Rialtas na hÉireann
Government of Ireland

National Smart Specialisation Strategy for Innovation

2022-2027

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Contents

Tánaiste's Foreword

The future health of our national economy rests on our ability to innovate to respond to change. Innovation and pioneering R&D will help us to take the radical actions required to build a sustainable planet and move towards a digital society. Ireland is making enterprise and innovation gains but we must make sure we realise the potential for innovation-led growth in every part of the country and make continued efforts to ensure balanced regional development.

Through our previous innovation policy cycles, we have made the right calls for our enterprise focussed R&D investment in the regions - with a strong focus on pharma, medical devices, food production, manufacturing and ICT. But what are the right calls for the future? Through this strategy we have assessed, with stakeholders, our economy's strengths and weaknesses, our national innovation resources, and where future opportunities for our regions might lie.

Building on the work of the Regional Enterprise Plans and the Regional Spatial and Economic Strategies, this National Smart Specialisation Strategy for Innovation brings everyone's voice to national innovation decision making. This regional insight into gaps and opportunities, and the recommendations arising, will guide future investment in regional innovation programmes through the European Regional Development Fund.

The pathway for investment set out in this strategy is intended to build on the complementarities between investments and institutions and to deliver novel programmes to drive a step-change in regional innovation capacity. We will create economic opportunity through research, training and collaboration, and establish bottom-up mechanisms to ensure that local and national policymaking recognises regional and sectoral needs so that nobody is left behind. In doing so, we will build a stronger, fairer, and more sustainable economy with thriving enterprises, strong public research systems and resilient regions.

Leo Varadkar TD
Tánaiste and Minister for Enterprise,
Trade and Employment

Executive Summary

Background and Vision

Innovation - the process of adapting from the old to the new – is the main source of economic growth and social progress. In recent years, innovation-led economic growth has been increasingly centred on technological change, digitalisation and environmental sustainability. Ireland's economic policymaking has adapted to meet these new challenges head-on, with recent strategies published to address issues such as Climate Action, Artificial Intelligence, Industry 4.0 and Digital Engagement.

However, Ireland's economic growth, while impressive overall, is uneven and some regions are struggling to transition towards new growth opportunities. Regional productivity and innovation gaps highlight that digital adoption, knowledge diffusion and sustainable growth are by no means automatic.

To reduce these regional disparities, address economic challenges and deliver a better quality of life for all, it is important to link Ireland's regional needs and potential with innovation policymaking. This is the basis for a 'Smart Specialisation' approach – a bottom-up, place based, dynamic process which brings together regional and national actors to identify opportunities and shape future policy direction. This National Smart Specialisation Strategy for Innovation builds on this approach and highlights the range and depth of Ireland's research and innovation activities, enabling greater levels of internal collaboration, while also allowing Ireland to present a more comprehensive picture of our activities internationally.

What is Smart Specialisation?

Smart Specialisation is an innovation policy concept developed by the European Commission which aims to boost regional innovation, contributing to growth and prosperity by helping and enabling regions to focus on their strengths. This will promote broader benefits, including innovation driven growth in regions and the promotion of sustainable growth models.

Our Vision

Ireland's Smart Specialisation Strategy will embrace a regional approach to addressing Ireland's Research, Development and Innovation (RD&I) challenges. It will provide a 'bridge' between regional and national innovation strategy building and decision making, bringing coherence to RD&I planning for the benefit of enterprise and advancing the RD&I agenda regionally and nationally.

Our Smart Specialisation Strategy will be focused on achieving impact in several national strategic areas of real significance if Ireland is to advance the RD&I agenda at regional and national level and achieve delivery of a more digitally connected, greener Ireland, which serves all of our residents. These national strategic priorities are:

1. Digitalisation and digital transformation.
2. Green transformation for enterprise.
3. Innovation diffusion.
4. International collaboration on Research, Development and Innovation (RD&I).
5. Improving the national or regional enterprise research and innovation system.

This Smart Specialisation exercise has also examined and identified regional economic and research strengths and emerging areas of opportunity. The preparation of the Smart Specialisation Strategy (S3) for Ireland through extensive stakeholder engagement regionally and nationally and at a European level, and our analysis of findings, has helped in clarifying a range of high-level strategic goals and deliverables that will be embraced in national policy and programmes, and in the development of new initiatives. This S3 will be monitored and implemented by a multi-level process involving national and regional stakeholders. A National Implementation Group responsible for the management of S3 will be established to ensure all enabling S3 criteria are met at national level, and that S3 governance and monitoring structures, as well as the role of regional interests within S3, are identified. This will also bring additional value to the S3 process by bridging any gaps between national and regional policies.

Smart Specialisation Strategic Goals and Deliverables

Considering Ireland's strengths, future challenges and opportunities to 2027 several strategic goals for S3 have been identified. These goals will support Ireland's ongoing efforts to rise to the challenges of the future identified by our stakeholders by supporting the smart specialisation process in all aspects. They are accompanied by high-level deliverables which will ensure these goals are met.

High Level Strategic Goals

1

Our new Smart Specialisation Strategy for Ireland will link national and regional enterprise and innovation policy, connecting the statutory RSESs, Regional Enterprise Plans, Impact 2030: Ireland's Research and Innovation Strategy and other national policies and will bring greater policy coherence at multiple levels of governance.

This will be achieved through:

- Convening a national Smart Specialisation Implementation Group to bring together regional and national innovation policymakers;
- Continuing to focus on identifying linkages and exploiting synergies between relevant national and regional strategies; and
- Providing input, informed by smart specialisation insights, into the development of new strategies and policies over the lifecycle of S3.

2

Smart Specialisation will support the adoption of the European Regional Development Fund in Ireland by supporting policy objective 1 'A Smarter Europe'

This will be achieved through:

- Approval of Ireland's Smart Specialisation Strategy by the European Commission.

3

Smart Specialisation will improve research and innovation capacity in Ireland's regions.

This will be achieved through:

- Increasing the intensity of Business R&D that takes place across all regions, with a particular focus on underperforming regions, through delivering new and enhanced agency interventions with a particular focus on strengthening industry-academic collaborations across Ireland.

4

Smart Specialisation will encourage more regionally dispersed RD&I, strengthen the enterprise base and identify emerging areas of opportunity.

This will be achieved through:

- Leveraging and building on the analysis of regional strengths and emerging areas of opportunity undertaken as part of the development of Ireland's S3;
- Addressing gaps in existing regional innovation infrastructures and systems through new funding, by supporting projects aligned with the nine Regional Enterprise Plans to 2024 (REPs); and
- Seeking out opportunities to enable inter-regional collaboration through the REP Implementation structures.

5

Smart Specialisation will increase the regional uptake of new advanced technologies to increase the reach of the twin green and digital transformation throughout Irish enterprise.

This will be achieved through:

- Enhanced supports prioritising knowledge transfer and industry-academic collaboration, informed by our smart specialisation analysis and findings including interventions with a particular focus on strengthening industry-academic collaborations across Ireland.

6

Smart Specialisation will drive the development of skills needed for enhancing innovation activity across the economy

This will be achieved through:

- New and enhanced supports based on creating the necessary skills for 'needs led' innovation, informed by our smart specialisation analysis and findings

7

Smart Specialisation will encourage the maximising of sectoral strengths through clustering and the scaling of Ireland's existing areas of research excellence.

This will be achieved through:

- Supporting the development of a new National Clustering policy framework through the identification of regional and national sectoral strengths, capabilities and opportunities; and
- Supporting the scaling of Ireland's existing network of national R&D facilities and clusters by establishing a coherent national framework for S3, and by setting out opportunities that exist within Ireland's regions.

8

Smart Specialisation will lead to a greater visibility and coherence of the innovation system in Ireland's regions both nationally and in Europe.

This will be achieved through:

- The establishment of an S3 monitoring implementation procedure and governance at local, regional and national level;
- The incorporation of S3 goals, approach and priorities into Impact 2030: Ireland's Research and Innovation Strategy;
- Ongoing engagement with S3 in Ireland by the European Commission.

Smart Specialisation deliverables are to be extensively supported by Ireland's ERDF programmes, subject to European Commission approval, that aim to enhance RD&I activity through new collaboration supports, improved HEI R&D capacity and novel innovation grant initiatives. It is also intended to bolster regional entrepreneurship through investment in the Technological Universities, leveraging the role of further and higher education institutions as anchors for enterprise and for regional growth. The ERDF draft programmes have been extensively informed by this strategy and include specific programme level metrics to ensure targeted impact. Supporting the work of these programmes will provide new and additional value for Ireland and push forward future regional and national advantages across a variety of areas.

More broadly, S3 will assist in guiding the focus of a range of other funding mechanisms across Government, including Horizon Europe, aimed at driving increased collaborations across research and innovation, industry and the higher education sector, and in ensuring their alignment with ERDF.

Governance, Monitoring and Implementation

Achieving impact from S3 will require comprehensive governance, monitoring and implementation procedures in order to ensure that its goals and deliverables are met. Ireland's S3 will be monitored and implemented by a multi-level process involving national and regional stakeholders. A National Implementation Group responsible for the management of S3 will be established that will oversee the delivery of S3 national and regional strategic priorities by bringing together relevant policy leads, as well as related agencies and bodies directly involved in implementation as required.
The National Implementation Group will ensure all enabling S3 criteria are met at national level, and that S3 governance and monitoring structures, as well as the role of regional interests within S3, are in place. This will also bring additional value to the S3 process by bridging any gaps between national and regional policies. The group will also be responsible for ensuring coherence and promotion of S3 principles across the whole of government.

1 Introduction

1.1 Development of the National Smart Specialisation Strategy

Smart Specialisation Strategies (or S3) are enterprise innovation strategies that aim to prioritise public research and innovation investments for the economic transformation of regions, building on regional competitive advantages and facilitating market opportunities. The development of a new Smart Specialisation Strategy for Ireland presented an opportunity to assess, with stakeholders, our regional competitive advantages, future market opportunities, solutions to societal challenges, and the effectiveness of the current suite of innovation supports. It is intended that S3 in Ireland will serve as an important strategic bridge, connecting national level innovation policy with regional enterprise priorities and regional actors, ensuring ongoing coherence between regional and national enterprise policymaking. S3 will link several major policy areas: Regional Enterprise Plans (REPs) and the Regional Spatial and Economic Strategies (RSESs) will inform the S3, which will in turn inform the regional enterprise aspect of Impact 2030: Ireland's Research and Innovation Strategy developed by the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS).

1.2 What is Smart Specialisation?

Smart Specialisation is an innovation policy concept developed by the European Commission which aims to boost regional innovation, contributing to growth and prosperity by helping and enabling regions to focus on their strengths. This will promote broader benefits, including innovation driven growth in regions and the promotion of sustainable growth models. The development of a national or regional smart specialisation strategy is a key enabling condition to ensure reimbursement by the European Commission of European Regional Development Fund (ERDF) receipts for the EU co-financed proportion of the programmes related to the 'Smarter Europe' objective. The enabling conditions must be met throughout the programming period.

The development of an S3 involves an 'Entrepreneurial Discovery Process' (EDP), a type of consultation process which ensures the inclusive and active involvement of all stakeholders. As part of the EDP government, business, academia and civil society identify a region's strengths and comparative assets, prioritise research and innovation investment in competitive areas and define a shared vision for regional innovation.

1.3 Background to the Development of Smart Specialisation in Europe

Smart Specialisation was developed in 2007 as a European research and innovation policy approach in the context of the European Research Area (ERA) as part of the objective of spending 3% of EU GDP on R&D. Approaches to Smart Specialisation have developed over the years, with guidance and strategic tools developed by the European Commission to assist countries and regions to identify their strategic innovation priorities. Since the 2014-2020 programming period, developing a Research and Innovation Strategy for Smart Specialisation has been a prerequisite to receive funding for R&D from the European Regional Development Fund (ERDF).

1.4 Smart Specialisation Success in Europe

Smart Specialisation Strategies have led to numerous instances of regions developing new strengths and creating opportunities out of their unique enterprise, research and skills mixes. Some examples include:

- **Eco-innovation towards a circular economy in the Basque Country.** The autonomous region has been promoting eco-innovation intensively for over 10 years and has achieved results: there are now 150 Basque industrial companies applying circular practices. The EDP established in the framework of the Basque Region's S3 has fostered productive dialogue between large companies, clusters, SMEs, universities and regional and local government bodies. This proactively managed EDP has strengthened the operational linkages between the region's circular economy initiatives and fed into the development of the new 'Circular Economy Strategy of the Basque Country 2030'. Support to eco-innovation is proving to be by far the region's most cost-effective public intervention in the circular economy sphere.
- **A living lab for the sustainable energy transition ambition of the Algarve Region.** The 'Culatra 2030 Sustainable Energy Community' initiative is a demonstration project on the island of Culatra in the Algarve, Portugal, covering multiple aspects of green transition. It implements the ambitions of the S3 in the Algarve, using a novel process to create a real-life laboratory for green transition, focusing on the specific needs of the island and capitalising on its assets. The central ambition of the initiative is to transform all structures on the island to become energy self-sufficient. The community will produce energy exclusively from renewable sources, use electric mobility, decarbonise its fishing industry and acquire sustainable habits. The key to its success is the active participation of the island's whole community through a continuous EDP process. This participatory model is proving effective in improving decision-making, compared to the previous situation, which was characterised by several scattered and unco-ordinated initiatives.
- **Creating Water Technology solutions through an open innovation ecosystem in Friesland.** WaterCampus Leeuwarden is a dynamic open innovation ecosystem in the field of water technology, based in Friesland, Northern Netherlands. The WaterCampus had a strong influence on the development of the S3 approach in the region and has been actively involved in the region's S3 partnership since the outset. This has helped to strengthen the position of the WaterCampus and water technology, increasing the visibility and in attracting global talent.

1.5 European Framework for Smart Specialisation

Smart Specialisation underpins or has complementaries with several EU Programmes.

Cohesion Policy

Cohesion Policy is the EU's strategy to promote and support the development of its Member States and regions. It aims to reduce disparities in development between Member States and regions, focusing on key areas to help the EU face challenges and remain globally competitive. Funding for cohesion initiatives is delivered through the EU's Multiannual Financial Framework (MFF).

One instrument that receives substantial funding from the MFF is the European Regional Development Fund (ERDF) which aims to strengthen economic and social cohesion by correcting imbalances between regions. The Department of Public Expenditure and Reform (DPER) is the co-ordination body for the funds under Cohesion Policy and has responsibility for the ERDF.

European Regional Development Fund

The ERDF focuses its investments on several key priority areas, one of which is innovation and research or a 'Smarter Europe'. A key enabling condition for ERDF in 2021-2027 is the development of a national or regional S3 to guide European and national investments in RD&I. Ireland must ensure the fulfilment of this enabling condition prior to claiming the EU co-financed funds relating to this policy objective. Other policy objectives include focusing on a low-carbon Europe, a connected Europe, a social Europe, and a Europe closer to citizens.

S3 is being used as part of the guiding process for the devising of the ERDF operational programme for 2021-2027 and the new and additional programmes therein.

National Recovery and Reslience Plan & S3

DPER working together with the Department of the Taoiseach, the Department of Finance and the Department of Enterprise, Trade & Employment, had responsibility for preparing the National Recovery and Resilience Plan (NRRP) with input from other Departments as necessary. The NRRP is aligned with domestic policies such as the Economic Recovery Plan and the National Development Plan.

The NRRP contains measures that will support the Smart Specialisation Strategy. The plan is designed to make a positive contribution to Ireland's economic rebound post COVID-19 and will accelerate the green and digital transitions. It includes measures to front-load private and public green investments and advance environmental, climate, energy and infrastructure projects. The plan also includes reforms and investments that are set to promote the digital transformation across society and help improve the prospects for welfare and equality, growth and employment measures, giving it the potential to contribute to territorial cohesion by addressing regional disparities.

European Green Deal

The European Green Deal is a new growth strategy that aims to transform the EU into a fair and prosperous society with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. It also aims to protect, conserve, and enhance the EU's natural capital, and protect the well-being of citizens from environment-related impacts. As part of a just and inclusive transition, it will pay attention to the regions, industries and workers who will face the greatest challenges. The Deal will accelerate and underpin the transition needed in all sectors.

The iterative, consultative approach used for the S3, empowering regions and stakeholders to focus on areas of current or future strength and identify areas which would benefit from sustainability supports and resource efficiency, acts in support of the transition required by the European Green Deal. Integrating sustainability into smart specialisation is leading to a new policy concept in Europe - S4, or Smart Specialisation Strategies for Sustainability.

