorities can be identified and assessed as to costs and benefits (Figure 45).

Figure 45: Indicative clustering investment priorities in EMR

Sector	Need	Priority
Agriculture / Food	Some extra focus on already strong academic research to ensure competitiveness. More new food platforms research Extra equine research with other regions (Enniskillen, Ballinasloe, etc.)	Medium
Pharma	More research investment into personalised medicines	Medium
Medical devices	Research investment for eHealth (records, processes)	Medium
Electricity / Renewables	Increase expertise to avail of the opportunity	High
Construction	Develop innovation services	Medium
Retail / Transport	Invest in a retail technology centre, eCommerce and innovation services. Build further expertise in sustainable transport and smart cities	High
Accommodation / Tourism	Academic research focused on sustainable urban tourism	Medium
Financial, insurance businesses	Centre for Financial Services Development and Governance Investment in FinTech Sandbox/FAB lab (with CBI etc.)	High
ICT (Software)	Major focus on increasing academic rankings on AI, big data and related areas to progress to within the top 5 global locations Research investment in key areas, e.g., smart city, travel tech, sportstech	High

7. Southern Region (SR – ROI)

7.1 Summary

With a population of 1.7m and 820k employment,[192] the SR has the strong urban centres of Cork, Limerick and Waterford and a range and depth of sectors, companies and expertise (Table 5). The region has an academic infrastructure of five universities and an extensive FET network of ETBs. UCC has a world university ranking 2023 within the 301/350 range.[193] UL is strongly developing towards a research-intensive university, and the three technology universities were former Institutes of Technology. The European Commission ranks SR as a 'more developed region' and 'strong innovator'.[194] Based on agency-assisted employment trends 2001-2022, SR's sub-regions Resistance Index for potential future external shocks is Southwest (1.75), Southeast (1.39) and Midwest (1.57) (Appendix 3).[195] Overall, R&D staff by headcount in 2021 is 6,938 (an increase of 5% on 2017), of which researchers in 2021 total 3,343 (14% of all researchers on the island of Ireland).[196] Enterprise Ireland's HPSU and CSF global start-ups in the region were 25 in 2021 (20% of the Republic's total of 125).[197]

EOCIC (2020) implies eight performing clusters for the SR and two as high-performing (Figure 46). The region has a range of companies across all sectors (Figure 47). With strong co-ordinated growth and development, the three urban centres (along with Galway) have the potential to be the counter-balancing urban arc to the Dublin/eastern metropolis.[198]

The Southern Region Assembly (2020) *Regional Spatial and Economic Strategy* outlines its vision and the strengths and challenges for the region.[199] Further sectoral analysis is detailed by consultants Babel in the Southern Regional Assembly's (2021) *Regional Approach for Development of a Smart Specialisation Strategy in the Southern Region*

Table 5: Sectoral profiles of the island of Ireland (NI 2011, ROI 2016)

	NWR	EMR	SR	ROI	NI
Agriculture	8.1	2.0	7.4	5.0	2.0
Mining	0.0	0.1	0.0	0.0	1.0
Manufacturing	13.2	8.0	14.0	11.0	10.0
Energy / Water	3.0	3.0	3.8	3.8	2.0
Construction	6.3	4.8	5.9	5.0	8.0
Retail / Wholesale	13.0	12.9	12.5	12.5	16.0
Transport	3.1	4.9	3.8	5.0	4.0
Accommodation / Food	6.4	5.8	6.8	6.3	5.0
Information / Comms	3.1	7.8	3.0	5.0	3.0
Financial, etc.	2.5	7.0	2.9	5.0	4.0
Professional Services	4.4	7.5	5.5	6.0	5.0
Administration / Support	3.1	4.4	3.8	3.8	4.0
Public Admin / Defence	6.3	6.4	5.0	6.3	8.0
Education	10.0	9.1	9.7	9.5	9.0
Health / Social Work	15.0	13.8	13.4	13.3	14.0
Personal Services	2.5	2.5	2.5	2.5	5.0
Total Employed	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO Census of Population 2016; NISRA Census of Population 2011.

Note: Data are approximations due to use of different classifications (NACE, SIC), different Census years, and omission of ROI category of "Other sectors", rounding, etc. More update sectoral employment data for both ROI (2022) and NI (2021) should be available during 2023

Figure 46: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A

Figure 47: SR - Examples of companies by sector

Agrifood	Dairygold Dawn Meats Folláin	Glanbia Kerry Group	Nestlé O'Hara's
Life sciences	Agilent Atlantia Clinical Trials Bausch + Lomb BD Enniscorthy Biomarin Gilead	Horizon/Amgen Janssen LEO Pharma Lilly Merck	Pfizer Regeneron Spearline Stryker Validant
Engineering	Analog Devices Burnside Eurocyl Dairymaster	Induchem Group Johnson Controls Liebherr	Tanco Taoglas Wilson Engineering
Construction	Conack Construction	Conradh Construction	

IT Software	Apple Cognizant Dell	Malwarebytes NetApp	Smarttech Qualcomm
Digital business	Abtran Eli Lilly	Eishtec Netwatch	Rigney Dolphin Telus
Financial services / FT	Carne Group Citco	Fexco Global Shares	Willis Towers Watson
Energy and circular	AMCS EPS	Schneider Electric	Wisetek
Hospitality & tourism	Dromoland Castle	Park Hotel Kenmare	
Creatives	Cartoon Saloon	Crawford Art Gallery	Troy Studios
Other	Nolan		

7.2 Sectoral assessment

Agriculture/Food (NACE A, C10/11), Mining (NACE B)

> *The AgriFood sector in the SR is well developed being home to world-class research centres of excellence … The key players and companies in the Irish dairy industry are concentrated in the SR … [with] the highest proportion of specialist dairy farms … [and] … Ireland's ruminant production systems have one of the lowest carbon footprints in the EU due to the predominantly grass-based dietary plan for Irish cows. … The Irish dairy sector is striving to be a global leader in the development of high-value, environmentally sustainable products. AgriTech research in the region involves livestock management, livestock nutrition, sustainable agriculture, and precision agriculture.*[200]

Also, functional foods and nutraceuticals (for infants, seniors and sports), high-value ingredients, new flavours and product/category variations and novel product development are all well supported by research centres (such as SFI Vistamilk, EI/IDA Dairy Processing Technology TC and Teagasc Centres (Moorpark)).

Fish and related blue economy

Generating 2,475 jobs in the south-west NUTS 3 region and 1,140 in the south-east region,[201] SR has five of the top 10 seafood ports in ROI with Castletownbere (21% of commercial fishing turnover in 2018), Kilmore Quay (13%), Union Hall (5%) and Dunmore East (2%).

Overall, the SR is the centre of Ireland's primary dairy sector, with other forms of farming also present, and with fishing in SW. Global companies present include Kerry, Tirlan (Glanbia), Dairygold, Nestlé, and a host of innovative SMEs (Follain, O'Hara's). Academic and research support is strong, with UCC and Teagasc long active in the area and, more recently, UL, MTU and TUSE. There appears to be little focus on innovative platforms, such as vertical farming, insect cultivation, lab-grown meat, etc. The development questions might be whether there are enough innovation

services to spread the latest practices and ideas for SMEs in particular, whether there is a clear and sufficient focus on consumer food products wider than dairy-related products, and whether there are strong enough linkages to and learning from other global centres (e.g. Piedmont/Emilia-Romagna for consumer foods, New Zealand for dairy, North East England Food Valley, etc.). Locating a new veterinary school in one of the region's HEIs also seems important for developing the region's agrifood ecosystem.

Overall, for the SR as well as other regions on the island, the key question is how to evolve "a sustainable food system (SFS) is profitable throughout (economic sustainability), has broad-based benefits for society (social sustainability) and has a positive or neutral impact on the natural environment (environmental sustainability)."[202] Such a green, sustainable food system is based on a "... distinctive food system" on the island overall, for which "the core of ... agrifood output will continue to be grass-based livestock production wherein lies [our] natural competitive advantage."[203]

The implications of this goal and vision and actions required need continuous reflection at regional and local levels, as well as at jurisdictional and all-island levels. The potential of a 'food diamond' linking key stakeholders within the region to deliver such a goal might be considered.[204]

Pharma/Chemicals (NACE C 20/21)

"The SR has a strong presence of pharmaceutical companies and RPOs conducting state-of-the-art life sciences R&D."[205] Cork is fundamental to Ireland's pharma industry with world-class MNC facilities and substantial research support in UCC, UL and related SFI/EI centres. Pharma in the SR around Cork focuses on drug substance chemical synthesis, and around Waterford, it focuses on drug product manufacturing.[206] Also, Limerick has several chemical products companies.[207] Overall, overseas FDI in and around Cork City and south coast towns is significant (with 37 plants)(Appendix 4).

Further development may be needed to achieve higher cluster rankings to achieve international academic rankings in the related pharmaceutical disciplines and associated research centres, especially around production at scale (process analytics, model predictive control, etc.) and leveraging clinical and translational research.

MedTech (NACE C325)

A range of MedTech operations in orthopaedics, prosthetics, cardio, etc., are present (Striker, BD Enniscorthy, etc.), with substantial concentrations around Cork and Limerick.[208] Academic and research support is substantial (Tyndall ICT for Health Strategic Programme, HSE Health Innovation Hub, HRB Clinical Facility, etc.). There is an opportunity "to develop personalised, precision medicine through new generations of Smart Medical Devices and to deliver novel solutions for diagnostics, connected health, smart drug delivery systems, cardio and neural recording and modulation, and minimally invasive surgery."[209]

Babel outlined areas to be addressed to achieve such and similar ambitions for the overall life sciences sector in the SR:

> *Stakeholders, during the workshops, highlighted [slow] application and commercialisation of ... strong academic research ... in the region ... need for specialisation ... lack of funding for the proof-of-concept stage, ... need for investment and support in the supply chain and service industries [for] life sciences, ...[industry-specific] apprenticeships, digitalisation ... upskilling, SMEs lack [of] financial support for*

investing in new technologies and new machinery, and the opportunity to test the technology. … While the region has strong skills in clinical research, significant efforts are required to encourage innovation and new ways of thinking. … the health care sector needs to be brought together to encourage innovation and specialisation … need for facilitating dialogue between the MNCs, indigenous companies, government and academia … [and supporting] understanding and adoption of cluster-based innovation."[210]

Production technology engineering and related subsectors (NACE C24-30)

Advanced manufacturing and production engineering have strong elements in the region around engineering for processing industries of food and pharma in south west, aerospace (aircraft maintenance, etc.), autos (e.g. autonomous/connected vehicles, EVs, drones), industrial chips manufacture and design (ADI Analogue, Tyndal[211]) and electrical equipment in Limerick/Shannon, AgriTech in Kerry, marine industry in Cork and elsewhere, and telecoms and renewables around Waterford/SE. Segments include precision engineering in subcomponents and niche products, process engineering (tanks, flow equipment, controls and analytics), and general metal fabrication and engineering services. Adopting new technologies in additive manufacturing (3D printing), embedded sensors, IIoT (Industry Internet of Things), new composite materials, sustainable manufacturing, MaaS, Industry 4.0., etc. will be key.

Shannon has the "largest aerospace and aviation cluster in Ireland, with over 50 firms and growing. … The automotive sector is also significant for the region, supported by the vehicle of the future cluster …. and investments in the relevant technologies across the mobility landscape are continuing to accelerate."[212]

Academic and research support is substantial in UCC (Tyndall, etc.), UL, etc. "While all advanced manufacturing technologies are deployed in the region … there are particular specialisms evident in the strongly competitive sub-sectors of Sensor Technology and Networks [and] … intelligent systems."[213] Also present are opportunities for further development of sustainable manufacturing and related energy and waste production. The region has research and innovation strength in engineering and ICT design aspects, such as industrial product design, UX-tech, service design, AI-based design, etc.

Energy and water production (NACE D, E)

Energy production is a core part of the region's capability, and a major "opportunity for the SR to become an international hub for energy innovation" is present owing to "strong renewable energy resources including wave, tidal and offshore wind … best solar resource in Ireland."[214]

Specific opportunities and resources include:

- Cork's depth in marine research and facilities has much potential and, along with Cork Energy Hub, can be leveraged for wave, tidal and offshore wind technologies, smart ports/harbours and smart ships for adoption throughout the region and beyond.
- Construction of the Moneypoint green energy hub – floating offshore wind farm, wind turbine construction hub, green hydrogen production storage and generation facility, etc.[215]

- "Nautilus Data Technologies, in partnership with the Shannon Foynes Port, is to develop the first set of floating data centres in Europe, employing water cooling technology that increases efficiency, tackling high energy usage and emissions from data centres globally – establishing a new trend: blue-green data centres."[216]
- For servicing offshore wind projects and building and assembling both fixed and floating platforms, "Shannon Foynes is in a strong geographic position in relation to natural deep water and proximity to south-west projects."[217] Other locations in the Shannon Estuary and throughout the SR can also develop.
- "... to develop biorefining technologies based on renewable biological resources" [218] (with the National Bioeconomy Campus in Lisheen, Co. Tipperary), with outputs of biodegradable plastics, biomass for food, bioconversion, biocomposites for construction, transport, etc.[219]
- "Ireland currently exports half of [its] hazardous waste" from life sciences manufacturing. There is a "... strong opportunity to invest in waste and wastewater management ... [as well as] energy-efficient production and ... use [of] low energy during operations."[220]
- Perhaps not surprisingly, over half of the RESS1 solar projects are in the SR, mainly in counties Cork and Wexford.[221]
- "Ireland's first Nearly Zero Energy Building (nZEB) training centre is in Enniscorthy",[222] and this expertise can be leveraged into a sub-specialism of services, etc.
- Developing "region-specific bio-resource data models" ... to inform a network for "biomass supply chain sustainability".[223]

There is also scope to build regional success on the infrastructures and practices of the future, and it is vital to seize the opportunity to adopt a circular economy approach. Much less waste generation and reduced energy consumption throughout the region significantly reduce the need for land infill, waste export, and the use of fossil fuels.

Construction (NACE D, E)

There has been some deep experience gained in building for the MNC sector, especially pharma (cleanrooms, etc.). Also, 10% of new dwellings completed are in Cork and wider SR. Some strong companies are present for servicing the regional and broader markets and providing some international services (e.g. Conack). There seems to be little academic support and a need for more innovation services to progress innovation. Linkage with the new University of Galway Construct Innovate centre and TUD construction innovation expertise would be important.

Retail/Wholesale (NACE G)

Various retail and wholesale operations respond to regional markets well, especially in Cork and Limerick. Still, there seems to be little research on strategy development and innovation support for best practices.

Transport (NACE H)

The SR is a critical access point to France, the rest of the EU and south Wales/England, with Rosslare and Cork as key points. Shannon and Cork provide air access, and Cork, Limerick, and Waterford are vital ports. Again, there may not be enough academic research for strategy development and innovation support for best practices in the sector.

Accommodation and food service (including tourism) (NACE I)

The region historically has a strong tourism industry with a depth and range of offers (scenery, culture, sports, etc.) and seminal brands (*Wild Atlantic Way*, *Ancient East*, *Hidden Heartland*), especially in SW and MW. It has, however, insufficient academic research for strategy development and innovation services back-up (there are groups such as UL's National Centre for Tourism Policy, University of Galway's Shannon catering college and the proposed ETB training centre in Killarney). In particular, the challenge of systematic and slow tourism and further development of innovative offer formats for sustainable and experience tourism needs addressing. (Ballyhoura has long been a developer of such new approaches.[224])

Overall, in 2019, the SR had 27% of overseas tourists to the island, the highest share after Dublin and driven by Kerry (Killarney), Cork City and Limerick City. SR also took 34% of tourists from across the island, the highest percentage of the NUTS 2 regions (see Appendix 5).

Information & communications (ICT) (NACE J – J58 (Software publishing), J62 (Software development and IT consultancy)

"Ireland [including SR] has become the global technology hub of choice when it comes to attracting the strategic business activities of ICT companies. … The SR has Ireland's highest ICT research capacity and infrastructure to support the digitalisation of manufacturing, energy, transport … agriculture and health."[225]

The SR has over 80 IDA IT Tech operations, with 45 in Cork (Apple, Dell, etc.) and 30 in Limerick (Appendix 4). Tech Industry Alliance serving the southwest has over 250 companies participating.[226] Cork is one of the two substantial concentrations of the software industry (with Dublin) in ROI.[227]

"Cork is the centre of Irelands cybersecurity cluster … with top 5 worldwide security software companies, over 40 MNCs with cyber security operations, over 60 Irish cyber security companies and start-ups, and over 6,000 people working in cyber security industry, … [and an opportunity for] significant job creation."[228] While Dublin has more cyber-involved companies, Cork has the greatest density of cyber companies in the Republic, with 129 cyber security offices and 37 dedicated offices.[229] "It is home to US firm McAfee's Centre of Excellence and Trend Micro's EMEA HQ, as well as the national cyber security cluster, … hosted at MTU." There is also investment in academic expertise, while greater access to innovation services and supports and strengthening of linkages through Cyber Ireland, etc., to Dublin, Belfast, and Galway centres on the island and international centres of expertise would be critical.

In a V-LINC detailed survey[230] and analysis of connections of Cyber Ireland members in the southwest (11 companies), "a highway of linkages between the south-west and Dublin exists… respondents are heavily connected across Europe … and [with] numerous connections with North America and Asia)"(p.3). "Cyber Ireland respondents report that 95% of output linkages are reported outside Ireland, with 54% destined for the European marketplace and 41% for international markets."(p.4).

> *In the midwest there is a growing cluster of international sports tech companies concentrated in the region which … could become a springboard for a unique new area of specialisation which intersects with software, ICT, media, health, nutrition, wearables, etc.*[231]

The emergence of eSports with the set-up of WYLDE Academy in Cork City (with a degree delivered in partnership with Belfast Metropolitan College) is particularly interesting.[232]

Also, in the midwest, aviation and travel tech are driven out of the Shannon Propeller Accelerator, supported by Shannon Group IASC.[233]

The telecoms subsector is present in SE due to SETU (formerly WIT) research and SFI/EI investment and can link closely with EMR's Athlone telecoms cluster around Ericsson.

Overall, a growing and emerging ITS applications sector, especially in Cork and Limerick, has strong UCC, UL, MTU and other HEIs' supports and EI/SFI supportive centres (LERO, etc.).

Films and videos (NACE J59)

Limerick (Troy Studios and the ENGINE training hub) is one of Ireland's film hubs capable of further growth, which may benefit from more targeted academic research and innovation around digitalisation, etc., in the sector. Kilkenny hosts Cartoon Saloon as a major independent animation studio.

Financial services (NACE K)

"The SR has developed a strong financial services base, ... with Cork now hosting Ireland's second-largest cluster of international service companies ... Activities in the region include international financial services, digital industries (FinTech, InsurTech, RegTech, cybersecurity, etc.), aviation financing, and global business services ... , [a] wide network of supports ... and a significant opportunity"[234] in sustainable finance. IDA financial services companies with significantly larger company employment in the SR are over 30 in Cork City and elsewhere. Also, Fexco in Kerry is a major Irish-origin enterprise in this space, with 2,500 employed internationally, 1,200 in ROI and 900 in Kerry. (Fexco is also core to the Kerry RDI Hub for various tech start-ups in the southwest).[235] Kilkenny and Wexford in SE have also become spokes for Dublin's IFSC and related companies. There is some academic and research support from UCC (GRCTC, FSIC), MTU and SETU (Rikon and InsurTechAccelator), which should be strengthened given the opportunity available.

Professional & technical services (NACE M)

There is a strong presence of services for the region's needs and substantial support from UCC, UL, MTU, SETU and TUS.

Environmental consulting services (part of NACE M70)

Some organisations and expertise exist in SR, originating in food and pharma processing and elsewhere. UCC and UL have some strengths in the area. There is a need for more innovative services to diffuse best practices.

Digital business (Administration) services (NACE J63 (Data processing), N822 (Call centres), etc.)

With the SR being the second biggest concentration of digital and professional services companies in the Republic, there are over 40 major MNCs and larger Irish companies, especially in the call centre/admin support industry (Abtran, Estec, etc.) both in Cork and Waterford. Stronger academic research related to the area (e.g., through SETU Rikon) can be a key resource for sectoral growth.

Cultural & leisure (NACE R)

There is considerable range and depth in culture, sport and leisure industries with corresponding strengths in the third level in UL (music, sports), UCC (literature), MTU (Art Crawford) and TUS. Kilkenny is home to the National Design and Crafts Council with showcases in Kilkenny. This is key to a strong combined experience/creatives sector in SR.

Other sectors (NACE O, P, Q, S)

There is a range of services for regional needs, with corresponding support from UCC, UL, MTU, SETU, TUS, etc., in public administration, health and education (tertiary, primary).

Figures 48, 49 and 50 summarise the sectoral assessment for SR.

Figure 48: Sectoral assessment SR (1)

Sectoral assessment Southern Region 1

Sectors (NACE)	Presence (H/M/L – E) Priority?	Capability (H/M/L)	Gaps to address?	Linkages to build?
A Agriculture +	H+ Esp dairy	H UCC , Teasgasc	New primary food tech (insects, under glass, lab meat etc.) ?	
B Mining				
C Manufacturing				
Food	H + Range of strong global food companies Kerry, Tirlan, Dairygold	H UCC, Teagasc, SFI/EI Centres	More innovative services to diffuse best practice to SMEs etc.?	
Chemical/Pharma	H Cork/Waterford+ (production)Limerick (Ch)	M UCC + SFI/EI Centres Commercialisation gaps No formal cluster	Networking and innovation services: root more global academics	Links to Dublin cluster New Jersey+, Cambridge+Oxford, Berlin/Freiburg
Medical devices	M Some MNCs, Irish	M UCC etc. Same issues E-Healthrecords		Link to NWR Galway cluster
Engineering	M Focus on agri-tech , aerospace, autos (Limerick), pharma industry	H Tyndal, UL etc.	Need for greater innovation services?	Link to NI (Antrim +), NWR+Midlands ; Link with West Midlands/Oxford, Stuttgart German car cl. etc

Figure 49: Sectoral assessment SR (2)

Sectoral assessment Southern Region 2

Sectors (NACE)	Presence (H/M/L – E)	Capability (H/M/L)	Gaps to address?	Linkages to build further?
D Electricity E Water	H OW opportunity Shannon Estuary Tipperary biomass	H UCC+ Foynes/Shannon Est Tipp etc.	Access to enough expertise, given opportunity?	OW: with NWR, EMR and NI; Yorkshire
F Construction	H International and regional companies	L	Innovation services to progress best practice	With NWR, EMR and NI
G Retail/wholesale	M core within region	L	Innovation services to progress best practice	With NWR, EMR and NI
H Transport	H Critical access to rest of EU	L	Innovation services to progress best practice	With EMR
I Accommodation + Food service (Tourism +)	H esp SW	M Shannon Catering College; UL Tourism Policy; Killarney skills	Greater Innovation services to progress best practice	With NWR, EMR, NI and with France and Swiss clusters
J Information and Communications (Software etc.)	M+ E growing sector Cyber a key cluster Telecoms in Waterford	H UCC, UL + SFI/EI Centres; SETU Telecoms; Technology Industry Alliance (SW)	Greater innovation services – more focus on a few areas?	With EMR and NI for cyber
Films etc.	H Limerick/Troy	M ? UL	Substantial capacity	With LA, France ,Berlin?; other regions (NI (GoT), EMR (Wicklow), NWR (Spiddeal)

Figure 50: Sectoral assessment SR (3)

Sectoral assessment Southern Region 3

Sectors (NACE)	Presence (H/M/L – E) Priority?	Capability (H/M/L)	Gaps to address?	Industry Linkages to build?
K Financial services	M Some MNCs, fintech Cork, Kerry (Fexco), Wexford+	M UCC Fexco RDI	More innovative services to diffuse best practice? Research into Fintech	Dublin and Belfast NY, Frankfurt, Paris, London, Shanghai
M Professional and Technical services	M Services in region +	H UCC, MTU, UL, TUS		
Environmental services	M Some organisations + expertise	M UCC, UL,	More innovative services to diffuse best practice?	
N Digital (Administration) Services	H Ireland origin companies (Abtran etc.) and some o/s MNCs	L	More innovative services to diffuse best practice? More research support	
R Cultural and Leisure	H Depth and range of experiences in the region (e.g. Crawford Arts, hiking, music +)	H UL, UCC, MTU, TUS	Substantial capacity	Links with WAW, GS, AE, HH thro Tourism Ireland
L, O, P, Q, S, T Other	H range of services for region	H UL, UCC, MTU, TUS		Links to rest of EU as crtical

7.3 Sectoral ambition

Feedback from stakeholder consultation (DBEI, 2022)

As in other regions, stakeholders were asked to identify the existing sectoral strengths in the Southern Region and the new and emerging areas of opportunity in their region. These were areas which could develop critical mass over the next seven years, creating new enterprises, employment, exports and value added to the regional and Irish economy.

In order to assist stakeholders, several sectors were identified based on regional data from the DETE enterprise agencies. These were divided between existing and emerging sectors. Stakeholders were asked whether they agreed with the sectors identified by DETE and whether any further sectors needed to be identified. The sectors presented to stakeholders were:

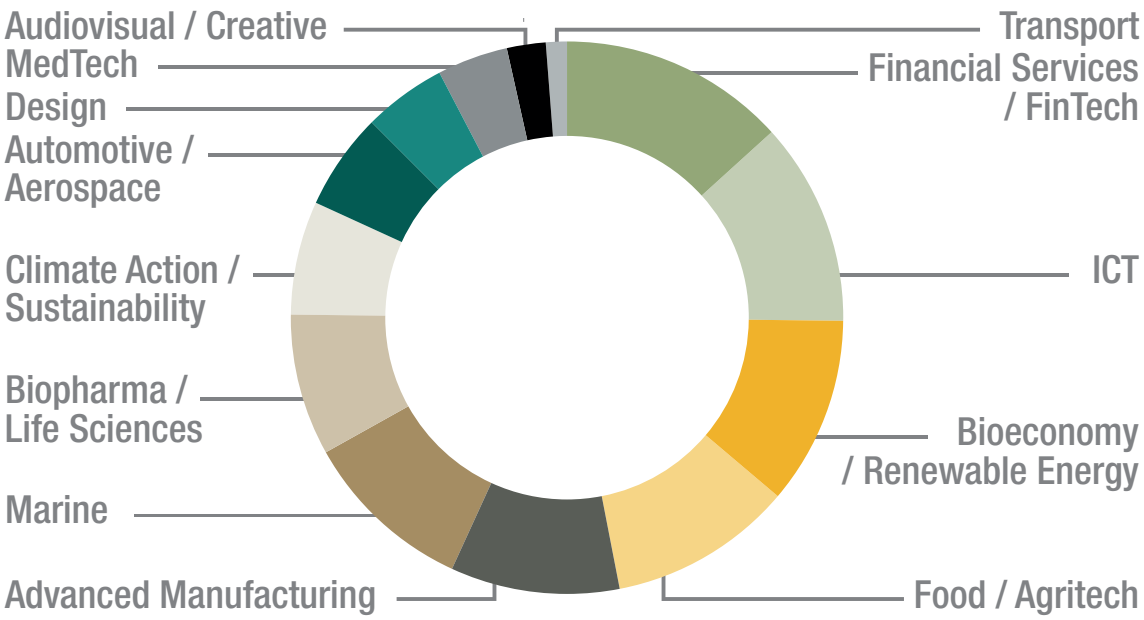
- *ICT;*
- *Pharma/MedTech;*
- *Automotive/Aerospace;*
- *Food/AgriTech*
- *Financial Services;*
- *Renewable Energy;*
- *Advanced Manufacturing;*
- *Design;*
- *Marine/Maritime.*

In the SR five sectors made up over half of all submissions, with approximately equal shares of the total. These were Financial Services, ICT, Bioeconomy/Renewable Energy, Food/AgriTech and Advanced Manufacturing. This reflects the established strengths of the region in terms of its research capacity and enterprise base. Including sectors that comprise pharmaceuticals and medical devices means that six sectors alone comprise 69% of the total submissions for the SR. The sectors identified include major employers such as ICT (39,000 across the region across 630 enterprises) and Financial Services (6,775 employees across 58 agency clients) as major sectors and opportunities in the region.

The SR has a dynamic and broad enterprise sector with a wealth of sectoral strengths and cluster activity. Advanced Manufacturing, Audiovisual/Creative, Automotive/Aerospace, Bioeconomy/Renewable Energy, Biopharma/Life Sciences, Food/AgriTech, ICT and Marine/Maritime are all strong sectors in the region that also have many emerging opportunities for growth and were major areas identified in consultation. These are all sectors that have a strong presence in Ireland and are particularly flourishing in the SR.[236]

Figure 51 summarises stakeholder feedback.

Figure 51: Identified sectoral strengths and opportunities for the SR



For the SRA's position paper on smart specialisation strategy, their consultants Babel developed a Capacity v. Opportunity Prioritization Model.[237] The capacity was mainly R&D capacity within the region, and the opportunity reflected market trends and European Commission investment priorities. Using this model, they identified sectors and subsectors for the SR: 'high opportunity' and 'high capability'. The capability information was gathered through a detailed review of all the facilities and centres presently aligned with key industries and technologies. The sectors identified included biopharmaceuticals and pharmaceuticals 4.0, additive manufacturing, bio-based economy, marine technologies, applied IoT, efficient and sustainable industries and FinTech.

SR: Towards key sectors

All sectors in the SR can and should increase incomes, employment, productivity and exports by progressing innovation, digitalisation, lean and sustainability, through investing in and improving their capability development and innovation services.

However, it is important to prioritise sectors that can progress through the Euro-cluster medium and high levels and become globally recognised as key clusters in growing industries, cascading income and job opportunities throughout the sectoral networks and hierarchies.

The high-performing clusters in the SR information technology and MedTech are currently *imputed*[238] to be present, according to the EOCIC (2020). The medium-performing sectors are bio-pharma, business services, financial services, transportation, and logistics. Low-performing sectors are upstream chemical products and hospitality & tourism.

In all, the SR has eight performing clusters (two high-performing). While other sectors and individual companies may be competitive internationally, there is not a critical mass in the region to reach the stage of an internationally performing cluster as classified and measured within the EOCIC (2020) rankings framework.

Clusters to progress and promote over the next seven years to 2030 could include:

Three high-performing clusters

- Sustaining and building further as high-performing **information technology** for cyber-tech and some vertical software applications (now high-performing), and promoting related **digital business services** (of call centres, data-processing, etc. and associated financial services (both currently medium-performing).
- Promoting and progressing to high-performing **biopharmaceuticals/pharma** (now medium-performing) and **upstream chemical products** (now low-performing), as well as sustaining **medical devices** in the region as high-performing.
- Progressing systematically to initially high-performing the broad **food processing & manufacturing, fishing and farming** sector as a sustainable food system (SFS) and building the cluster as one of the top 5 global locations for the industry. Currently, the sector is not a cluster performing at relative critical mass in this region in the EOCIC (2020) framework.

Three medium-performing clusters

- Sustain as medium-performing **transportation & logistics**, a key sector in the region post-Brexit context.
- Promoting systematically to medium-performing level a sustainable and digitalised **hospitality & tourism**, grounded in the **creatives/cultural** industries (now low-performing), based on the region's rich resources of music, performing arts (dance, literature, visuals, etc.), videos/films, crafts etc., with IP and content being commercially developed.
- Progressing to medium-performing the **production technology engineering** (agricultural, auto, aerospace, etc.) cluster. Currently, the cluster is not performing at relative critical mass in this region).

Other basic-performing clusters

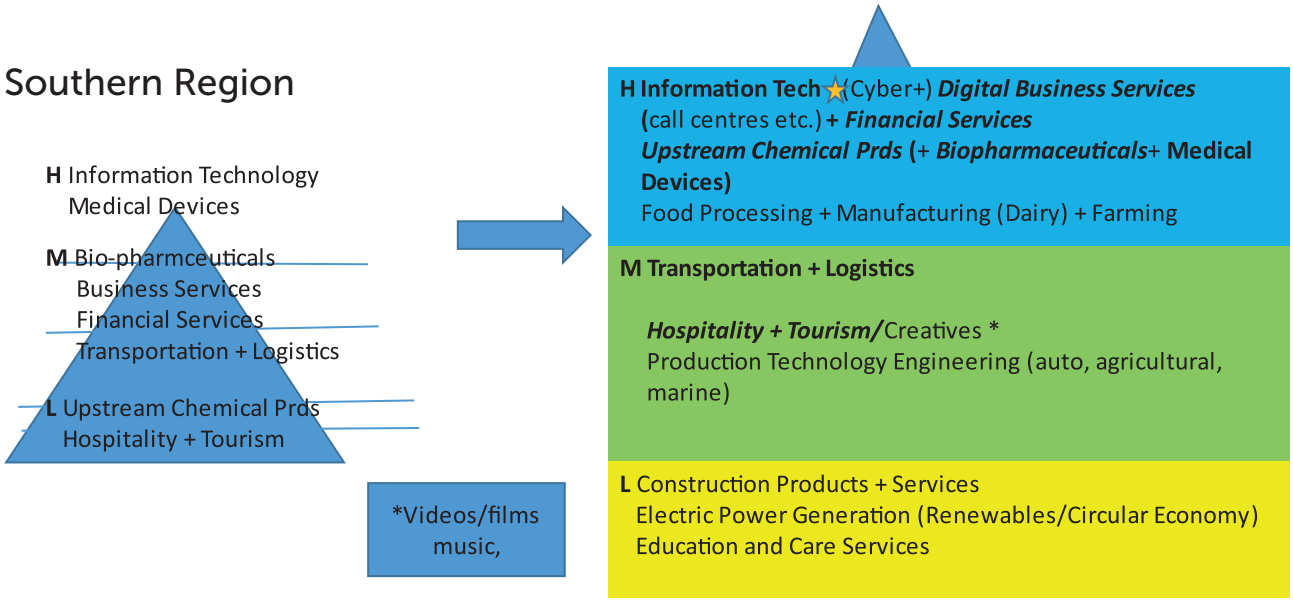
- Developing as initially basic-performing **electricity power generation & transmission** to urgently realise the emerging opportunities of renewables, and especially in offshore wind electricity generation and circular economy opportunities
- Develop as initially basic-performing **construction products & services**
- Developing the **education & care services** sector as a major opportunity and resource to further progress both economic and social development within the region

In summary (Figure 52), the broad clustering goal for the SR to 2030 could be to progress from having eight performing clusters (two high-performing) to at least 14 performing clusters grouped in eight related groups of clusters (three high-performing). At least one cluster could be building towards becoming recognised as one of the world's top 5 locations for that industry, as either a core hub or a critical spoke. All sectors should aim to become recognised globally as best-in-

class in some aspects of practice and process within their sector. Such a goal and its pathway to achievement need intensive discussion within the region and beyond, as it is a considerable challenge for all stakeholders.

As stated, all sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, nourishing and investing in the region's specific sectoral skills, expertise and platforms, more general technological, digital, lean and sustainability capabilities and broader inclusive leadership and organisation abilities will be critical to underpin SR as a learning community and system at multiple levels.

Figure 52: Clusters progression potential (SR summary)



Note: **bold** is current ranking, ***bold italic*** is promotion, and no bold is currently not ranked within the EOCIC (2022) rankings framework.

7.4 Sectoral development actions

Linking HEIs and FETs and key sectors

The contribution to sectoral development of the HEIs in the region (UCC, UL, MTU, TUS, SETU) and the extensive network of ETBs is crucial. Focusing on the key sectors is vital, similar to the MIT Local Innovation System. The MIT/LIS approach can be applied to the SR (Figure 53).

Figure 53: Sectoral development and HEI/FET interaction in SR (MIT LIS)

	EXISTING INDUSTRIES		EMERGING INDUSTRIES	
Performance levels 2030 **Aim**	**CONVERT**	**TRANSFORM**	**CREATE**	**TRANSPLANT**
High-performing +		(Sustainable farming)	Food processing	(New food formats)
			(IT cyber+ / eHealth records)	IT cyber / other software, Digital business and financial services
		Biopharmaceuticals	(New bio)	
Medium-performing +		Transport & logistics		
	(Creatives – Commercial IP) (Sustainable tourism)	Hospitality & tourism / Creatives		
		Production technology engineering	(New EngTech)	(Automotives)
Low-performing	(Construction: Scaling with standards)	Construction products & services		Electricity generation
		Education & care services		

Note: In brackets () is the subsector part of the broader sector.

Specifying indicative sectoral investment priorities

Following the range of possible actions suggested at sectoral level, some indicative investment priorities can be identified and assessed as to costs and benefits (Figure 54).

Figure 54: Indicative clustering investment priorities in SR

Sector	Need	Priority
Agriculture/Food	New food platforms research	Medium
Pharma	Higher academic expertise at UUC is needed if the industry cluster to be in the global top 5	High
Medical devices	Research investment for eHealth (records and processes)	Medium
Electricity (offshore wind)	Expertise for opportunity	High
Construction	Sustainable innovation service	Medium
Retail / Transport	Transport efficiencies expertise for innovation services	Medium
Accommodation / Tourism	Academic Centre for Sustainable Tourism	High
Digital (incl. financial & insurance) businesses / administration & ICT (software)	Build on Rikon for innovation services Co-invest in FinTech, e.g., blockchain Major investment in blockchain and its technologies Investment in sportstech (Limerick)	Medium Medium High Medium
Creatives / Cultural industry	Linked to tourism – see above Innovative services increased	Medium
Production technology engineering	Academic research into automatic cars, etc.	Medium

Part 3

All-island perspective

8. Sectoral clustering at an all-island level

8.1 Focusing all-island sectoral clustering

Currently, on the island of Ireland, there are seven high-performing clusters, 15 medium-performing clusters, and 19 low-performing clusters, so a total of 41 performing clusters at some level (based on an application of the EOCIC (2020) framework). One of the regions – the former Southern and Eastern Ireland, but in reality today's Dublin-centric EMR – is one of the leading European regions for sectoral clustering. The 41 clusters are spread as follows:-

- NI – 11
- NWR – 4
- EMR - 18
- SR - 8

In reflecting on the sectoral capabilities and EOCIC (2020) clusters within each of the regions and jurisdictions on the island of Ireland, there are significant sectoral clustering opportunities in each of the individual regions. Opportunities for synergies and collaborations can also exist for further growth across the island and for becoming more recognised as evolving into a location with world-class clusters. The question is whether and how an all-island perspective brings more remarkable growth to the overall sector and how the whole becomes greater than the sum of its parts.

Chapter 5.2 of DBEI (2022), *National Smart Specialisation Strategy for Innovation 2022-2027*[239] on the island's key sectors states:

> *Considering their contribution to Ireland's GDP, employment, wages, research and innovation levels and in the view of government enterprise agencies, it is evident that Ireland has a global competitive advantage in the following sectors, namely:*
>
> - *Pharmaceuticals and chemicals*
> - *ICT and computer services*
> - *Business services*
> - *Financial services and insurance*
> - *Agriculture, food and beverage*
> - *Medical devices*
>
> *Also mentioned as important are retail and tourism.* [240]
>
> *DfE (2021), concerning Northern Ireland, also identified similar sectoral priorities for the 10X Economy. They are:*
>
> - *Digital, ICT and creatives*
> - *FinTech/Financial services*
> - *Advanced manufacturing and engineering*
> - *AgriTech/Agrifood*
> - *Life and health sciences* [241]

In examining each region/jurisdiction (in chapters 4-7), the potential and capability of key sectors compared to their priority in regional policy and plans (the gap analysis) and using EOCIC (2020) methodology to assess and rank internationally relative cluster performance (the progression analysis), for each region a triad of potentially high-performing sectors and a triad of potentially medium-performing sectors, to be realised by 2030, have been identified (Figure 55).

Figure 55: 2030 priorities at region levels - Summary of potential sectoral clusters

	1	2	3	4
Level for 2030	**NORTHERN IRELAND (NI - UK)**	**NORTHERN & WESTERN REGION (NWR - ROI)**	**EASTERN & MIDLAND REGION (EMR - ROI)**	**SOUTHERN REGION (SR - ROI)**
High	Biopharma / Diagnostics (eHealth aged) Production technology engineering IT cyber and digital business services	Medical devices (eHealth aged) Production technology engineering Digital business & financial services and IT applications	Information technology Financial, insurance and business services Biopharma / MedTech	IT cyber, digital business and financial services Biopharmaceuticals Food processing
Medium	Financial services / FinTech Food processing Hospitality & tourism / Creatives	Biopharmaceuticals Food processing Hospitality & tourism / Creatives	Production technology engineering Distribution, eCommerce / Transport & logistics Hospitality & tourism / Creatives	Transport & logistics Hospitality & tourism / Creatives Production technology engineering
Low / Basic	Construction products & services Electricity power generation & transmission Education & care services	Construction products & services Electricity power generation & transmission Education & care services	Food processing Electricity power generation & transmission Paper & packaging, Printed services and Fired materials Education & care services	Construction products & services Electricity power generation & transmission Education & care services

In seeking alignment and potential for synergies across the island of Ireland, several sectors can be identified as (potentially) high-performing sectoral clusters at an all-island level. All of these sectors (as entire sectors or with related smaller clusters as elements) have been ranked by EOCIC (2020) as performing at the medium or higher level in one or more of the regions on the island. Also, all these sectors are high-performing in at least three regions (potentially by 2030) triads. On that basis, these three sectors are suggested as clusters to be aimed for as high-performing by 2030 at an all-island level and within the regions and jurisdictions. They should also seek to become recognised by 2030 as building towards becoming one of the world's top 5 locations for that industry, as either a core hub or a critical spoke.

Three high-performing sectoral clusters at all-island level

The **life sciences** broad cluster on the island of Ireland has a strong presence in all regions. It is already recognised globally, with pharma and chemical production in the SR, MedTech and pharma in the NWR, diagnostics and biopharma in NI and biopharmaceuticals and pharma in the EMR. There is also an emerging eHealth opportunity - for records and processes in EMR and SR regions and for ageing at home/in community services for NI and NWR.

The **information technology** and related activities broad cluster on the island is also strongly present in all regions and recognised globally, within EMR with MNC strategic business services and an IT start-up ecosystem in Dublin especially, in NI with IT cyber and related grouping in Belfast and beyond, in SR similarly with IT cyber and related digital business services grouping in

Cork City and beyond, and in NWR with digital business services in Mayo/Sligo/Leitrim/Donegal, financial services and FinTech in Donegal, and information technology/software verticals applications as well as business and financial services in Galway City and its environs.

The **production technology engineering** and related sectors as a broad cluster is strongly present in all regions on the island of Ireland, especially in Antrim, Belfast, Tyrone, etc. in NI, with sustainable transport, aerospace, construction, energy, and related materials handling, etc. throughout adjacent NWR with toolmaking, materials handling (Monaghan), cranes, etc., in SR with Limerick autos and aerospace, etc. and in EMR with automotives in Midlands, microprocessor chips (Intel) in Leixlip and aerospace services in North Dublin/Louth.

Three medium-performing (at least) sectoral clusters at all-island level

Agrifood, food processing and manufacturing, and l**ivestock processing** as a cluster is present in all four regions. In NI are dairy, beef, sheep, chickens, pigs, and food and drink (whisky) products. Similarly, NWR has a range of dairy, sheep, food products, and fish (Killybegs), and EMR has substantial consumer foods, beef processing, equine in Kildare, and fish in Howth and Clogherhead. In SR, dairy and a rich range of food products are strong throughout the sector, while fish is strong in Cork and Kerry. Overall, the aim is a world-leading sustainable food system (SFS) based on the island's "own distinctive food system", of which "the core of … agrifood output will continue to be grass-based livestock production wherein lies [our] natural competitive advantage."[242]

Financial services, along with **insurance services**, as a cluster is present in all four regions, with a strong presence, particularly in Dublin (with International Financial Services Centre (IFSC), etc.) and Louth, Kilkenny, etc., NI in Belfast and Derry/Londonderry, NWR in Donegal and elsewhere, and SR in Cork, Kerry (Fexco), and Wexford.

As a broad cluster, the **hospitality & tourism** and related **creatives industry** (music, performing arts, etc.) is present in all four regions. Within EMR, most overseas tourists are coming into Dublin attracted by strengths in film, theatre, etc. NI's strong scenery, golf, history/other attractions and strong film industry (Game of Thrones, etc.) attract many tourists. Similarly, in NWR - scenery, music, sports, hiking, etc. - and SR, with scenery, hiking, sport, golf, etc.

Three other potentially performing sectors

Three other sectors have been identified as potentially ranking across the island as basic/low-performing internationally (within EOCIC (2020) rankings) by 2030. **Construction products & services**, with associated environmental services and non-metallic mining (quarries), are well regarded internationally. They are present in all four regions on the island of Ireland, especially in NI and Dublin/EMR. There is also a significant and essential emerging opportunity for the whole island of Ireland in **offshore wind electricity generation and transmission** that needs developing and exploiting. **Education and care services** (including childcare, aged care and healthcare) have deep capabilities throughout the island and international recognition (e.g. nursing schools are highly ranked academically, the island is only one of three locations worldwide with competitive entry for primary school teaching, and has one of the major global mass learning platforms[243]) that needs to be systematically nurtured and fostered in a modern competitive economy.

All of these sectors (Figures 56 and 57) can be systematically assessed, prioritised, developed and invested in on an all-island basis to maximise the mutual synergies, benefits and impacts and to

progress their cluster rankings and global profile and leadership and so reinforce their strengths in each of the regions and jurisdictions on the island. All sectors within each region should aim to become recognised internationally as best-in-class in some aspects of practice and process within their global sector.

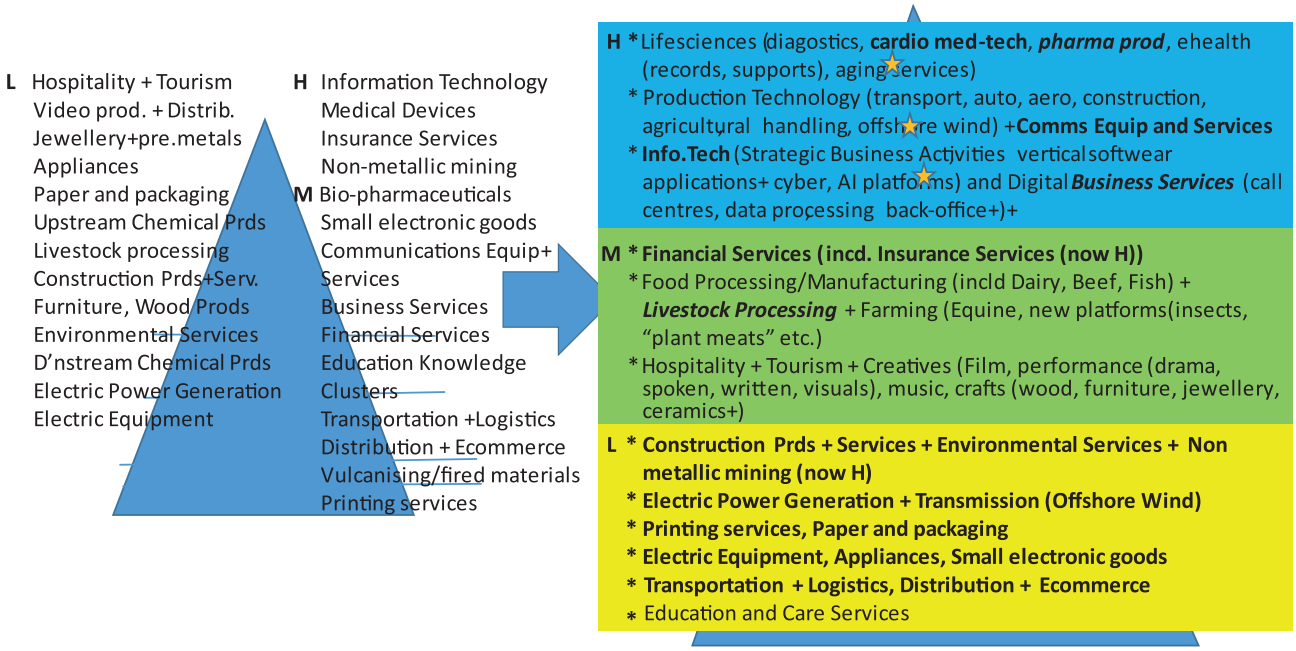
Figure 56: Sectoral priorities to 2030 – overall island of Ireland

Ranking Aim (EOCIC)	Broad Sector
High by 2030	Life sciences Software/Digital business services Production engineering
Medium by 2030	Agrifood Financial services Hospitality and creatives
Basic by 2030	Construction products Energy/Environment Education and care services

All sectors need investment in sector-specific capability, innovation development, and opportunities for clustering at various levels. Overall, it is also critical that the specific sectoral skills, experience, expertise and platforms, more general technological, digital, lean and sustainability capabilities and broader inclusive leadership and organisation abilities are all nourished and invested in to underpin the island of Ireland, its two jurisdictions and its four regions as an adaptive learning community and system at a multiple of levels.

Figure 57: Clusters progression potential (all-island summary)

ALL-ISLAND



Note: **bold** is current ranking, ***bold italic*** is promotion, and no bold is currently not ranked within the EOCIC (2022) rankings framework.

8.2 Putting the experience of the end-user at the core of global ambition

In seeking to progress to higher levels of performance for key sectors across the island of Ireland, it is necessary to start at the end-point, that is, the global end-users' experience of what is provided by the sectors. That entails detailed discussion in each sector of what is available now and what is emerging. It also requires consideration of what might be a highly positive experience in each sector of meeting the needs of end-users of the sector's outputs throughout the globe. That becomes the vision of what will drive global perceptions of the relative strength of the sectors here.

Once the direction and focus of the journey are clear, the pathways and their options, challenges, technologies, organisation, alliances and resources can then be worked out. This becomes the work of high-level discussions within each broad sector, reflecting how to generate and realise synergies island-wide and benefit the sectors' presence in each region and jurisdiction. Tentative outlines of such directions and focus based on this reflection are presented (Figures 58 and 59) as one input of many into the sectoral discussions.

Figure 58: Global end-users' experience of key sectoral clusters on the island of Ireland by 2030 (Manufacturing)

Sector	Features
Agrifood	
Have Now	Dairy herds, beef herds, sheep flocks, dairy products, sheep, fish, chicken/ducks, dairy products, baby food, meat products, food ingredients, baked goods, beer/porters/ales, whiskey/gins, dairy creams, juices, consumer foods products, artisan + (cheeses /chocolates,/ice-creams etc.), organic, fruit and vegetables, other
Emerging	Nutraceuticals, plant "meats", insects, hydro, precision agriculture
Core Known for	*Producing high-quality, healthy food and drink from traceable, digitalised and sustainable **grassland production** system.*
Human Need	Nutrition
UN SDGs	1 No Poverty 2 Zero Hunger
Lifesciences	
Have Now	Diagnostics, Cardio MedTech, Small/large molecule ramp-up pharma scale production
Emerging	eHealth (processes), eHealth (remote), Personalised medicine, social robots
Core known for	*Making excellent components/tools and combining delivery within **intelligent health** service*
Human Need	Health
UN SDGs	***3 Good health and wellbeing***
Engineering	
Have Now	Mobile structures (autos, airspace, materials handling, forklifts, cranes, windmill platforms, etc.), process engineering (food, pharma), forms engineering (civil, etc.), metal manipulation, computer chips etc.
Emerging	New materials, intelligent systems, autonomous machines, robots, Industry 4.0, etc.
Core known for	Making sophisticated, sustainable ***mobile structures within intelligent systems***
Human Need	Mobility
UN SDGs	***9 Industry, Innovation and Infrastructure*** ***11 Sustainable Cities and Communities***

Construction	
Have Now	Constructing housing, building hotels, offices, etc., doing big infrastructure (roads etc.)
Emerging	Digitalisation, sustainable materials, green design, modular/offsite build
Core Known for	*Building physical structures **at scale** sustainably and rapidly **to high standards***
Human Need	Shelter
UN SDGs	***11 Sustainable Cities and Communities***
Energy	
Have Now	Fossil fuels infrastructure, onshore wind and solar, hydropower, some insulation, Great Britain connectors
Emerging	EVs, biodiversity, offshore wind, solar, hydrogen, etc., French connectors
Core known for	Powering Connected Grids through massive ***Offshore Wind*** and other renewables
Human Need	Fuel
UN SDGs	***7 Affordable and clean energy*** ***13 climate action***

Figure 59: Global end-users' experience of key sectoral clusters on the island of Ireland by 2030 (Services)

Sector	Features
Software	
Have Now	Cyber-security, intelligent wearables/sporttech, e-learning, customer access, eCommerce, verticals applications (HR, Finance, etc.), group sharing (membership apps, etc.), process systems/legacy change, telecoms, platforms (AI, etc.), etc.
Emerging	AI, blockchain, new software languages, quantum computing
Core Known for	*Coding creatively for **cyber-security platforms, vertical applications and related software platforms***
Human Need	Feedback
UN SDGs	***9 Industry, Innovation and Infrastructure*** ***11 Sustainable Cities and Communities***
Business Services	
Have Now	Strategic EMEA Business supports/shared services; Remote digital back-offices, call centres; professional services.
Emerging	Automated/self-operated services (with chatbots, etc.); digitalised operations/platforms; remote operations
Core known for	*Organising **very responsive digitalised service systems** in both urban and rural locations*
Human Need	Help
UN SDGs	***11 Sustainable Cities and Communities***
Financial Services	
Have Now	Commercial banking, aircraft leasing, back office administration, FinTech (processes, cyber and new money access)
Emerging	Automated processes, service bots, blockchain
Core known for	*Applying **digital to Finance** for security, regulations, efficiencies, access and new models*
Human Need	Time
UN SDGs	***8 Decent work and economic growth***

Hospitality	
Have Now	Hotels, hiking, culture, sports, scenery, history, food, attractions
Emerging	Digital trips, very targeted marketing, holograms, etc.
Core Known for	*Ensuring a relaxing journey within a place of highly* ***welcoming and interesting people, encounters and surroundings***
Human Need	Connection
UN SDGs	***3 Good health and well-being***
Creatives	
Have Now	Films, TV, games, drama, poetry, wood, painting, singing, music, sculpture, dancing, other art forms, etc.
Emerging	Digital media, games, mixing cultures, streaming, IP-linked products
Core known for	*Sharing deep,* ***insightful storytelling*** *across many forms of expression*
Human Need	Expression
UN SDGs	**3 Good health and well-being** **17 Partnership for goals**
Education and Care Services	
Have Now	Deep competencies in operational delivery; high nursing academic rankings; deep professional commitments at all levels; one only of three locations worldwide for competitive entry for primary school teachers; high social value for education
Emerging	Blended and Lifelong learning, whole person approach, co-robotics, remote digital services
Core known for	Realising personalised responses to individual needs through high-quality services delivered by profoundly committed staff and intelligent systems
Human Need	Nurture
UN SDGs	**3 Good health and well-being**

Underpinning these individual sectoral ambitions is a sectoral template and fundamental *'omega'* vision for the island of Ireland to be globally recognised as "producing user-driven innovative, digitalised and sustainable products and services that are connected and embedded within human-centric, values-based, intelligent, data-rich, adaptive learning systems."

8.3 Nurturing regional synergies and global linkages

Developing key clusters on an all-island basis and leveraging our scale, proximity, and synergies implies nurturing strategic intensive linkages within clusters in the regions on the island and with key global clusters. Being globally ambitious entails engaging with and spending time in the top global clusters in a sector, mixing with the best quality and most experienced people in various roles, continuously learning from them and - progressively - sharing with them.

The island of Ireland is a small open economy, with 7m people within the two jurisdictions and four regions in a world of 8 billion people. Developing strategic sectoral linkages in the wider Europe (including Great Britain (UK)), the Americas, Asia and Africa are vital to our shared economic growth. Such sectoral linkages and connections need to be a central part of our *Belfast/Good Friday Agreement* East-West relationships and involve the EU and wider European, transatlantic and international global relationships.

Such strategic positioning goes alongside the myriad of informal and formal connections globally that individuals, groups and institutions on the island have with the rest of the world. Cultural openness, respect and curiosity, widespread international travel and fluency in key languages are central to our economic development. Extensive study visits, exchanges, placements, work periods, hiring overseas staff, co-creation projects, and closeness to global best practice are all vital to sectoral development. In this context, cultural openness, respect, and self-confidence in our own cultures and place in the world are important, as well as the practical ability to engage through key languages.