Horizon Europe

Running from 2021-2027, Horizon Europe will be the most ambitious Research and Innovation programme in the world with a budget of €95.5 billion. Building on the achievements of Horizon 2020, Horizon Europe offers a broad range of opportunities for Irish researchers, innovators and Irish companies of all sizes in the pursuit of new discoveries, scientific and technological advancement and innovation. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

Smart Specialisation Strategies are key to developing synergies between Horizon Europe and other EU smart growth-related instruments. Considering ways to blend or align EU Programme funding to improve and develop RD&I eco-systems to prepare for Horizon Europe participation will be an aspect of this S3.

1.6 National Smart Specialisation Strategy 2014-2020

Ireland's previous Smart Specialisation Strategy for Research and Innovation (2014-2020) was translated from and aligned with the National Research Prioritisation Exercise (NRPE) of 2012, which was refreshed in 2017 as part of national innovation policy at the time. Accordingly, the strategy was focused mainly on research driven innovation for the national industry base. Its approach was national, as opposed to regional, in outlook. A fresh approach is being taken to the development of the new S3, which will be a regionally focused 'living' strategy and will link regional and national policymaking for RD&I.

In early 2020, DG REGIO commissioned a report on Smart Specialisation in Ireland by Alison Hunter, an economic and public policy consultant. Key stakeholders including DETE were consulted as part of the process. This report recognised Ireland's strong research planning and investment framework, but also revealed a perceived lack of visibility on the S3. It will be important that the findings / recommendations of the report be considered in the development of this new strategy such as:

- Existence of a competent regional / national institution or body, responsible for the management of the S3 ensuring an appropriate governance system is in place ;
- Place-based policymaking to enable regions to identify and develop their commercial and social advantages, through a bottom-up process engaging everyone in the region;
- Monitoring and evaluation tools to measure performance towards the objectives of the strategy;
- Effective functioning of entrepreneurial discovery process (EDP).

In the 2014-2020 cycle, ERDF co-funded a variety of initiatives that contributed to 'smarter' innovative and economic transformations. These included SFI Research Centres, the Enterprise Ireland Commercialisation Fund, Innovation Partnerships, the Industry R&D Fund and New Frontiers.

1.7 Requirements for a Smart Specialisation Strategy 2021-2027

The fulfilment criteria for S3s during the 2021-2027 cycle are set out in the European Commission's Cohesion Policy legislative package and are summarised below:

1. Up-to-date analysis of bottlenecks for innovation diffusion, including digitalisation;
2. Existence of competent regional/national institution or body, responsible for the management of the smart specialisation strategy;
3. Monitoring and evaluation tools to measure performance towards the objectives of the strategy;
4. Functioning of Stakeholder Co-operation (Entrepreneurial Discovery Process (EDP));
5. Where relevant, actions necessary to improve national or regional research and innovation systems;
6. Where relevant, actions to manage industrial transition;

7. Measures for enhancing - with partners outside a given Member State in priority areas supported by the smart specialisation strategy.

Ireland's Approach to the S3 Process 2021-2027

Ireland has used a two-stage consultation process (entrepreneurial discovery process) for the S3. At a regional level, Smart Specialisation has been integrated as a thematic area in the consultation process to develop new Regional Enterprise Plans (REPs) to 2024 and is a part of the statutory Regional Spatial and Economic Strategies (RSESs). The 'stage one' consultations took place as a part of the REPs process in the nine NUTS 3 areas, giving local insights into regional priorities.

The 'stage two' online consultation engaged key innovation stakeholders who may not have been represented at the REPs Steering Committees and provided broader insights. There are also numerous recent studies and policy documents to consider in the context of this strategy, and the S3 draws together the relevant findings of these policies and well as the insights gained during the two-stage consultation process.

This process was overseen throughout by a steering group of key government stakeholders, providing governance of S3 during strategy creation. Their role included ensuring that all the criteria for S3 are met, identifying S3 monitoring structures, and identifying the regional and national interests within S3, thus bridging any gap between national and regional policies.

1.8 Our Vision

Ireland's Smart Specialisation Strategy will embrace a regional approach to addressing Ireland's Research, Development and Innovation (RD&I) challenges. It will provide a 'bridge' between regional and national innovation strategy building and decision making, bringing coherence to RD&I planning for the benefit of enterprise and advancing the RD&I agenda regionally and nationally.

Our Smart Specialisation Strategy will be focused on achieving impact in several national strategic areas of real significance if Ireland is to advance the RD&I agenda at regional and national level and achieve delivery of a more digitally connected, greener Ireland, which serves all of our residents. These national strategic priorities are:

1. Digitalisation and digital transformation;
2. Green transformation for enterprise;
3. Innovation diffusion;
4. International collaboration on RD&I;
5. Improving the national or regional enterprise research and innovation system.

The preparation of the S3 through extensive stakeholder engagement regionally and nationally, and the analysis of findings, helped clarify a range of high-level strategic goals and deliverables that will be embraced in national policy and programmes and in the development of new initiatives. S3 will be monitored and implemented by a multi-level process involving national and regional stakeholders. A National Implementation Group responsible for S3's management will be established to ensure all enabling criteria are met at national level, and that governance and monitoring structures, as well as the role of regional interests within S3, are identified. This will also bring additional value to the S3 process by bridging any gaps between national and regional policies.

2 S3 Methodology

2.1 Overview

For a country of Ireland's scale, many sectoral strategies are developed at national level. However, smart specialisation can only work if choices are based on real knowledge of local potential and if the right actors are involved. Therefore a bottom-up approach is also necessary. For instance, when considering the development of sectoral opportunities, it is important to consider the past and current industrial composition in that location, along with place-specific needs from industries, such as proximity to energy infrastructure, water capacity, availability of talent, proximity to public transport, access to international markets through airports and ports, serviced lands, local clusters, supply chains and economies of scale.

2.2 Smart Specialisation Steering Group

To guide the development of the S3, a dedicated steering group was convened, consisting of relevant stakeholders across DETE and other Departments and bodies. The role of the steering group includes ensuring that all enabling criteria are met at a national level, identifying S3 governance and monitoring structures and identifying the role of regional interests within S3, thus bridging any gap between national and regional policies.

Steering Group (Core Stakeholders)
DETE Innovation, Research and Development Programmes Unit
DETE Regional Enterprise Plans and Initiatives Unit
Department of Public Expenditure and Reform
Department of Further and Higher Education, Research, Innovation and Science
Eastern and Midland Regional Assembly
North and Western Regional Assembly
Southern Regional Assembly

The Role of the Regional Assemblies and RSES Alignment

Ireland's three Regional Assemblies (Northern and Western, Southern, Eastern and Midland) are statutory bodies responsible for co-ordinating, promoting and supporting strategic planning and sustainable development in the regions. The Regional Assemblies also manage certain EU funding programmes like the European Regional Development Fund and, as such, are integral to the development of a Smart Specialisation Strategy.

The assemblies have developed Regional Spatial and Economic Strategies (RSESs) as part of the government's long-term plans to meet the challenges of population growth, climate change and a competitive economy. The primary statutory objective of the RSESs is to support, at a regional level, the implementation of the Project Ireland 2040 - National Planning Framework (NPF) and National Development Plan (NDP). The RSESs set out a long-term framework for spatial planning and economic development in Ireland's three NUTS 2 regions, with "Smart Specialisation" being one of the key economic principles adopted in each of these high-level statutory frameworks.

The RSESs are strongly aligned to Europe's objectives and the national spatial, economic and climate policies of the Government to drive policy alignment from EU to local level in Ireland, and to ensure that funding follows policy by providing a framework for investment in the Regions. The RSESs also provide the policy framework for the preparation of Local Authority City and County Development Plans and Local Economic and Community Plan (LECPs). The RSESs seek to optimise the potential of the regions providing an evidence place-based approach for growth and how it will be directed and managed over the next decade.

The S3 presents an opportunity to build on the RSESs and tap into the expertise of the Regional Assemblies in providing an evidence and place-based approach for managing and directing future growth and investment at a NUTS 2 Regional level, including ERDF for Regional Programmes. As such, the Regional Assemblies are core stakeholders in the development of this S3 and are members of the S3 Steering Group.

The Role of the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) and Alignment with National Research Priorities

DFHERIS was established in 2020 with a remit to focus on talent and knowledge, and to accelerate investment in human capital, research and innovation to respond to the range of challenges and opportunities faced by Ireland as a country. DFHERIS will work to position Ireland globally as a leading knowledge economy with a skills and innovation focus and as a leader in higher education and research, deepening collaboration on an all-island and East-West basis, within the EU and beyond, attracting talent from around the world to Ireland's international education system and equipping Ireland to compete on the world stage.

Agencies now under DFHERIS account for just under half of this funding (€423.1 million in 2020 or 49% and an estimated €466.0 million in 2021 or 49.1%) Science Foundation Ireland, the Higher Education Authority and the Irish Research Council is the driving force behind public investment in RD&I but is not alone in funding research and development across Government.

DFHERIS works closely with other Government Departments, agencies and bodies on the national RD&I agenda, and it is in this capacity it is a core stakeholder for S3 – providing advice and guidance on national level priorities. DFHERIS will also work to ensure alignment between S3 and the new national strategy for research and innovation, which is currently in development.

2.3 Entrepreneurial Discovery Process (EDP)

The development of an S3 involves an EDP, ensuring inclusive and active involvement of all stakeholders. This is a process whereby government, business, academia and civil society identify a region's strengths and comparative assets, prioritise research and innovation investment in competitive areas and define a shared vision for regional innovation.

S3 in Ireland used a two-stage consultation as part of its EDP. At a regional level, Smart Specialisation was integrated as a thematic area in the consultation process to develop new Regional Enterprise Plans (REPs) to 2024 and is a part of the statutory Regional Spatial and Economic Strategies (RSESs). The 'stage one' consultations took place as a part of the REPs process in the nine NUTS 3 areas, giving local insights into regional priorities. The 'stage two' online consultation engaged key innovation stakeholders who may not have been represented at the REPs Steering Committees and provided broader insights.

EDP Stage One: Consultation With The Regional Enterprise Plans

The nine NUTS 3 level Regional Enterprise Plans (REPs) are an integral part of Ireland's enterprise policy, aimed at driving economic growth and sustaining better standards of living throughout Ireland. As a 'bottom-up' initiative, the Plans complement national level policies and programmes such as Ireland's national enterprise policy, Enterprise 2025 Renewed and the National Development Plan.

The REPs are 'live' documents, implemented by Steering Committees chaired by private sector businesspeople and comprising representatives of Local Authorities,

LEOs, Enterprise Ireland, IDA Ireland, Regional Assemblies, Regional Skills Fora, Higher and Further Education Institutes, enterprise champions and others. The development of the REPs involved a series of structured engagements with regional stakeholders. This engagement sought to highlight gaps and strengthen the conditions for entrepreneurs to start and scale their businesses, encourage new investment and business growth, and lead to increased employment in every region.

The process to develop a series of new Regional Enterprise Plans (REPs) commenced in early 2021.The process saw the development of nine new REPs for each region which will cover the period through to 2024, with each REP guided by a Regional Steering Committee. The Committees considered emerging opportunities and challenges facing their regions including Brexit, recovery from COVID-19, remote working, climate action and transition to a low-carbon economy. While the REP Steering Committees had considerable discretion in what they discussed, all nine regions considered Smart Specialisation, along with issues regarding digitalisation and the green transition in their considerations.

All consultation for the REPs to 2024 took place as online meetings. While this differed from previous REP cycles this was the result of restrictions arising from the COVID-19 pandemic. Each region approached consultation in a slightly different way. Several regions hired facilitators to chair discussions and manage breakout sessions. The final analysis was undertaken by the regional Steering Committees.

A new National Oversight Group, chaired by Ministers of State, was established to oversee firstly the development of the new Plans and monitor implementation to 2024.

EPD Stage Two: Online Consultation

The general public and other key stakeholders were invited to make a written submission setting out their views on enterprise innovation and Smart Specialisation. A stakeholder consultation paper was developed to provide background information on Smart Specialisation and to help guide responses. This consultation opened on 13 July 2021 and closed on 10 August 2021.

Through this online consultation the views of stakeholders with an interest in the development of the national and regional enterprise innovation landscape were solicited, especially businesses or business support organisations, national/regional/local public authorities and research and innovation organisations. Targeted requests were also sent to a number of agencies and departments, including units responsible for the implementation of specific strategies in order to ensure that all relevant stakeholders were aware of the consultation.

The consultation paper set out suggested regional strengths and emerging areas of future opportunity and asked stakeholders for feedback on the areas proposed. In line with the fulfilment criteria for a S3, as set by the European Commission, the paper also addressed the following cross-cutting issues in national enterprise innovation (the industrial transition aspect of the S3 requirements being split into digital transformation and green transformation):

1. Digitalisation and digital transformation;.
2. Green transformation for enterprise;
3. Innovation diffusion;
4. International collaboration on RD&I;
5. Actions to improve the national or regional enterprise research and innovation system;
6. Regional economic and innovation strengths and emerging areas of opportunity.

DETE received 45 submissions in total, comprising 463 pages. These submissions came from businesses, research/academia, local and regional bodies, state agencies and individuals. A number of submissions were also sought and received internally within DETE. It is intended that all external submissions received will be made available under the Freedom of Information Act 2014 (FOI) and as such may be published following the publication of the Strategy.

The views expressed in these submissions are represented throughout this document and were used to inform the findings and analysis contained therein.

2.4 Identifying Sectoral Strengths

The sectoral strengths identified in this 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.

2.5 Alignment with Priorities for the ERDF

The European Commission has stipulated that S3 should determine RD&I funding priorities for the ERDF. It is important that the identified RD&I priorities are novel and do not focus on funding the same ongoing activities, instead looking at how to enable the transformation of sectoral specialisms identified in the S3.

The Regional Assemblies, in their capacity as the Managing Authorities for ERDF implementation, have also examined relevant economic and environmental indicators to identify the key development challenges facing their regions which will assist in addressing regional disparities and delivering effective regional development in Ireland. Their findings and identified priorities have fed into S3.

The Regional Assemblies have engaged with DPER and the European Commission to prepare the ERDF Programmes, with their priorities framed in the context of EU Cohesion Policy Objectives, which seek to strengthen economic & social cohesion between regions with a focus on the urban dimension and policy areas such as:

- Research, innovation capacity and uptake of advanced technologies;
- Benefits of digitalisation for citizens, government, and companies;
- Developing skills for smart specialisation, industrial transition, and entrepreneurship;
- SME competitiveness and growth;
- Energy efficiency, renewable energy;
- Climate Change adaptation, risk prevention;
- Enhancing green infrastructure, reducing pollution.

There are currently two ERDF Operational Programmes in Ireland; one covering the Southern Region (SR) and the Eastern and Midland Region (EMR) with the other covering the North and Western Region (NWR).

The 2021-2027 ERDF Programmes will have a significant emphasis on the 'Smarter Europe' policy objective which requires an S3 in place as an enabling condition. The Operational Programme designs are closely aligned with the priorities identified in the NPF and RSESs, aiming to target regional strengths while promoting innovative and smart economic transformation – key requirements for any S3.

2.6 Future Consultation

It is intended that S3 will act as a key input for a number of parallel and future strategy and policy documents. These exist at both regional and national level and cover all aspects of S3. They include, but are not limited to:

- Impact 2030: Ireland's Research and Innovation Strategy;
- New National Cluster Strategy;
- SRA Smart Specialisation Strategy regional framework paper;
- OECD Innovation Diffusion project for the North-West;
- NWRA Smart Specialisation Strategy position paper;
- Future cycles of the Regional Enterprise Plans.

It is intended that the S3 Steering Group will transition to an S3 Implementation Group following publication of this strategy. This will ensure that S3 continues to receive due consideration in new policy areas as they arise and will ensure that S3 retains real impact as a living and evolving strategy.

3 National Economic and Innovation Context

3.1 Overview

Ireland has one of the most open economies in the EU. Knowledge-intensive services and high-tech manufacturing are key drivers of the economy, with the Irish Government steering this direction to generate and build on the country's strong economic success. Ireland has demonstrated a strong economic comeback since the 2007-2008 global financial crisis and is set to recover well economically post-COVID. Ireland is also the most R&D efficient country in Europe, generating more innovation output per euro of public funds invested than any other country[1] .