Nurturing key linkages and synergies between clusters on the island and with key overseas clusters in Great Britain (UK), wider Europe, the Americas, Asia, and Africa/rest of the world is critical. The maps in Figures 60-69 of the eight key sectors on the island of Ireland give some idea of the current and potential linkages between regions on the island as well as potential key learning relationships with leading clusters overseas in the UK/GB, wider Europe, the Americas and Asia/Africa/rest of the world. Also indicated is where in the global value chain the island of Irelands' presence is now and what direction that presence might be encouraged to deepen and widen.

Figure 60: Island of Ireland's presence now and potential - Agrifood GVC

Innovation/Design	Production	Marketing	Distribution	Support	Final customer
XX	XX	XX	XX	XX	

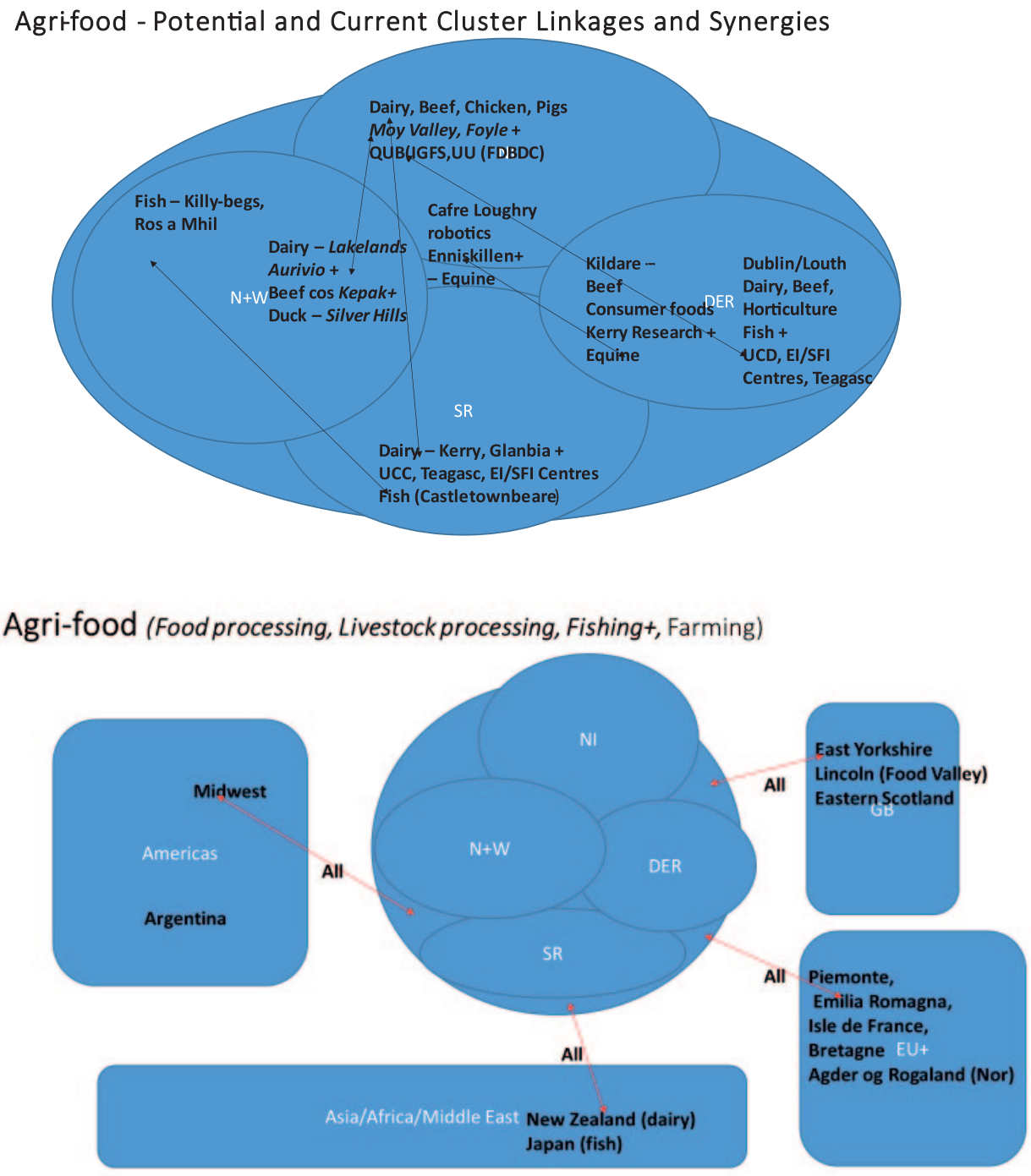
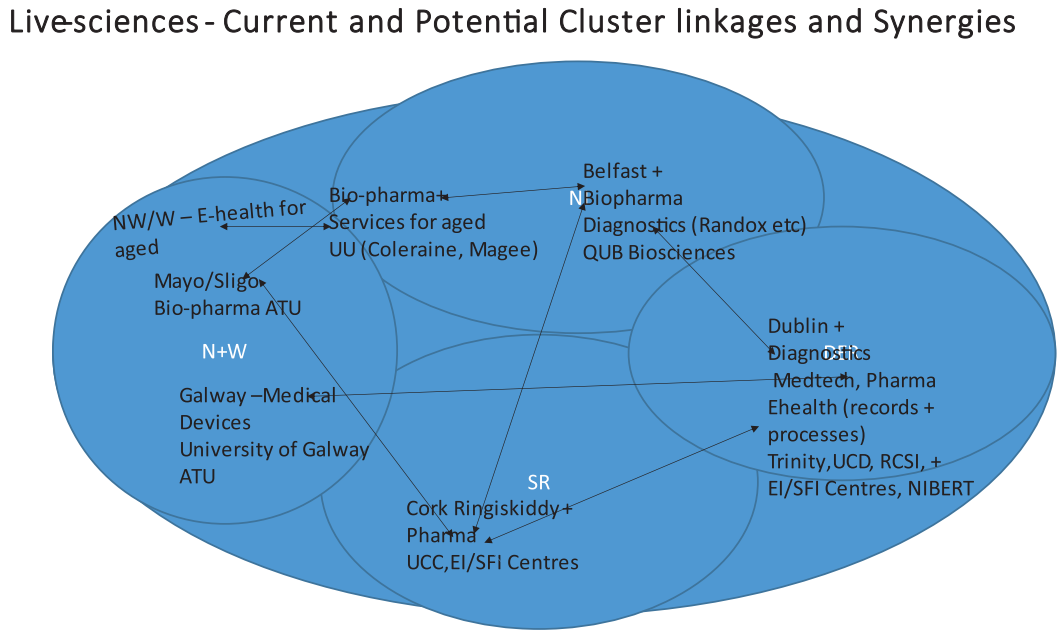


Figure 61: Island of Ireland's presence now and potential - Life sciences GVC

Supply	Innovation/Design ←	Production XXX	Marketing	Distribution	Support	Final customer



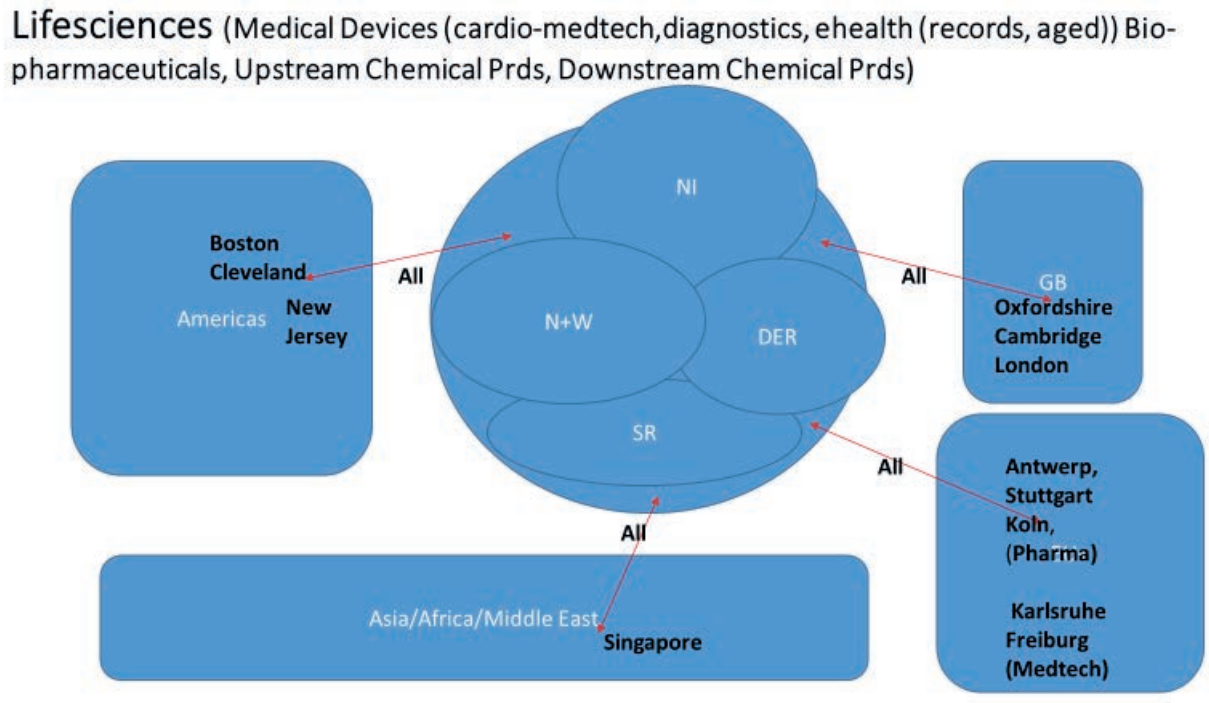


Figure 62: Island of Ireland's presence now and potential – Engineering GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support	Final customer
	↑ X	XX	X	X	X	

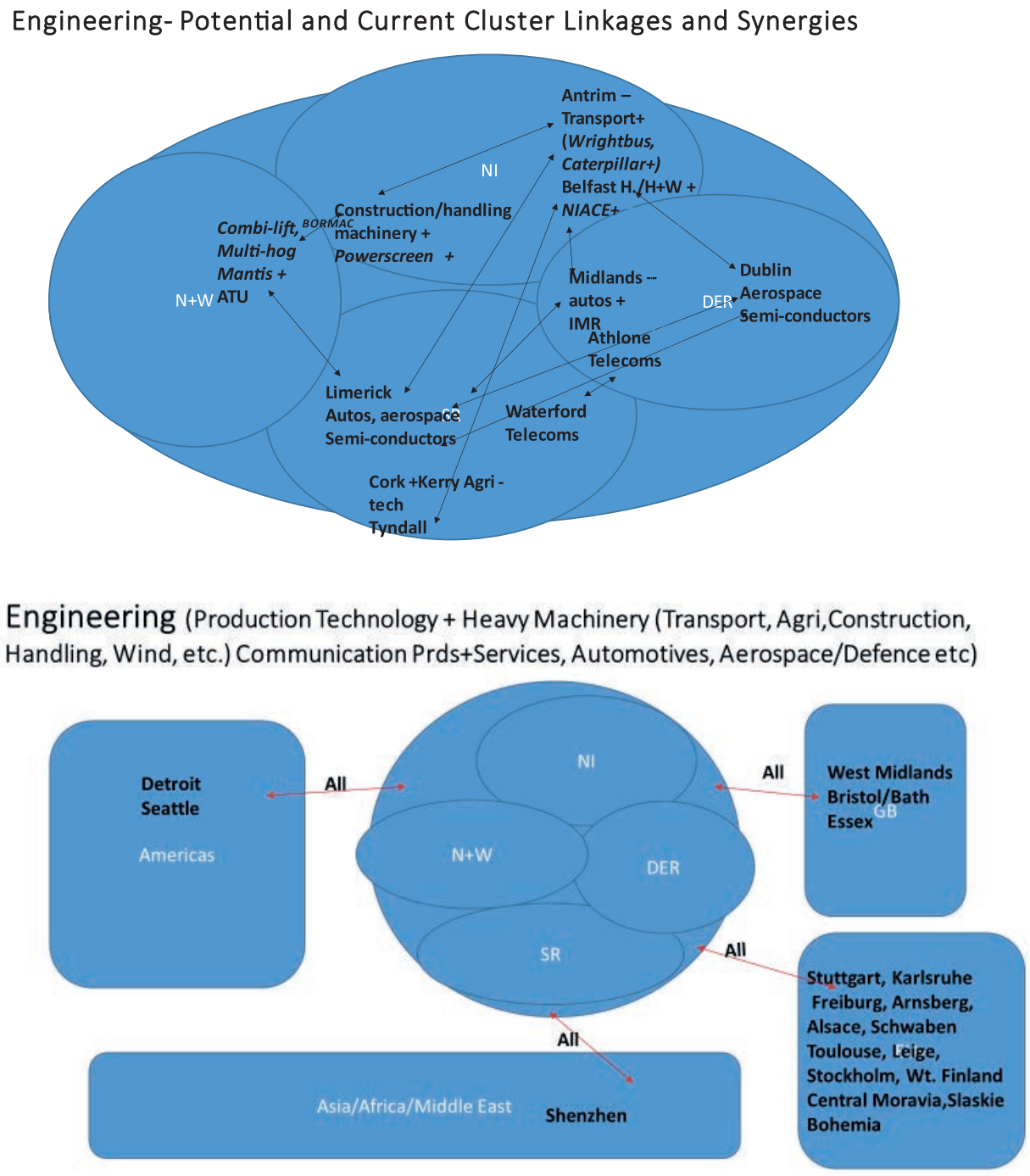
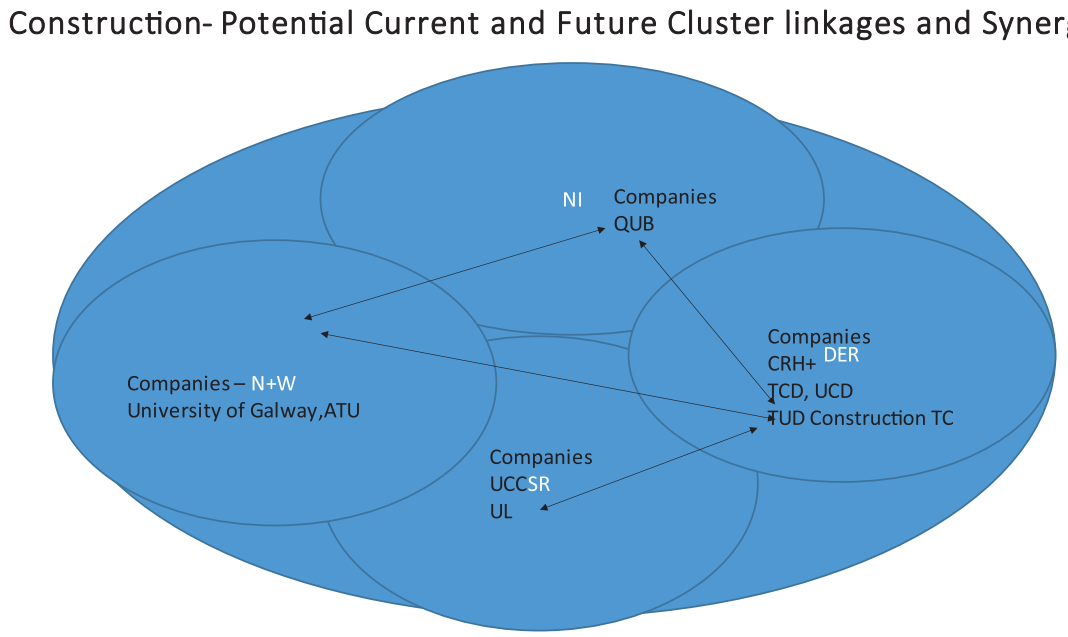


Figure 63: Island of Ireland's presence now and potential – Construction GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support	Final customer
XX	X	XX	X	X	X	



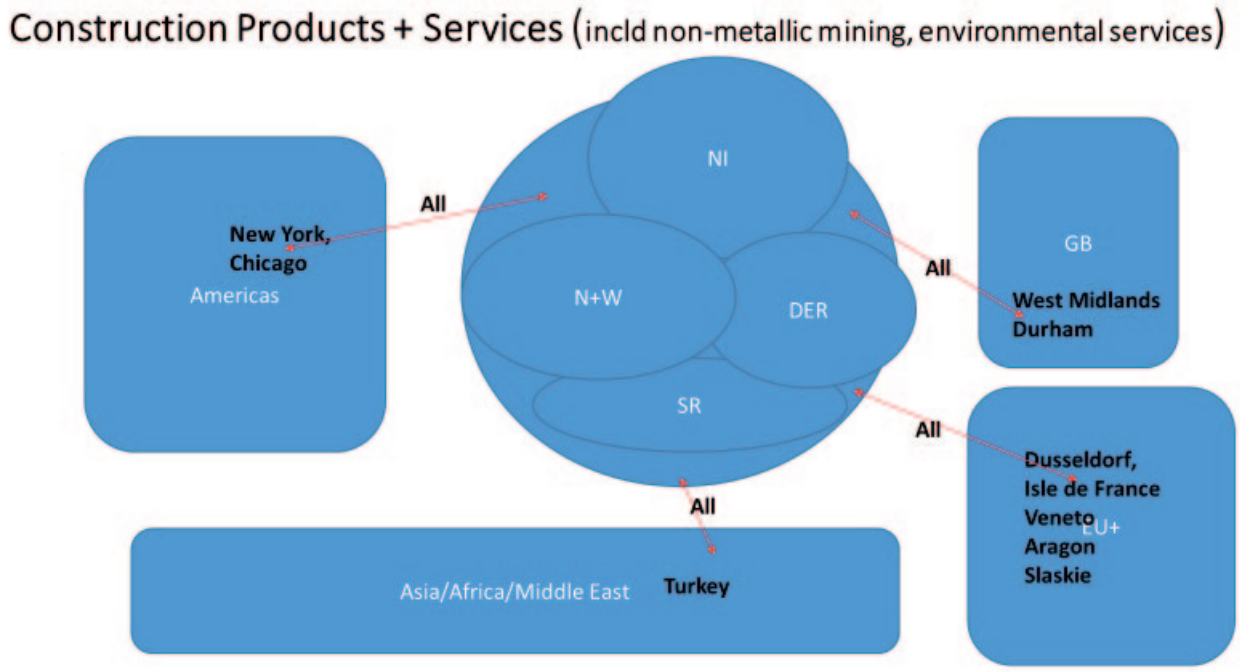


Figure 64: Island of Ireland's presence now and potential – Energy production GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support	Final customer
	←	X	X			

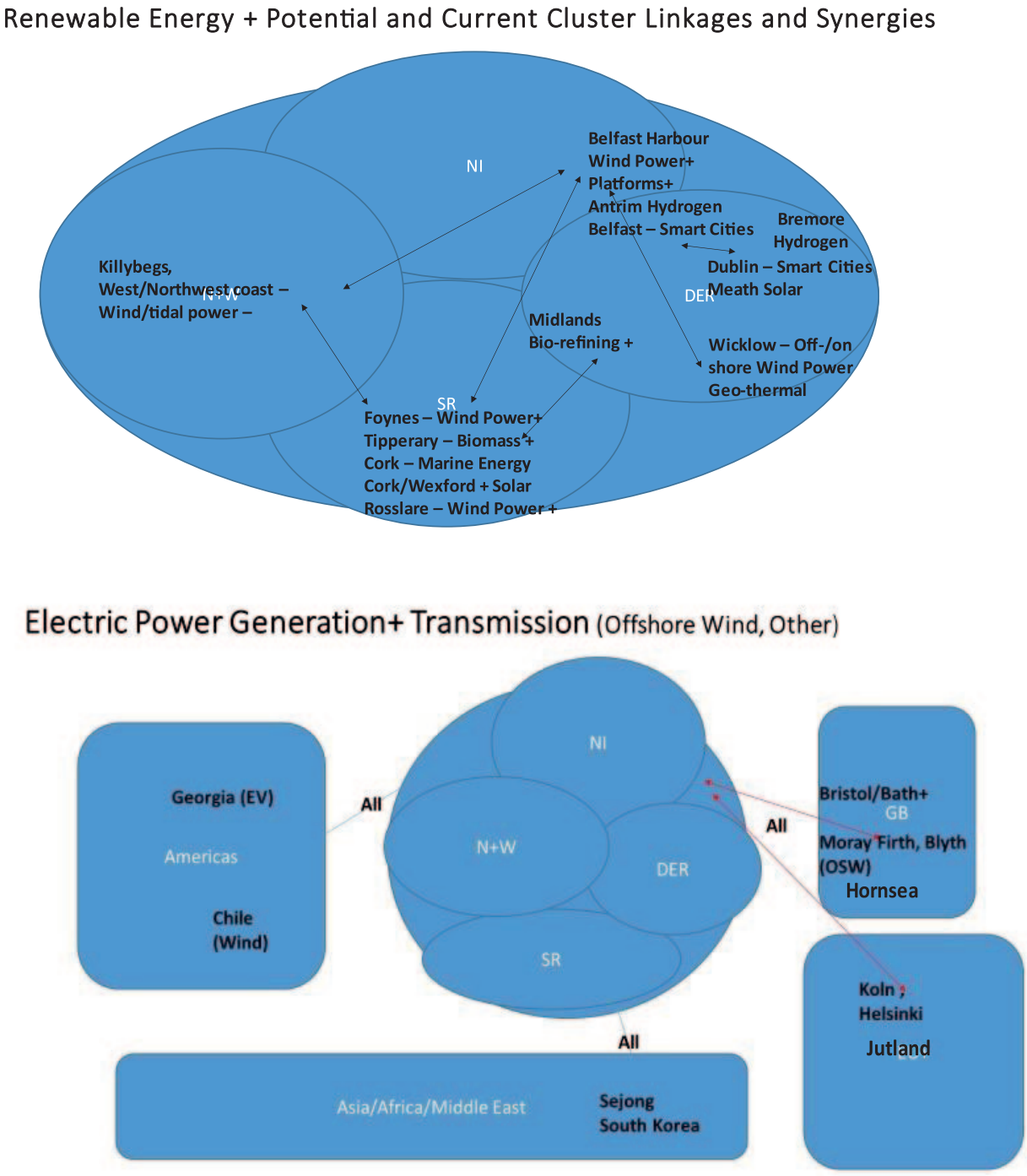
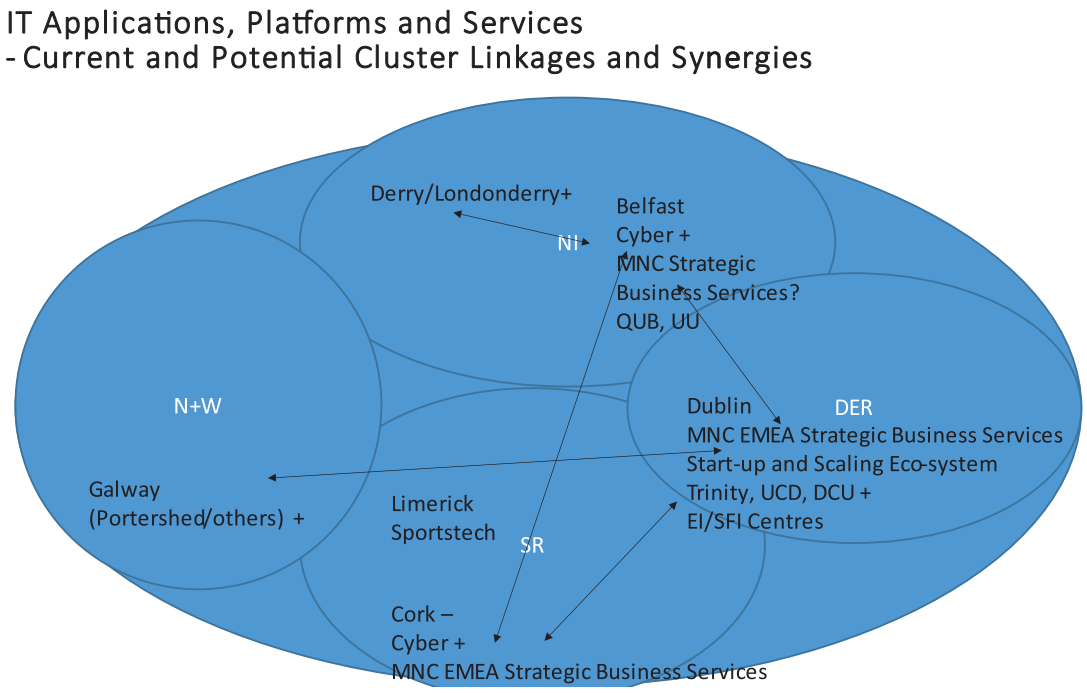


Figure 65: Island of Ireland's presence now and potential – IT/Software development GVC

Supply	Innovation/Design ←	Production X	Marketing XX	Distribution X	Support XX	Final customer



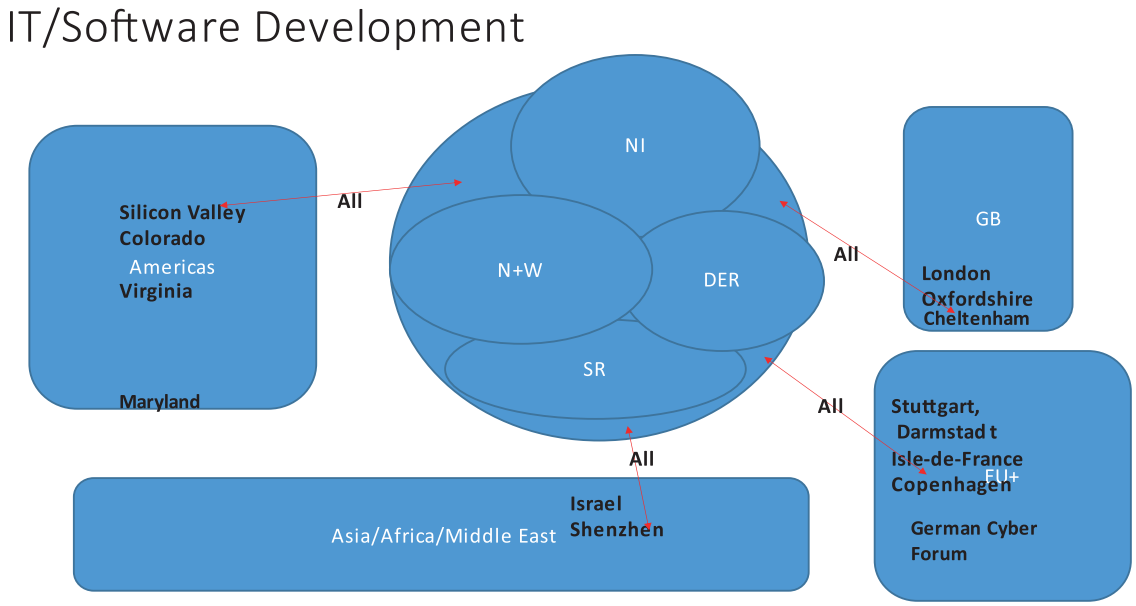
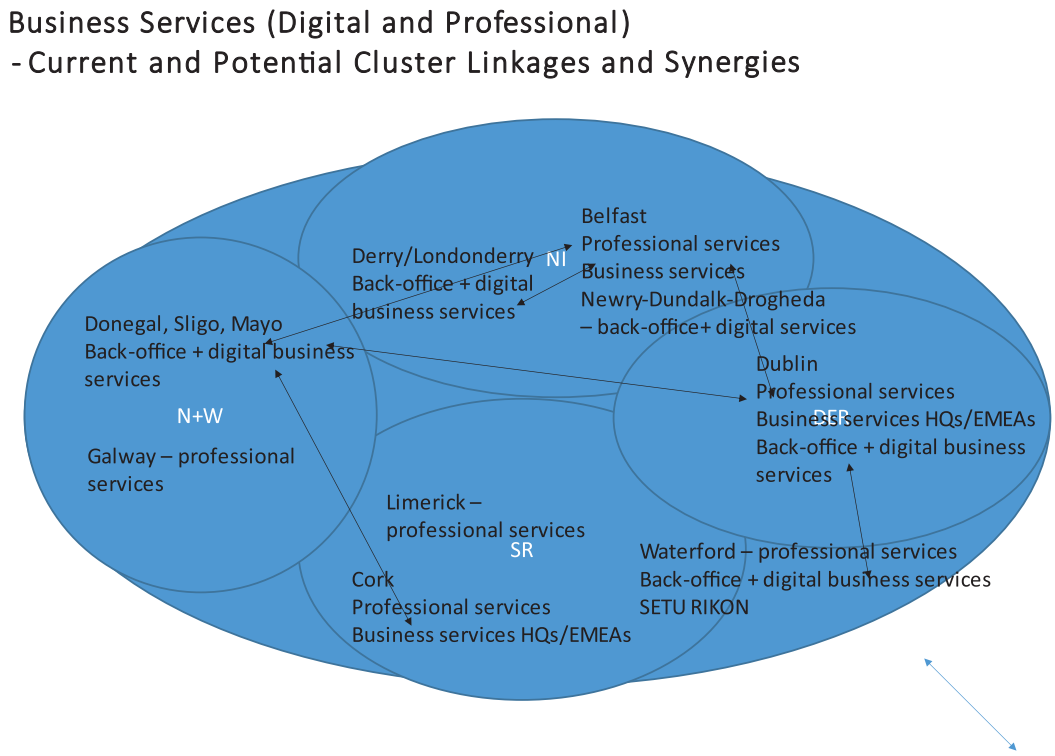


Figure 66: Island of Ireland's presence now and potential – Business services GVC

Supply	Innovation/Design ←	Production XX	Marketing X	Distribution	Support XX	Final customer



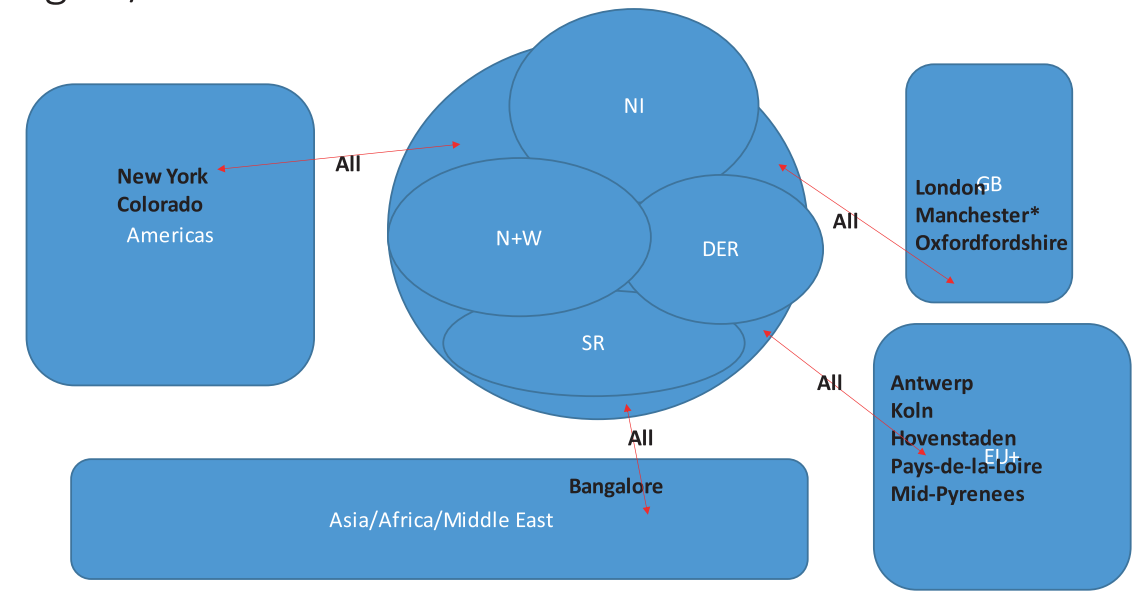


Figure 67: Island of Ireland's presence now and potential – Financial services GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support	Final customer
	X	XX	X		XX	

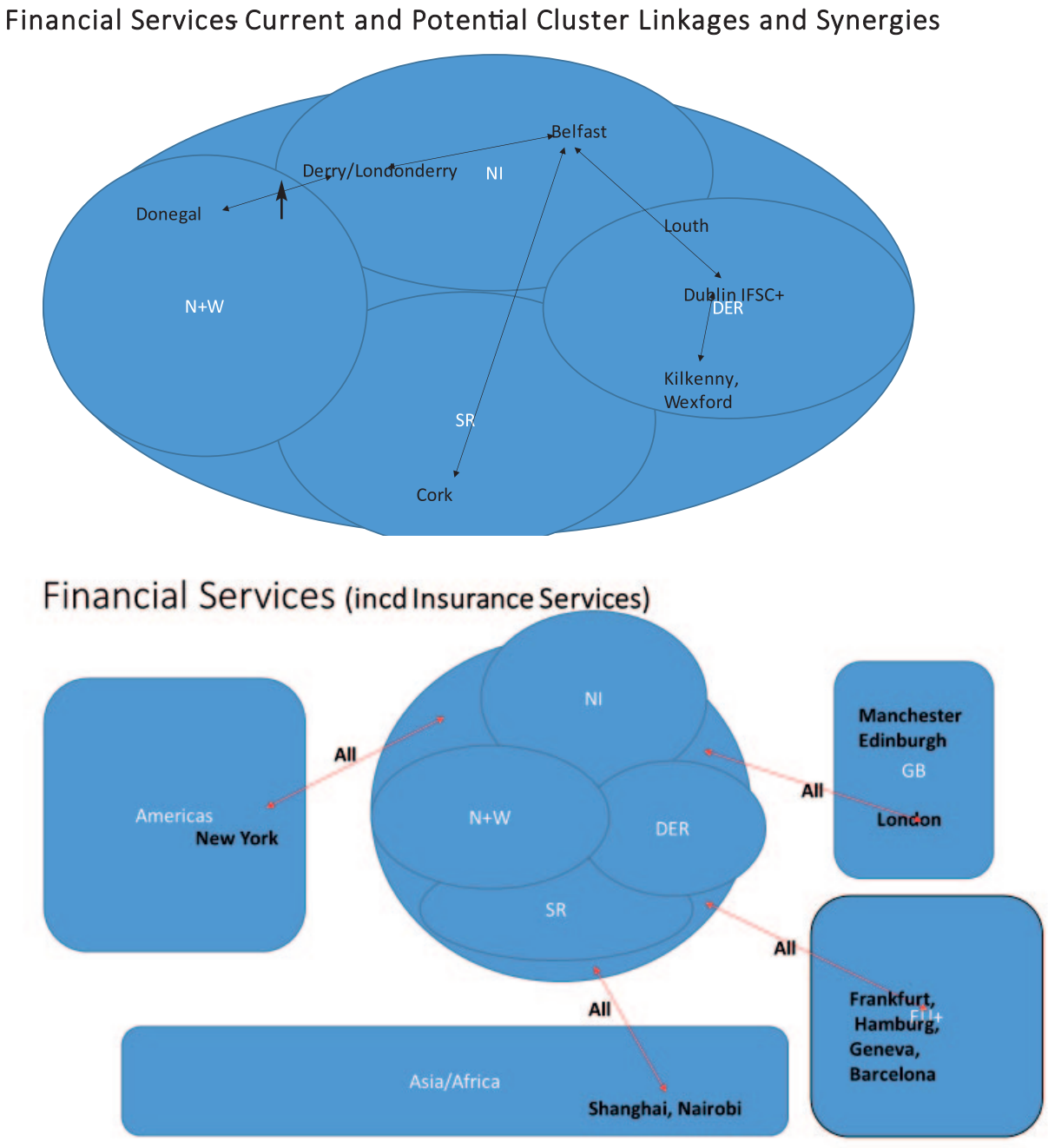


Figure 68: Island of Ireland's presence now and potential – Hospitality & tourism GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support	Final customer
←		XX	X		→	

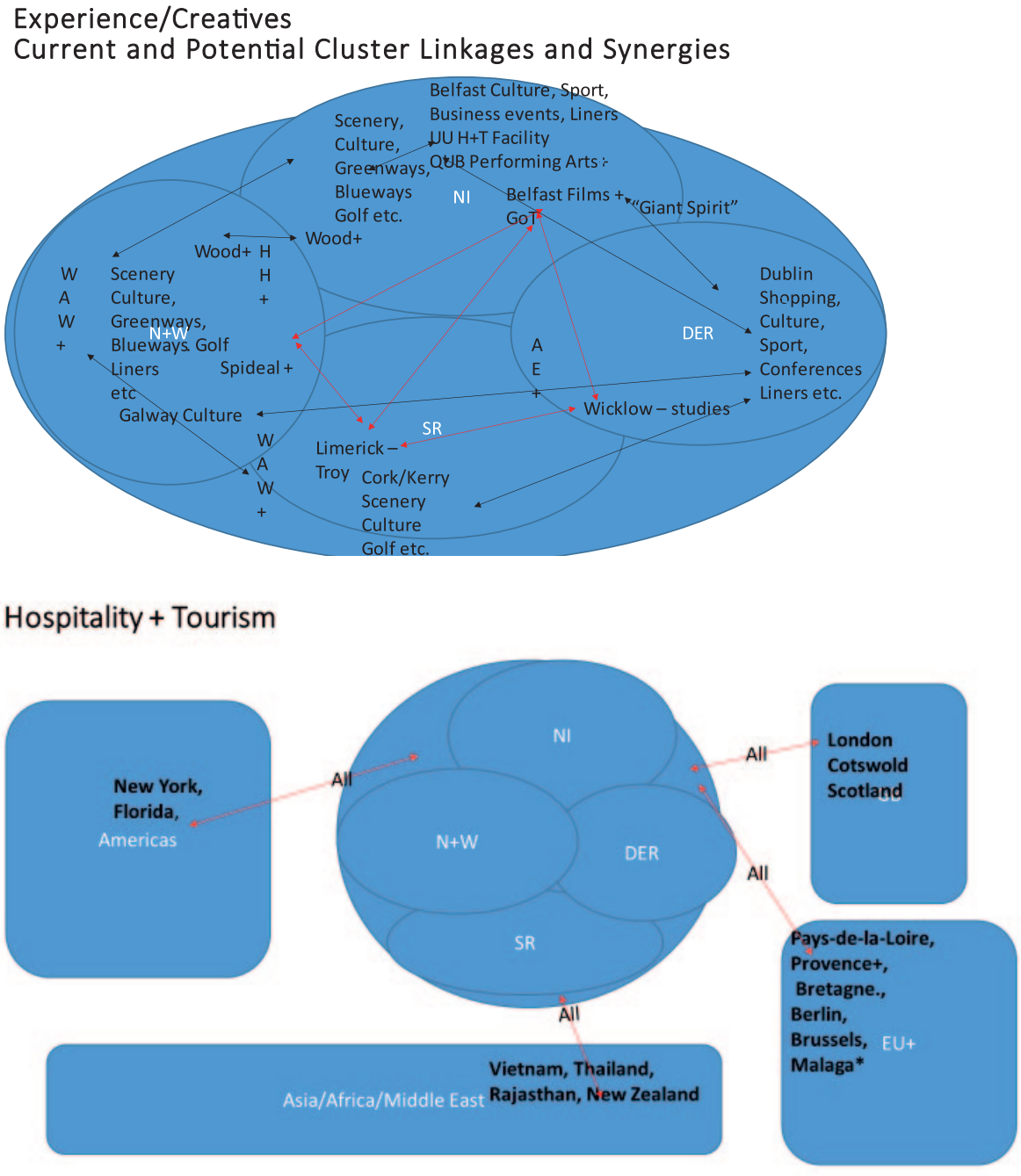
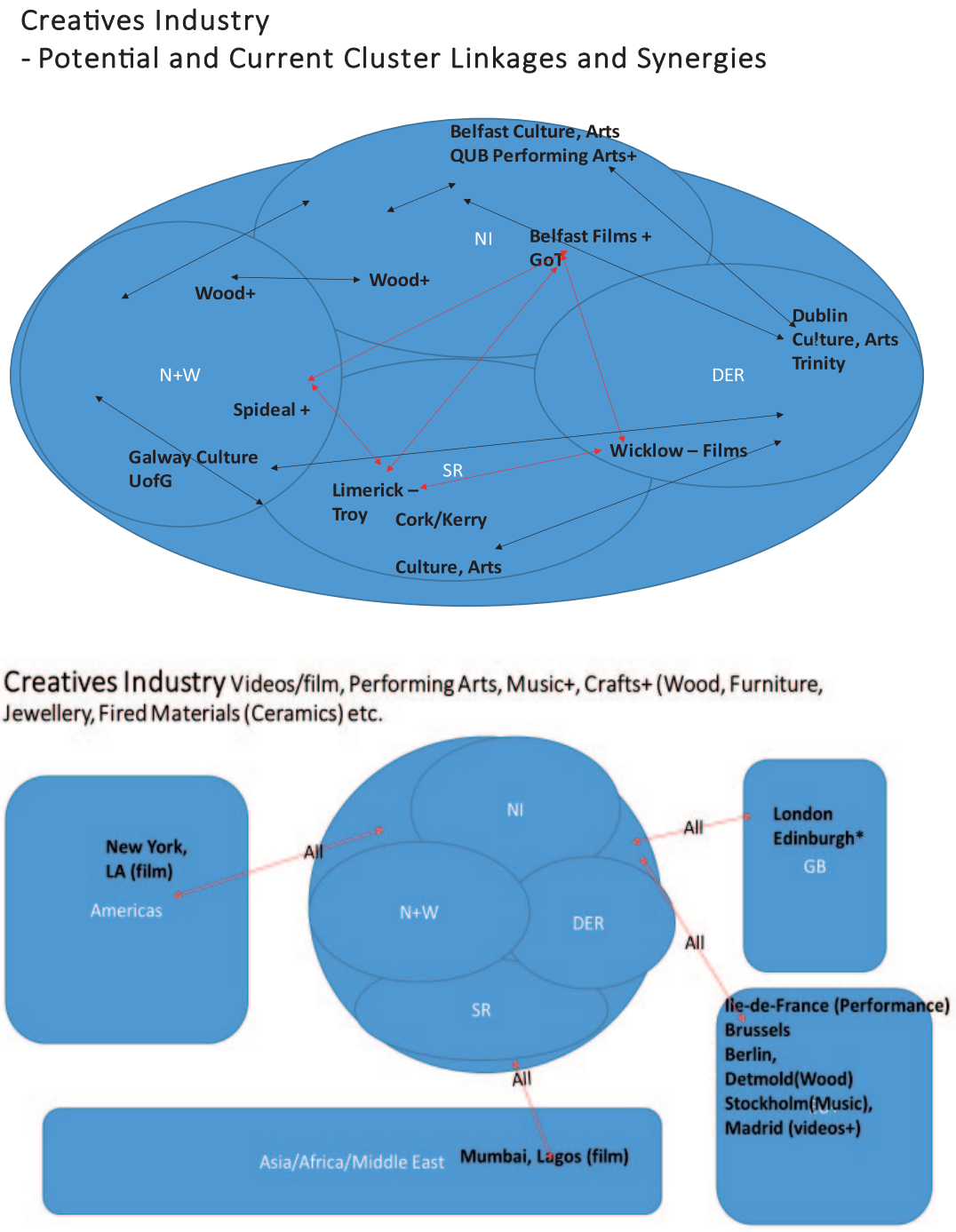


Figure 69: Island of Ireland's presence now and potential – Creatives industry GVC

Supply	Innovation/Design	Production	Marketing	Distribution	Support Intellecual Property	Final customer
←		XX	X	→		



8.4 Imagining illustrative joint projects for key sectors

In each region, several possible investment opportunities have been identified to address gaps which need to be closed for progression to higher cluster performance. The question now is what are the opportunities for joint investment projects to accelerate the progression in each of the regions/jurisdictions and across the island of the eight sectors identified island-wide for advancing to higher and world-class performance levels?

The review of priorities of DETE (formerly DBEI) and DfE, insights into global technologies underpinning sectors (see McKinsey (2022), the mapping of potential and current linkages, as well as the detailed examination of strengths and weaknesses at regional and jurisdictional levels gives some indications of possible joint investment projects that might accelerate growth and realise synergies. Figure 70 suggests potential cross-border (and inter-regional) projects to illustrate the overall approach.

There is already considerable experience in Interreg, PEACE, shared-island HEI research projects, etc. that can guide us in choosing and organising such joint projects. The Tourism Ireland campaign to select global markets to leverage the regional/jurisdictional brands of *Wild Atlantic Way*, *Giant Spirit*, *Hidden Heartlands,* and *Ancient East* is a good example of how such joint projects can help accelerate growth in all regions and jurisdictions across the island.

Figure 70: Illustrative joint projects for island-wide progression of key sectoral clusters

Level aimed for by 2030		Technology and science	Global linkages/other
High	**Life sciences**	High-level professorships across hubs (diagnostics, MedTech, bio-pharma, pharma production) Major research programme for the eHealth industry (aged services, data)	Joint learning mission to Boston and Cleveland
	Engineering	Major research programme on applied science for mobile structures (transport, handling, platforms, etc.) Major joint research and development programme for industrial chip manufacture and design	Joint learning missions to world-leading clusters e.g. West Midlands, Stuttgart/Freiburg, Shenzhen, etc.
	IT/Software	Focused research programmes for key segments (cyber, consumer engagement, wearables/sports tech, energy-saving, EdTech, etc.) Major investment in an island-wide network of quantum computing facilities High-level professorships in areas underpinning sector on the island of Ireland	Joint learning missions to world-leading clusters, e.g. Silicon Valley
Medium+	**Agrifood**	Major research hub and spoke centre for next-generation food tech (plant meats, insects, hydroponics, etc.)	Joint learning missions to Italian, French and Indian artisan food production systems/cultures
	Financial services	FinTech research programme on key technologies (blockchain, legacy process conversion, mobile finance, etc.) and new options for money exchange, etc.	Joint learning mission to New York for next-generation finance (Columbia Business School)
	Hospitality / Creatives	Shared innovation services for commercialising IP for creatives and linked joint research programme	NWxW digital/creatives festival (wider NW and NWR/NI)
Low/Basic +	**Construction**	Research programme into scaling with high standards construction (modular housing, etc.) within budgets, time and benefits	
	Energy plus	Research programme for smart cities (led by Belfast and Dublin)	Joint learning mission to east coast England, Scotland and Jutland
	Other sectors	Joint Research and Innovation Transport and Logistics Centre	

9.1 Building shared vision and pathways

Building on the sectors already or potentially present in a region – and progressing them to a higher level of relative performance and global ranking – requires focus, analysis and action by key stakeholders working together and individual stakeholder actions. Towards that, it is critical to have a shared understanding of the global and regional sector and a shared vision and pathway for its development and progression. A sectoral development framework that enables shared understanding, vision and insight into key factors and pathways for its development facilitates the follow-on discussions and further detailed work by the relevant stakeholders and partners on agreed three-year action plans and budgets for each key growth sector.

See Appendix 2 for more elaboration on what a sectoral development framework/checklist of best practices, useful models, etc., might look like.

More important than the content of a strategy development framework is the process of shaping and sharing such a framework and sense of strategic direction, systematically inclusive of key stakeholders and players, including enterprises of all sizes, employees and others engaged directly.

What is needed is for stakeholders to interact and discuss systematically, interactively, and proactively to understand and clarify the actuality of sectors and their real potential in a region, understanding the enterprise growth engine and ecosystem for the sector in the region, raising issues and concerns and risks, developing pilots and initiatives to test assumptions about markets, technology and capabilities etc., understanding at a granular level the real specific few SWOTs for their sector in the region, and reflecting on what has been learnt from testing of assumptions and related experience. The classic and central questions of reflection – what has worked well, what has not worked so well, and what can be done differently next time – are at the core of the progressive adaptive learning process.

This process is often described as a 'growth diamond' or 'quadruple/quintuple helix' for the sector. The formation of a sectoral growth diamond reflecting Porter's Five Forces involves a range of stakeholders with specific responsibilities and roles, especially in the quintuple helix of enterprise/business, education & research (HEIs/FETS), government & public sphere, community & NGOs, and stewards/advocacy groups for the environment.

The core role is to develop and agree on an agenda of strategic direction for the sector and a sectoral strategic framework to deliver and proactively progress its coordinated and integrated implementation. Such stakeholders can contribute to the upgrading of key resources (skills, finance, research, etc.). as well as be involved in networking, peer mentoring and building relationships and linkages within the region and jurisdiction, all-island, east-west, and wider afield, both overseas and globally, to best practice and opportunities.

Also, stakeholders operate at different levels and spheres and must reflect and discuss systematically and proactively between the levels (Figure 71).

Figure 71: Different levels of growth partnerships and agency within broad sector

Level	Theme	Structure	Scope
Horizon	Global drivers, dynamics, structure and trends	Euro-clusters UK cluster networks World cluster associations	EU UK International
Framework	Global trends, internal capabilities & SWOT, strategic direction & purpose; joint projects & networks for synergies	Sectoral forum	All-island
Plan	Response plays & patterns, strategic goals, enterprise growth ecosystem, key responses	Sectoral diamond/helix	Jurisdiction Region
Projects	Marketing, technology, skills, etc. sharing	Formal collaborative cluster in sector	Grouping often local / specialist
Roles	Own strategic goals, resources, constraints and concerns	Enterprises / organisations	Representatives
Inputs	Experiences, insights, ideas	Networks within and between sectors	Individual participants

Such evolution of a collective grouping to drive the development of a sector to higher levels of performance is essentially adaptive leadership in response to complex challenges as applied to a broad sector in a region, jurisdiction, and all-island.

Reaching such shared understandings and vision requires inclusive and structured sectoral planning discussions with key stakeholders rooted in analysis and experience and taking account of the multiplicities of roles and identities that all play.

9.2 Clustering collaboratively as a tool of sectoral development

Collaborative clustering can have a major role to play in developing sectors to higher performance levels, with companies working together on a few or more key business areas for mutual benefit. CRN (2022), with support from ITI, held a series of workshops with over 100 practitioners in autumn 2021 to reflect on collaborative clustering on the island of Ireland. The workshops concluded that three gaps needed to be addressed:

1. **Moving to clarity from confusion**

   ... 'cluster' as a concept remains confusing and lacks an agreed definition, and this position is likely to continue without departmental leadership across the island driving ahead with cluster goals, programmes and criteria.

2. **Policy development, implementation and funding**

   ... need for any cluster policy ... to take account of factors including life cycles of clusters, the need to include both mature and nascent industries, the scale (geography and resources) at which clusters best operate and the understanding

that the trust and collaborative relationships … take a longer-term timescale to develop.

3. **Learning, education and career progression**

   The need for the development of a professionalised group of cluster managers … [with] an appropriate support infrastructure."[244]

Six recommendations were made:

1. *Leadership and buy-in at … government level* [for] *a clustering programme of substance, to drive competitiveness in key areas of … importance across the island.*
2. *Agree* [jointly] *appropriate definitions for cluster, cluster organisations and cluster initiatives … and differentiate them clearly from alternatives.*
3. *Develop a cluster policy which includes programmes with appropriate … medium to long-term time scales and cycles … based on best international practice … and explicit links with strong international clusters.*
4. *Establish a centralised cluster financing programme … aligned with strategic priorities.*
5. *Provision of professional and accredited training, education and career progression opportunities for cluster managers and practitioners.*
6. *Develop a centralised hub to connect and inform clusters across the island of Ireland and promote them nationally and* internationally [commissioned by DfE and DETE where the opportunities are specifically cross-border in nature or where all-island coordination is appropriate, InterTradeIreland can take a lead role]*."*[245]

In the context of an all-island clustering policy framework and of the 40 or so formal collaborative cluster groups already working away, the key broad sectors can be examined within each of the regions and jurisdictions and island-wide to see where the gaps are and what would be useful to progress. Denmark underwent a major overhaul of its clustering groups and rationalised them from 40 to 14 grouped around their main sectors.[246] While a less directive approach might be more sensible here, the evolution of several broad groupings, forums or alliances of formal collaborative clusters in the eight to ten priority sectors island-wide to co-ordinate initiatives and learn from others' experiences could be encouraged. Smart specialisation strategies as a framework are necessary to leverage and multiply the impacts of formal collaborative clustering initiatives.

Building company and other stakeholders' capability to do joint collaborative projects and build linkages at regional, jurisdictional, all-island and international levels is key to nurturing shared analysis, agency and alliance-forming within the sectors overall.

9.3 Shaping technology competencies for key sectors

Importance of key technologies for sectoral development

Given the current shift from sectoral dynamics to global value chains, it is relevant to identify niche areas with high transformative potential, especially for smaller open economies such as Ireland's. The Southern Region specialises in three of the top 5

niche areas, and they reflect strengths both in the development of ICT devices and biotechnologies.[247]

Underpinning sectoral development are deep capabilities and expertise in key technologies driving that sector and the ability to develop global linkages and access such technologies in other areas. McKinsey (2022), in its strategic reflection on the development of the European economy, outlines the key areas of technology competence needed to compete in a range of industries (Figure 72).

Figure 72: 0ver 60 future areas of competition at the intersection of traversal technologies and sectors

Industrials (incl. auto and defence)	**Chemicals and materials** (incl. agriculture)	**Transportation, energy, and infrastructure**	**Pharmaceuticals and healthcare**	**Consumer and retail**	**Financial and professional services**
Next level process automation					
Robotics, additive manufacturing, drones, digital twins	Virtual development, modelling, testing, nextgen agriculture	Modular construction, prefab, additive manufacturing, robotics	Virtual clinical trials, surgery robots, additive manufacturing	Domestic service robots, warehouse automation	
Future of connectivity					
Industry 4.0 connected cars, connected soldiers	Smart farming	Smart cities, smart power plants & grids, embedded sensors	Remote health monitoring, wearables	Wearables, smart home	
Distributed infrastructure - Cloud & Edge computing					
Next Generation Computing - Quantum Computing					
Applied AI					
Autonomous vehicles	Precision agriculture	Last-mile drone usage, smart power plants & grids	AI imaging & diagnostics, drug discovery	Marketing analytics, speech recognition	Pricing risk analytics, automated operations, tech-automated advisory
Future of programming - Software 2.0					
Trust architecture					
Cyberware	Traceability	Smart contracts	Blockchain in supply chain & records	Smart sourcing	Blockchain smart contracting
Bio Revolution					
Industrial enzymes, exoskeleton	Next-gen crops, bio-route for chemicals	Biopolymers, biofuels, engineered produce transportation	Gene & stem cell therapy, tissue engineering, brain device interaction, neurogenic, biomolecules	Alternative proteins, microbiome-based products	
Next-generation materials					
Nanomaterials, new materials, new-gen weapons	Nanosensors, next-gen composites, synthetic materials, chemical design	New materials, new construction materials	Tissue engineering	Personalisation, new materials	
Future of cleantech					
Decarbonisation, electric vehicles	Wireless, irrigation systems, green cement & steel, recycling	Modular, virtual twins, renewables, CCS, green energy			

Note: Adapted from McKinsey Securing Europe's Competitiveness: Addressing its technology gap (2022)(Exhibit 3)

Need for Small Open Economies (SOEs) to focus on critical technologies for sectors

While leading large global economies such as the USA, China, and Europe can seek to develop deep capabilities across the full range of sectors and technologies, small open economies (SOEs), such as on the island of Ireland, cannot and must focus instead on key sectors and the related (few) technologies that we want to be excellent in. This needs inclusive reflection and consultation amongst industry, academics, policy-makers, end-users and others, as has been periodically done in both jurisdictions on the island.

Technology Foresight has been a highly influential process in the ROI, leading to the set-up of Science Foundation Ireland and the ramping up of multiples of public investment in key technology areas such as ICT, materials and biotechnology. The DBEI (2019) reflection on research priorities outlined key areas for the Republic's technology development (Figure 73). In NI, Matrix, the Northern Ireland Science Industry Panel[248] has specified technology areas for sectoral growth (Figure 74).