However, Ireland retains a number of key economic and innovation challenges that will need to be addressed over the coming period. Irish SMEs are widely reported as under-performing in RD&I compared to their EU counterparts of comparable economies. This is especially the case for SME productivity, understood to be lacking in impact relative to RD&I investment, although that a positive change was noted from 2018 to 2019. There is a heavy dependence on relationships with, and performance of, multinationals (MNCs). The Dublin and Cork agglomerations very strongly outperform the country's wider economic and RD&I performance. In addition, firms outside of Dublin and Cork are less likely to introduce product / service innovations. Any future changes in regulatory frameworks could have strong impacts on Ireland's economic model. This makes resilience planning all the more important, not least in refreshing the strategic framework underpinning the country's RD&I approach and S3.

3.2 Economic Context

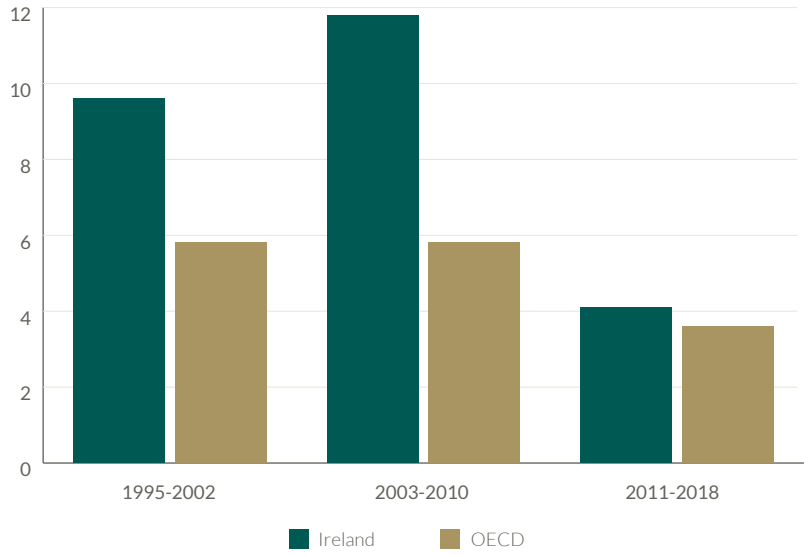
Ireland's economy was the only one to grow in the EU last year boosted by medical and pharmaceutical exports[2] . The European Commission expects Irish GDP to grow by 7.2% in 2021 and slower in 2022 at 5.1%.[3] The eurozone economy as a whole will grow 4.8% this year, and at roughly the same pace next year.

The impressive economic growth of recent years has contributed to the economy beginning to run up against capacity constraints, with some skill shortages and strains on key infrastructure. The population is ageing, with the number of people aged over 65 outpacing that of the prime working age cohort since 2008.

The structure of the economy is also undergoing sizeable change. Businesses located in Ireland have been keener to embrace new technologies than their counterparts in most other OECD countries[4] , but the impact on productivity growth in most firms has been modest so far. These trends unfold against a backdrop of heightened global uncertainty and with scars of the financial crisis, notably high general government debt, fragilities in the banking sector and high long-term unemployment still apparent.

1. Shaping Our Future - Science Foundation Ireland Strategy 2025, Eurostat 2021
2. European Economic Forecast. Winter 2021 (Interim) (europa.eu)
3. Economic forecast for Ireland | European Commission (europa.eu)
4. OECD Economic Surveys: Ireland 2020 (oecd-ilibrary.org)

Figure 3.1: Index of Structural Change 1995-2018



Source: OECD

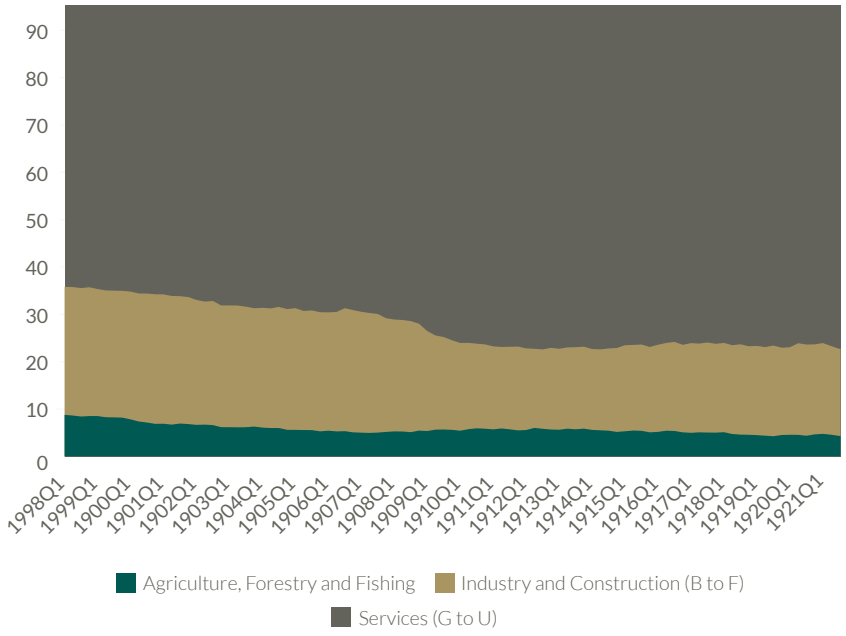
Structural economic change has been a persistent feature of Ireland's past three decades, more so than in most other OECD countries. This is reflective of the ability of the economy to adapt to new demographic, economic and technological trends. Since the mid-1990s, the average real wage has increased by over 50% in Ireland, compared with around 30% in the United States or the average OECD country. These trends have coincided with growing innovation activity, increased infrastructural support for RD&I through initiatives such as PRTLI, and the expanding role of technology in the Irish economy.

The COVID-19 pandemic has either accelerated or sharpened many trends and shifts that have been emerging for some time. The labour market composition changes; growing digital economy; decarbonising the economy; global developments including Brexit, geo-political change, trade protectionism, and international taxation among others comprise a complex landscape for S3 to operate. Some of these trends are worth analysing in the context of S3.

Human Capital and Labour Market Composition Changes

In recent times, the Irish labour market has experienced significant turmoil and has shown a remarkable ability to recover. However, the negative impact of the pandemic has highlighted longer term structural changes facing the workforce, such as digitalisation and sectoral shifts. Over the last 20 years, the employment composition of the Irish economy has moved increasingly towards the services sectors, and in particular to the knowledge intensive services sector, as outlined in Figure 3.2 below. This trend is likely to continue and may be accelerated by the impact of COVID-19. Ireland's changing demographics, with an increasing share of older people in the population, will also have implications for employment growth, with increasing opportunities emerging in the care and health sectors, for example.

Figure 3.2: Percentage Employed by Economic Sector 1998-2020



Source: CSO Labour Force Survey

Global Developments - Ireland as a Small Open Economy

Ireland's highly open export-orientated economic model has proved extremely robust through various international shocks, not least over the last year. This model is however sensitive to global changes including tensions between the largest trading blocs and wider "de-globalisation" trends. There are several significant downside risks over the medium term facing the global economy, some of which have been exacerbated by the pandemic.

Adverse external developments could impact the Irish economy through numerous channels, including through exchange rate fluctuations, Foreign Direct Investment (FDI) flows, reduced demand for exports, onshoring supply chains, increased public and private sector borrowing costs, and deteriorating consumer and market sentiment. Ireland is particularly sensitive to developments in global value chains given its comparatively high dependence on foreign produced inputs in domestic production of goods for exports. In addition, increased tariff and other barriers to trade would adversely affect the exports of Irish firms and MNCs operating in Ireland and potentially increase import costs for inputs.

Openness to foreign investment has been a key driver of Ireland's economic development, however, attracting investment is becoming increasingly competitive. Recent incentives to re-shore in the US highlight how quickly the economic calculus facing MNCs can change. Compounding the challenge is the profile of FDI in Ireland. Foreign investment is heavily concentrated in Ireland's high value-added sectors such as pharmaceuticals, digital services and ICT. Ongoing uncertainty around the future international tax and IP frameworks governing these sectors, as well as technological change, represents risks.

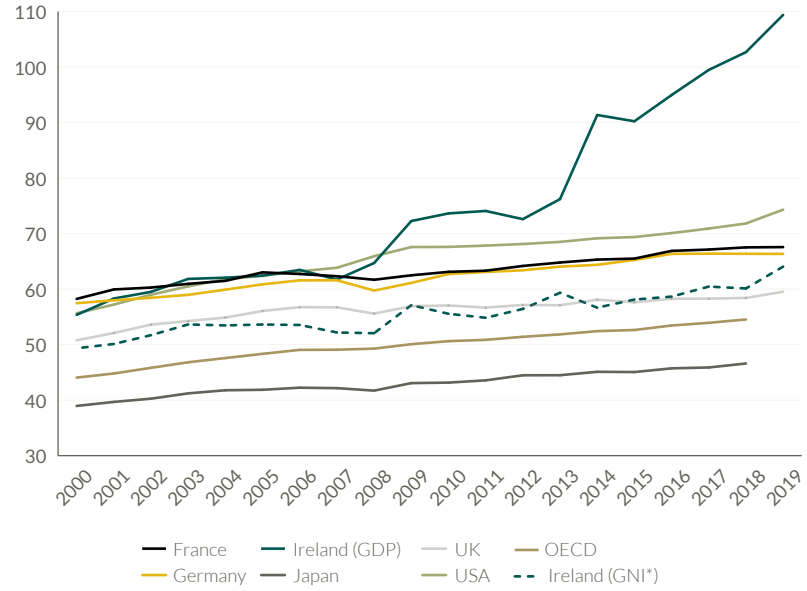
2021 has been a critical year for International Taxation arrangements. The recent OECD tax accords, which set a global minimum corporation tax of 15% applying to large companies, ensure that Ireland will remain competitive from a tax perspective and will continue to provide stability for investors.

While the full, and long-term impacts of Brexit for the economy will remain unclear for some time and to a large extent have become entangled with pandemic impacts, the overall level of output for the Irish economy is expected to be lower than if Brexit had not occurred. Over the short term there may continue to be supply chain disruptions. Longer term, notwithstanding the significant opportunities for FDI and export diversification as a result of Brexit, a reduction in output is expected. Brexit will also likely see the emergence of a considerable competitor on the margins of the EU, the consequences of which are not yet clear.

Productivity Growth

There is a strong link between innovation performance and productivity growth, which is in turn, an important long-term predictor of future economic growth. Despite the global slowdown over the past decade, aggregate labour productivity figures for Ireland continue to show a strong performance relative to other advanced economies. This finding prevails (although to a lesser extent) even when globalisation activities are excluded from the calculations; this is done by using the CSO's adjusted Gross National Income (GNI*) rather than Gross Domestic Product (GDP) to measure economic activity. According to the latest OECD and CSO data available, Ireland's GDP per hour worked in 2019 is significantly above the OECD average and some of the world's most advanced economies (Figure 3.3). On a GNI* basis, Irish labour productivity remains above the OECD average and above the UK, but below the USA, France and Germany.

Figure 3.3: Labour Productivity, GDP and GNI* per hour Worked (USD)



Source: National Competitiveness and Productivity Council Bulletin 20-1

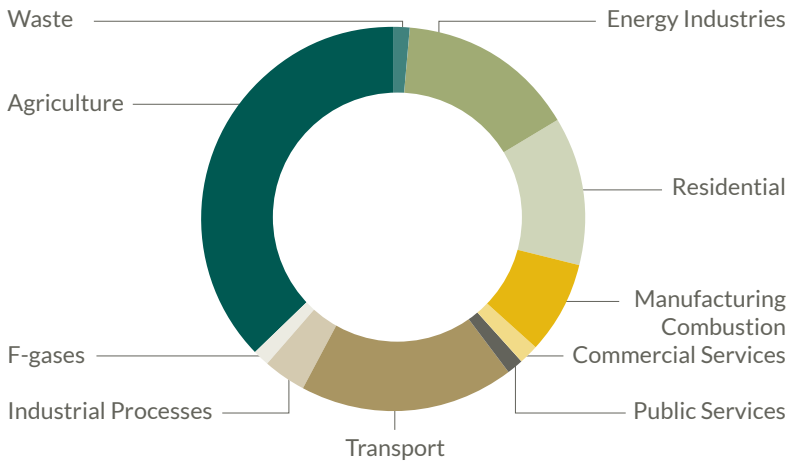
The latest CSO productivity report confirms that the labour productivity growth rate of the Foreign MNC dominated sector was on average 9.3% per year between 2000 and 2018, significantly above the European Union average of 1.3% per year. However, the labour productivity growth rate of 1.5% per year during the same period for the domestic sector was just above the EU average[5]. The same report also confirms that Ireland's strong performance can, to a significant extent, be attributed to the operations of large enterprises in specific sectors. The manufacturing sector made

5. CSO Productivity in Ireland 2019 Executive Summary - CSO - Central Statistics Office

by far the largest contribution to overall labour productivity growth over the period 2000-2018. This was followed by information and communications technology; Professional, scientific, administration and support services; and financial and insurance activities.

How COVID-19 will affect Ireland's short and medium-term productivity growth remains uncertain. The disruption caused by the virus could harm productivity growth if resources (i.e., capital and labour) are slow to reallocate towards fast growing industries. As well as this, innovation could be impaired by lower spending on research and development owing to the prolonged period of elevated uncertainty. However, there may also be a 'digital dividend' spurred by the COVID-19 crisis, via the increased adoption of new technologies. This feature of the pandemic may accelerate the digital transformation of the economy and contribute positively to productivity growth.

Figure 3.4: Greenhouse Gas Emissions Share by Sector 2020



Source: EPA

Decarbonisation Transition

Over the next decade, Ireland faces unprecedented structural economic change through the transition away from fossil fuels to a low-carbon economy. Ireland is committed to achieving net zero emissions by 2050 and recognises the long-term costs of not doing so.

Despite a decrease in greenhouse gas emissions by 4.5% in 2019, the figures indicate that Ireland will exceed its 2019 annual EU emissions allocation by 6.98Mt which makes it highly unlikely that Ireland will meet its overall 2020 targets, even taking the impact of COVID-19 on emissions in 2020 into account. Significant effort will be required across our economy especially among the largest contributing sectors, which are Agriculture (35.3%), Transport (20.3%) and Energy (15.8%).

The decarbonisation of the enterprise/industrial sector, along with the energy transition, brings both challenges and opportunities. The challenges arise from awareness raising, the initial costs of investment and the change in skills or practices required to adopt a more climate friendly business model. However, opportunities in pivoting to a decarbonised structure are also significant in terms of reduced energy costs, reduced waste, regulatory benefits, consumer goodwill and, most of all, contributing to the mitigation of the harmful impacts of global warming. For enterprise, on-site renewable electricity generation can bring additional benefits

including an income stream from exported electricity and improvements to the security of supply. The roll-out of a comprehensive enabling framework for micro and small-scale generation and the development of support schemes for this generation by the Department of the Environment, Climate and Communications will be important in this regard[6]. Enhancing national R&D activity in developing renewable energy generation would also be of significant benefit to the realisation of our decarbonisation goals.

An Accelerating Digital Economy

Technology is the key driver of the digital and knowledge-based economy which is reshaping Ireland's economic landscape. Looking at the broad picture of the digital economy, Ireland has, in recent years, been a strong and consistently improving digital performer in Europe. In 2020, the Digital Economy and Society Index[7] ranked Ireland as the leading country in the EU for the integration of digital technology, and sixth overall for digital performance across society. Ireland's progress in industrial digitalisation will be reviewed more closely in the digitalisation section.

Remote working and online shopping have considerable implications for the future landscape of our urban and rural spaces while increased automation has implications for employment, labour pools, working environments and conditions, and indeed the volume and type of future FDI flows. OECD analysis has forecast that two in every five jobs in Ireland face a significant risk of automation in the next two decades[8]. Some industries will not offer the same employment as they once did nor require different skillsets, while other activities may be replaced altogether by new industries that do not even exist today. In many cases, higher wages are likely to become increasingly skewed towards occupations with the skills necessary to work with technology, while those in other more labour-intensive occupations may see their incomes stagnate or even decline[9]. However, labour intensive occupations associated with the caring and health sectors are likely to be insulated due to the nature of this work.