Figure 73: Refreshed priority areas 2018-2023

Theme	Priority area
ICT	Future networks, communications and IoT
	Data analytics, management security, privacy, robotics and AI (incl. machine learning)
	Digital platforms, content & applications, and augmented & virtual reality
Health and wellbeing	Connected health and independent living
	Medical devices
	Diagnostics
	Therapeutics
Food	Food for health
	Smart and sustainable food production and processing
Energy, climate action and sustainability	Decarbonising the energy system
	Sustainable living
Manufacturing and materials	Advanced and smart manufacturing
	Manufacturing and novel materials
Services and business processes	Innovation in services and business processes

Note: Adapted from DBEI (2019)

Figure 74: The technologies that will shape the future of Northern Ireland

Security	**CyberSecurity**
Digital workplace	Software engineering and AI
IT Automation	Robotics
Network	Advanced composites
Computer infrastructure & platform services	Zero carbon tech, transport, energy, agrifood
Storage and databases	Digital transaction/ID authentication
	Food supply chain/safety
	Virtual production

Note: Adapted from DfE (2021)(Table 6.5)

Company and academic technology and science strengths

Company (ROI only)

For the Southern Region's S3, Babel[249] analysed the *Technology Generation of Advanced Technologies for Industry (ATI)* of EU 27 member-states. They concluded that ROI at 28% is somewhat behind the EU 27 average (34%) but significantly behind the top leader (Germany at 90%). Areas in ROI that are ahead of the EU 27 average in technology generation are AI, big data, connectivity, cloud computing, and security (i.e., digitalisation technologies). However, in all cases, ROI is nowhere near the top-performing country in these areas, and only three come within half of the top performers' level.

In contrast, the Babel analysis of the *Technology Uptake of Advanced Technologies for Industry (ATI)* suggests that ROI at 50% is ahead of the EU 27 average (31%) but again clearly behind the top leader (Iceland at 65%). ROI is ahead of the EU 27 average in technology uptake in advanced areas: advanced manufacturing technology, AI, AR/VR, big data, blockchain, connectivity, cloud computing and IoT (again, almost all in the digitalisation technologies). Again, ROI is significantly behind the top performers in all these technologies, although it is now within half of the top performers' level in nine areas. (It would be helpful to include Northern Ireland specifically and the UK generally in this comparison).

Academic (ROI and NI)

While much debate exists about the merits, methodologies and motivations of academic rankings, examination of academic rankings by subject (QS Subjects[250]) can be illuminating. There are now 14 universities in both jurisdictions on the island of Ireland (10 in 2021, the year of the QS Subject Rankings comparison[251]). In total, 98 university subjects on the island of Ireland were ranked by QS as being within the top 200 globally (Table 6). Universities in EMR (Trinity, UCD, DCU, MU and NCAD) had 70, those in Northern Ireland (QUB and UU) had 14, those in SR (UCC, UL) had 11, and NWR (NUIG[252]) had 3. Particularly interesting were the subject categories focused on with life sciences (23%), public administration (24%) and culture (18%) being the lead subject categories, followed by environment (10%) and professional services (7%). Food (4%), engineering (4%), construction (3%), education (4%) and information and communications (2%) all received much lower shares of the top 200 global rankings on the island of Ireland.

A similar spread by subject categories is reflected in the HEA North-South Joint Research University Awards (Table 7), with life sciences (34%) and health (21%) being the strongest categories, followed (again) by public administration (16%) and culture (13%). Environment (8%), digital (3%) and other (5%) are all at much lower levels.

Table 6: Spread of high-level HEI subjects by region and sector (QS Subject world rankings under 200[253])

Theme	EMR	SR	NWR	NI	Total
Agrifood	2	1			**3**
Life sciences	14	3	1	5	**23**
Engineering	3			1	**4**
Environment	10				**10**
Construction	1	1		1	**3**
Information and communications	2				**2**
Professional services	7				**7**
Education	3	1			**4**
Public administration	17	2	1	4	**24**
Culture	11	3	1	3	**18**
Total	**70**	**11**	**3**	**14**	**98**

Source: QS Subject Rankings 2021

Table 7: Themes of projects supported by north/south research programme, Jan 2022

Themes	Project No.s	%
Health	13	21%
Life sciences	21	34%
Environment	5	8%
Digital	2	3%
Culture	8	13%
Public administration	10	16%
Other	3	5%
Total	**62**	**100%**

Source: HEA

Implications and questions

Several implications and questions arise:

1. It is optimistic that ROI-based companies can adopt and generate some key digital technologies well. However, they are significantly behind leading countries. Is that enough to ensure a progressively stronger software industry here? What are the critical gaps?
2. It is not so positive that ROI-based companies seem slow in adopting and generating technologies in other sectors critical to the economy, such as life sciences, engineering, environment, etc. If that is the case, it is a significant problem, and the question arises about what actions to undertake.
3. The emphasis on life sciences within the academic system in ROI and NI is striking. It is a major strength that can underpin significant progression in the relative global performance of the life sciences cluster on the island of Ireland.

4. The relative lack of focus in academic rankings on other key areas critical to the economy here, such as digital technology, engineering, environment and others, is surprising and needs more reflection and discussion to understand.
5. The academic underpinning of the relevant science and key technologies does not appear as strong as it ought for these sectors to progress to higher performance levels and global perceptions.
6. The strength in academic subjects relating to public administration and cultural activities has to be strongly welcomed, as these areas build capability throughout society to analyse, act, and ally to address our major challenges, including how to step-change key sectors and strengthen the ability to individually and collectively imagine and connect, critical features of any working economy and society.

Overall, the question is how to judge the specific technology capabilities on the island of Ireland as to whether they underpin and drive sectoral cluster development or if there are some significant gaps.

9.4 Embedding higher and further education as key to sectoral development

Building outside-in from sectors already/almost here

Intense focus on and understanding of the reality of the region's industrial structure:

- HEIs need to focus very specifically on the actual key sectors existing and emerging in their region and drive regional growth by relating in detail to the current and future needs of sectors at the stage of development.
- In particular, HEIs can use the Create, Transplant, Transform, and Convert 'types' of the MIT Local Innovation System (LIS) 'outside-in' model (http://web.mit.edu/lis/) to understand the stage of development of the sectors and subsectors that are actually or potentially present in the regions on the island and tailor their offer accordingly into appropriate 'mixes' of teaching, education, training, research and proactive engagement.[254]

Skill development is central

Providing skilled people remains the critical HEI and FET contribution to regional sectors. Constant interaction between companies and educators is key to ensuring relevance and responsiveness. In its *Skills Strategy Assessments and Recommendations* for NI (2020) and ROI (2023), the OECD spells out the opportunities and challenges for skill development in both jurisdictions to achieve innovative economies, inclusive societies and sustainable environments.[255] The HEIs, ETBs/FECs, Skillnet and many other stakeholders all have key roles to play here. The potential of a more integrated tertiary system of higher education, further education & training, and research & innovation to achieve multiple benefits is highlighted.

Prioritising HEI research and innovation for companies and sectors within the region

- Focusing research on the companies in the sectors currently or potentially within the region, in particular, applied and commercialisable, useable research and innovation, as well as the use of facilities and equipment, is critical for upgrading

sectoral clusters in the regions. In some cases, developing greater levels of basic research is also key. The choice is not between globally excellent and regionally relevant research, as is often positioned amongst academics, but between research excellence that is "global, as rooted in a region as platform, versus global, as every and anywhere."[256]

- In a study of linkages of the Cork ICT cluster using V-LINC techniques, low levels of R&D linkage between enterprises and both other enterprises and HEIs were found:

> *The singular lack of positive impact across any geography for R&D stands out, a finding evident only from our differentiation of impact. A low-density linkage, R&D is among the lowest ranked … in terms of both outcomes and input linkages.*[257]

The question is whether this is a once-off random outlier or a 'canary in the mine' indicating a systemic problem. Generally, feedback from various enterprises, especially SMEs, might suggest the latter.

HEIs and FETs proselytising for innovation diffusion and *really* reaching out to the under-20s

- The diffusion of technologies remains central to regional success. It is a central regional weakness if high technology users are limited to a small number of large corporates and very technology-intensive SMEs. Addressing the long tail of low performance – i.e. the weakest link of an innovation system – through widely spreading technology is a success of some regions (such as Bavaria and other German regions) and is done by a culture and practice of intensive and very proactive enterprise/HEI engagement.
- In particular, responding to the smaller (especially the under-20s) companies is always for the HEIs (as for many others) in the 'too hard to do box' and given no priority. Yet, such companies are central to varying degrees within each region. The size structure of businesses varies by region. Dublin has about half the employment involved in large companies and SMEs, whereas NWR has 85% employed by SMEs (and 35% in micros), and the rest of EMR, NI and SR are in between. SME enterprises' step-changing productivity and efficiencies (especially smaller under-20 enterprises) are key to developing innovative and inclusive regions.[258]
- In all regions and jurisdictions, there is a need for a proactive strategic approach involving measures such as:
    - ramp-up of innovation vouchers (to multiples of current levels), which are the starter bridge for smaller companies to become familiar with higher education;
    - use of graduates and alums as small business ambassadors;
    - proactive use of virtual access and online education/training delivery;[259] and
    - further education and training bodies reaching out to smaller companies to promote and progress innovation and skill development, including apprenticeship and lifelong learning
    - the use of regional enterprise-led bodies such as Chambers, Skillnet groups and others to promote and access skill development

Shaping the region as an adaptive learning system

- With several HEIs in each region, the opportunities for differentiation are now considerable, especially on the continuum of research-intensive and technological/practice universities; companies and each sector in all regions now have an opportunity to have two or more HEIs focused on its needs, but with some concentrating on basic/strategic research and others on skill development (from apprentices, diplomas, certificate programmes, degrees, undergraduates and postgraduates, innovative services and contract and applied research).
- Further education (Education and Training Boards in ROI, Further Education Colleges in NI) also have a significant role to play in skill development, and in some cases, have developed major centres relevant to regional sectors, e.g. Ballymena Hydrogen Training Centre and test beds (NRC), advanced manufacturing in Dundalk (LMETB) and (proposed) hospitality in Killarney (KETB).[260]
- The importance of the HEI and FET roles in developing cultural openness and exchanges with the global best practice clusters in the sectors of relevance in their region is vital. This implies a strongly proactive strategic approach to student exchange (especially through the Erasmus programmes) and language training and education both for full-time students (required on key courses to some level, e.g. German for engineering, French for leisure and cultural activities, etc.) and for part-time students/CPD (certificates and diplomas in key languages of German, French, Spanish, Chinese, etc.).

Overall, ensuring an outside-in approach to the targeting by HEIs and FETs of key sectors and company categories (including the under-20s) in each of the regions/jurisdictions is vital for regional and sectoral development.

9.5 Leveraging regional structure and experience

In analysing the 3,000 clusters in Europe, EOCIC (2020) mapped them by the population size of the regions they were located in (Figure 75). They showed that the number of clusters per region increased by the region's size and plateaued at urban regions of 2-3m people.

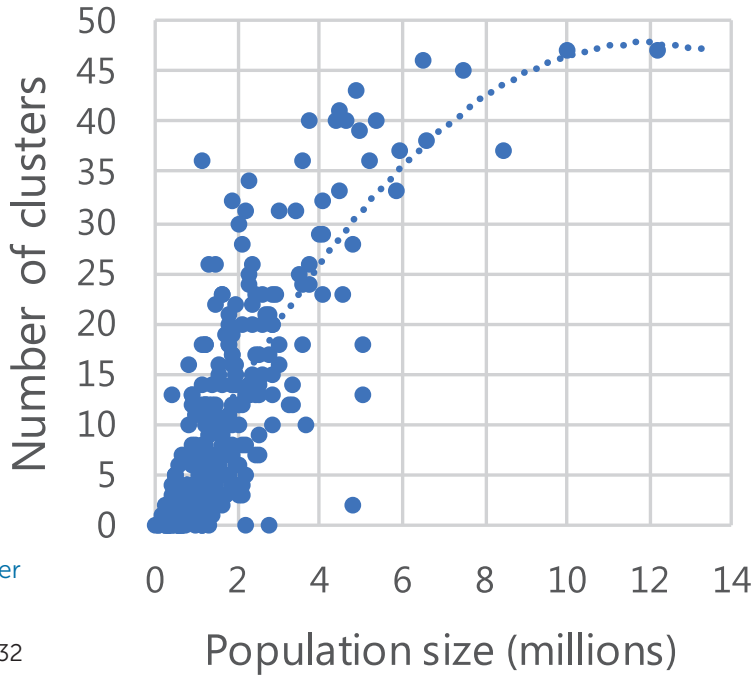


Figure 75: Size of region matters for the number of clusters (and associated productivity gains)

Source: EOCIC (2020) p.32

Most of the NUTS 2 regions on the island of Ireland are numerically in the order of that 'optimum' size for clustering (in the sense of clusters defined by EOCIC (2020)). Indeed,

> *Most ... [cluster] locations involve one of the main city-regions of the country. Applying the CI index to the space-economy of Ireland, van Egeraat et al. (2016) identified thirty-one substantial concentrations. Of these concentrations, twenty-nine encompass at least one of the main city-regions in the country.*[261]

Over 90% of substantial concentrations are co-located in Dublin, Cork, Limerick-Shannon and Galway.[262]

Van Egeraat et al.'s (2023)(p.28) analysis of agency-assisted employment 2001-2022 by sector and regions and of regional resistance to potential future external shocks shows that the combined share of Dublin, South West and West increased from over 60% to over 72%. "Furthermore, in the light of the current regional industrial structures and the variation in level of regional resistance, in the absence of stronger policy intervention, the trend will be one of further regional divergence post-2022." (Appendix 3)(p.28).

From an all-island regional perspective, it can be argued that:

- Already, Dublin/EMR is an *actual* city region of a 2-3m population size;
- The other urban cities of Project 2040, i.e. Cork-Limerick-Galway-Waterford combined, are an *emerging* city-region of that size; and
- Belfast City, the other cities and towns of Northern Ireland, and the regional towns and rural areas of the NWR north of the Dublin-Galway line are a *potential* city-town-rural linked zone also of that size.

This is the perspective presented in the CCBS discussion paper by O'Donnellan, N. and McCormack, B. (2022), *Accelerating Growth: Towards an all-island perspective on regional development*.[263]

The implication is that to avail of the benefits of scale and proximity, viewing and organising clusters and sectors and sector-specific infrastructure needs to be done at that NUTS 2 region level, as well as at jurisdictions and state level and EU (with Euro-clusters linking major regional clusters[264]) and UK levels.[265] Such EOCIC (2020)-type clusters also have a local, city, town and county dimension based on the building block of clusters, i.e. individual companies, enterprises and individuals and their connections.

DBEI (2022) and DfE (2021) have both based their sectoral specialisation strategies on NUTS 2 regions, i.e. Eastern and Midland, Southern, and Northern and Western Regions in the Republic of Ireland, and the whole of Northern Ireland itself is one such region. The EC Regional Ecosystem Scoreboard shows that: "In Ireland [i.e. ROI], the Eastern and Midland and Southern regions outperformed the EU average in 2021, while the Northern and Western Region performed below the EU average. Between 2017 and 2021 all three Irish [ROI] regions saw a deterioration in scores."[266]

In contrast, while scoring somewhat less than the Eastern and Midland ROI regions, Northern Ireland is ahead of the other two ROI regions. It is the only NUTS 2 region on the island to improve its score between 2017-21. EU regions as a whole improved over 2017-21, as did most NUTS 2 regions in the UK.

In the context of scale and proximity at regional and higher levels, the generic key to regional economic development is to:

a) Specify and focus on the broad sectors with opportunity (global growth and challenges) and capability (regional strengths and weaknesses) relevant to the region;

b) Understand and respond to each sector's dynamics within the region, as Create, Transplant, Transform and Convert;

c) For each sector important to the region, identify, fill out, access, strengthen and globally link the seeding, starting, scaling, innovating, larging, and rooting enterprise growth engine and ecosystem (see Figure 76 for example of approach (MedTech in NWR (ROI));[267]

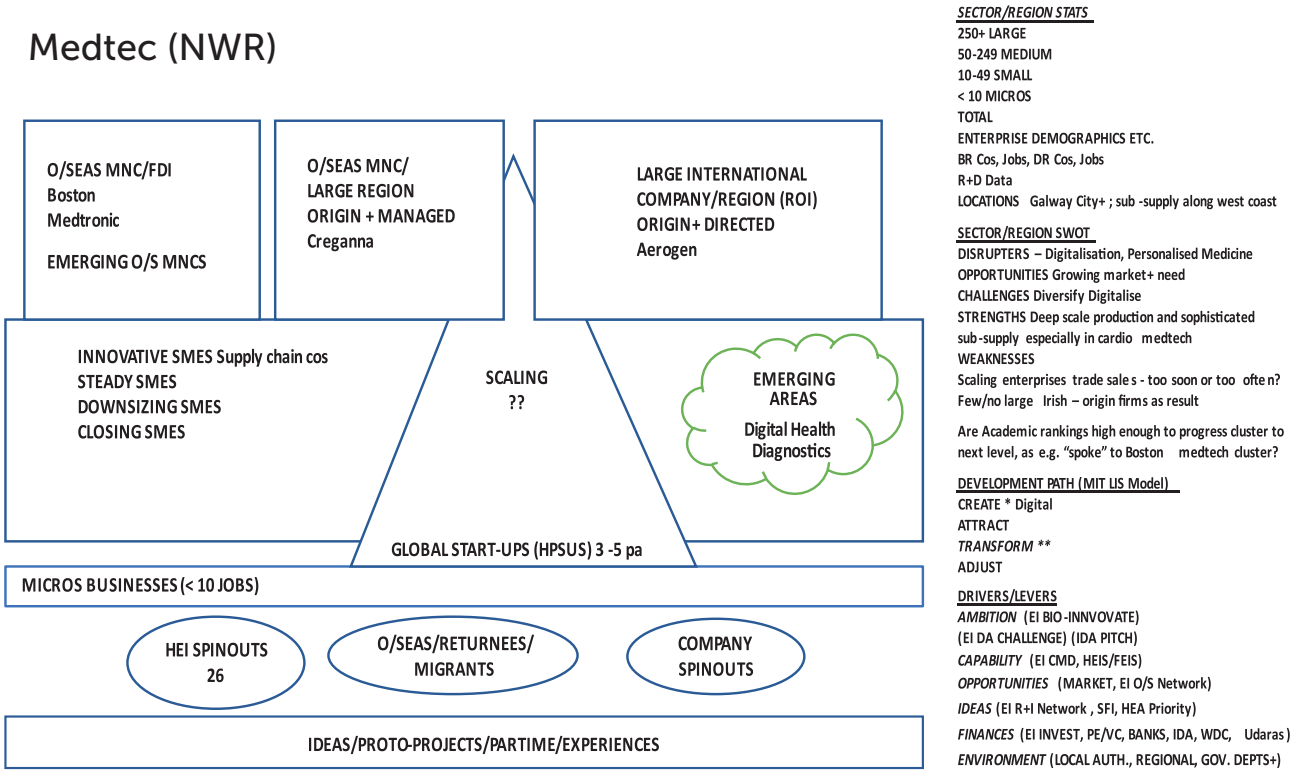
d) Stimulate constant company-led evolution and change within each sector's portfolio in the region as renewed platform launches, positioning and scouting options and stepping stones; and

e) Build complex sectoral alliances and quintuple helix/diamonds to drive the goal of inclusive growth and progression to higher and world-class levels.

The delivery question may be at a regional or higher level of whether and how to coordinate or integrate sectoral and individual enterprise development processes.

Having a regional dimension as the foundation for sectoral planning and development is now necessary in a developed, sophisticated economy.

Figure 76: Example of regional sectoral enterprise growth ecosystem



Source: O'Donnellan (2023)

9.6 Specifying indicative sectoral investment priorities

For sectoral development to drive economic growth, sectoral change initiatives are required to step-change key factors in each broad sectoral cluster's success. As discussed, such sectoral change initiatives require key drivers and network investment. The tentative insights on priorities and gaps summarised in each of the four regions on the island of Ireland might suggest broad investment areas (as indicated in each region's/jurisdiction's assessments).

The investment priorities should reflect a balance of short-term, medium-term and longer-term capabilities, technologies and impacts. In software development, for example, investments in cyber security coding skills (short-term), AI/blockchain deep tech (medium-term) and quantum computing (longer-term) have different horizons of commercial value-generation and employment. In particular, future-proofing a region's sector requires some investment in activities and technologies with open and unclear outcomes, either because of market or technology uncertainty or both (Figure 77).

Figure 77: Sectoral activity/products - 80/20% balance of the present and future

Positioning options (High technology uncertainty, low market uncertainty)	**Stepping stones** (High technology uncertainty, high market uncertainty)
Platform launches (Low technology uncertainty, low market uncertainty)	**Scouting options** (Low technology uncertainty, high market uncertainty)

Source: Adapted from McMillan and McGrath (2000)

Stakeholder consultation and policy-makers decisions on priorities are required at regional, jurisdictional and all-island levels to progress. The recent investment in Northern Ireland's cyber-security ecosystem of £20 million might be a helpful starting point in considering the scale of investment within a region/jurisdiction needed to progress a key sector to the next higher level of performance. Developing a portfolio of competitive world-class sectors within each region, jurisdiction and island-wide will require multiples of such levels.

The key challenge is choosing which sectors to invest in and planning for successful outcomes of employment and incomes. Developing implementation strategies with budgets and indicative returns (i.e. employment, incomes, productivity, exports and taxes) on investment, with medium costs and benefits broadly assessed, is an essential next step in choosing both sectoral cluster priorities, sectoral initiatives and investment budgets.

With many competing demands on finite resources in both jurisdictions, not all desirable initiatives and projects will be funded, at least not all at once! Prioritising and timelining initiatives with the most income and job growth returns is critical while making some open-ended 'bets' as positioning options, stepping stones and scouting options. In some cases, potential synergies and economies of scale may be obtained by a holistic and all-island approach.

Specifying and choosing between investment proposals to drive sectoral growth is central to making any progress, alongside effective implementation and learning review.

9.7 Nurturing a competitive, innovative, inclusive and sustainable economy at all levels

In considering in what sectors the island of Ireland, and its regions and jurisdictions, is now and potentially can be more competitive as internationally benchmarked well-performing clusters, wider economic competitiveness needs to be taken into account, with a focus on developing the range of enterprises, technologies, experiences and capabilities, infrastructure and values/culture that underpin and drive economic activity in a globally trading world (Figure 78).

Figure 78: Elements of innovative, inclusive, and sustainable economy at regional, jurisdiction and all-island levels

OUTCOMES Sustainable value-added, productivity, jobs, incomes, surplus, wellness and ecology

CLUSTERS **(H)** Life-sciences, production engineering, digital business services and software
(M) Agri-food, financial services, hospitality and creatives
(L) Construction products and services, electric power generation (offshore wind etc.), education and care services

ENTERPRISES/BUSINESS MODELS* Large Island of Ireland orgin corporates, overseas multinationals, scaling, medium + small enterprises, smaller/micros/self-employed, born globals, start-ups

CIVIL SOCIETY/STATE Communities, HEI/FETs, public sector, local/regional authorities, political structures (e.g. jurisdiction, state, UK, EU, European, global), industry representative groups, trade unions, credit unions, voluntary/community groups, environment stewarts etc.

TECHNOLOGIES/SCIENCE

(NI 10x economy) Cyber-security, software engineering + AI, robotics, advanced composites, zero-carbon tech (energy, transport, food), digital transactions with id, virtual production, food chain

(Others) Nanotechology, gene editing (Crispr), personal health profiling, experience/creatives psychology + pedagogy, blockchain, new food platforms (insects, "meat" alternatives, hydroponics) etc.

PRODUCTION CAPABILTIES*/EXPERIENCE Technology and sector-specific skills and experience, networks/access to world-class expertise, generic interpersonal/teamwork, problem-analysis/solving, creative/innovative, project management and adaptive leadership/strategic capabilitities

CAPITALS

ECOLOGICAL Life-sustaining environment on cool planet v. rapid climate warming and disintegration

SOCIAL Skill formation*, life-long learning/nurturing 4 all, research + innovation networks, open, multi-lingual and welcoming culture

FINANCIAL Credit, equity and resources, infrastructure (broadband+, air/ports/road/rail/canals)

AGENCY** Strategic systems thinking, project managment/implementation, collaborative discourse, active listening + reflective learning, trust and social contract, solidarity + subsidiarity, transparency + accountabilty of power, resilience, resourcefulness + patience

VALUES Respect for diversity and unique value of each individual, equal opportunity and care for all, social market (pro-enterprise, ambitious ends, flexible means, rewarding work for all, surplus-generating), connected families and communities, safety at/in home, work, street and socal media, active citizenship, inclusive government of, by and for the people, human interdependence, as we all are children of the universe

Note: * Includes Best (2018) Capability Triad of Business Models, Productive Capabilities and Skill Formation

** Agency Capital is the culture, art, science, skill, focus, energy, collaboration, discipline and plain common sense of groups of people working together to get big difficult and complex things done well, such as the Marshall Plan, Moon Landings, Belfast/Good Friday Agreement, Newgrange, Ireland's Rugby Team as a top world team etc.

10. Progression and conclusion

10.1 Progression

The alignment and linkages of various activities and policy initiatives can be made clearer using the range of sector-related information and data available within the common NACE/SIC sectoral categories. An assessment can be (tentatively) made as to gaps, linkages, etc., that need to be addressed if individual regional or jurisdiction economies or all-island networks of regional economies are to progress to higher levels of incomes, employment, productivity and exports through sectoral development and clustering. The overall sectoral development framework that has evolved here can hopefully provide helpful input for discussions and action agendas at regional, jurisdictional, all-island and cross-border levels.

Next steps include:

- Widespread discussion and evolution of approach towards all-island sectoral development at regional, jurisdictional and all-island levels, with this reflection as input;
- Reflections on the adoption of sectoral clustering progression goals to 2030 at:
    - Regional and jurisdictional levels in the context of progressing *DfE's 10X Economy* strategy, DETE (BDEI)'s *3S Strategy for Innovation*, the Regional Spatial and Economic Strategies (RSES), the City and Growth Deals, etc.; and
    - All-island level, with consideration led by ITI and guided by DETE and DfE, of all-island broad sectoral priorities that can become mutually beneficial shared 2030 goals.
- Facilitated by InterTradeIreland, discussions on the creation of all-island cross-border sectoral development planning frameworks and forums to accelerate the development of eight to ten agreed broad sectors;
- Co-creation of all-island broad sectoral development agendas and identification of three or four major shared and joint cross-border (and cross-regional) projects within each broad sector to drive step-change in capability and global recognition;
- Further evolution within the four regions and two jurisdictions of NUTS 2 level sectoral agendas to develop the enterprise growth engine and ecosystems for key sectors and clusters and the stakeholder diamonds to drive them;
- Cocreation of a collaborative clustering policy, led by DETE and DfE, involving ITI and the Cluster Centre, CRN, EI, INI and others with helpful experience here;
- More detailed and comprehensive mapping of the sectoral clusters on the island of Ireland, as a follow-up to ITI's 2015 pioneering mapping study with:
    - Use of concentration indices (with travel areas)(van Egeraat et al. methodology);
    - MTU V-LINC (Hobbs et al. methodology) with actions to strengthen the relevant linkages with most impact;
    - EOCIC approach to comparative sectoral cluster performance at a broad European level, for at least a measurement of whether the sector clusters here have advanced and ideally for a Europe-wide comparison for the 25 or so sectors of interest; and

    - Other analytical methodologies that can add to our understanding of clustering and how to leverage it to improve economic impact.
- Develop follow-on action and investment planning for the key strategic sectors:
    - Selecting a few key technology platforms
    - Building wider cluster linkages overseas and globally
    - HEI/FET focuses on regions and jurisdictions
    - Public investment priorities
- Consider at all levels as a policy delivery question whether and how to co-ordinate, or to integrate, the processes of sectoral development and individual enterprise development;
- Participate within European, UK and other overseas and international forums and similar groupings in benchmarking and comparative rankings; and share in the learning about sectoral development and clustering as policy tools to foster regional economic growth, especially in Small Open Economies (SOEs); and
- Consider putting in place an Observatory for Sectoral and Company Dynamics and Development based in one or more of the universities to absorb and adapt international (OECD, etc.) thinking and insights into how sectors evolve and best policy practice, the interaction of technologies generation and adoption, and innovation diffusion, as well as insights into each of the eight to ten broad sectors of interest on the island of Ireland and its prosperity (a hub and spoke model might work best with spokes near to relevant clusters, etc. or current interests, e.g. MedTech sector, family businesses, etc.).

10.2 Conclusion

This reflection shows that the nature of the economies in all the regions and jurisdictions across the island are well beyond being economies whose foundations are *primarily* built on competing on costs, subsidy-driven investment, and/or speculation and arbitrage. There are now deep roots of experience and capability in all the key sectors throughout the island of Ireland. As Bradley (2001) put it: "In a sense, Best's framework requires a type of 'critical mass' of change in each element of the triad before growth can take off."[268] What is clear is that this inflection point of 'critical mass' of change at sectoral level is now being reached across the island of Ireland.