3.3 National Innovation Overview

Ireland has increased its investment in research, development and innovation (RD&I) over the past decade, while also introducing a range of measures to improve commercialisation of research and build strong linkages between the higher education sector and enterprise. Ireland's overall investment in R&D has increased by 79% from €2,564 million in 2011 to an estimated €4,595 million in 2020. Public expenditure on R&D is increasing and rose to €866.8 million in 2020, representing an increase of €148 million since 2016. Government allocations for 2021 are estimated at €949.1 million, which will be the highest level of public expenditure on R&I in the history of the State. However, Ireland is ranked well below the EU average for Government Budget Allocations on R&D (GBARD) as a percentage of Government Expenditure, and the gap has widened between Ireland and the EU average in overall investment in R&D as a share of GDP (research intensity) and, in particular, the Innovation Leaders over the last decade.

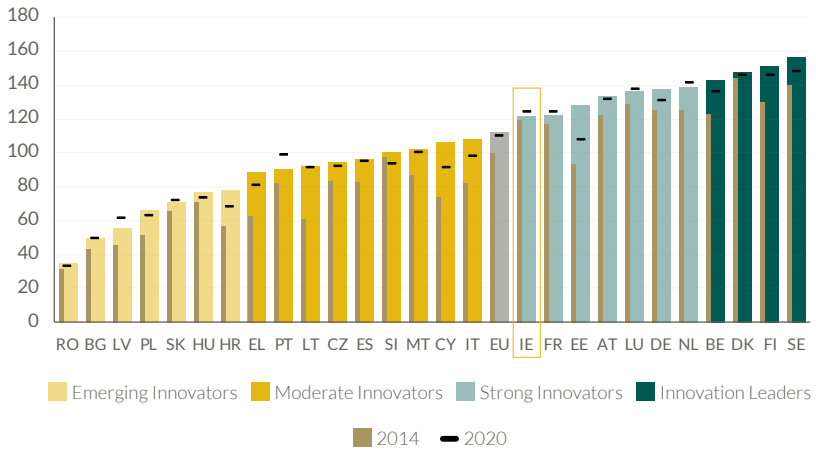
In 2019 our R&D intensity stood at an estimated 1.59% of GNP, down from 1.86% in 2011. This compares to an EU average R&D intensity rate of 2.23% of GDP. Even when using GNI* as a complementary indicator (GNI* removes globalisation impacts on the Irish economy), the R&D intensity rate was 2.03% for 2019[10].

6. Climate Action Plan 2021: Securing Our Future
7. DESI | Shaping Europe's digital future (europa.eu)
8. OECD Employment outlook 2019
9. Hays Global Skills Index - https.//www.hays-index.com/
10. The Research and Development Budget 2020-2021

Economic studies (OECD, WEF etc) and European Commission Country Specific Recommendations have all identified Ireland's comparatively low levels of direct public funding for R&D as an area of concern and a significant factor in not reaching our R&D intensity rate target. The low direct funding levels are also an inhibiting factor in Ireland's performance on economic indicators (European Innovation Scoreboard, Global Innovation Index, Global Competitiveness Index etc).

In 2021, Ireland was ranked as the 11th most innovative country on the European Innovation Scoreboard (EIS)[11], performing above the EU average and classified as a Strong Innovator. Ireland performs well in the subcategories of population with tertiary education, innovative SMEs collaborating with others, and employment in knowledge-intensive activities. However, the 2021 scoreboard notes that over time, Ireland's performance relative to the EU has decreased strongly, in particular in the last three years. This reflects the relative improvement by other Member States as they seek to improve their research and innovation systems. Ireland's performance is poor in Government funding for business R&D, Business R&D expenditures, employment in innovative enterprises, sales of innovative products, and environment-related technologies. Performance is also below the EU average in Intellectual assets.

Figure 3.5: European Innovation Scoreboard 2021

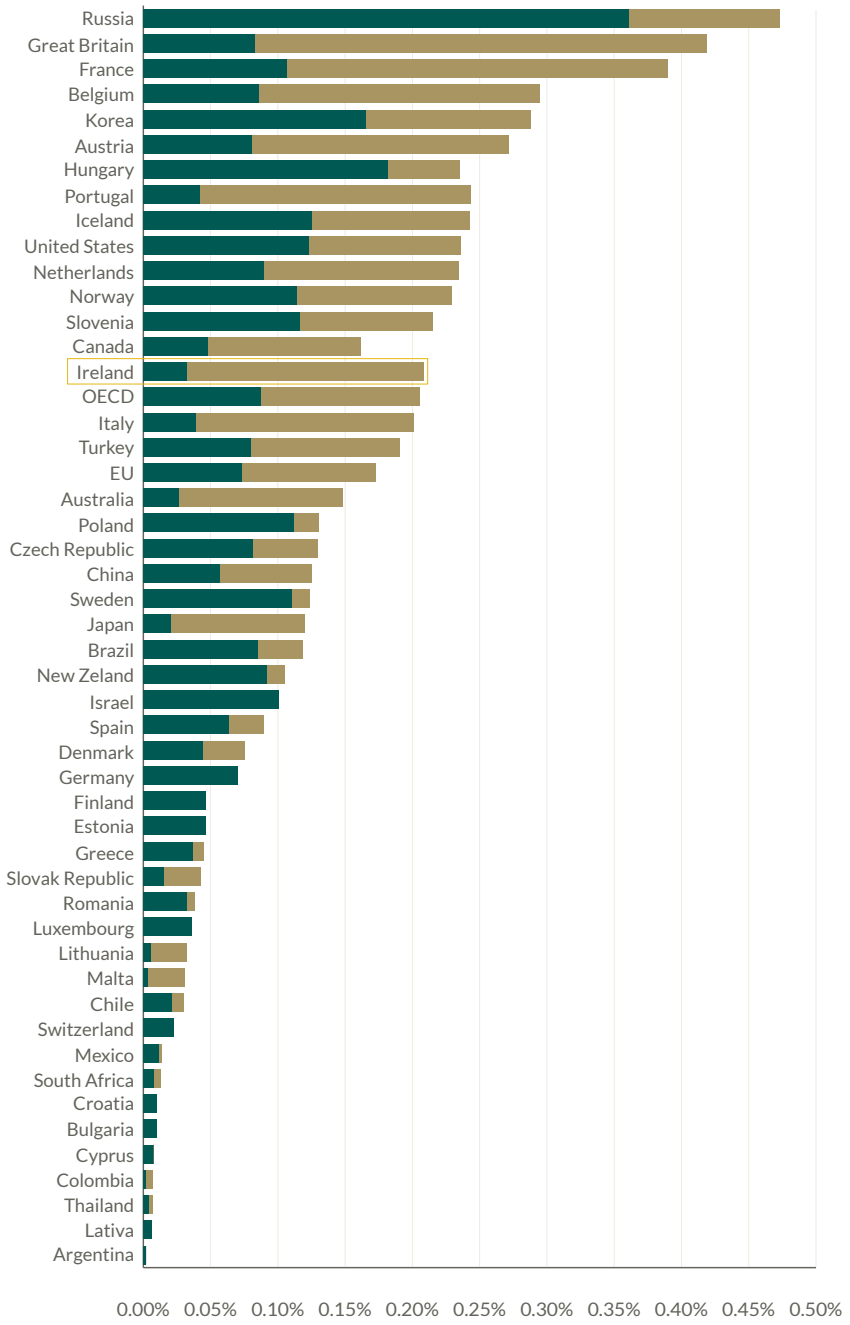


Source: European innovation scoreboard | Internal Market, Industry, Entrepreneurship and SMEs

Business expenditure on R&D (BERD) accounts for 74.46% of overall R&D in 2019, which is a good indication of smart industrial transformation. However, BERD remains below the EU average and is highly concentrated in foreign-owned firms. Indirect support (i.e. tax credits) remains the main instrument of public support for business R&D in Ireland (accounting for 80% of total public support). Figure 3.6 shows direct government funding and tax support for business R&D as a percentage of GDP in the OECD countries for 2018, with 2006 being used as a comparison year.

11. European innovation scoreboard | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu).

Figure 3.6: Direct Government Funding and Tax Support for Business R&D, 2018 as a Percentage of GDP

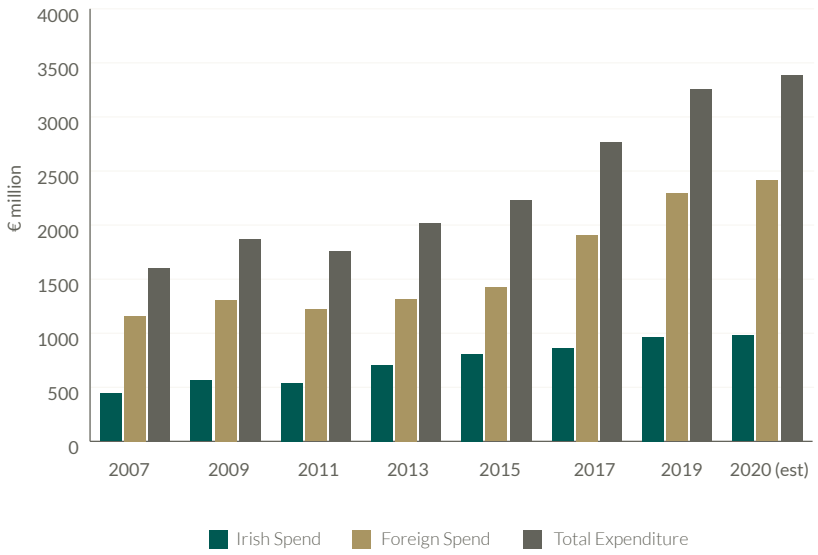


Source: OECD R&D Tax Incentive Database.

Foreign-owned firms account for the majority of R&D expenditure (70%), however, three-quarters of all R&D expenditure by Irish firms is carried out by SMEs, reflecting the dual structure of Irish enterprise base[12]. The "innovation gap" is illustrated by the BERD data below which points to a significant gap between foreign and indigenous firms in terms of R&D expenditure and activity.

12. Business Expenditure on Research and Development - CSO - Central Statistics Office

Figure 3.7: Total Irish and Foreign Business Spend on R&D

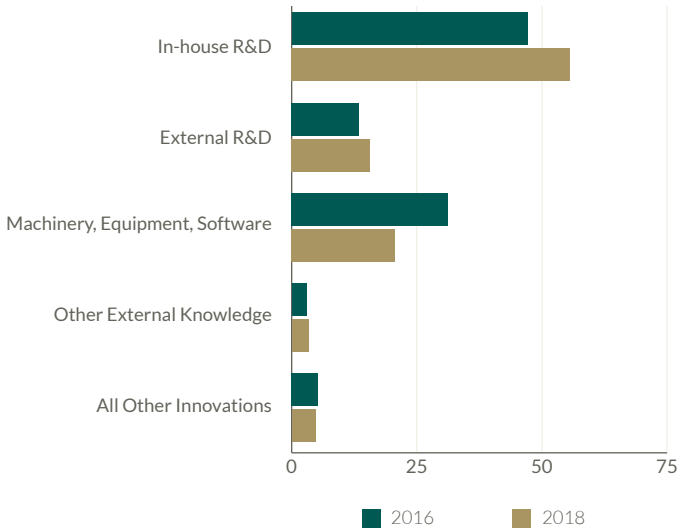


Source: CSO BERD 2019-2020

Enterprise Innovation

With respect to all enterprise innovation activities (including R&D, purchase of new tech and machinery and new systems), statistics from the CSO show that the total spend was almost €5.5 billion in 2018, an increase of 18.2% on the 2016 figure of €4.6 billion.[13] The main driver for this increase was a 39.4% rise in expenditure for in-house Research and Development (R&D) from €2.2 billion in 2016 to €3 billion in 2018. This was the highest share of spend and accounted for 55.6% of all innovative expenditure.

Figure 3.8: Percentage Share of Innovation Expenditure by Type, 2016 and 2018



Source: CSO Ireland

13. Innovation in Irish Enterprises 2018 - CSO - Central Statistics Office

Ireland's Research and Innovation Strategy

Published in May 2022, Impact 2020 is a whole-of-government strategy which will ensure that Ireland's investment in R&I makes as big a difference as possible to as many people as possible. Impact 2030 will achieve this by building a more inclusive and engaged R&I system that is recognised as integral to addressing major societal issues ranging from climate change to health and wellbeing.

To realise this vision, the strategy will foster greater engagement among a wide range of stakeholders including research organisations, the third-level education system, enterprise, public policymakers, civic society organisations and European partners. Grounded in extensive consultation and analysis, it will progress objectives that are shared across the Irish research and innovation system. These include, for example, ensuring that research expertise is more accessible to policymakers and the public, and nurturing and attracting top talent. Impact 2030 is composed of the following five pillars:

1. Impact of Research and Innovation on our Economy, Society and the Environment,
2. Impact of Research and Innovation Structures on Excellence and Outcomes,
3. Impact of Innovation on Enterprise Success,
4. Impact of Talent at the Centre of the Research and Innovation Ecosystem,
5. Impact of Research and Innovation on Ireland's all-island, EU and global connectivity.

Successive action-led Work Programmes will map out specific deliverables over shorter timescales. This will enable agility and responsiveness over the full period of the strategy and a strong focus on delivery and reform. DFHERIS will work with DETE and other key stakeholders to ensure that the priorities identified in the Smart Specialisation Strategy are reflected in the context of implementation of Impact 2030 and that there is co-ordination, collaboration and efficiency between the two strategies.

Even though foreign owned enterprises accounted for only 17.1% of all relevant enterprises, they accounted for €3.45 billion or 63.3% of all innovation-related expenditure, including €1.9 billion on in-house R&D.

Irish-owned enterprises, which accounted for 82.9% of all relevant enterprises, spent €2 billion on innovation related activities in 2018 or 36.7% of the total, of which €1.1 billion was spent on in-house R&D.

The distribution of innovation expenditure between Irish and foreign-owned enterprises has stayed broadly consistent over the period 2010-2018.

3.4 Current National RD&I Policy Priorities and S3

Through successive innovation and enterprise strategies and policies, Ireland has successfully built research capacity in targeted areas of economic importance, a reputation for research excellence, a maturing national knowledge transfer system with European recognition, an increasing base of enterprises engaging in innovation activity, and a cohort of spinout companies from the research system that have won significant commercial success. While we still have a way to go to deliver our high-level innovation goals, such as the 2.5% research intensity target, it should be borne in mind that Ireland's RD&I performance over the last 15 years has been remarkable considering it started from a very low base. Strategic national investments in RD&I have contributed significantly to:

- employment, export and investment growth;
- the competitiveness of indigenous enterprise;
- embedding the foreign direct investment base in Ireland;
- the creation and application of new knowledge.

Reinforcing, refining, and scaling that success both nationally and at a regional level will be the policy challenge in coming years.

At a broad, high level, current priorities for national enterprise-focused RD&I investment are:

- enhancing the R&D capacity of SMEs;
- driving industry-academic collaboration and clustering to support an internationally competitive enterprise base;
- encouraging new technology adoption in Irish businesses;
- funding state-of-the-art research infrastructure including for the benefit of enterprise;
- international connectedness in the area of enterprise research and innovation;
- supporting excellence in strategically important research areas.

Mechanisms for the delivery of these priorities include the Disruptive Technologies Innovation Fund, the SFI Research Centres Programme, Enterprise Ireland/IDA Ireland Technology Centres and EI Gateways, Knowledge Transfer Ireland and various RD&I funding and programme supports from Enterprise Ireland, IDA Ireland and Science Foundation Ireland.

These priorities and supporting actions are set out in various policy documents, a summary of which follows. It should be noted that Ireland's RD&I priorities are typically set at a national level given Ireland's relatively small size and population density. This strategy marks something of a departure in RD&I policymaking, as the focus is on regional capacity and how it can best be developed within a national context.

Impact 2030: Ireland's Research and Innovation Strategy

The Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) leads on national RD&I policy and its associated strategies, such as Impact 2030: Ireland's Research and innovation Strategy. This new Strategy was published in May 2022 and three successive work programmes will guide its implementation. The first of these was published with the Strategy and covers the period 2022-2024. The new Strategy highlights the role of S3 in making the connections between national innovation policy and regional enterprise development (see text box overleaf for more information about Impact 2030).

Research Priority Areas 2018 to 2023

Since its inception in 2012, Research Prioritisation has concentrated the majority of competitive research funding on areas deemed likely to yield greatest economic and societal impact. As a small country, Ireland cannot be a leader in all areas of enterprise research and innovation, so it is necessary to target investment at areas of commercial opportunity that are strategically important.

The current Research Prioritisation areas were identified in 2017 further to a horizon scanning report, a technology futures report and a series of consultation events. These areas, valid until 2023, comprise:

- ICT including Future Networks, Communications, Internet of Things, Data Analytics, Artificial Intelligence, Digital Platforms, Content and Applications, and Augmented Reality and Virtual Reality;
- Health and Wellbeing, including Medical Devices, Connected Health and Independent Living, Therapeutics and Diagnostics;
- Energy, Climate Action and Sustainability including Decarbonising the Energy System and Sustainable living;
- Food including Food for Health and Smart and Sustainable Food Production and Processing;
- Manufacturing and Materials, including Advanced and Smart Manufacturing, Manufacturing and Novel Materials;
- Innovation in Services and Business Processes.

National Development Plan (NDP)

The reviewed NDP 2021-2030 commits to an investment of approximately €165 billion to address the impacts of COVID-19 and Brexit, the housing and health challenges and will tackle climate change in a more meaningful way.

Enterprise innovation is supported by National Strategic Objective 5: A Strong Economy Supported by Enterprise, Innovation and Skills. This will be achieved by

- supporting entrepreneurialism and building competitive clusters;
- sustaining talent and boosting human capital in all regions;
- the Digital and Green Transition Funds.

Creating Our Future – a National Conversation on Research in Ireland

Creating our Future, launched in July 2021, was a government-led national brainstorm that brought the people of Ireland into a conversation on the role all areas of research can and should play in addressing opportunities, challenges and hopes for the future. Creating Our Future was initiated so that the direction of research in our country is informed by the people of Ireland. The primary motivation behind Creating our Future was to gather the public's ideas and to generate a snapshot of what is important to the people of Ireland. The campaign was designed to facilitate the collection of ideas but importantly, it was done so with an emphasis on dialogue – of bringing researchers and the public closer together to share perspectives. An advisory forum was established so that the campaign was informed from the outset by a diversity of views and ideas, with inclusion from all sectors, demographics and regions. Community, business and researcher activation events were hosted in September and October, these events were designed to provide stakeholder organisations, across Ireland, with information for Creating Our Future and to equip them to mobilise their communities to engage with the campaign.

A regional roadshow travelled to every county in Ireland and provided ample opportunity for people to interact with the campaign and submit ideas. Over 18,000 ideas were submitted by the public by the time the submission gathering phase closed on November 30th. An independent Expert Committee was established to analyse the submissions and to produce a report that accurately reflects what people were saying in their submissions. The findings will be submitted to Government along with recommendations that support, activate and inspire future research in Ireland.

The campaign was led by the Department for Further and Higher Education, Research, Innovation and Science. Science Foundation Ireland was tasked with operationalising the initiative.

Economic Recovery Plan

The 2021 Economic Recovery Plan included a strong focus on investment and policies for a new stage of economic recovery and renewal and supporting the transition towards a decarbonised and digital economy, with an overarching ambition of 2.5 million people in work by 2024, with more productive, innovative, and resilient jobs, including in new areas of opportunity. Supporting investment includes €915 million under Ireland's National Recovery and Resilience Plan under the European Recovery and Resilience Facility. A progress report was published in June 2022, highlighting a number of significant milestones under the plan, including delivery of Pathways to Work 2021-2025, the Climate Action Plan 2021, a new national digital strategy - Harnessing Ireland: The Digital Ireland Framework, the new national AI strategy and Impact 2030: Ireland's Research and Innovation Strategy.

National Enterprise Policy - Enterprise 2025 Renewed

Enterprise 2025 Renewed is Ireland's current national enterprise policy, developed and overseen by the Department of Enterprise, Trade and Employment. The policy aims to deliver sustainable and skills-based jobs which can support productivity-led wage increases. The strategy echoes the aim of national innovation policy to make Ireland a Global Innovation Leader through various measures including collaboration and clustering, as well as placing a spotlight on innovation and talent and leverage our strengths in disruptive technologies. A new enterprise policy review and white paper has commenced preparation by the Department of Enterprise, Trade and Employment.

SME and Entrepreneurship Growth Plan

The SME and Entrepreneurship Growth Plan, which was published in January 2021, was developed by a taskforce of entrepreneurs and business leaders and was based on the recommendations of the OECD Report on SME and Entrepreneurship Policy in Ireland 2019, a comprehensive and deeply researched study examining the means to strengthen SME and entrepreneurship policy. The SME and Entrepreneurship Growth Plan sets out a broad range of recommendations to enhance SME growth, each supported by specific actions. These actions include measures to accelerate the digital transformation of the SME sector; to bolster the clustering and network infrastructure in place for SMEs and entrepreneurs nationwide; to enhance innovation capacity through the use of internationally recognised standards and optimisation of R&D tax incentives; to ensure adequate access to financing; and to increase SME productivity through improved management skills.

AI: Here for Good - National AI Strategy

AI – Here for Good, the National Artificial Intelligence Strategy, was launched in July 2021 and sets out a vision of Ireland as an international leader in using AI to the benefit of our population, through a people-centred, ethical approach to AI development, adoption and use.

Industry 4.0 Strategy 2020-2025

The vision underpinning Ireland's Industry 4.0 Strategy, launched in December 2019, is that by 2025 Ireland will be a competitive, innovation-driven manufacturing hub. Industry 4.0 capability will be a critical driver of that competitiveness, underpinning productivity growth and innovation in new goods and services across the value chain. Developing and delivering initiatives to increase RD&I in manufacturing and drive new technology adoption is a priority under this strategy.

Our Rural Future Rural Development Policy 2021-2025

Our Rural Future: Rural Development Policy 2021-2025, launched in March 2021, represents the Government's strategy for the development of rural Ireland over the next five years, as well as the post-COVID-19 recovery. Rural development is integrally linked to policies across a wide range of areas, including the S3 relevant aspects of innovation, enterprise growth, sectoral growth, job creation, digitalisation, reducing regional disparities and the transition to a climate neutral society.

Regional Enterprise Plans (REPs)

The nine REPs – at NUTS 3 level - are an integral part of Ireland's enterprise policy, aimed at driving economic growth and sustaining better standards of living. The plans are a 'bottom-up' initiative to complement national level policies and programmes such as Ireland's national enterprise policy. As part of the development of the Plans, and as a key input to the development of Ireland's S3, Smart Specialisation was incorporated as a thematic area during consultation stage for the new cycle of REPs, which were launched in early 2022.

Regional Spatial and Economic Strategies (RSESs)

The three Regional Assemblies (one for each NUTS 2 region) are responsible for co-ordinating, promoting and supporting the strategic planning and sustainable development of their regions through their respective Regional Spatial and Economic Strategies, RSES. These strategies are aligned with the statutorily based Project Ireland 2040 and identify opportunities for increased co-ordination of investments within and across regions to unlock potential (including through RD&I initiatives).

Climate Action Plan

The Climate Action Plan 2021 provides a detailed plan for taking decisive action to achieve a 51% reduction in overall greenhouse gas emissions by 2030 and setting us on a path to reach net-zero emissions by no later than 2050. The Plan outlines steps to reduce emissions from all sectors as part of its commitment to achieving net zero and includes enterprise related solutions such as aligning grant funding and supports with progress towards achieving our emissions reductions targets for enterprise; administering, the Climate Enterprise Action Fund to help companies reduce emissions and embed sustainability in how they work; promote the potential of innovation and applied research in Artificial Intelligence, Machine Learning and Data Analytics to solve complex challenges related to sustainability and the low-carbon transition; and perform research and encourage Irish researchers to contribute to the EU Green Deal.

EXPLORE Regional Skills Programme

EXPLORE is a Regional Skills initiative developed to help address the issue of Ireland's low level of participation in lifelong learning, particularly targeting persons over 35 years of age in employment.

Objectives are:

- Address the lack of digital skills in this cohort
- Provide a novel approach to overcome barriers to participation in lifelong learning
- Address the key issue of skills obsolescence which is a significant concern for employers
- Showcase the benefits of collaboration between local Education and Training Providers and Industry.

The programme is an innovative, fully funded, flexible initiative offering opportunity to boost employee's digital skills, adaptability and productivity.

The programme was piloted and proved highly successful in 2018 and will continue to run in all Nine Regional Areas in 2022.

Harnessing Digital – The Digital Ireland Framework

Ireland's new national digital strategy was launched in February 2022. It will drive and enable the digital transition across the Irish economy and society. This high-level framework sets out a pathway to position Ireland as a digital leader at the heart of European and global digital developments; and places a strong emphasis on inclusiveness, security and safety, underpinned by strong governance and a well-resourced regulatory framework.

Food Vision 2030

The Food Vision 2030 Strategy for the Irish agrifood sector sets out an ambition for Ireland to become a world leader in Sustainable Food Systems over the next decade. By adopting an integrated food systems approach, Ireland will seek to become a global leader of innovation for sustainable food and agriculture systems, producing safe, nutritious, and high-value, high-quality food, while protecting and enhancing our natural and cultural resources and contributing to vibrant rural and coastal communities and the national economy. An Innovative, Competitive and Resilient AgriFood Sector, Driven by Technology and Talent is one of the four underpinning Missions in this strategy, with goals that include moving to a challenge-focused innovation system, having a strategic approach to funding R&D, developing dynamic knowledge exchange practices, enhancing the use of technology and data, improving competitiveness and resilience, and attracting and nurturing diverse and inclusive talent.

Other Strategies

In addition to the above strategies, the enterprise and RD&I agencies such as Enterprise Ireland, IDA Ireland, Science Foundation Ireland, the Irish Research Council, Higher Education Authority and Health Research Board each have their own strategic plans with RD&I targets and actions within.

There are also ongoing reports and consultations being prepared for the selection of priorities for the use of EU Cohesion Funding in Ireland for the period 2021-2027, which will be reflected in this strategy.

It is intended that this new S3 will bring together the diverse recommendations of the various above-named strategies into one coherent document that can bring new focus to the various policy priorities for RD&I. S3 will also act as a bridge between national level enterprise RD&I priorities and regional priorities, ensuring policy coherence and connection between both.

Ireland is also committed to making progress towards the UN's Sustainable Development Goals (SDGs). Achieving our aims under S3 to drive sustainable, innovation-led growth in the regions will contribute towards our national goals under SDG 8 (promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all) and SDG 9 (build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation).

3.5 Skills Policy and S3

While the skills policy space is not the focus of this strategy, it is worth pointing out the importance and key role of skills development for enterprise, research, development and innovation in Ireland. It is not intended that S3 will be making specific recommendations in respect of skills policy. Ireland already has a sophisticated national skills architecture with several bodies and a dedicated Department ensuring that national skills policy fits the needs of enterprise. However, an overview of the national skills landscape is important to provide here as a context piece.

Overview of Skills Development in Ireland

Ireland's skills development policy is framed by Ireland's National Skills Strategy 2025, which was published in 2016 and will shortly be the subject of a review undertaken by the OECD. This ushered in significant reforms in the education and training sector, resulting in the establishment of a responsive National Skills Architecture overseen by the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS).

This architecture draws on a number of sources of skills needs and labour market intelligence, which in turn inform education and training provision:

- The labour market intelligence of the Skills and Labour Market Research Unit of SOLAS publishes the annual National Skills Bulletin, which details skills shortages at occupational level across the main economic sectors. There are also annual bulletins on lifelong learning trends, as well as difficulties arising in filling vacancies;
- The enterprise skills demand forecast studies of the Expert Group on Future Skills Needs, whose role is to advise the Government on the current and future skills needs of the Irish economy. The membership of the Group includes key Government Departments and agencies, as well as representation from trade unions and business communities;
- The activities of the network of nine Regional Skills Fora and Regional Skills Managers, which work to address the skills needs of regional enterprise by enhancing linkages and engagement between local education and training providers and employers, and by helping employers better understand and access the full range of services available across the education and training system;
- This skill needs and labour market intelligence informs the work of the National Skills Council which is composed of the chief skills development policy stakeholders from across the public and private sectors and advises on the prioritisation of identified and emerging skills needs and the allocation of resources to address these needs.

The alignment of provision with the immediate and emerging skills needs of enterprise is calibrated through the education and training programmes supported through the National Training Fund (NTF), which is financed through a 1% levy on employer social insurance contributions. Programmes under the fund, many of which are linked to competitive funding calls, are based on collaboration between enterprise and the education sector on the development of courses aligned with enterprise needs. The enterprise sector also has a voice in the direction and allocation of resources within the Fund, through the National Training Fund Advisory Group. The chief collaborative or industry-led programmes supported through the NTF are:

- Skillnet Ireland, Ireland's enterprise led, in-employment training agency which provides funding to almost 70 training networks i.e., groups of private sector companies with shared training needs to help provide high quality training at subsidised rates;

- The Higher Education Authority's Springboard+ initiative, which is subject to an annual funding call, complements the core State funded education and training system and provides free (if on the Live Register) or 90% funded (if in employment) upskilling and reskilling higher education opportunities at levels 6 to 9 on the National Framework of Qualifications, in areas of identified skills needs;
- The Fund supports the expansion of the apprenticeship system by industry led consortia, working in collaboration with education providers, beyond traditional craft areas across all sectors of the economy. These include ICT, Hospitality, International Financial Services, Retail, as well as Biopharma and MedTech;
- The Fund is also supporting several programmes directed towards future proofing Ireland's workforce, especially those with lower skills levels, in the face of technological change, through SOLAS Skills to Advance, targeted at upskilling workers within SMEs, the Skills to Compete labour activation initiative, and the EXPLORE Skills Programme.

From 2020, the Fund is also supporting an additional annual €60 million investment for five years as part of a total €300 million fund in the Higher Education system through the Human Capital Initiative. This investment involves the drawing down of the substantial surplus that has been generated within the NTF to incentivise and further strengthen education and training sector relations with enterprise, and meet future skills needs, mitigate Brexit risks, respond to digitalisation and the future of work, and support upskilling and reskilling.

Digital Skills

Digitalisation is key aspect of this S3, with digital skills being an integral aspect of digital transformation. Outside of the digital native cohort, Ireland's deficiency in digital skills rests with the adult working age population, in particular those with lower skills levels, who as analysis has borne out have a lesser propensity to participate in lifelong learning. This has accounted for the development of key digital upskilling interventions, including: the EXPLORE skills programme for older workers delivered through the Regional Skills Fora; SOLAS Skills to Advance programme for SMEs, and its labour activation strand, Skills to Compete, and the 10 Year Adult Literacy, Numeracy and Digital Literacy strategy, Literacy for Life, which aims to reduce the share of adults in Ireland without basic digital skills from 47% to 20%.

Underpinning the process of cross-sectoral digital transformation are the advanced or higher-level ICT skills required to design, build, implement and maintain the integrity of high-level ICT systems driving this transformation. These skills are in areas including AI, Data Analytics, the Internet of Things, Cloud Computing, Blockchain and Cybersecurity. As identified in the Expert Group on Future Skills Needs 2019 report, Forecasting the Future Demand for High Level ICT Skills in Ireland, 2017-2022, the output of high-level ICT skills from the education and training system is failing to keep pace with demand across the economy. This EGFSN analysis, which forecast an 8.5% annual growth in demand for High Level ICT skills to 2022 (from a 2017 baseline of 85,000 to 139,000), informed the development of Technology Skills 2022, Ireland's Third ICT Skills Action Plan, which is aiming to increase high level ICT output from Ireland's education and training system. The Action Plan is pursuing this objective through a number of skills interventions: the incentivisation of additional places in Further Education and Higher Education in ICT/Technology programmes; the provision of reskilling pathways into ICT/Technology roles; an expansion in ICT apprenticeships; the delivery of targeted ICT technical and management programmes to industry; and the promotion of Ireland as a destination for high level ICT skills and ICT education and training.

Smart Specialisation and Skills Development

As mentioned at the outset, S3 does not intend to be a skills strategy as there are several competent authorities and strategies in place already. However, as this strategy will identify regional sectoral expertise and opportunities it may be a useful document for the Regional Skills Fora and Regional Skills Managers to consider in the context of developing their skills and training options. In addition, as part of our consultation process, several stakeholders raised the importance of skills development and certain sectoral skills shortages. Accordingly, where relevant, this strategy will make reference to these skills related findings.