To further root and develop the sectoral experiences and capabilities island-wide and become recognised globally as building towards becoming world-class in the key sectors, there is a need now to:

- strategically and systematically **intensify the transformation to an innovative, sustainable economy**;
- **deepen the sectoral enterprise engines and ecosystems** throughout each region and jurisdiction; and
- **leverage further the step-change opportunities for synergies** and collaboration to mutual benefit both across the island, overseas and globally.

The insights of this reflection are offered at regional, jurisdictional, all-island and cross-border levels for intensive consultations with key stakeholders at all levels and as the basis for accelerating

growth within the two jurisdictions and four regions throughout the island. As one sectoral report put it so well: " ... if the various actors in the ... sector were connected better the sector could be world-class, a force to be reckoned with ... there is a need for greater joined-upness here."[269]

There is a range and complexity of stakeholders and a multiplicity of objectives, priorities, and constraints, as well as the realities of different cross-border contexts and powers, to be taken into account and involved in the processes of reflection and focus.

The prize is greater 'joined-upness' in exploring opportunities for synergies and mutual benefit, achieving higher performance clusters and greater global recognition of the deep sectoral capabilities within both jurisdictions and in all of the regions on the island of Ireland.

As was once said in a somewhat different context, *"Laat ambitie brand uw verstand"* (*"Let ambition fire thy mind"*[270]*)!*

List of tables

List of figures

List of abbreviations used

A. General (in alphabetical order)

Republic of Ireland (ROI)

BIM	Bord Iascaigh Mhara
CBI	Central Bank of Ireland
CSO	Central Statistics Office
CI	Chambers Ireland
DAFM	Department of Agriculture, Food and Marine
DBEI	Department of Business Enterprise and Innovation (now DETE)
DETE	Department of Enterprise, Trade and Employment
DoE	Department of Education
DFHERIS	Department of Further and Higher Education, Research, Innovation and Science
EMRA	Eastern and Midland Regional Assembly
EI	Enterprise Ireland
EPA	Environmental Protection Agency
ETB	Education and Training Board
FAILTE IRELAND	National Tourism Development Authority
HEA	Higher Education Authority
HRB	Health Research Board
IBEC	Irish Business and Employers' Confederation
IDA	Industrial Development Authority Ireland
IFSC	International Financial Services Centre
LEO	Local Enterprise Office
MI	Marine Institute
NWRA	Northern and Western Regional Assembly
SFI	Science Foundation Ireland
Skillnet	Skillnet Ireland
SOLAS	Further Education and Training Authority
SRA	Southern Regional Assembly
TEAGASC	Agriculture and Food Development Authority
UDARAS	Údarás na Gaeltachta
WDC	Western Development Commission

Northern Ireland (NI)

AFBI	Agri-Food & Biosciences Institute
CAFRE	College of Agriculture, Food and Rural Enterprise
CBI NI	Confederation of British Industry – Northern Ireland
DAERA	Department of Agriculture, Environment and Rural Affairs
DfE	Department for the Economy
DoE	Department of Education
FEC	Further Education College
INI	Invest Northern Ireland
MANUFACTURING NI	Manufacturing Northern Ireland
MSW	Mid South West
NI CHAMBER	Northern Ireland Chamber of Commerce and Industry
NISRA	Northern Ireland Statistics and Research Agency
SIB	Strategic Investment Board
TOURISM NI	Tourism Northern Ireland

Other bodies

CC	Cluster Centre
CRN	Cluster Research Network
EOCIC	European Observatory for Clusters and Industrial Change
ITI	InterTradeIreland
RESS	Renewable Electricity Support Scheme (ROI)
	Tourism Ireland

Terms

FDI	Foreign Direct Investment
FET	Further Education and Training
HEI	Higher Education Institution
LC	Large Company (employs 250 people or more, either island of Ireland (ROI or NI) origin or overseas multinational)
MaaS	Manufacturing as a Service
MICRO	Micro-Enterprise (employs ten or less people)
MNC/MNE	Multinational Corporation/Enterprise (overseas)
OSW	Offshore Wind
PGT	Power Generation and Transmission
RDI	Research, Development and Innovation
SME	Small and Medium Enterprise (employs 250 people or less)
UN SDGs	United Nations Sustainable Development Goals

B. Higher Education Institutions (HEIs) (within jurisdiction/region)

Republic of Ireland (ROI)

Eastern and Midlands Region (EMR)

DCU	Dublin City University
DkIT	Dundalk Institute of Technology
IADT	Dun Laoghaire Institute of Art, Design and Technology
MU	Maynooth University
NCAD	National College of Art and Design
NCI	National College of Ireland
RCSI	Royal College of Surgeons Ireland
TUD	Technological University Dublin
Trinity	Trinity College Dublin
UCD	University College Dublin
TUS - ML	Technology University of the Shannon – Midlands

Southern Region (SR)

MTU	Munster Technology University
UCC	University College Cork
UL	University of Limerick
SETU	South-East Technology University
TUS – MW	Technology University of the Shannon – Midwest

Northern and Western Region (NWR)

ATU	Atlantic Technology University
	University of Galway

Northern Ireland (NI)

OU	Open University
QUB	Queens University Belfast
UU	Ulster University

Note: Company names in the text are listed in the company examples relevant figures; Names in the text of formal clusters, state-backed research centres and HEI centres of excellence are listed in Appendix 7. Sectoral associations are explained in the text endnotes as needed.

Appendices

Appendix 1

Methodology of assessing cluster progression

1. Overall progression approach

Overall progression

Understand the current group of clusters in regions, as measured and benchmarked internationally (EOCIC 2022).

Qualitatively consider capability, opportunity and impact for each sector, using outcomes of regional/jurisdiction stakeholder discussions (DBEI (2022), DfE (2021)).

Assess progression from levels of 'not a performing cluster' to 'basic/low-performing cluster' (L), 'medium-performing cluster' (M) and 'high-performing cluster' (H) over the next seven years, 2023-2030.

Proposed for stakeholder discussion 'Cluster Priority Pyramid' (triads of max. three high (H) and max. three medium (M)) based on opportunity, capability, and impact.

For region/jurisdiction, for development to 2030

Seek to keep clusters at the current level (i.e. no 'demotions' unless part of a wider cluster).

Consider those already performing for 'promotion'.

Debate those clusters not yet performing for 'progression' (can be to H, M, or L levels).

For all-island high clusters by 2030 (and becoming 1 in 5 globally), ensure sector cluster (see below)

Has been at high or medium level beforehand.

Is present in at least two of four NUTS 2 regions (at any performing level).

Consider implications for investment, HEI/other linkages, etc.

A three-step approach to reach initial priorities for discussion with stakeholders

Note current clusters as per adapted EOCIC 2020 rankings methodology, in 'scoring' as rankings H, M, L.

Do mechanical allocation, based on one-step up promotion and three sectors max. in H.

Evolve developmental proposition based on judgement (max. 3 in both H and M).

2. Approach applied to each region and jurisdiction

2.1 Overview

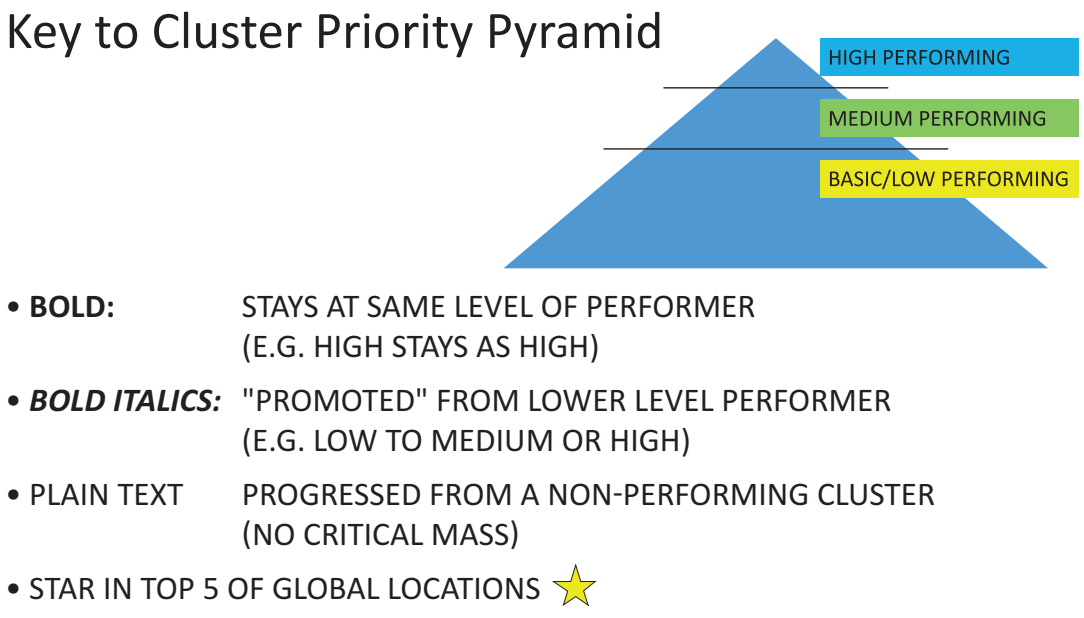
The logic is shown for each of the NUTS 2 regions based on the listing of current clusters on the island of Ireland as assessed by EOCIC (2020)(Figure A1). The model seeks to progress clusters from current to potential levels (Figure A2).

Figure A 1: Clusters on the island of Ireland

Clusters	NORTHERN IRELAND (11)	NORTHERN & WESTERN (4)	EASTERN & MIDLANDS (18)	SOUTHERN (8 imputed)
High	Non-metallic mining	(Medical Devices)	Information Technology Insurance Services Medical Devices	Information Technology Medical Devices
Medium	Biopharmaceuticals Recreational & small electronic goods	Communications equipment / Services	Transportation & logistics Distribution / eCommerce Education & Knowledge Cl. Business services Financial services Printing services Communications equipment / Services Vulcanising / fired materials	Biopharmaceuticals Financial services Business services Transportation & logistics
Low	Vulcanising / fired materials Livestock processing Furniture, Wood products Environmental services Construction products & services Downstream chemical products Electric PGT	Biopharmaceuticals Lighting / Electrical equipment	Appliances Video production & distribution Hospitality & tourism Jewellery & precious stones Paper & packaging Non-metallic mining Small electronic goods	Upstream chemical products Hospitality & tourism
% jobs in large enterprises 250+	Northern Ireland 22%	Border 12% West 16%	Dublin 47% Mideast 17% Midlands 8%	Southeast 18% Southwest 24% Midwest 20%

Source: Adapted from EOCIC (2020) Annex A

Figure A 2: Key to cluster priority pyramid



2.2 Northern and Western Region (NWR)

Current – as above for region.

Mechanical

High

1) Medical devices (H->H)
2) Communications equipment & services (M->H)
3) Biopharmaceuticals (L->M)

Medium

Electrical equipment (L->M),

Low

n/a

Developmental

High

1) Medical devices (H->H)
2) Production engineering (0->H), (+Communication Products and Services M->H), Electrical equipment (L->H))
3) Digital business services (including financial) and IT (Software development) (0->H)

Medium

1) Biopharmaceuticals (L-> M)
2) Food processing (0->M)
3) Hospitality/Tourism and creatives (0->M)

Low

1) Construction products & services (0->L)
2) Electricity (PGT) (0->L)

Comment:
Digital business services are ranked high whilst not featuring before because of job potential.

2.3 Northern Ireland (NI)

Current – as above for region/jurisdiction.

Mechanical

High

1) Non-metallic products (H->H)
2) Biopharmaceuticals (M->H)
3) Recreational/Small electrical goods (M->H)

Medium

1) Livestock processing (L->M)
2) Downstream chemical products (L->M)
3) Construction products & services (L->M)

Low

All other low/basic performing clusters for region.

Developmental

High

1) Life sciences – Biopharmaceuticals (M-> H), Downstream chemical products (L ->H), Medical devices (including diagnostics and eHealth for ageing) (0->H)
2) Production technology engineering (including small electric goods (M-> H)) (0-> H)
3) IT software development (cyber plus) and digital business services (O->H)

Medium

1) Financial services and FinTech (0 ->M)
2) Food production/manufacturing (including livestock processing (L-> M)
3) Hospitality/Tourism and creatives (0 ->M) (including furniture, wood products (L ->M))

Low

1) Construction products & services (including fired materials, furniture, wood products, and environmental services) (L ->L)
2) Electrical PGT (0-> L)

Comment:
Construction, already ranked low, might be considered a better 'promotion' than Hospitality/Tourism and Creatives, not ranked at all, but the jobs potential of the latter sector is reason

2.4 Eastern and Midland Region (EMR)

Current – as above for region.

Mechanical

High

1) IT (H ->H)
2) Insurance services (H ->H) and Financial & business services (both M ->H)
3) Transport & logistics, Distribution and eCommerce (M->H)

Medium

1) Communication equipment & services (M->M)
2) Vulcanised/Fired materials (M->M)
3) Printing services (M ->M)

Low

All other low/basic performing clusters for region.

Developmental

High

1) Biopharmaceuticals (M ->H) (and Medical devices (H->H (incl. Diagnostics and eHealth (records))
2) Information technology (H->H)
3) Financial services (M->H), Insurance services (H->H) and Business services (M->H)

Medium

1) Production technology engineering (0 -> M (incl. Communication equipment & services (M->M), Appliances (L ->M))
2) Transport & logistics, Distribution and eCommerce) (M->M)
3) Hospitality/Tourism (L ->M), Creatives (videos, jewellery both L->M)) and education (M ->M)

Low

1) Food processing (0->L)
2) Electrical PGT (0->L)
3) Paper & packaging (L->M) and Printing services (M->L)
4) Vulcanised/Fired materials (M-> L), Construction products/services (0->L)

2.5 Southern Region (SR)

Current – as above for region.

Mechanical

High

1) IT (H ->H)
2) Medical devices (H-> H)
3) Biopharmaceuticals (M-> H)/Upstream chemical products (L-> H)

Medium

1) Financial services (M->M)
2) Transport & logistics (M->M)
3) Business services (M->M)

Low

All other low/basic performing clusters for region.

Developmental

High

1) IT software (Cyber) (H ->H), Business & financial services (both M ->H)
2) Life sciences - Biopharmaceuticals (M ->H), Medical devices (H-> H), Upstream chemical products (L-> H)
3) Food processing & manufacturing (0-> H)

Medium

1) Transport & logistics (M ->M)
2) Hospitality/Tourism and creatives (L ->M)
3) Production engineering (0-> M)

Low

1) Construction products & services (0 -> L)
2) Electricity PGT (0 ->L)

Summary of progression analysis

Figures A3 and A4 summarise the outcome of the process.

Figure A 3: Summary of potential sectoral cluster 2030 priorities at region levels

	1	2	3	4
Level for 2030	NORTHERN IRELAND (NI - UK)	NORTHERN & WESTERN REGION (NWR - ROI)	EASTERN & MIDLAND REGION (EMR - ROI)	SOUTHERN REGION (SR - ROI)
High	Biopharma / Diagnostics (eHealth aged) Production technology engineering IT cyber and digital business services	Medical devices (eHealth aged) Production technology engineering Digital business & financial services and IT applications	Information technology Financial, insurance and business services Biopharma / MedTech	IT cyber, digital business and financial services Biopharmaceuticals Food processing
Medium	Financial services / FinTech Food processing Hospitality & tourism / Creatives	Biopharmaceuticals Food processing Hospitality & tourism / Creatives	Production technology engineering Distribution, eCommerce / Transport & logistics Hospitality & tourism / Creatives	Transport & logistics Hospitality & tourism / Creatives Production technology engineering
Low / Basic	Construction products & services Electricity power generation & transmission Education & care services	Construction products & services Electricity power generation & transmission Education & care services	Food processing Electricity power generation & transmission Paper & packaging, Printed services and Fired materials Education & care services	Construction products & services Electricity power generation & transmission Education & care services

Figure A 4: Sectoral priorities to 2030 – Overall island of Ireland - Method

RANKING AIM (EOCIC) BY 2030	BROAD SECTOR	NI	NWR	EMR	SR
High	Life sciences	H	H	H	H
	Software/Digital business services	H	H	H	H
	Production engineering	H	H	(M+)	(M+)
Medium	Financial services	M+	(H*)	(H)	(H*)
	Agrifood	M	M	(L+)	(H)
	Hospitality and creatives	M	M	M	M
Low / Basic	Energy/Environment	L	L	L	L
	Construction products	L	L	L	L
	Education and care services	L	L	L	L

Note: * Segment within broader sector – i.e. associated with IT and business services in these regions.

3. Gap analysis

For each region's sectors, the approach compares the sector's presence and priority for policy-makers and its capability (academic research, R&D/innovation centres/supports, cluster groups, etc.). Then, an assessment is made as to the level (H, M, L) of presence/priority and capability and whether there is a gap between the presence/priority and capability gaps (Table A1). For example, H-L indicates a gap between high-level presence and priority and low-level capability. Also, H+ indicates a sector that is seen as potentially going towards being in the top five global locations in the medium-term.

Table A1: Gap analysis

	NWR	NI	EMR	SR
Agriculture	H-M	H-H	H-H	H+ -H*
Food and drink	H-M*	H-H	H-H*	H+ -H**
Pharmaceuticals	H-M*	H-H	H+ -H**	H-M**
Medical devices	H+ -H**	H-H**	M-H	M-M
Production technology engineering & related	H-M**	H+ -H**	H-H	M-H*
Energy and water production	H-M*	H-H*	H-M*	H-H
Construction sector	H-M	H-H*	H-H	H-L
Retail/Wholesale	H-L	H-L	H-L*	M-L
Transport	H-L	H-L	H-L*	H-L
Accommodation and food service[a]	H-L*	H-M*	H-L*	H-M
Information and communications	H-M *	H-H**	H-H*	H-H**
Films and videos	M-H	H-H*	H-M	H-H
Financial services	M-L	H-H*	H-M**	M-M*
Professional and technical services	H-H	H-H	H-H	M-H
Environmental consulting services	M-M	M-H	M-H	M-M
Digital business (administration) services	H-L**	H-L	H-L	H-L*
Cultural and leisure sector[b]	H-M*	H-H	H-H	H-H
Other sectors	M-H	H-H	H-H	H-H

[a] Hospitality & tourism

[b] Creatives/Cultural industries

Priority/presence v Capability Gap

** denotes a significant gap

* denotes major gap

Expenditure projects

H – critical for progression M – useful for progression

Strategic sectoral development framework – format/checklist

Strategic sectoral development framework

1. Definition

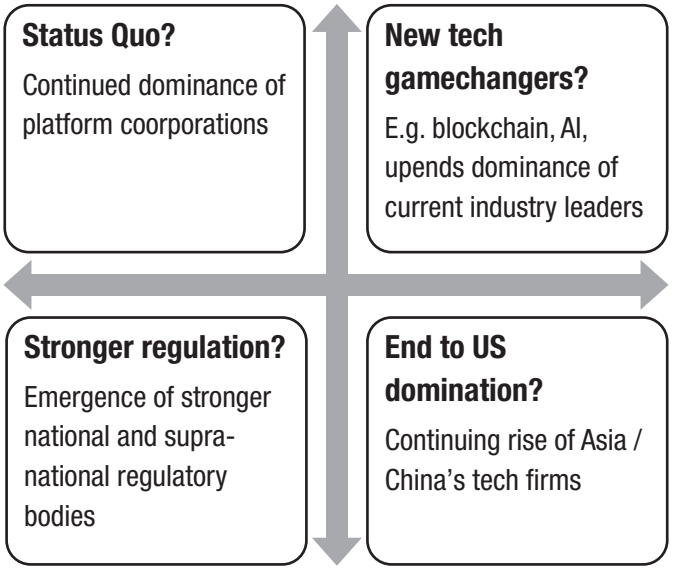
- NACE sector subsections (also SIC)
- Scope and spread (can be broad or narrow)
- Boundaries fluid or steady, changing or static
- End-users' needs (Maslow hierarchy)
- UN SDGs addressed by sector
- Babel prioritisation matrix (opportunity v capability)

2. Global value chain/network

- Flow of value chain/network
- Geographic map of key locations
- Structure of industry – concentration, change over time, etc., moving and overlapping with other sectors
- Porter model forces and dynamics as applied to the sector
- Underlining technologies required and evolving (see McKinsey framework)
- Key players, roles, and chains and layers of companies (Key, Tier 1, Tier 2, Tier 3, etc.)
- Future scenarios of industry and what is driving them (see image)

Sources: See OECD, EC, McKinsey and many others

Future Scenarios



All-island profile (1 island - 2 jurisdictions – 4 NUTS 2 regions)

Features
Jobs, sales, exports, productivity, research, development and innovation, skills, export destinations, import sources (for overall sector and subsectors)

Locations
Key locations on the island, jurisdictions, within regions and for NUTS 3, county and similar sub-regions

Individual companies and supports
Main companies and research/support. Examples of companies, etc, in each region. Examples of HEIs and FEIs

Global comparisons

Relative metrics
Relative productivity levels and growth, employment share, FDI flows, business start-up/exit churn, etc.

OECD GVC metrics
Share of GVC, distance, participation indicators, etc.

Global Linkages
To world best practice clusters (see text for examples)

Assessment of sector in regions, jurisdictions, all-island

SWOT	Strengths, Weaknesses, Opportunities and Threats/challenges
Development model	Opportunity, Capabilities, Potential, Levers, Impact

Figure A 5: Sectoral activity/products - 80/20% balance of the present and future

Positioning options (High technology uncertainty, low market uncertainty)	**Stepping stones** (High technology uncertainty, high market uncertainty)
Platform launches (Low technology uncertainty, low market uncertainty)	**Scouting options** (Low technology uncertainty, high market uncertainty)

Source: McMillan and McGrath (2000)

Key elements of the sector's ecosystem in each region and gaps that need to be progressed for 'how to go large':

Enterprises	Ecosystem
Starting Scaling Innovating Larging Rooting	Nurturing supply chain Direct and indirect micro-services Skills supply

Development gaps

3-5 major challenges to address for evolving value chain

Ambition and action

Basic game-plan

Vision of where can get to from here (in 10 years etc.)

Figure A 6: Deepening and widening global sectoral business GVC/network within region

Playbook/options for the sector on the island of Ireland to respond to main global scenarios (as above)

3 to 5 major challenges and strategic actions to address

Strategic actions

Short-term, medium-term, long-term sectoral development initiatives

Economic and fiscal costs-benefits of short-term/medium-term actions

Pathways to sequence and navigate as options unfold and fold

Progression

Implementation – what, who, when, how

Key milestones

Risks to progression

Measures to address risks

Strategic metrics

Activities	Outputs
Resources	Outcomes

Responsibility/governance structure

Who are the stakeholders of the growth diamond, and what roles and actions? What is one group owning, facilitating and driving overall strategy? How much 'joined-upness' in thinking and action?

Appendix 3

Analysis of sectors and regions by concentration and resistance indices

A.1 Sectoral substantial concentrations (ROI) (from van Egeraat et al. (2016))

Table A.1: Substantial industry concentrations (based on CI index and labour field methodology)

Sector	Concentration (Index)	
Manufacturing		
Manufacturing of food products	Ubiquitous	0
Manufacturing of beverages	Dublin	1
Manufacturing of textiles	Dublin/Mid-East region, reaching into Dundalk	1
Manufacturing of apparel	Dublin/Mid-East region	1
Manufacturing of wood and wood products, except furniture	Very extensive – Leinster province/West/Midlands	0
Manufacture of paper and paper products	Dublin reaching into the Mid-East region	1
Printing and reproduction of recorded media	Dublin	1
Manufacture of chemicals and chemical products	Dublin reaching into Midlands; Cork; Limerick	3
Manufacture of basic pharmaceutical products and pharmaceutical preparations	Dublin; Cork and Waterford/South East	3
Manufacture of rubber and plastic products	Midlands plus Monaghan, Dublin/ Mid-East coast	2
Manufacture of other non-metallic mineral products	Almost ubiquitous except for West and South	0
Manufacture of fabricated metal products, except machinery and equipment	Almost ubiquitous	0
Manufacture of electrical equipment	Dublin; Limerick	2
Manufacture of motor vehicles, trailers and semi-trailers	Greater Dublin	1
Manufacture of furniture	East coast including Monaghan down to Waterford and Midlands Region	1
Manufacturing of medical devices	Dublin; Midlands; The West; Cork	4
Repair and installation of machinery and equipment	No single substantial concentration	0
Services		
Publishing activities	Greater Dublin	1
Motion picture, video and television programme production, sound recording and music publishing activities	Dublin stretching into Wicklow; Galway	2
Computer programming, consultancy, and related activities	Extensive concentrations Dublin/Mid-East; Cork	2
Information service activities	Dublin	1
Financial services activities, except insurance and pension funding	Dublin	1
Activities of head offices; management consultancy activities	Dublin, stretching into Kildare	1
Architectural and engineering activities; technical testing and analysis	Dublin reaching south to Carlow and into the Midlands	1
Office administration, office support and other business support activities	Dublin, reaching into the Mid-East region	1

Source: Table 3, p.15 in van Egeraat, C., Morgenroth, E., Kroes, R., Curran, D., Gleeson, J. (2016) "A measure for identifying substantial geographic concentrations" Papers in Regional Science,

A.2 Analysis of ROI agency-assisted employment by sector and regions 2001-2022 (from van Egeraat et al. (2023))

Van Egeraat et al. (2023)'s analysis of agency-assisted employment by sector and region categorises:

- Over 2001-2011:

  Sectors and regions experiencing a long-term decline (LTD), long-term growth (LTG) and recession-sensitive (RS) are a measure of a region's *resilience* (i.e. the ability to recover when an external shock has impacted it).

- Over 2011-2022

  Sectors and regions with above-average growth (AAG) and below-average growth (BAG) are a measure of a region's *resistance* (i.e. ability to withstand future external shock).

The analysis is then applied to the eight NUTS 3 regions in the ROI. Regions with higher resilience include Dublin, West, South West, and Midlands, and regions with lower resilience include South East, Border, Mid West and Mid East. Regions with higher resistance include Dublin, West, South West and Mid West, and regions with lower resistance include South East, Midlands, Mid East and Border. Regions' resilience in recovery from recession and resistance to potential future external shocks are driven by a broad sector mix and, in some regions, by a few key companies.

Table A.2: ROI NUTS 3 resilience and resistance Indices

ROI NUTS 3 Regions	Resilience index	Resistance index
Border	0.87	0.75
Dublin	2.68	9.42
Mid East	0.74	0.89
Mid West	0.79	1.57
Midlands	0.92	0.99
South East	0.90	1.39
South West	1.02	1.75
West	2.03	3.44

Source: van Egeraat, C., Curran, D. and Breathnach, P. (2023) "Regional Economic Resilience and Resistance in Ireland 2001- 2022: The Roles of Industrial Structure and Foreign Inward Investment". NESC Research Paper 26, p.11 & p.21

Interestingly, for both periods examined, the association between foreign firm share and employment growth rate is moderate (van Egeraat et al. (2023) pp.13 and 21). The overall conclusion is that "it is the sectoral mix, per se, more than the nationality mix which has the main impact on regional growth performance." (p.27).