4 National Strategic Priorities under Smart Specialisation

4.1 Identifying the National Strategic Priorities for S3

The European Commission, in drafting the Common Provision Regulations (CPR) for the management of cohesion funds in 2021- 2027, has clearly set out fulfilment criteria for national smart specialisation strategies. As per Article 15 (1) of the CPR, Annex IV contains the thematic enabling conditions and the criteria necessary for the assessment of their fulfilment as set out below:

Table 4.1

Name of Enabling Condition	Fulfilment criteria for the enabling condition
1.1. Good governance of national or regional smart specialisation strategy	**Smart specialisation strategy or strategies shall be supported by:** 1. Up-to-date analysis of challenges for innovation diffusion and digitalisation. 2. Existence of competent regional or national institution or body, responsible for the management of the smart specialisation strategy. 3. Monitoring and evaluation tools to measure performance towards the objectives of the strategy. 4. Functioning of stakeholder co-operation ("entrepreneurial discovery process"). 5. Actions necessary to improve national or regional research and innovation systems, where relevant. 6. Where relevant, actions to support industrial transition. 7. Measures for enhancing co-operation with partners outside a given Member State in priority areas supported by the smart specialisation strategy

Ireland must ensure the fulfilment of this enabling condition to secure funds under ERDF.

In line with the fulfilment criteria as set by the European Commission, the following have been identified as the national strategic priorities for S3 (the industrial transition aspect of the S3 requirements being split into digital transformation and green transformation):

1. Digitalisation and digital transformation (addressing fulfilment criteria 1 and 6);
2. Green transformation for enterprise (addressing fulfilment criterion 6);
3. Innovation diffusion (addressing fulfilment criterion 1);
4. International collaboration on RD&I (addressing fulfilment criterion 7);
5. Improving the national enterprise research and innovation system (addressing fulfilment criterion 5).

Digitisation, digitalisation and digital transformation are three terms often used interchangeably but mean different things.

- **Digitisation** is the process of converting information from a physical format into a digital one.
- When this process is leveraged to improve business processes, it is called **digitalisation**.
- The results of this process are called **digital transformation**.

4.2 Digitalisation and Digital Transformation

What do we mean by Digitalisation and Digital Transformation?

Digitalisation refers to the use of digital technologies, data and applications to deliver scale, productivity and innovation advancements in both established and emerging sectors. Using these digital technologies to create new or modify existing business processes, culture and customer experiences, as well as create new products, is referred to as digital transformation. The adoption of digital technologies is also a key element of innovation diffusion. The family of technologies underpinning digitalisation includes:

- artificial intelligence;
- high performance computing;
- digital fabrication;
- robotics;
- big data and analytics;

Digital technologies are disrupting market dynamics at increasing speeds and will create unprecedented opportunities for business as well as for economic growth in Ireland. The need for SMEs to adopt digital technologies (such as automation and secure remote working) was highlighted by the recent COVID-19 crisis.

The Digital Economy in Ireland

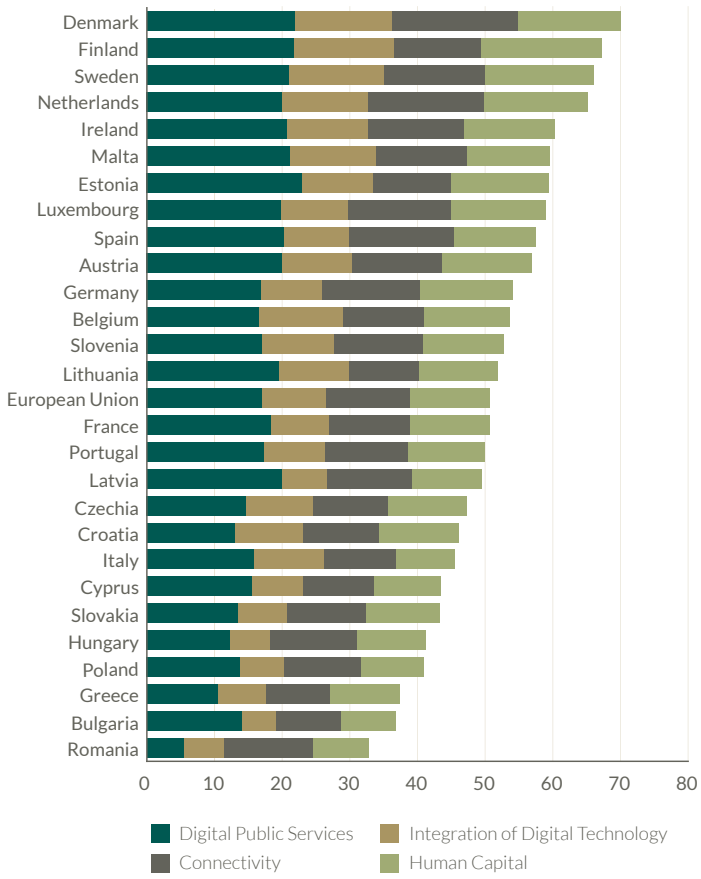
Looking at the broad picture of the digital economy, Ireland has, in recent years, been a strong and consistently improving digital performer in Europe. Ireland ranks 5th out of 27 EU Member States in the Digital Economy and Society Index (DESI) 2021.

The key indicator in the DESI that relates to digital transformation is the 'Integration of digital technology'. Over the past four years Ireland has consistently performed very well on this indicator and maintains its high scores in the use of e-commerce by SMEs . For example, indicators for SMEs selling online and across borders are well above the EU averages. Ireland's performance for connectivity improved substantially in 2020. For example, fixed very high-capacity network (VHCN) coverage rocketed from 35% to 83%. Ireland also scores well for digital public services, particularly in open data and providing digital public services for citizens and businesses. With regard to the latter, Ireland scores a perfect 100. Although Ireland performs above the EU average in advanced digital skills (for example, for the indicators on ICT specialists, female ICT specialists and ICT graduates), the basic digital skills of the population are a little lower (53% against the EU average of 56%).

In 2020, a European Commission enterprise survey indicated that 35% of Irish enterprises had adopted at least one AI technology, which is lower than the EU average of 42%[14]. To create long-term resilience, we will likely see further robotic automation and AI within our supply chains to enable production to scale and shrink in response to sudden demand. Helping enterprises understand the benefits of advanced technologies for their businesses and developing initiatives to encourage the adoption of such technologies will be a key challenge for policymakers and the enterprise agencies in the near term.

14. European enterprise survey on the use of technologies based on artificial intelligence - Publications Office of the EU (europa.eu)

Figure 4.1: Digital Economy and Society Index (DESI) 2021 Ranking



Source: Digital Economy and Society Index (DESI)

Impacts of Digitalisation

Digitalisation is affecting all sectors and all regions. Since the start of the COVID-19 pandemic, digitalisation has a become a necessity. Any companies that could do so, switched to a remote working environment. Partly as a result of greater reliance on these virtual working arrangements, and as the risk and possible impact of operational incidents has increased, we have seen a spike in cyber threats, like ransomware attacks and phishing. This was most evident by the cyber attack on the HSE in May 2021. In addition, the digital transformation drive of all major economic sectors creates further demand on new digital technologies. This is illustrated by the recent global shortage of semiconductors, which is having an impact on every sector that manufactures products containing chips – from cars to toothbrushes. This scarcity will inevitably lead to increases in consumer prices, at least in the medium term.

In Ireland it is projected that there will be growth in high-tech and manufacturing employment over the next five years, but only under the assumption that enterprises in Ireland remain internationally competitive [15]. Digital capability will be a critical driver of that competitiveness, underpinning productivity growth and innovation in new goods and services across the value chain. However, evidence suggests companies often have difficulty in deciding when to invest in digital technologies, up to what level, and in which innovative field. Not enough companies know how to translate the use of technologies into economic impact, and how to build a new incremental business.

15. Ireland's Industry 4.0 Strategy 2020-2025.

It should be noted that companies in the manufacturing sector are particularly exposed to the impacts of digitalisation. The global manufacturing landscape is becoming more competitive. Large developing economies are achieving increasingly sophisticated manufacturing capabilities and becoming more successful in winning large-scale manufacturing campaigns. Ireland's manufacturing sector employs almost 232,000 people[16] and accounts for over 34% of national GDP, well above the European average of 15%[17]. As a small economy, with a limited domestic market, a high export orientation is one of the characteristics of the manufacturing sector. Exported goods from Ireland in 2020 were recorded at €160 billion, a 5% increase on the previous year despite the pandemic[18]. The first half of 2021 showed a continuation of this trend, with exports increasing by €2.9 billion in June 2021 compared with June 2020[19]. This is a good indication of the current robustness of the manufacturing-led export sector, but with increasing global competition, potential international tax reforms and ongoing technological acceleration, complacency is not an option for Ireland.

There are indications that the pandemic has hastened the update of new digital solutions such as secure remote communications, large-scale tele-working, developing new business models such as moving from B2B to direct-to-consumer, automating end-to-end operational processes, etc. A number of recent private business surveys have indicated that COVID-19 is accelerating digitalisation of operations, with one study showing that 81% of Irish CEOs have seen the digital transformation of their business accelerate in 2020[19].

Challenges to Digitalisation

As indicated in the previous sections, Ireland has made good progress towards digitalising the economy and adopting new technologies. However, the speed of change leaves no time for pause. Ireland has evident system weakness in new technology adoption by SMEs, basic digital skills, rural broadband infrastructure and more broadly in the challenge to remain competitive in the face of a rapidly digitalising global economy. The 2019 and 2020 EC Country Specific Recommendations (CSRs) pointed to the need for Ireland to support employment through the developing of skills and to address the digital divide particularly in education and SMEs.

Digitalisation requires investment by enterprises to innovate and by people to learn new skills. This means encouraging greater investment by enterprises in research, development, innovation and digital skills. It also requires new business strategies to guide the digital transition as well as forming specialised teams to exploit opportunities that will arise.

Current Digitalisation Policy and Programmes in Ireland

National Broadband Plan

A digitally connected Ireland will enhance our competitiveness, enabling more quality jobs in both urban and rural communities, and providing an improved quality of life for citizens and communities across the country. The Government objective of having every home, school and business in Ireland, regardless of how remote or rural, with access to high-speed broadband is being achieved through a combination of Exchequer investment of €2.7 billion in the National Broadband Plan (NBP) and commercial investment across Ireland.

16. Labour Force Survey (LFS) Employment Series - CSO - Central Statistics Office
17. Goods Exports and Imports December 2020 - CSO - Central Statistics Office
18. Goods Exports and Imports June 2021 - CSO - Central Statistics Office
19. Digital Acceleration - KPMG Ireland (home. kpmg) (2020)

The availability of high-speed broadband services in rural communities can have a transformative effect on these parts of the country. The NBP will play a major role in promoting balanced regional development as part of a sustainable and equitable post-pandemic recovery. Rural communities will have access to greater digital connectivity, which will support enterprise development and jobs creation. Citizens and businesses in remote areas will enjoy the same opportunities to benefit from a connected and digital economy as those in urban areas. This will enable rural communities to avail of the opportunities presented by the digital economy including healthcare, education, farming, rural development and tourism.

Harnessing Digital – The Digital Ireland Framework
This was launched in February 2022. This positions Ireland as a digital leader, through supporting transformation of enterprise, connectivity and cyber security, digital skills, inclusive and effective digital Government services, and ensuring a modern and well-resourced regulatory framework.

Digitalisation for Enterprise
The Department of Enterprise, Trade and Employment and its agencies design and deliver programmes to drive the digitalisation of enterprises in Ireland. This work is bolstered by research and skills initiatives under the Department of Further and Higher Education, Research, Innovation and Skills and digital adoption and broadband programmes under the Department of the Environment, Climate and Communications.

Ireland's policy and programme interventions for digitalisation include:

- Harnessing Digital – The Digital Ireland Framework was launched in February 2022. This sets out a pathway for Ireland to be a digital leader, through supporting connectivity, digital skills, inclusive digital services, grants, investing in cybersecurity and ensuring a modern and well-resourced regulatory framework for skills;
- The Irish Industry 4.0 strategy was launched in December 2019 with the aim for Ireland to become a competitive, innovation-driven manufacturing hub at the frontier of the fourth industrial revolution and at the forefront of Industry 4.0 development and adoption by 2025;
- AI – Here for Good, the National Artificial Intelligence Strategy, was launched in July 2021 and sets out a vision of Ireland as an international leader in using AI to the benefit of our population, through a people-centred, ethical approach to AI development, adoption and use;
- Cyber security in Ireland is implemented under the National Cyber Security Strategy 2019-2024, which covers cyber security research and investment in operation and infrastructure and references the Cyber Security Skills Initiative;
- In recognition of the importance of digital transformation to our recovery, Ireland's Recovery and Resilience Plan includes an €85 million competitive digital transition fund which will incentivise businesses to progress along a digital transition ladder, from going online to digitalisation of products and business processes, to facilitate exporting and to using technologies to develop new markets and business models. The digital transition will be supported by the establishment of four Digital Innovation Hubs under the European Digital Innovation Hub initiative, subject to European Commission designation, with one of these Hubs to be designated as the National AI Innovation Hub;
- Enterprise Ireland currently offers a number of supports for digital transformation including a learning platform (eiLearn), funding for consultancy and feasibility studies (LeanPlus/Exploring Innovation), capital investment funding, R&D grants and training costs for staff (LeanTransform);
- The Disruptive Technologies Innovation Fund is a €500 million fund available to support innovative and transformative technology investments. The fund is a key policy initiative to achieve digital transformation in various sectors of economic

importance. Only projects that involve collaboration between businesses, SMEs and researchers are eligible for funding;
- The Enterprise Ireland/IDA Ireland Technology Centres and the EI Technology Gateways are key drivers of enterprise digitalisation in Ireland. Technology Centres such as CeADAR (Ireland's national centre for applied data analytics and AI) and Irish Manufacturing Research (Ireland's Advanced Manufacturing and Digitalisation centre) and Gateways such as Nimbus (applied IoT), WiSAR (wireless, embedded systems and related software) and TSSG/Walton (ICT, AI, IoT) have specific expertise in digitalisation technologies. In addition, the SFI Research Centres provide infrastructure to support researchers to commercialise their research, including in digitalisation (for example, AI, cloud computing, virtual/augmented reality, Internet of Things, and cyber security);
- Tyndall National Institute is Ireland's largest research centre. With a focus on ICT and underpinning technologies such as Micro & Nano Systems, Photonics and Deep-Tech, it is an important facility for addressing digitalisation changes for industry, and provides design capacity, prototyping pilot lines and test facilities to help create new value chains;
- Ireland's EuroHPC Competence Centre was launched in 2020. Hosted by ICHEC, this initiative includes two programmes: (i) an SME Accelerator offering advanced training in HPC and new technologies for eligible Irish SMEs; and (ii) an Academic Flagship, which aims to increase Irish competitiveness in the European supercomputing landscape;
- In 2020, Ireland acquired a Quantum Learning Platform, which will be used to conduct R&D and national-level skills development activities in quantum technologies;
- The nine Regional Skills Fora help employers connect with the range of services and courses available across the education and training system, including upskilling for workers in digital technologies. Over 70 Skillnet Networks work with businesses in specific sectors, developing bespoke, State subsidised solutions to meet existing and emerging skills needs.

S3 Consultation Findings for Digital Transformation

Stakeholders were asked in the public consultation paper to consider:

- How digitalisation is impacting their sectors or regions;
- Could they benefit from new digital technologies;
- What supports are needed to adopt them; and,
- How the alignment of ICT and digitalisation expertise, initiatives and investments can be improved?

Impact on Sectors and Regions

There was universal agreement in the submissions received that digitalisation is affecting all sectors and regions, with the COVID-19 pandemic accelerating digital transformation. Some submissions pointed to how the impact of digitalisation can be seen through vibrant and growing sectors, such as FinTech and InsurTech. However, there was overall agreement that much remains to be achieved to harness the potential of digital technologies in the manufacturing and SME sectors, with many organisations lacking the digital skills necessary to lead in the adoption of technologies or the ability to act as digital-change leads. There is also room for further enhancing digital adoption, innovation, and entrepreneurship across enterprises, both large and small. A key challenge which may emerge will be to ensure an appropriate pipeline of skills and expertise to meet current, as well as future, labour market demand in emerging technologies and sectors.

Benefits from adoption of new technologies

It was agreed that digital transformation as a driver of all major economic sectors would create further demand for deep-tech innovation and for new digital technologies. The use of community digital or digital RD&I hubs could act as a catalyst for digital adoption in the wider community. Increased digitalisation, some submissions pointed out, provided an opportunity for Ireland and the regions to position themselves as a location of choice for sectors serving as a gateway to the EU, UK and US, such as FinTech and InsurTech.

Supports Needed

In general, stakeholders felt that while there were considerable public supports in the area of digitalisation, there needed to be greater focus on digital skills and simplifying the range of offerings available to enterprise. Specific proposals, such as regulatory Sandboxes, were also proposed.