Van Egeraat et al. (2023) also concluded that:

> *... employment in agency-assisted firms is not only becoming concentrated in a select number of regions, it is also becoming concentrated at a rate faster than that of the population as a whole. ... The combined share of the three most vibrant regions (Dublin, South West and West) increased from over 60% to over 72% (2001-2022). (p.24)*
>
> *Furthermore, in light of the current regional industrial structures and the variation in the level of regional resistance, in the absence of stronger policy intervention, the trend will be one of further regional divergence post-2022. (p.28).*

Appendix 4

ROI IDA client mapping numbers

by main sectors and city catchment areas (approximations)

SECTOR	EMR	SR	NWR
MedTech	Dublin 20	Cork 11 Limerick/Ennis 13	Galway 20 Sligo 12 Athlone 13
Biopharma	Dublin 73	Cork 26 Waterford/Clonmel/ Wexford/Dungarvan 11	Sligo/Mayo 7
Engineering	Dublin 75	Cork 33 Limerick/Shannon 31 Waterford/Clonmel 10	Galway 9 Sligo/Mayo 10 Cavan/Monaghan/(Louth) 9
IT Technology	Dublin 164 Athlone 6	Cork 45 Limerick/Shannon 31 Kilkenny/Waterford 5	Galway 22 Sligo/Mayo 5 Donegal 5
Business services	Dublin 155	Cork 20 Limerick/Shannon 23	Galway 15 Sligo/Mayo 4 Donegal 2 Cavan/Monaghan/(Louth) 7
Financial services	Dublin 252	Cork 13 Limerick 13 Kilkenny/Wexford 9	Galway 5 Sligo/Mayo 3 Donegal 3 Cavan/Monaghan/(Louth) 6
Total	**745**	**294**	**157**

Source: IDA

Notes:

1. Numbers are operations rather than employment (which may differ significantly).
2. Engineering includes green economy (10 operations), and IT Technology includes Media (7).
3. Louth included in NWR, rather than in ER, reflecting the case up to 2014

Tourist numbers on the island of Ireland 2019 ('000)

	All Overseas	Other Island	Domestic*	All island	Total
Northern Ireland	2244 **13%**	756	2332	3088 **20%**	5332
Border	768	597	1189	1786	2554
West	1943	113	1848	1961	3904
NWR	2711 **16%**	710	3037	3747 **23%**	6458
Midwest	1432	23	1197	1220	2652
Southwest	2335	38	2316	2354	4689
Southeast	945	53	1795	1848	2793
SR	4712 **27%**	114	5308	5422 **34%**	10134
Mideast/Midlands	954	170	1513	1683	2637
Dublin	6644	283	1763	2044	8690
EMR	7598 **44%**	453	3276	3729 **23%**	11327
Total ROI	15021	1277	11621	12898	27919
Total island of Ireland	17265 **100%**	2033	13953	15986 **100%**	33251

Note: Domestic* are tourists from the same jurisdiction (i.e., NI and ROI, respectively), not within the same NUTS 2 region. Also, tourists spend at least one overnight on their trip

Appendix 6

Spread of high-level HEI subjects by region and sector

SECTOR (NACE)	DUBLIN/EAST TRINITY	DUBLIN/EAST UCD	DUBLIN/EAST OTHER	SOUTH UCC (OTHER)	NORTH & WEST University of Galway (ATU)	NI QUEENS (UU)	QS REFERENCE
A, B Primary		X X		X			Agriculture, Veterinary
C Manufacturing							
Life sciences	XXXXX X 6	XXXXX XXX 8		XXX	X	XXXXX 5	Anatomy, Biologicals, Chemistry, Medicine, Nursing, Chemical engineering, Pharmacy, Psychology
Engineering/ Electronics	XX	X				X	Electrical engineering & electronics, Mechanical engineering
D, E Environment/ Materials	XXXXX 5	XXXX 4	X (MU)				Earth/Marine, Environmental science, Geography, Geology, Material science, Physics
F Construction	X	X				X	Architecture, Civil & structural engineering
I Accommodation +							
J Information & communication	X	X					Computer science
K Finance							
M Professional services, etc.	XXX	XXX	X (DCU)				Accounting/finance, Business/management, Communications, Economics
P Education	X	X	X (DCU)	X (UL)			Education
O Public admin	XXXXX XXX 8	XXXXX XXX 8	X (DCU)	XX (UL)	X	XXXX 4	Law, Politics, Social policy, Sociology, History, Philosophy, Theology, Classics, Information, Statistics
Q Health							(See Life sciences)
R Recreation & culture	XXXXX 5	XXXX 4	X (NCAD) X (DCU)	XXX (UL)	X	XX X (UU)	Hospitality, Sports, Archaeology, Art & design, English, Modern languages, Performing arts
S Other							

Source: QS Subject world rankings under 200

Appendix 7

Detailed mapping

of formal clusters, state-supported research centres and higher education research and related centres by sector and region

A. Examples of formal clusters

Sector	Formal company-led/engaged cluster	
Agrifood	**NWR**	The Food Coast Donegal (LEO)
	NI	Irish Nutrient Sustainability Platform (QUB)
	EMR	
	SR	
Life sciences	**NWR**	MedTech Cluster (Digital health) (ATU (G)) EI1
	NI	HIRANI (Health Innovation Research Alliance)
	EMR	Connected Health Innovation Centre (CHIC) Connected Health and Wellbeing Cluster (DkIT) EI1
	SR	
Engineering	**NWR**	Border Region Manufacturing Cluster (BORMAC) (ATU (S)) EI1 Donegal Engineering Profitnet (LEO)
	NI	Manufacturing & Engineering Growth Advancement (MEGA) (Dungannon)
	EMR	Engenuity ATIM Cluster (Advanced Technologies in Manufacturing) (Midlands, TUS) EI1
	SR	Ireland South East (TUS Carlow) EI1 The Shannon Airport Group (Shannon) Emerald Aero Group IDEAM Cluster (Irish Digital Engineering) (TUS MW) EI1 AgriTech Ireland (MTU) EI1 Design + (SETU – all sectors – Carlow)
Construction	**NWR**	
	NI	Passive Housing Design INI
	EMR	Construction Cluster Ireland* (TUD) EI1
	SR	
Energy / Environment	**NWR**	Killybegs Marine Cluster (ATU (D)) EI1 Marine Ireland Industry Network (ATU (G))
	NI	Sea Source Kilkeel INI
	EMR	Geoscience Ireland*
	SR	Irish Bioeconomy Foundation (Tipperary) Circular Bioeconomy Cluster South-West (SW, MTU) EI1
Software development	**NWR**	
	NI	Cyber NI INI
	EMR	
	SR	Tech Industry Alliance (SW) Cyber Ireland* (MTU Cork) EI1

Sector	Formal company-led/engaged cluster	
Digital business (incl. technology hubs)	NWR	
	NI	
	EMR	
	SR	STEM South West
Financial services / FinTech	NWR	The FinTech Corridor (Co. Cavan)
	NI	
	EMR	
	SR	Ireland South East Financial Services Cluster
Hospitality / Tourism	NWR	
	NI	Taste Causeway INI, Strangford Lough Tourism Cluster INI LoughSholin Tourism INI
	EMR	
	SR	
Creative industry	NWR	Creative Coast Donegal
	NI	
	EMR	
	SR	
Other	NWR	Irish Wood & Interior Network* (Monaghan) Wood Connect (ATU Connemara) EI1
	NI	
	EMR	
	SR	

Source: Cluster Centre and sponsors Enterprise Ireland, Invest NI, LEOs, etc.

Note: * If scope beyond region

EI1 Regional Technology Cluster Fund
EI2 Cluster Programme 2012
EI3 Cluster Programme 2018
INI Collaborative Growth Programme

B. State-funded research centres by sector and region

Sector	Research, etc. centres	
Agrifood	**NWR**	
	NI	Agrifood Quest NI CC
	EMR	Food for Health Ireland (UCD) EITC Meat Technology Ireland (Teagasc, Ashtown) EITC
	SR	Dairy Processing Technology Centre (UL) EITC Science Foundation Ireland: VistaMilk (Teagasc Moorepark)
Life sciences	**NWR**	Enterprise Ireland Technology Gateways: Medical & Engineering (ATU (G)) Science Foundation Ireland: CÚRAM (University of Galway)
	NI	Bio-discovery Medicines Discovery Catapult** – 7 company collaborations NI Connected Health Innovation Centre (CHIC) INI CC
	EMR	Enterprise Ireland Technology Gateways: MiCRA Biodiagnostics (TUD) Science Foundation Ireland: FutureNeuro (RCSI) National Institute for Bioprocessing Research & Training (NIBRT) (UCD/IDA)
	SR	Enterprise Ireland Technology Gateways: PMBRC (SETU -Waterford) Enterprise Ireland Technology Gateways: Shannon ABC Gateway (MTU Kerry) Pharmaceutical Manufacturing Technology Centre (UL) EITC Science Foundation Ireland: APC Microbiome Ireland (UCC) Science Foundation Ireland: SSPC (UL) Health Innovation Hub Ireland (HIHI) (Cork, HSE/DBEI)
Engineering	**NWR**	Enterprise Ireland Technology Gateways: PEM Gateway (ATU(S)) Enterprise Ireland Technology Gateways: WiSAR Gateway (ATU(D))
	NI	Northern Ireland Advanced Composites and Engineering Centre (NIACE) INI CC High-Value Manufacturing Catapult: See HVM Catapult Annual Review 2021/22 North West Centre for Advanced Manufacturing (NWCAM) (UU/ATU/Catalyst/University of Glasgow)
	EMR	Enterprise Ireland Technology Gateways: TSSG Gateway (TUD) Enterprise Ireland Technology Gateways: CREST Gateway (TUD) Irish Manufacturing Research (IMR) EITC Science Foundation Ireland: AMBER (Trinity) Science Foundation Ireland: CONNECT (Trinity) Science Foundation Ireland: I-Form (UCD)
	SR	Enterprise Ireland Technology Gateways: CAPPA Gateway (MTU Cork) Enterprise Ireland Technology Gateways: ImaR Gateway (MTU Kerry) Enterprise Ireland Technology Gateways: SEAM Gateway (SETU Waterford) Telecoms (SETU Waterford) MCCI (Tyndall) EITC Science Foundation Ireland: CONFIRM (UL) Science Foundation Ireland: IPIC (Tyndal)
Construction	**NWR**	Construct Innovate (University of Galway) EITC
	NI	
	EMR	
	SR	

Sector		Research etc. centres
Energy / Environment	**NWR**	Páirc na Mara (Údarás) (marine)
	NI	Centre for Advanced Sustainable Energy (CASE) INI CC Catapult Research: Smart Belfast Framework**
	EMR	Enterprise Ireland Technology Gateways: APT Gateway (TUS – Athlone) Enterprise Ireland Technology Gateways: CREDIT Gateway (DkIT Dundalk) Science Foundation Ireland: BiOrbic (UCD) Science Foundation Ireland: iCRAG (UCD)
	SR	Science Foundation Ireland: MaREI (UCC)
Software development	**NWR**	Science Foundation of Ireland: Insight (University of Galway)
	NI	Digital Catapult Northern Ireland (Ormeau Baths Belfast)
	EMR	Enterprise Ireland Technology Gateways: COMAND Gateway (TUS – Athlone) CeADAR (UCD + TUD) EITC Science Foundation Ireland: ADAPT (Trinity) Science Foundation Ireland: Insight (UCD, DCU, UCC, University of Galway)
	SR	Enterprise Ireland Technology Gateways: Nimbus Gateway (MTU (Cork) Enterprise Ireland Technology Gateways: Design+ Gateway (SETU Carlow) Science Foundation Ireland: Lero (UL)
Digital business (incl. technology hubs)	**NWR**	Data2Sustain (ATU (S)) EDIH candidate
	NI	NIEMR
	EMR	Learnovate (TCD) EITC FxC (IMR Mullingar) EDIH CeAdar AI Hub (UCD)
	SR	ENTIRE (Tyndall) EDIH candidate
Financial services / FinTech	**NWR** **NI** **EMR** **SR**	
Hospitality / Tourism	**NWR** **NI** **EMR** **SR**	
Creative industry	**NWR** **NI** **EMR** **SR**	
Other	**NWR** **NI** **EMR** **SR**	

Sources: SFI, EI, INI, etc.

** Based in GB (See "The Catapult Network – Driving Prosperity across the UK")

Note: Centres hosted in one HEI, etc., can work with many other HEIs, have national/all-island roles, and can apply technology to a range of sectors, etc.

C. HEI by research/innovation and skills by sector/region (selection) - NWR[271]

Sector	
Agrifood	**Teagasc (G)** Animals, rural economy
Life sciences	**University of Galway** Regenerative Medicine Institute (Remedi) HRB Clinical Research Facility Galway **Atlantic Technological University** The Health and Biomedical Research Centre (HEAL) (S) Centre for Personalised Medicine (with UU) (D)
Engineering	**Atlantic Technological University** Engineering Research Group (G) Toolmaking Centre (S)
Construction	**University of Galway** Built Environment and Smart Cities Research Cluster
Energy / Environment	**University of Galway** The Ryan Institute Combustion Chemistry Centre **Atlantic Technological University** Centre for Environmental Research Innovation and Sustainability (CERIS) (S) Brydon Centre (with QUB) (D) Marine and Freshwater Research Centre (G)
Software development	**University of Galway** ICHEC
Digital business (incl. technology hubs)	**University of Galway** Data Science Institute (DSI)
Financial services / FinTech	
Hospitality / Tourism	**Atlantic Technological University** Sustainable Tourism Observatory at ATU (Story@ATU)
Creative industry	**University of Galway** Moore Institute for Research in the Humanities and Social Studies (incl. CCAR – creative arts)
Other	**University of Galway** Whittaker Institute for Innovation and Change UNESCO Child and Family Research Centre **Atlantic Technological University** Business Research Innovation Network Group (BRING) Centre for Research in Social Professions (CRISP) Contract Research Unit (CRU) **Atlantic Technology University (St Angelas)**

D. HEI by research/innovation and skill development by sector/region (selection) - NI

Sector	
Agrifood	**Queen's University Belfast** The Institute for Global Food Security **Ulster University** The Food and Drink Business Development Centre **Agrifood and Biosciences Institute** (7 centres and research boat) Animal health, fisheries, farm productivity, etc. **College of Agriculture, Food and Rural Enterprise** (CAFRE) Greenmount: dairy/other farming Loughry: Food tech/innovation, robotics, enterprise Enniskillen: Equitation
Life sciences	**Queen's University Belfast** The Institute for Health Sciences Wellcome-Wolfson Institute for Experimental Medicine (WWIEM) **Ulster University** The Centre for Health and Rehabilitation Technologies (CHaRT)
Engineering	**Queen's University Belfast** Centre for Wireless Innovation (CWI) Centre for Intelligent Autonomous Manufacturing Systems **Ulster University** Nanotechnology and Integrated Bioengineering Centre (NIBEC) Advanced Future Materials & Manufacturing (AFMM)
Construction	**Ulster University** Architecture Research Group (ARG)
Energy / Environment	**Queen's University Belfast** Sustainable Development Solutions Network Ireland (SDSN Ireland) (with UCC) **Ulster University** Hydrogen Safety Engineering and Research (HySAFER)
Software development	**Queen's University Belfast** CSIT
Digital business (incl. technology hubs)	**Ulster University** Cognitive Analytics Research Lab (CARL)
Financial services / FinTech	**Queen's University Belfast** Finance and Artificial intelligence research laB (with WBS)
Hospitality / Tourism	
Creative industry	**Ulster University** Creative Industries Institute
Other	**Queen's University Belfast** The Senator George J. Mitchell Institute for Global Peace, Security and Justice **Ulster University** Centre for Public Administration

E. HEI by research/innovation and skill development by sector/region (selection) - EMR

Sector	
Agrifood	**University College Dublin** School of Veterinary Medicine Institute of Food and Health Digital agriculture **Technological University Dublin** Food Innovation Lab Teagasc Research Programmes & Collaborations (Ashtown D15 (Food, Rural economy) Dunsany (Animals))
Life sciences	**Trinity College Dublin** Trinity Biomedical Sciences Institute (TBSI) Trinity College Institute of Neuroscience Trinity Translational Medicine Institute **University College Dublin** Conway Institute of Biomolecular and Biomedical Research **Dublin City University** Biodesign Europe Centre for eIntegrated Care (CeIC) **Maynooth University** Kathleen Lonsdale Institute for Human Health Research **Technological University Dublin** Centre of Applied Science for Health **Dundalk Institute of Technology** NetwellCASALA Research Centre and Living Lab Regulated Software Research Centre
Engineering	**Trinity College Dublin** Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) **University College Dublin** Centre for Biomedical Engineering National Centre for Sensor Research **Maynooth University** Innovation Value Institute (IVI) **Technological University Dublin** Focas Research Institute **Technological University of the Shannon - Midlands** Materials Research Institute
Construction	

Sector	
Energy / Environment	**Trinity College Dublin** Future Cities **University College Dublin** BiOrbic Next Generation Energy Systems **Dublin City University** Water Institute **Maynooth University** ICARUS Climate Research Centre **Technological University Dublin** Dublin Energy Lab **Dundalk Institute of Technology** Centre for Freshwater and Environmental Studies
Software development	**Trinity College Dublin** School of Computer Science and Statistics **Maynooth University** Hamilton Institute **Technological University Dublin** ICE Research Institute
Digital business (incl. technology hubs)	**Dublin City University** Irish Institute for Digital Business (IIDB)
Financial services / FinTech	
Hospitality / Tourism	
Creative industry	**Trinity College Dublin** Trinity Long Room Hub (TLRH) Arts & Humanities Research Institute CHIME _ Creative techs **Dundalk Institute of Technology** Creative Arts Research Centre **National College of Art and Design (NCAD)** **Institute of Art, Design + Technology**
Other	**Trinity College Dublin** Trinity Research in Childhood Centre (TRiCC) **University College Dublin** The Geary Institute for Public Policy **Dublin City University** National Centre for Family Business Anti-corruption Research Centre (ARC) Anti-Bullying Centre **Maynooth University** National Institute for Regional and Spatial Analysis (NIRSA) **Technological University Dublin** National Centre for Franco-Irish Studies **National College of Ireland** **The Institute of Public Administration** **Irish Management Institute**

F. HEI by research/innovation and skill development by sector/region (selection) - SR

Sector	
Agrifood	**University College Cork** The Food Institute **University of Limerick** Bernal Institute SoNS Research **Teagasc** Research Programmes & Collaborations
Life sciences	**University College Cork** Analytical & Biological Chemistry Research Facility (ABCRF) APC Microbiome Ireland HRB Clinical Research Facility **University of Limerick** Health Research Institute Sport and Human Performance Research Centre
Engineering	**University College Cork** Tyndall National Institute **University of Limerick** Mobile and Marine Robotics Research & Development Optic Fibres Sensors RC Telecoms RC **Munster Technological University** Nimbus Research Centre **South East Technological University** designCORE (C) Telecommunications Software & Systems Group (TSSG) (W)
Construction	**South East Technological University** iBerg Engineering Research Group
Energy / Environment	**University College Cork** Environment Research Institute (ERI) **University of Limerick** Centre for Environmental Research **Munster Technological University** Clean Technology Centre
Software development	**University College Cork** Centre for Unified Computing **South East Technological University** Walton Institute for Information and Communications Systems Science
Digital business (incl. technology hubs)	**South East Technological University** RIKON
Financial services / FinTech	**University College Cork** Financial Services Innovation Centre (FSIC) **South East Technological University** AIB Centre for Finance and Business Research

Sector	
Hospitality / Tourism	**University of Limerick** The National Centre for Tourism Policy Studies (NCTPS) **University of Galway** Shannon College of Hotel Management
Creative industry	**University of Limerick** Digital Media and Arts Research Centre (Dmarc) **Munster Technological University** Crawford College of Art & Design **Technological University of the Shannon (Midwest)** ACADEmy Institute
Other	**University College Cork** The Keynes Centre Centre for Co-operative Studies Spatial and Regional Economics Research Centre **University of Limerick** Centre for Irish-German Studies **Munster Technological University** V-LINC Research Group Technology Enhanced Learning (TEL) **Technological University of the Shannon** Sustainable Development Research Institute

Selected bibliography

General

Anyadike-Danes, M., Bonner, K., Drews, C.-C., and Hart, M. (2013) *Localisation of Industrial Activity Across England's LEPs: 2008 & 2012*, Enterprise Research Centre.

Atluri, V. and Dietz, M. (2022) *The Ecosystem Economy: How to lead in the New Age of Sectors without Borders* (McKinsey and Co.) John Wiley & Sons.

Best, M. (2000) *The Capabilities and Innovation Perspective: The Way Ahead in Northern Ireland*, Research Monograph, No. 8, Belfast: Northern Ireland Economic Council

Best, M. (2018) *How Growth Really Happens: How Growth Really Happens: The Making of Economic Miracles through Production, Governance, and Skills*

Bradley, J. (2001) "The Computer Sector in Irish Manufacturing: Past Triumphs, Present Strains, Future Challenges", *Journal of the Statistical and Social Inquiry Society of Ireland* Vol. XXXI.

Bradley, J. and Best, M. (2012) "Cross-Border Economic Renewal: Rethinking Regional Policy in Ireland", Centre for Cross Border Studies (Armagh)

Byrne, E., Doyle, E. and Hobbs, J. (2021) 'Network diversity, distance and economic impact in a cluster: visualising linkages and assessing network capital', Competitiveness Review doi: 10.1108/CR-10-2020-0135

Cassidy, J., Barry, F. and van Egeraat, C. (2009) 'Ireland – Industrial Competitiveness In a Small Open Economy, *NIRSA Working Paper Series No 44 – January 2009 NUI Maynooth*

Clancy, P. and Twomey, M. (1997) *The Irish Popular Music Industry: An Application of Porter's Cluster Analysis*, Research Series Paper No. 2, Dublin: National Economic and Social Council

Clancy, P., O'Malley, E., O'Connoll, L. and Egeraat, C. van (2001) 'Industry Clusters in Ireland: An Application of Porter's Model of National Competitive Advantage to Three Sectors', *European Planning Studies*, Vol. 9(1), pp.7-28

Clarivate (2022) *Clarivate Names World's Influential Researchers with Highly Cited Researchers 2022 List*.

Clusters Research Network (CRN) (2022) *Clustering on the Island of Ireland: A Gap Analysis*.

Cork Institute of Technology (2020) *Mapping the Cyber Island*.

Culliton, J. (1992) *A Time for Change: Industrial Policy for the 1990s*, Report of the Industrial Policy Review Group, January, Dublin: The Stationery Office

De Backer, K. and Miroudot, S. (2013)(a) 'Mapping Global Value Chains', *OECD Trade Policy Papers*, No. 159, OECD Publishing, Paris.

Delgado, M., Porter, M., and Stern, S. (2016) 'Defining clusters of related activities', *Journal of Economic Geography*, 16(1) p.1–38

Department of Business, Enterprise and Innovation (DBEI) (2018) *Research Priority Areas 2018 to 2023* (p.4 for table)

Department of Business, Enterprise and Innovation (DBEI) (2022) *National Smart Specialisation Strategy for Innovation 2022-2027*.

Department for the Economy (DfE) (2021) *10X Economy: Northern Ireland's Decade of Innovation*, Belfast.

Dettoni, J. (2022) 'European Cities and Regions of the Future 2022/23', *Financial Times*, 17 February.

Doyle, E., and Fanning, C. (2007) 'The role for clusters in Irish economic development policy', In C. Aylward & R. O'Toole (Eds), *Perspectives on Irish Productivity – A selection of essays by Irish & international economists*, pp.267–81. Dublin: Forfás

European Commission, Executive Agency for Small and Medium-sized Enterprises, Hollander, H. (2020) *Methodology report for the European panorama of clusters and industrial change and European cluster database*, Publications Office.

European Commission (2021) *European Expert Group on Clusters: Recommendation Report*, Publications Office of the EU, Luxembourg.

European Commission (2023) *Smart Specialisation Platform*.

European Observatory for Clusters and Industrial Change EOCIC (2019) *European Panorama of Clusters and Industrial Change 2019*, Publications Office of the EU, Luxembourg

European Observatory for Clusters and Industrial Change EOCIC (2020) *European Panorama of Clusters and Industrial Change 2020*. Publications Office of the EU: Luxembourg.

European Cluster Collaboration Platform (ECCP)(2021) *European Cluster Panorama 2021: Leveraging clusters for resilient, green and digital regional economies*

Goddard, J. and Vallance, P. (2013) *The University and the City*. Abingdon: Routledge.

Goddard, J., Kempton, L. and Vallance, P. (2013) 'Universities and Smart Specialisation: challenges, tensions and opportunities for the innovation strategies of European regions', *Ekonomiaz: revista vasca de economia*, (83), p.83-102.

Grashof, N. and Fornahl, D. (2021) ''To be or not to be' located in a cluster?', *The Annals of Regional Science,* (67) p.541-91.

Hamilton, A. (2021) 'Tech Cities of the Future', *Financial Times*, 12 August.

Hazelkorn, E. (2011) *Rankings and the Reshaping of Higher Education - The Battle for World-Class Excellence*, Palgrave Macmillan

Hetherington, G., Magennis, E. and Victor, K. (2019) *Cluster Policy in Northern Ireland: Best practice and findings from consultation across three sectors*.

HM Government (2022) *Levelling up the United Kingdom*.

Hobbs, J. (2015) Cork ITC Cluster – Interactive Cluster Workshop Series 28/29 September, MTU/V-LINC/MTU/Cork County Council.

Hobbs, J. and Crowley, E. (2018)(a) *Cluster Efforts in Ireland*, V-LINC CIT (now MTU).

Hobbs, J. et al. (2018)(b) *Evidencing the Role of Clusters in Smart Specialisation Strategies*.

InterTradeIreland (2015) *Mapping the Potential for All Island Sectoral Ecosystems*.

Jacobson, D. and Andréosso-O'Callaghan, B. (1996) *Industrial Economics and Organization: A European Perspective*, McGraw-Hill Book Company Limited.

Ketels, C. and Protsiv, S. (2021) 'Cluster presence and economic performance: a new look based on European data', *Regional Studies*, 55 (2), p.208-220.

Lester, R. K. (2005) 'Universities, Innovation, and the Competitiveness of Local Economies: A Summary Report from the Local Innovation Systems Project – Phase I', *Massachusetts Institute of Technology,* Industrial Performance Center Working Paper 05-010.

Marshall, A. (1922) *Principles of Economics*, London Macmillan.

McGrath, R. G. and MacMillan, I. C. (2000) *The Entrepreneurial Mindset: Strategies for Continually Creating*. Boston, MA: Harvard Business School Press.

MSW Mid South West Economic Engine (2020) *Regional Economic Strategy*.

O'Connell, L., van Egeraat, C. and Enright, P. (1997) 'The Irish Dairy Processing Industry: An Application of Porter's Cluster Analysis', *National Economic and Social Council*, Research Series Paper No. 1, Dublin.

O'Connor, S., Doyle, E. and Brosnan, S. (2017) 'Clustering in Ireland: development cycle considerations', *Regional Studies, Regional Science*, (4)1, p.263–283.

O'Donnellan, N. (1994) 'The presence of Porter's sectoral clustering in Irish manufacturing', *The Economic & Social Review*, (25)3, pp.221-232, Dublin: Economic & Social Research Institute.

O'Donnellan, N. (2021) 'Ireland: price level comparison (using Eurostat data and National Competitiveness and Productivity Council analysis)', *Nevin Economic Research Institute*, 9th Annual NERI Labour Market Conference, 6 July.

O'Donnellan, N. (2022)(a) 'Ireland's Productivity Challenge – exploring Eurostat cross-country sector-size data for insights', *Nevin Economic Research Institute,* 10th Annual NERI Labour Market Conference, 14 June.

O'Donnellan, N. (2022)(b) 'ATU Engagement: Some Questions and Reflections', *Atlantic Technology University (ATU),* Leadership Workshop

O'Donnellan, N. (2023) 'Examining Republic of Ireland's Low Enterprise Churn Rate, using Eurostat and related data sources', *Nevin Economic Research Institute*, 11th Annual NERI Labour Market Conference, 23 May.

O'Donnellan, N. and McCormack, B. (2022) 'Accelerating Growth: Towards an all-island perspective on regional development', *The Centre for Cross-Border Studies*.

OECD (2013)(b) *Interconnected Economies: Benefitting from Global Value Chains*.

OECD (2013)(c) *Supporting Investment in Knowledge Capital, Growth and Innovation*.

OECD/UNCTAD (2016) *The 16th Report on G20 Trade and Investment Measures*.

OECD (2017) *'The future of global value chains business as usual or "a new normal"?', OECD Science, Technology and Industry Policy Papers,* No. 41 (for REFS).

OECD (2007) *Competitive Regional Clusters: National Policy Approaches*.

O'Gorman, C., O'Malley, E. and Mooney, J. (1997) 'The Irish Indigenous Software Industry: An Application of Porter's Cluster Analysis', *National Economic and Social Council*, Research Series Paper No. 3, Dublin.

O'Malley, E. (1989) *Industry and Economic Development: the Challenge for the Latecomer*.

O'Malley, E., and van Egeraat, C. (2000) 'Industry Clusters and Irish Indigenous Manufacturing: Limits of the Porter View', *Economic and Social Review,* 31(1), pp.55-79.

Porter, M.E. (1990) *The Competitive Advantage of Nations*, Palgrave Macmillan, London.

Porter, M. E. (1998)(a) *On competition*, Harvard Business School Press, Boston.