With specific regard to digital skills, submissions centred on the need to address gaps to lead in the adoption of emerging technologies. Digital skills tend to be centred around high-level ICT but as digitalisation extends across all sectors of the economy, more general digital skills will be needed. For example, as construction and manufacturing sectors lag in the adoption of digital technologies, several submissions argued for the need for focused investment in tailored digital skills to assist these sectors. Bespoke and specialist advice, based on regional/sectoral maturity and relevance, through digital innovation support programmes was advocated. The commitment to a new Construction Technology Centre in Budget 2022 and Enterprise Ireland's Built to Innovate programme and grants will improve this area.

Existing supports for digitalisation are seen as more than adequate and well structured. However, the complexity of the support environment was highlighted as an issue, with stakeholders desiring a single source that sets out the range of offerings by Departments and their Agencies in order to simplify the choice available.

The majority of submissions backed the development of the network of European Digital Innovation Hubs (EDIHs) to support businesses and organisations in their digital transformation. Prioritising and enhancing efforts to support enterprise efforts to access EU funding in enhancing digital adoption, innovation, and entrepreneurship was also advocated.

The development and deployment of a Sandbox environment to safely and cost effectively test new solutions was proposed. Accelerated capital allowances were also suggested for several areas of advanced manufacturing such as computer-aided machinery and robotics.

Improving Alignment

It was generally acknowledged that alignment of the digital ecosystem is important, with numerous proposals to enhance alignment of various policies and programmes. It was proposed that an analysis of digital maturity be conducted to set a baseline which, in turn, would allow the development of follow-on roadmaps as useful supports to help manage digitalisation across enterprise and regions.

Further access to digital opportunities must be promoted, with enterprise engaged through meaningful mechanisms to ensure the delivery of these actions. There must also be investment in initiatives and strategic infrastructure which will support further understanding, technology diffusion, skills and training development, and research commercialisation to enhance innovation and employability across sectors and regions.

The current approach to support the establishment of dedicated centres of excellence in academic institutions is considered positive. However, it is felt a greater focus on applied research and the linking of successful application to funding outcomes is needed.

Supporting Ongoing Digitalisation and Digital Transformation with S3

Accelerating the adoption of digitalisation will not only ensure we can compete on a global stage. It will address several broader challenges by increasing production efficiency, driving more energy efficient, resource efficient and sustainable production, and facilitating the servitisation of manufacturing, leading to new jobs, more exports and more revenue. It is therefore of fundamental importance to promote the adoption and deployment of digital technologies.

Towards this end, significant investments have been made in recent years to support research and innovation in digitalisation and manufacturing technologies through the network of national RD&I centres. The promotion of digital technologies among the industry base has been a priority activity for the national enterprise agencies and has resulted in a substantial number of research, training, capital investment and process improvement measures being implemented in the last number of years. However, it is generally acknowledged that engagement with public supports is made by proactive and innovative companies and that the remainder of the industry base needs substantial guidance and support to encourage innovation and investment in digital technologies. In short, there remains much to be achieved to harness the potential of digital technologies.

In the context of Smart Specialisation, where national initiatives are designed to harness regional strengths as well as capitalise on opportunities of convergence between dissimilar industry sectors, it is imperative to have well mapped operational boundaries and clearly defined mandate among stakeholders. Clustering initiatives offer a great deal of potential to act as catalyst for business growth through the formation of business to business as well as business to RD&I centre initiatives. The network of RD&I centres offers a variety of resources across the TRL spectrum while the government agencies offer support mechanisms to financially de-risk strategic investments. To realise the goals of S3, it is essential to have defined mandate and co-ordination surrounding the mechanisms designed to harness the potential opportunities of digitalisation.

S3 supports the Vision of Ireland's Industry 4.0 Strategy 2020-2025 and the Establishment of Future Manufacturing Ireland

Central among the actions to bring Ireland to forefront of Industry 4.0 development and adoption under Ireland's Industry 4.0 Strategy 2020-2025 is the establishment of Future Manufacturing Ireland (FMI).

FMI aims to establish a national co-ordination structure for Advanced Manufacturing resources, which will be engaged with and responsive to industry, open to collaboration and of the scale required to offer the broad spectrum of Technology Readiness Level (TRL) support required by industry. It is intended to integrate the current network of advanced manufacturing RD&I Centres into this co-ordinated structure. This is intended to provide clarity for all stakeholders (including domestic and international industry, the centres, the State research funding organisations, and researchers). FMI will work across stakeholder government departments, to ensure a co-ordinated approach towards the provision of resources for Advanced Manufacturing.

FMI, as a co-ordination mechanism for Advanced Manufacturing supports, will form linkages with clusters which have a related function, and will be open and accessible to all business. To be successful, FMI will ensure a high level of collaborative interface between the network of RD&I centres which focus on Advanced Manufacturing and

will create a collective network offering a spectrum of resources to the manufacturing sector across all regions.

S3 supports Co-working Hubs and the Goals of Our Rural Future Rural Development Policy 2021-2025

The last 18 months have shown that accelerated change towards digital and remote working in response to the COVID-19 pandemic. The availability of broadband is crucial to enable remote working, e-learning and necessary digital infrastructure for business, research and innovation. It is also essential to ensure social inclusion and engagement with marginalised and vulnerable societal groups. The roll-out of rural broadband and rapid shift towards remote working opens new opportunities for rural regeneration and diversification of local economies supported by targeted investment in serviced sites and improved connectivity to drive enterprise development.

Enhanced investment to develop a network of high-quality co-working hubs of scale within or in close proximity to the designated centres and prominent rural communities will help to increase regional enterprise capacity and is an approach advocated in the RSESs.

Remote working is supported by the National Remote Work Strategy. The objective of the strategy is to ensure that remote working is a permanent feature in the Irish workplace in a way that maximises economic, social and environmental benefits. The strategy has three pillars: creating a conducive environment; developing and leveraging a remote work infrastructure and building a remote work policy and guidance framework.

ConnectedHubs.ie is the one-stop-shop for co-working hubs throughout Ireland and was a key action of Our Rural Future – Rural Development Policy 2021-2025. Launched in May 2021, it is designed to simplify and standardise the process of sourcing and booking spaces, desks, offices and events in hubs. ConnectedHubs.ie is operated by The National Hub Network, a Government of Ireland initiative that provides a vehicle for individual hubs to come together under a shared identity to maximise the economic opportunity of remote working. The National Hub Network has Government support, remote working advocacy groups and industry representatives. In this way, ConnectedHubs.ie also encompasses a range of key features that deliver significant benefits to member hubs, hub clients, employers, local communities and the wider economy.

S3 supports the Goals and Actions of the AI Strategy

AI has grown in importance for business as more understand its advantages and impacts, and Ireland is well-placed to be at the forefront of that change. Ireland has invested heavily in developing IT talent, entrepreneurship and connectivity. S3 supports the development of AI at a regional level by supporting new and emerging sectors and technologies in Ireland's regions. It complements existing AI commitments, such as:

- Examining and promoting ways to help businesses self-assess the trustworthiness of their AI systems, including through development of case studies and toolkits for SMEs;
- Establishing an AI Innovation Hub, as part of Ireland's planned programme of European Digital Innovation Hubs, to act as a National First Stop for AI, providing expertise and guidance to enterprises on their AI adoption journey;
- Assisting employers to expand workplace-focused AI upskilling and reskilling, including through apprenticeships, SOLAS programmes, Skillnet Ireland training programmes and enterprise partnership schemes.

S3 supports use of ERDF to Drive Green and Digital Transition

ERDF programmes in Ireland will drive the green and digital transformations as these are major components of the industrial transition at the heart of ERDF and S3 and have been informed by S3. Ireland's ERDF programmes under PO1 are diverse and reflect the needs of the country as we move towards industrial transition.

The draft Regional Programmes set out how the managing authorities plan to use funding consistent with a 'Greener and Smarter Europe' and in line with regional priorities as expressed in the statutory Regional Spatial and Economic Strategies.

These programmes will advance several areas. First, they will bridge the knowledge transfer gap between industry and academia. They will fund specialists in university systems across Ireland who will help companies and investors to access new knowledge and expertise to drive innovation through collaboration, identify and license new technologies and IP.

They will create an innovation training environment, leading to an increase in the number of individuals and inter-disciplinary teams who, through their immersion and observation of "real needs in their immersive environment" will be encouraged, through a design methodology, to increase the number of product and process ideas which may lead to the creation of HPSUs from research across Ireland's regions in sectors of strategic importance to Ireland.

ERDF will support regional enterprise ecosystem strengthening projects to boost regional enterprise innovation and growth and address regional disparities. This will see regionally based SME businesses working collaboratively with other partners to embrace digitisation, green economy opportunities, and relevant technological advances. In doing so, it will improve their competitiveness and potential for growth and internationalisation.

ERDF will also assist with providing the TUs with an Industry gateway with dedicated staff who work with industry to articulate company problems in a manner that can be addressed by the established expert base in each TU.

Through these supports Irish enterprises will be more ready to adopt the latest advances in green and digital technological breakthroughs, leading to greater technological take-up and more HPSUs and spinouts with the ability to grow, scale and compete on international markets across Ireland's regions.

4.3 Green Transformation for Enterprise

What do we mean by Green Transformation?

Green transformation refers to processes within industries or companies that lead to reduced environmental change impact. With the increasingly prominent problems of global resource consumption, environmental pollution and greenhouse gas (GHG) emissions; green transformation is becoming a necessity for many businesses. The green transformation importantly also presents many new enterprise development and market opportunities for Irish based companies across the regions.

Climate action is one of the most pressing and pertinent issues facing the Irish economy and society. Enterprises that make the move early to reduce their carbon footprint will be more resilient to climate change impacts and there are significant opportunities for both existing and new firms to provide the goods and services that will be needed to decarbonise our economy. In addition, driving environmental and resource efficiencies and achieving improved sustainability by establishing and embedding continuous improvement systems and behaviours will enhance the competitiveness of many industries in Ireland.

The recent and sobering IPCC report on global climate change has highlighted the commitment needed to achieve our climate goals and the objectives set out in the European Green Deal. The Climate Action and Low Carbon Development (Amendment) Act 2021 significantly strengthens the framework for governance of climate action by the State in order to realise our national, EU and international climate goals and obligations. The Act places a commitment to achieve a climate neutral economy no later than 2050, to be known as the 'national climate objective' on a statutory basis.

The Government's Climate Action Plan 2021 reflects the Government's ambition to meet a 51% reduction in greenhouse gas emissions by 2030 and to achieve net-zero emissions no later than 2050. The Enterprise sector has an important role to play in meeting these targets. In 2018, the sector emitted 7.9 MtCO2eq., or 12.7% of Ireland's total emissions. The enterprise sector has been tasked with reducing emissions to 5 MtCO2eq. by the end of the decade.

The ambitions for energy efficient retrofit, the installation of heat pumps and other renewable heating options, coupled with a substantial increase in onshore and offshore wind and solar energy targets, present significant enterprise opportunities regionally and nationally.

Efforts to meet Ireland's renewable energy targets will meanwhile increase demand across a range of engineering and technician roles, including civil, electrical/ electronics, mechanical, naval, production and process, quality control and planning, telecommunications, IT, and energy. There will also be demand for a range of Built Environment jobs, including construction and building trades supervisors elementary construction occupations, health and safety officers, chartered surveyors, as well as supporting roles such as environment professionals, finance and investment analysts and advisers, physical scientists, solicitors and accountants and tax experts.

Enterprises can add value for customers and access new markets through decarbonisation, circularity, and sustainability by differentiating their products and services, reducing their resource intensity and costs, and creating innovative business models or production processes.

Current Enterprise Policies for Climate Action

In 2018, Ireland had the third worst emissions of greenhouse gases per capita in the EU at 12.6 tonnes of carbon dioxide equivalent per capita. Ireland's emissions were 53% higher than the EU 28 average of 8.2 tonnes[20]. The enterprise sector is responsible for 12.9% of Ireland's total GHG emissions[21], the majority of which are accounted for by large energy using companies (alumina, cement, food, pharmaceuticals, and ICT) operating in the EU emissions trading scheme (ETS). The Department of Enterprise, Trade and Employment (DETE) contributes to Government targets for greenhouse gas emissions from 2021 to 2030 and to achieving net zero emissions by 2050. The Climate Action Plan outlines steps to reduce emissions from the enterprise sector as part of its commitment to achieving a net zero carbon energy systems objective, including DETE RD&I related solutions such as:

- Accelerating decarbonisation of the enterprise sector, through providing supports for Irish SMEs and exporters to address their emissions, develop on-site renewable electricity generation, and by investing in carbon measurement and abatement technologies for manufacturing companies;
- Accelerating climate neutrality of the enterprise sector value chains through[22];
  - Recycling carbon from waste streams, from sustainable sources of biomass or directly from the atmosphere, to use it in place of fossil carbon in the sectors of the economy that will inevitably remain carbon dependent.
  - Upscaling carbon removal solutions that capture CO2 from the atmosphere and store it for the long term, either in ecosystems through nature protection and carbon farming solutions or in other storage forms through industrial solutions including bioeconomy while ensuring no negative impact on biodiversity or ecosystem deterioration in line with the precautionary and Do No Significant Harm principles. The development and deployment at scale of carbon removal solutions is indispensable to climate neutrality and requires significant targeted support in the next decade.
- Aligning grant funding and supports with progress towards achieving our emissions reductions targets for enterprise, including amending project appraisal methods;
- Administering, through EI, and IDA Ireland, the Climate Planning Fund for Business and the Enterprise Emissions Reduction Investment Fund to help companies reduce emissions and embed sustainability in how they work;
- Promoting the potential of innovation and applied research in Artificial Intelligence, Machine Learning and Data Analytics to solve complex challenges related to sustainability and the low-carbon transition;
- Performing research and encourage Irish researchers to contribute to the EU Green Deal research programme with respect to metrological assistance for the development of clean energy technologies;
- Building a Pilot Technology Gateway in the Northeast Region to harness the expertise of Dundalk IoT in terms of Energy Efficient and Energy Optimisation of products;
- Continuing development of the second phase of the Dairy Processing Technology Centre to develop technologies and approaches that will deliver reduced carbon and greenhouse gas footprints in the dairy industry;
- Continuing development of the second phase of the Irish Manufacturing Research Technology Centre as a hub of sustainable manufacturing expertise;
- Proactively engaging with opportunities to support business cluster and network development which will support the all-island circular economy.

20. CSO Environmental Indicators Ireland 2020
21. Current Situation: Environmental Protection Agency, Ireland (epa.ie)
22. Sustainable carbon cycles (europa.eu)

In addition to the Climate Action Plan, the National Adaptation Framework (NAF) sets out a national strategy for the application of adaptation measures in different sectors (including agriculture, transport and health) and by local authorities in their administrative areas in order to reduce the vulnerability of the State to the negative effects of climate change and to avail of any positive effects that may occur. This NAF sets out the context to ensure local authorities, regions and key sectors can assess the key risks and vulnerabilities of climate change, implement climate resilience actions and ensure climate adaptation considerations are mainstreamed into all local, regional and national policymaking. The NAF will be reviewed in 2022 and this review may lead to a revised NAF for the period 2023-2027.

The OECD Economic Survey of Ireland (2020)[23] noted Ireland's strong innovation outputs in ICT and biotechnologies. However, it points out a lag in environmentally related inventions, which is a concern given the pressing global need to combat environmental pressures and the fact that the market for such new technologies is likely to expand over the coming years.

As part of its regional development strategy, DETE and its agencies will encourage new sustainable investments in the regions and promote the growth of entrepreneurial activity with a focus on the green agenda. As part of the development of the nine Regional Enterprise Plans to 2024, climate action and transition to a low-carbon economy were key themes at stakeholder consultation in each region. In addition, the National Recovery and Resilience Plan aims to contribute to a sustainable, equitable, green and digital recovery effort. This will be achieved through grants from the Recovery and Resilience Facility to drive actions such as accelerating the decarbonisation of the enterprise sector and a National Grand Challenges Programme which will address climate change.

DETE has also identified strong potential over the next few years to use space applications to address climate change and other environmental goals. There is an opportunity for Ireland to look at how our national digital assets and expertise can be applied to spaceborne satellites carrying Earth observation sensors, navigation services and satellite communications to generate innovative products and services in targeted application areas (e.g., AgriTech, Maritime Surveillance, Critical infrastructure Monitoring, Disaster Management) for the international market. The development of the commercial space sector in Ireland is being driven by the goals of the National Space Strategy for Enterprise 2019-2025. In 2022, Enterprise Ireland will explore the potential to establish a space cluster to promote collaboration across the industrial base and align resources.