Porter, M. E. (1998)(b) 'Clusters and the New Economics of Competition', *Harvard Business Review*, (76)6, p.77-90.

QS (2021) *World University Rankings by Subject 2021*.

Smit, S., Tyreman, M. et al. (2022) 'Securing Europe's competitiveness: Addressing its technology gap', *McKinsey Global Institute*, 22 September 22.

The Labour Party (2022) *A New Britain: Renewing our Democracy and Rebuilding our Economy*.

Times Higher Education (2023) *Best Universities 2023*.

van Egeraat, C., and Curran, D. (2013) *Spatial Concentration in the Irish Pharmaceutical Industry: The Role of Government Intervention and Agglomeration Economies*. Journal for Economics and Social Geography,104(3), 338–58.

van Egeraat, C., Morgenroth, E., Kroes R., Curran, D., and Gleeson, J. (2016) 'A measure for identifying substantial geographic concentrations', *Papers in Regional Science*.

van Egeraat, C. (2018) 'Identifying clusters: A review of methodological approaches', *State of the Art Review*, (9) 23 October.

van Egeraat, C. and Doyle, E. (2018) 'Rethinking Irish Cluster Policy', *Administration*, (66)1, p.107-128.

van Egeraat, C., Curran, D., Breathnach, P. (2023) 'Regional Economic Resilience and Resistance in Ireland 2001-2022: The Roles of Industrial Structure and Foreign Inward Investment', *NESC Research Paper No.26*

Wilkes, G. (2020) 'How to design a successful industrial strategy', *Institute for Government*, 16 December, London.

Regional Assemblies ROI

Eastern and Midland Regional Assembly (EMRA)

(2019) *Regional Spatial and Economic Strategy 2019-2031*.

Southern Regional Assembly (SRA)

(2020) *Regional Spatial and Economic Strategy for the Southern Region*.

(2021) *Regional Approach for Development of a Smart Specialisation Strategy in the Southern Region* with Babel Consultancy.

Northern and Western Regional Assembly (NWRA)

(2020) *Regional Spatial and Economic Strategy*.

Hunter, A. (2020) 'Smart Specialisation Position Paper', Economic and Public Policy Consultancy.

Sectors

Agrifood

Government of Ireland (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*.

Department of Agriculture, Environment and Rural Affairs (DAERA) (2021) *Independent Strategic Review of the Northern Ireland Agri-Food Sector*.

DAERA April (2021) *Future Agricultural Policy Framework Portfolio for Northern Ireland*.

Life sciences

HM Government (2017) *Life Sciences Industrial Strategy – A report to the Government from the life sciences sector*.

Engineering

IBEC (2022) *Engineering Industries Ireland Strategy*.

Manufacturing Task Force (MTF)(2023)

Tyndall National Institute (2023) *Ireland's role in the global semiconductor industry*.

Construction

AECOM (2022) *Ireland Annual Review 2022* (Construction Industry ROI and NI).

Energy

Wind Energy Ireland (2022) *National Port Study 2022*.

ICT/Software

Data Center Map (2023) *Ireland Data Centers*.

McAliskey, P. (2021) 'Northern Ireland's technology sector in great shape now', *The Irish News*, 13 April.

Digital DNA (2021) *Top 100 Tech Companies in Northern Ireland*.

Cyber Ireland (2022) *State of the Cyber Security Sector in Ireland*.

Crozier, D., Donaldson, S. and Tinnelly, C. (2021) *Northern Ireland Cyber Security Sector Snapshot 2021*.

Hamilton, A. (2021) 'Tech Cities of the Future', *FDI from the Financial Times*, 12 August.

Finance

Government of Ireland (2019) *Ireland for Finance: The strategy for the development of Ireland's international financial services sector to 2025*.

HM Treasury (2021) Policy Paper: The Kalifa Review of UK FinTech.

FinTechNI

Jenkins, A. (2021) 'A three-year roadmap to take Northern Ireland FinTech to the next level', *Silicon Republic*, 13 October.

Whitecap Consulting (2020) *Northern Ireland FinTech Ecosystem Report 2020*.

Creatives

Screen Ireland (2021) *Building for a Creative Future*.

NI Screen (2023) *Business Plan 2022-2023*.

Tourism

Failte Ireland (2021) *Key Tourism Facts 2019*.

Tourism Northern Ireland (2021) *Republic of Ireland Market Strategy 2021-2026*.

NISRA (Northern Ireland Statistics and Research Agency) (2019) *Northern Ireland Annual Tourism Statistics 2019*.

Note on companies' listings

Sources for companies' listings and names include: **IDA Ireland**, **Enterprise Ireland**, **Invest Northern Ireland**, **Insider Media**

As well as newspapers such as Irish Times, Irish Examiner, Business Post, Belfast Telegraph, The Irish News, Belfast Newsletter, etc. and websites from the clusters groups and similar groupings.

Endnotes

1 For NACE – see reference 8

2 For SIC – see reference 9

3 Now renamed Department of Enterprise, Trade and Employment (DETE)

4 For NUTS 2 definition as a statistical spatial concept, see ec.europa.eu/eurostat/web/nuts/background: **Note:** NUTS 2 is described as the "basic regions for the application of regional policies."

5 DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS)

6 Alison, based in Galway, is one of the leading global platforms for Massive Open Online Courses (MOOCs) with over 25 million users worldwide

7 DAERA (2021) Independent Strategic Review of the Northern Ireland Agri-Food Sector, p.38

8 The EU legislative basis for NACE Revision 2

9 The UK legislative basis for SIC 2007

10 OECD (2013)(a) *Interconnected Economies: Benefiting from Global Value Chains*, pp.4

11 Porter, Michael E. (1998) 'Clusters and the New Economics of Competition', *Harvard Business Review* 76, no. 6 (November–December) 77. (from Abstract)

12 Ketels, S. and Protsiv, C. (2021) *Cluster presence and economic performance: a new look based on European data*, pp.217-218

13 Kane, R. "The Industrial Resources of Ireland", reprinted 1971, Shannon: Irish University Press

14 Cluster Centre (2023) *Cluster Networks: About Cluster Development*.

15 Doyle, E. and van Egeraat, C. (2018) *Rethinking Irish cluster policy*, pp.116-124

16 Bradley, J. (2001) 'The Computer Sector in Irish Manufacturing: Past Triumphs, Present Strains, Future Challenges', *Journal of the Statistical and Social Inquiry Society of Ireland*, 31, p.44.

17 O'Donnellan, N. (1994) p.230

18 Doyle, E. and Fanning, C. (2007) p.276

19 O'Connell, L., van Egeraat, C. and Enright, P. (1997) (dairy); Clancy, P. and Twomey, M. (1997) (popular music); and O'Gorman, C., O'Malley, E. and Mooney, J. (1997) (indigenous software).

20 Doyle, E. and Fanning, C. p.276

21 Cassidy, J., Barry, F. and van Egeraat, C. (2009) p.44

22 O'Connor, S., Doyle, E. and Brosnan, S. (2017) *Clustering in Ireland: Development Cycle Considerations*, p.278

23 The non-availability of services data at a NUTS 3 level necessarily limited this analysis to CIP industry data only

24 SRA, Babel Consultancy (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.27

25 van Egeraat, C. et al. (2023) p.27

26 InterTradeIreland (2020) *Mapping the Cyber Island*

27 Hetherington G., Magennis, E. and Victor, K. (2019) p.6

28 Byrne, E. Doyle, E. and Hobbs, J. (2021) *Network Diversity, Distance and Economic Impact in a Cluster: Visualising Linkages and Assessing Network Capital*, 31 May. University College Cork, p.20

29 Massachusetts Institute of Technology LIS (2005) *Universities, Innovation, and the Competitiveness of Local Economies*, p.4

30 Michael Best has, with John Bradley, produced a seminal CCBS report *Cross-Border Economic Renewal: Rethinking Regional Policy in Ireland* (2012). He also has advised the Northern Ireland Economic Council. Best, M. (2000) Research Monograph, No. 8, Belfast: Northern Ireland.

31 Bradley (2001) p.45/46

32 Ibid p.48

33 Bradley, J. and Best, M. (2012) *Cross-Border Economic Renewal: Rethinking Regional Policy in Ireland*, p.67.

34 European Commission (2023) Smart Specialisation Platform: Strategies for research and innovation-driven growth.

35 DBEI (2022) *National Smart Specialisation Strategy for Innovation 2022-2027*, p.15.

36 Ibid p.21 (The reference to RSESs is the need for each NUTS 2 Region to have a Regional Spatial and Economic Strategy)

37 DfE (2021) *10X Economy - Northern Ireland's Decade of Innovation*, p.9.

38 Ibid p.5

39 Ibid p.6

40 Ibid p.4

41 Ibid p.21

42 QS Top Universities (2021) QS World University Rankings by Subject.

43 For background and analysis:
NWRA (2020) *Regional Spatial & Economic Strategy 2020-2032*.
OECD (2023) Rethinking Regional Attractiveness in the Northern and Western Region of Ireland.
DETE Regional Enterprise Plans for West, Northwest and Northeast.

44 CSO: Census of Population (2022) and Labour Force Survey (Q4 2022)

45 DBEI (2022) pp.96, 99

46 van Egeraat et al. (2023) p.21

47 Central Statistics Office
(2023) *Business Expenditure on Research and Development 2021-2022*, Table 10d.
(2019) *Business Expenditure On Research And Development 2017-2018*, Table 4.

48 Enterprise Ireland (2022) (Start-Up Showcase 2022).

49 North West Strategic Growth Partnership (NWSGP) (2016) *The North West Strategic Growth Plan: A Model for Regional Development and Growth of the North West of the Island of Ireland*.

50 Irish Central Border Area Network (ICBAN) (2023)

51 East Border Region (EBR) (2021)

52 Times Higher Education (2023) *Best Universities 2023*.

53 Alison (2023)

54 O'Donnellan, N. (2022)

55 DBEI (2022) p.107

56 BIM (2020) *The Economic Impact of the Seafood Sector at Ireland's Main Ports*, p.4. (Subsectors covered are commercial fishing, aquaculture and fish processing.)

57 DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS).

58 See later for a discussion of Food Diamond as proposed for the NI agrifood sector

59 See later for a description of the subsector in NI.

60 van Egeraat, C. et al. (2016) p.14

61 DBEI (2022) *National Smart Specialisation Strategy for Innovation 2022-2027*, p.15

62 van Egeraat, C. et al. (2016) p.13. Also: *MedTech Cluster in Galway Region*, The story of how Ireland became a success in global MedTech.

63 Coyle, D. (2022) 'Medtronic announces 200 R&D roles at Galway plant', *Irish Times*, 15 July. Also: Corrigan, S. (2023) 'Fears for Galway jobs as Medtronic announces cuts', *Connacht Tribune*, 27 April. (Medtronic, for example, has roots in Galway since 1982 (having taken over CR Bard operations after its acquisition by AVE in 1998 (*Irish Times*, 10/10/1998)) and employs over 3,000 people there, with strong R&D operations

64 NWRA (2021) *Offshore wind energy crucial to economic recovery in the Northern and Western Region*, 13 December.

65 Eir Grid Group (2020) *Renewable Electricity Support Scheme 1*.

66 Western Development Commission (2021) *Renewable Energy: An Opportunity for a Just Transition to Net Zero on the Atlantic Coast*.

67 Raidió Teilifís Éireann (RTE) (2020) *Seven offshore wind projects fast-tracked by Government*.

68 Wind Energy Ireland (2022) *National Ports Study*, p.67-72.

69 Ibid p.72

70 Sunday Independent, 21/08/2022

71 Irish Times (2023) *Green hydrogen developer plans to raise 100m in pursuit of expansion*, 17 July.

72 South West College

73 European Digital Innovation Hubs Network (2023) *Data2Sustain*.

74 Center Parcs Longford Forest

75 van Egeraat, C. et al. (2016) p.14

76 PorterShed

77 Cyber Ireland (2022) *State of the Cyber Security Sector in Ireland*.

78 North West Regional Skills (2023) *Cyber Security Skills Briefing*.

79 Western People 03/07/2023 "Delight at planning approval for major film production studio in region".

80 Galway Games Developers.

[81] Atlantic Economic Corridor

[82] Enhanced by the recent *Launch of the University of Galway's Centre for Creative Technologies*.

[83] Western Development Commission (2023) Creative Industries Investment and Sustainable Enterprise: Creative Economy

[84] SXSW (South by Southwest)

[85] DBEI (2022) pp.102-103

[86] MedTech as a high-performing cluster in NWR is imputed, as it is not actually listed for the NWR/BMWR in the EOCIC (2020) framework; but as the Southern and Eastern Region (EMR/SR combined region until 2014) includes MedTech as a performing cluster, it is assumed to also be applicable to NWR/BMW, which is generally recognised to be stronger in MedTech.

[87] Northern Ireland Statistics and Research Agency (NISRA) NISRA Census 2021 and Labour Market Report, February 2023

[88] DBEI (2022) Map for *Regional Innovation Performance throughout Europe*, p.99

[89] HM Government (2022) *Levelling up the United Kingdom*.

[90] NISRA (2022) *Northern Ireland Research & Development Survey 2021*, Table 6 and 7. Also: Tables 13 and 16 of (2018) *Archive data for Research & Development and quality report*.

[91] Derry Now (2023) *NI economy 'transformed' since Belfast Agreement – analysis reveals*, 13 March. Also: Birnie, E. (2023) 'It far exaggerates things to say that the 1998 *Belfast/Good Friday Agreement* caused the Northern Ireland economy to double', *News Letter*, 14 March. Also: BDO NI (2023) *Northern Ireland: The Prosperity Dividend*.

[92] DfE (2021) p.24

[93] DAERA (2021) *Independent Strategic Review of the Northern Ireland Agri-Food Sector*, p.14. Also: DAERA/SIBNI (2022) *NI Veterinary Services Situational Analysis* p.12.

[94] DAERA (2018) *Draft Marine Plan for Northern Ireland*, p.87.

[95] DAERA (2021) Independent Strategic Review of the Northern Ireland Agri-Food Sector. Also: DAERA (2021) *Future Agricultural Policy Framework Portfolio for Northern Ireland*.

[96] DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS).

[97] DAERA (2021) *Independent Strategic Review of the Northern Ireland Agri-Food Sector*, p.42.

[98] Mid South West Economic Engine (2020) *Regional Economic Strategy*, p.17.

[99] DfE (2021) p.25

[100] HM Government (2017) 'Life Sciences Industrial Strategy', *Office for Life Sciences,* p.37.

[101] DfE (2021) p.25

[102] Ibid p.22

[103] Invest Northern Ireland (2023) Advanced manufacturing and engineering

[104] The Smart Nano NI Consortium includes Seagate Technologies, Queens University Belfast, Ulster University, Northwest Regional College, three QUB spin-outs (Analytics Engines, Causeway Sensors and Cirdan Imaging), Digital Catapult NI and test equipment manufacturer, Yelo. The UK Research and Innovation's (UKRI) Strength in Places Fund provided a £42.4 million grant. See also reflections on potential and opportunities for all-island chip industry at 18/09/23 Letterkenny gathering organised by UU, ATU, Seagate and Tyndall. See 18/09 LinkedIn Post John Durcan IDA

[105] HVM Catapult (2023) *Delivering industrial transformation and insight for the UK – Annual Review 2021/22*, p.41.

[106] DfE (2021) p.26

[107] Enterprise Research Centre (2013) *Business Clusters Project 2013*, p.35.

[108] Wind Energy Ireland (2022) *National Port Study*, p.77-78.

[109] Londonderry Port and Harbour Commissioners (2023) *Annual Report and Financial Statements for 2022*, p.15

[110] B9 Energy Solutions

[111] DAERA (2021) *Independent Strategic Review of the Northern Ireland Agri-Food Sector*, p.32.

[112] North Channel Wind

[113] Wrightbus (2023) Plans announced for state-of-the-art green hydrogen project at Wrightbus Ballymena.

[114] Belfast Innovation and Inclusive Growth Commission (2021) *Reset for Growth*, pp.15, 16

[115] Mid South West Economic Engine (2020) *Regional Economic Strategy*, p.38.

[116] DfE (2021) p.32

[117] Association of British Professional Conference Organisers (2023) *Belfast Named World's Best Conference Destination*.

[118] NISRA

[119] Mid South West Economic Engine (2020) *Regional Economic Strategy*, pp.38-39.

[120] Tourism Northern Ireland (2021) *ROI Market Strategy 2021-2026*.

[121] DfE (2021) p.24

[122] HM Government (2022) *Levelling up the United Kingdom*, p.236/237.

[123] Crozier, D., Donaldson, S. and Tinnelly, C. (2021) *Northern Ireland Cyber Security Sector Snapshot 2021*.

[124] Cork Institute of Technology (2020) *Mapping the Cyber Island*.

[125] Data Center Map (2023) *Ireland Data Centers*.

[126] Catapult Network (2023) *Creating A New Future For Belfast*.

[127] McAliskey, P. (2021) 'Northern Ireland's technology sector in great shape right now', *The Irish News*, 13 April.

[128] fdi (2021) *Top 25 Tech Cities of the Future*.

[129] Queen's University Belfast (2016) *Queen's welcomes award of Northern Ireland's first Regius Professorship by Her Majesty the Queen*, 6 June.

[130] Digital Catapult (2023) Ormeau Baths Belfast

[131] Canning, M. (2023) 'UK government announces £20m funding boost for NI cyber security industry', *Belfast Telegraph*, 22 February.

[132] Irish News (2023), 7 March.

[133] McAleer, R. (2022) 'Belfast event seeks to strengthen links between north-south tech founders', *Irish News*, 4 October.

[134] Northern Ireland Screen (2022) *Business Plan 2022-23*.

[135] Future Screens NI provides technical skills and related expertise, and comprises the two higher education institutions (UU and QUB) and a number of key industrial partners central to the creative economy in the region.

[136] Northern Ireland Screen (2022) *Business Plan 2022-23*, p.3.

[137] FinTech Futures (2019) *The secret behind Northern Ireland's fintech success*.

[138] DfE (2021) p.25

[139] HM Treasury (2021) *The Kalifa Review of UK FinTech*, 26 February.

[140] Whitecap Consulting (2020) *Northern Ireland FinTech Ecosystem Report 2020*.

[141] Gain, V. (2021) 'Fintech boom could create thousands of jobs in Northern Ireland', *Silicon Republic*, 14 September.

[142] Finance and Artificial intelligence research laB

[143] The Centre for Cross Border Studies

[144] Hume Foundation

[145] Pivotal

[146] Centre for Democracy and Peace Building

[147] Times Higher Education (2023) *Discover best universities*.

[148] CSO: Census of Population (2022) and Labour Force Survey (Q4 2022)

[149] Times Higher Education (2023) *Discover best universities*.

[150] DBEI (2022) p.110

[151] Van Egeraat, C. et al. (2023) p.21

[152] Central Statistics Office
(2023) *Business Expenditure on Research and Development 2021-2022,* Table 10d.
(2019) *Business Expenditure On Research And Development 2017-2018*, Table 4.

[153] Enterprise Ireland (2022) (Start-Up Showcase 2022).

[154] Dettoni, J. (2022) 'European Cities and Regions of the Future 2022/23', *Financial Times*, 17 February.

[155] EMRA (2020) *Regional Spatial & Economic Strategy 2019-2031*. Also: OECD (2023) *Rethinking Regional Attractiveness in the Eastern and Midland Region of Ireland*.

[156] DBEI (2022) p.116

[157] Ibid p.120

[158] Ibid p.120

[159] BIM (2020) *The Economic Impact of the Seafood Sector at Ireland's Main Ports*, p.4. (Data on jobs generated for regions is on p.4 and commercial fishing turnover is on p.13.).

[160] DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS).

[161] van Egeraat, C. et al. (2016) p.14

[162] Ibid p.15
[163] Ibid p.13
[164] DBEI (2022) *National Smart Specialisation Strategy for Innovation 2022-2027*, p.15. DBEI (2022)
[165] van Egeraat, C. et al. (2016) p.15
[166] Raidió Teilifís Éireann (RTE) (2020) *Seven offshore wind projects fast-tracked by Government*.
[167] Wind Energy Ireland (2022) *National Port Study*, p.52.
[168] Eir Grid Group (2020) *Renewable Electricity Support Scheme 1*.
[169] DBEI (2022) p.118
[170] Construction Magazine (2022) *Sky rise cities: Construction activity in Dublin is roaring but regional cities also need investment*.
[171] DBEI (2022) p.121
[172] van Egeraat, C. et al. (2016) p.14
[173] Cyber Ireland (2022) *State of the Cyber Security Sector in Ireland*, p.30.
[174] DBEI (2022) *National Smart Specialisation Strategy for Innovation 2022-2027*, p.121.
[175] Ibid p.121
[176] Data Center Map (2023) *Ireland Data Centers*.
[177] Bitpower Energy Solutions (2023) Tracking Ireland's Data Hosting Industry. Also: Baringa Green Data Report.
[178] fdi (2021) *Top 25 Tech Cities of the Future*.
[179] DBEI (2022) p.118
[180] Ibid.
[181] Screen Ireland (2021) *Building the Future*, p.59
[182] van Egeraat, C. et al. (2016) p.15
[183] DBEI (2022) p.120
[184] Department of Finance (2019) *Ireland for Finance*, p.11
[185] DBEI (2022) p.120
[186] Department of Finance (2019) *Ireland for Finance,* p.33
[187] Ibid p.17
[188] van Egeraat, C. et al. (2016) p.15
[189] Times Higher Education (2023) *Discover best universities*.
[190] esri.ie, nesc.ie, ipa.ie, imi.ie, iiea.com, nerinstitute.net, tasc.ie
[191] DBEI (2022) pp.115-117
[192] CSO: Census of Population (2022) and Labour Force Survey (Q4 2022)
[193] Times Higher Education (2023) *Discover best universities*.
[194] DBEI (2022) p.124
[195] van Egeraat, C. et al. (2023) p.21
[196] Central Statistics Office
(2023) *Business Expenditure on Research and Development 2021-2022,* Table 10d.
(2019) *Business Expenditure On Research And Development 2017-2018*, Table 4.
[197] Enterprise Ireland (2022) (Start-Up Showcase 2022).
[198] O'Donnellan, N. and McCormack, B. (2022) 'Accelerating Growth: Towards an all-island perspective on regional development', *The Centre for Cross Border Studies*, 5 May.
[199] See also OECD (2023) *Rethinking Regional Attractiveness in the Southern Region of Ireland*.
[200] DBEI (2022) p.134
[201] BIM (2020) *The Economic Impact of the Seafood Sector at Ireland's Main Ports*, p.4. (Subsectors covered are commercial fishing, aquaculture and fish processing. Data on jobs generated for regions is on p.4, and commercial fishing turnover is on p.13)
[202] DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS).
[203] Ibid
[204] See earlier discussion of Food Diamond in NI sector.
[205] DBEI (2022) p.132
[206] van Egeraat, C. et al. (2016) p.14

[207] Ibid p.15

[208] Ibid p.13

[209] DBEI (2022) p.133

[210] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.45.

[211] Tyndall National Institute has called for an overall strategy to capitalise on the opportunity presented by the global reshaping of the chip supply chain. See *Ireland's role in the global semiconductor industry*

[212] DBEI (2022) p.130

[213] Ibid p.129

[214] Ibid p.132

[215] Ibid p.132

[216] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.51.

[217] Wind Energy Ireland (2022) *National Port Study*, p.61-66.

[218] DBEI (2022) p.131

[219] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.61.

[220] Ibid p.65

[221] Eir Grid Group (2020) *Renewable Electricity Support Scheme 1*.

[222] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.39.

[223] Ibid p.35.

[224] Ballyhoura Country

[225] DBEI (2022) p.135

[226] Tech Industry Alliance

[227] van Egeraat, C. et al. (2016) p.14

[228] DBEI (2022) p.137

[229] Cyber Ireland (2022) *State of the Cyber Security Sector in Ireland*, p.30.

[230] Cork Institute of Technology (2020) *Mapping the Cyber Island*.

[231] DBEI (2022) p.137

[232] Wylde (2023) *Wylde and Belfast Met Partner to Deliver Ireland's First eSports Degree*, 20 June.

[233] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*.

[234] DBEI (2022) p.133/134

[235] RDI Hub

[236] DBEI (2022) p.128/129

[237] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.70-73. With Babel Consultancy.

[238] Imputed as both EMR and SR are taken as one region pre-2015 i.e. the Eastern and Southern Region, and so have to be separated, and clusters allocated to the two current regions

[239] DBEI (2022) p.88

[240] Ibid p.89

[241] DfI (2021) p.22

[242] DAFM (2021) *Food Vision 2030 - A World Leader in Sustainable Food Systems*, pp.13-14 articulates the concept of a Sustainable Food System (SFS).

[243] Alison, based in Galway is one of the leading global platforms for Massive Open Online Courses (MOOCs) with over 25m users worldwide

[244] CRN (2022) *Clustering on the Island of Ireland: A Gap Analysis*, p.29-34.

[245] Ibid p.4-6

[246] Ibid p.32

[247] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.22. With Babel Consultancy.

[248] Matrix

[249] Southern Regional Assembly (2021) *Regional Approach for development of a Smart Specialisation Strategy in the Southern Region*, p.22-26. With Babel Consultancy.

[250] QS Subject Rankings 2021

[251] Ibid

[252] Now University of Galway

[253] Top Universities (2021) *QS World University Rankings by Subject 2021*.

[254] Massachusetts Institute of Technology (2023) *Local Innovation Systems Project (LIS)*.

[255] OECD (2023) Skills Strategy Northern Ireland (United Kingdom): Assessment and Recommendations. Also available at gov.ie

[256] O'Donnellan, N. (2022)(b)

[257] Byrne, E., Doyle, E. and Hobbs, J. (2021) *Network diversity, distance and economic impact in a cluster: visualising linkages and assessing network capital*, p.22.

[258] O'Donnellan, N. (2022)(a)

[259] O'Donnellan, N. (2022)(b)

[260] Republic of Ireland: FET/SOLAS
Northern Ireland: Further Education NI

[261] van Egeraat, C. and Doyle, E. (2018) p.124

[262] van Egeraat, C. et al. (2016) *Rethinking Irish cluster policy*, Fig. 3, p.12. The analysis used 2013 employment data for agency-assisted firms in the Republic of Ireland

[263] O'Donnellan, N. and McCormack, B. (2022) 'Accelerating Growth: Towards an all-island perspective on regional development', *The Centre for Cross-Border Studies*. Also: Accelerating Growth Policy Seminar.

[264] European Expert Group on Clusters (2021) p.25

[265] HM Government (2022) *Levelling up the United Kingdom*.

[266] National Competitiveness and Productivity Council (2023) *Ireland's Competitiveness Scorecard 2023*, Figure 4.3.3.

[267] O'Donnellan, N. (2023) 'Examining Republic of Ireland's Low Enterprise Churn Rate, using Eurostat and related data sources', *Nevin Economic Research Institute*, 11th Annual NERI Labour Market Conference, 23 May. Slide 49 offers context of overall enterprise structure in both jurisdictions on the island of Ireland.

[268] Bradley, J. (2001) p.49

[269] DAERA (2021) pp.38-41

[270] "King William III encourages his troops, on the morning of 12 July 1690" – from a mural at the top of Sandy Row, Belfast.

[271] It should be noted that Further Education (Education and Training Boards (ETBs) in ROI and Further Education Colleges (FECs) in NI) has a significant role to play in skill development, and in some cases have developed major centres e.g. Ballymena Hydrogen training centre and test beds (NRC), advanced manufacturing in Dundalk (LMETB) and (proposed) hospitality in Killarney (KETB). Generation Apprenticeship (ROI) and Apprenticeship NI are progressing major change in work-based skill development at company and sectoral levels. Skillnet Ireland also plays a key role in skill development for enterprises in ROI, with Business Networks developing skills in, for example, sustainable finance, connected health, it@cork Skillnet, and Tech NW

CONTACTS

CENTRE FOR CROSS BORDER STUDIES

39 Abbey Street, Armagh BT61 7EB

028 (048 from Republic of Ireland) 3751 1550

ccbs@qub.ac.uk

Centre for Cross Border Studies

@CCBSCrossBorder

@crossborderstudies

www.crossborder.ie

A valued source of research, information and support for collaboration across borders on the island of Ireland, Europe and beyond.

Trimprint Ltd,Armagh