By 2030, Ireland will have taken significant steps to address the climate crisis which threatens our safe future on this planet by more than halving our greenhouse gas emissions over the course of the decade.

Programmes to Drive the Green Transition for Enterprise

DETE and its agencies promote research and innovation including in areas that help enterprises make their products and operations more energy efficient and sustainable. As Ireland transitions to a low-carbon economy, innovation will play an even greater role in the evolution of firm-level productivity over time. In recent years several initiatives have been developed to support enterprises in their green transition. These are not only delivered by DETE and its agencies, but also by Departments such as the Department of Further and Higher Education, Research, Innovation and Science; the Department of the Environment, Climate and Communications and the Department of Agriculture, Food and the Marine. Some of the more notable programmes for enterprise RD&I include:

- Through the Enterprise Ireland/IDA Ireland Technology Centres and the EI

23. OECD iLibrary | OECD Economic Surveys: Ireland (oecd-ilibrary.org)

Technology Gateways RDI activities are funded to assist in the green transition and to leverage the private sector knowledge base and investment in delivering climate related objectives, including at a regional level. The Dairy Processing Technology Centre develops technologies and approaches that will deliver reduced carbon and greenhouse gas footprints in the dairy industry. Irish Manufacturing Research has expertise in sustainable manufacturing and lead on CIRCULÉIRE, the first cross-sectoral industry-led innovation network dedicated to closing the circular innovation gap and accelerating the net-zero carbon circular economy in Ireland. The CREDIT Gateway in DkIT is focused on energy efficiency, with expertise in solar, wind and ocean energy and will assist companies to make both their products and their manufacturing operations as energy efficient as possible.

- The SFI Research Centres BiOrbic, MaREI and VistaMIlk operate in the green transformation space and work with enterprises to develop solutions to climate challenges. BiOrbic works in Bioeconomy research, including seeking solutions for the agrifood and marine sectors. MaREI is the SFI Research Centre for Energy, Climate and Marine, focusing on defined global challenges such as the Energy Transition, Climate Action and the Blue Economy. VistaMilk drives sustainability in the dairy supply chain through innovation and new technology development.
- The national network of Local Enterprise Offices operates the free Green for Micro programme to help prepare small businesses for the low-carbon, more resource efficient economy of the future.
- DECC's Climate Action Fund (CAF) was established to provide assistance and financial support to projects which will help Ireland achieve its climate and energy targets. The Fund will allow for the development of innovative initiatives which, without this support, may not otherwise be possible to accomplish. The CAF will have a number of calls for applications, which may include calls focusing on specific sectors.
- The SEAI Energy Academy is a free online training resource offering a wide range of courses and modules focused on all areas of energy efficiency and energy management for business, including upskilling for staff, to help save energy and lower costs. The SEAI also offers a range of energy efficiency grants for business and Accelerated Capital Allowances, a tax incentive scheme which allows businesses to reduce their taxable profits by the full level of expenditure on energy efficient equipment in the year the investment is made.
- The SEAI's Excellence in Energy Efficiency Design (EXEED) grant scheme supports organisations with the costs of embedding energy efficient design in their assets, to reduce lifecycle impact with lower energy use and carbon emissions; its Support Scheme for Energy Audits supports SMEs with a €2,000 voucher towards the costs of a professional energy audit; and its Large Industry Energy Network was established to enable where members work together to improve energy performance and share experiences.
- Skillnet, the national agency for workforce learning, has developed Climate Ready to offer leadership and skills support for enterprises who want to develop their operational and strategic sustainability. Also in the skills area, Springboard+ offer training courses related to Climate Action and Just Transition leading to qualifications in areas where there are employment opportunities in the economy.
- Bord Bia's Origin Green is the world's only national food and drink sustainability programme and enables the industry to set and achieve measurable sustainability targets that respect the environment and serve local communities more effectively.

The Department of Enterprise, Trade and Employment was recently approved for funding through the National Recovery and Resilience Package from the EU to accelerate the decarbonisation of the enterprise sector in Ireland. The package has two elements, the Climate Planning Fund for Business and the Enterprise Emissions Reduction Investment Fund. The two elements of the fund incorporate €55 million of grants to help business decarbonise. The programmes will run over five years. The package was launched in June 2022. The programmes with the package are

expected to launch in mid-2022. In addition, the recent third call for the Disruptive Technologies Innovation Fund (DTIF) included 'Economic Impact and Sustainability' as a new criterion for selection. This incorporates the commitment in the Climate Action Plan for all NDP funds to prioritise the selection of low-carbon investments.

Challenges to Green Transformation

Building sustainable, low-carbon businesses is becoming increasingly imperative, from a social and environmental perspective, but also from a market competitive and financial perspective. A business model which is sustainable and focused on decarbonisation is now crucial to long-term resilience.

A number of challenges exist for businesses that are trying to reduce their own emissions or introduce sustainable practices to their operations. The main challenges include:

- Cost of decarbonisation measures;
- Lack of knowledge on decarbonisation measures;
- Low-carbon economy skills deficits.

Cost of Decarbonisation Measures: According to the results of the June 2021 SSE Airtricity "Green Business Sentiment Index", Irish businesses see the cost of introducing sustainable measures as a significant challenge in reducing their carbon emissions, with 47% claiming that financial costs were main hurdle in this regard. This proportion was unchanged compared to the previous year's publication. Such findings are in line with separate research undertaken by the Tipperary Energy Agency when similar challenges were highlighted by residential households.

Lack of Knowledge on Decarbonisation Measures: Further findings from the Green Business Sentiment Index highlight how a sizable proportion of enterprises have a lack of knowledge on renewable energy, methods of decarbonisation and the process involved in retrofitting, which this lack of knowledge affecting their ability to reduce their emissions and introduce sustainable practices. Such research found that:

- 47% were unaware if their energy is renewable or not which was unchanged from the July 2020 publication
- 15% of businesses in Ireland do not have enough information on methods of decarbonisation
- 31% of businesses in Ireland do not know what retrofitting involves.

Low-carbon Economy Skills Deficit: Based on consultations with key stakeholders involved in the education and training sectors, it was noted that there was an underlying lack of demand for training courses with respect to the low-carbon economy, particularly with respect to retrofitting, renewable energy, circular economy, environmental engineering and other sustainable engineering practices. As a result, it was noted that this underlying lack of demand was affecting the supply of workers capable of carrying out decarbonisation measures, a factor which may be preventing enterprises from reducing their carbon footprint. Stakeholders noted that existing construction workers were generally most suitable for these types of courses, however these workers generally did not want to return to education for a variety of reasons, including apprehension about returning to education, lack of previous engagement with the education system and demanding work schedules in their existing jobs.

Recent enhancements to home energy upgrade schemes and supports under the National Retrofit Scheme with greatly enhanced grants to drive demand, funding commitments out to 2030 providing certainty on the pipeline of work, and changes to SEAI supports to transform the retrofit sector into an 'always on' industry are creating the conditions for businesses in the sector to expand, grow and create more

career opportunities. These roles will require various levels of skills as identified in the recent Expert Group on Future Skills Needs report "Skills for Zero Carbon". While the further education and training sector is also gearing up to provide additional training opportunities there also needs to be a continued focus on upskilling and on continuous professional development. In this context it is important to further explore how upskilling opportunities can be made more accessible with a view to maximising uptake. Approaches involving blended learning can help deliver improved accessibility. It will also be crucially important to consider further options to encourage, facilitate and where appropriate incentivise additional skills acquisition so that the uptake of training places and upskilling courses is forthcoming at the levels needed.

Consultation Findings for the Green Transformation

Stakeholders were asked in the public consultation paper to consider:

- What more can be done to support green transformation in Irish enterprise;
- What opportunities do they see as arising from green transformation for their sectors or regions;
- What challenges exist for enterprises trying to reduce emissions or introduce sustainable practices;
- How could government or enterprise agencies assist them in meeting those challenges?

Opportunities for Sectors and Regions

All submissions agreed Ireland must develop a more sustainable economic model. With increased investment and smart targeted measures, Ireland has the opportunity to become a global leader in sustainable enterprise and green innovation.

Several submissions highlighted renewable energy production as a main area of opportunity for regions. Investment in renewable energy in Ireland alone will be over €10 billion and is a major government commitment, with significant scale of offshore wind and onshore solar energy generation to be delivered. Ireland's ambitious target of sourcing 80% electricity from renewable resources by 2030 means it will have a unique opportunity to be the first to solve emerging challenges and to share these learnings to help others accelerate towards solving climate change challenges. Securing Horizon and Green Deal funding will help with our targets and will create jobs and a sustainable economy in Ireland. In the long term, several submissions saw significant export opportunities in this area with, for example, the distribution Ireland's future surplus offshore wind supply to mainland Europe, as well as hydrogen generation and storage at international scale.

The need for investment in RD&I to address areas where solutions do not already exist is also important as adequate investment will lead to new industries of the future. One example given was that of research and innovation in geothermal energy which is leading to industrial application in several sectors. Other suggested areas where Ireland has several opportunities include energy management and storage technologies, hydrogen production plants, a decarbonised agrifood industry for sustainable food production, autonomous vehicle development, sustainable construction, and the circular economy.

Challenges Exist

Challenges identified by stakeholders include introducing sustainable practices in a variety of sectors, engaging the enterprise base in the climate agenda, and ensuring that the necessary skills for the green transformation exist among workers.

Challenges to reduce emissions and introduce sustainable practices cover many sectors. For example, agrifood and the transport/supply chains are still heavily dependent on fossil fuels. A key challenge to reducing emissions will be to get all businesses, particularly microenterprises and SMEs, engaged in the climate action agenda. It was pointed out how an obstacle for enterprises in developing

carbon-reduction strategies is knowing where to start and how to prioritise activities. Challenges also emerge in determining how enterprises can measure carbon footprint and overcome cost barriers in the shift towards greener, cleaner practices. Accordingly, better-informed businesses can drive decarbonisation in their communities while enhancing their own resilience in such a transition. Being better informed can also reduce concerns about the negative impacts on business, especially where there is lack of knowledge of what is possible, what is involved, as well as the costs and returns.

Tied into this, some submissions highlighted the challenge in ensuring workers have the necessary skills to meet current, as well as future labour market demand, in relation to emerging green technologies and sectors.

Helping to Meet Challenges

In general, existing supports were praised by stakeholders. Submissions recognised the Climate Action and Low Carbon Development (Amendment) Act 2021 has significantly strengthened the framework for governance of climate action by the State. However, submissions called on further supports for green transformation to be delivered through financial incentives, training and innovation.

Submissions recognised that innovation is needed to help businesses develop circular products and services, increase resource efficiency and maximise the use of end-of-life materials. Targeted R&I will also ensure policymaking is grounded in scientific evidence and will be appropriate in an Irish context. Financial incentives to aid green transition, along with grant aid for the provision of new equipment where needed, must be made available. For example, the wide range of grants which already exist to help upgrade homes to make them more energy efficient should also be directed at businesses.

In the area of training, submissions pointed to existing educational supports such as SEAI's energy academy. Development of peer learning networks for innovative solutions in this area will also assist. Attention was drawn to the crossover between digital and green transition skills. The pilot Digi-Eco initiative, delivered through the regional skills fora, aims to instil cultural and behavioural change in enterprises by developing the digital capacity of employees to help implement new work processes which contribute towards greener and cleaner working environments. Other supports referred to in submissions included leveraging existing industry clusters and expertise to help businesses develop new circular products and services; and directing research into ways of reducing costs of viable but prohibitive technological solutions to environmental challenges such as hydrogen and advanced biofuels.

Supporting the Green Transition for Enterprise with S3

In the coming years, the accelerating impact of greenhouse gas emissions on our climate will significantly alter the manner in which all global economies operate with such trends requiring policymakers to deliver major policy and legislative changes that will facilitate a low and eventually a zero-carbon future. As a result of such trends, it is likely that the low-carbon economy and its associated sub-sectors are uniquely positioned to achieve critical mass within the next seven years. Notwithstanding the fact that the transition to a low-carbon economy poses substantial economic and social challenges to Ireland, it is evident that such a transition also provides considerable economic opportunities for Ireland's enterprise base, primarily through new climate-oriented innovations, efficiencies, products, services, employment and export markets.

The RSESs prioritise action on climate change across all economic sectors and the Regional Assemblies are committed to implementing national policy under Ireland's Transition to a Low-carbon Energy Future 2015-2030.

S3 Supports the Goals of Our Rural Future Rural Development Policy 2021-2025
S3 supports maximising our resources and strengths in the Green Economy to support employment opportunities for rural communities in areas such as renewable energy, sustainable tourism, energy retrofitting, the Bioeconomy and the Circular Economy

S3 Supports the Goals of the National Recovery and Resilience Programme (NRRP)
S3 supports the implementation of the NRRP, which has a key priority of advancing the green transition. In addition to projects involving the rehabilitation of peatlands and commuter rail, the NRRP includes measures to support actions to accelerate decarbonisation of the enterprise sector and to develop a National Grand Challenges Programme.

S3 Supports the Goals of the EU Just Transition Fund
The EU Just Transition Fund (JTF) assists communities to meet the challenges of the green transition. This supports enterprise innovation and S3 in Ireland's regions as they work towards climate change targets.

S3 Supports the Goals of the Climate Action Plan 2021
The Climate Action Plan 2021 provides a detailed plan for taking decisive action to achieve a 51% reduction in overall greenhouse gas emissions by 2030 and setting us on a path to reach net-zero emissions by no later than 2050, as committed to in the Programme for Government and set out in the Climate Act 2021. S3 will support the actions needed to deliver on our climate targets, in particular where those actions are of relevance to regional RD&I supports.

S3 Supports ERDF with the Goals of the Green Transition
ERDF in Ireland is committed to supporting measures that support the green transition. This includes supporting local projects, identified in consultation, which support industrial transition and supporting TUs and other HEIs in taking up new technology and new sectoral opportunities in the area.

4.4 Innovation diffusion

What do we mean by Innovation Diffusion?

Innovation is of crucial importance for countries and regions to strengthen economic growth and find solutions to societal challenges. Innovation does not only take place by creating knowledge (for instance through research and development) but also by learning from others. Such learning processes enable the diffusion or transmission of innovation, and can help companies, regions or countries to catchup to higher productivity levels. Innovation diffusion is of particular importance for SMEs and start-ups and reflects the process through which these firms gather knowledge, information, and innovations from outside and use them to introduce their own innovative products or processes. It refers, for instance, to the adoption of new-to-the-firm technologies, the introduction of new management techniques, the digitalisation of certain processes, or the introduction on the market of a new product.

Innovation diffusion relates to three sets of factors:

- The local and national framework conditions, which affect a firm's incentives and capacities to adopt innovations. Examples of framework conditions are the regulatory framework, market conditions, access to finance and skills, and infrastructure;
- The functioning of the channels through which the diffusion can take place. These channels include supply chains, workers careers and mobility, academic-business collaboration or knowledge intensive business services;

- The presence and functioning of a variety of intermediary organisations that help companies build the capacity for innovation adoption, identify external resources, and share knowledge among peers.

In the 2021 Global Innovation Index[24] Ireland was ranked the top economy worldwide in knowledge diffusion and knowledge impacts, a good indication of the strength of our enterprise agencies in driving innovation impacts. Knowledge diffusion and knowledge impacts can be measured a number of ways, but a good indicator of performance is looking at the research commercialisation activities of the HEIs. Table 4.2, compiled by Knowledge Transfer Ireland, is based on the activities of its network of Technology Transfer Offices, which are based in every HEI in the country. Given the small size of the country, and the impact of COVID-19 in 2020, there is significant commercialisation and industry collaboration activity in the HEIs.

Table 4.2: Knowledge Transfer Activities in Irish HEIs

Name of Enabling Condition	2018	2019	2020	Grand Total
Midlands & East	**1237**	**1020**	**1125**	**3382**
Invention Disclosures	261	237	265	763
Licences, Options & Assignments	122	106	117	345
Patent applications filed	68	71	84	223
Research agreements with industry	765	590	640	1995
Spin-out companies	21	16	19	56
North & West	**198**	**191**	**144**	**533**
Invention Disclosures	62	63	33	158
Licences, Options & Assignments	19	18	9	46
Patent applications filed	15	12	24	51
Research agreements with industry	100	97	74	271
Spin-out companies	2	1	4	7
South	**650**	**677**	**619**	**1946**
Invention Disclosures	135	137	127	399
Licences, Options & Assignments	59	68	47	174
Patent applications filed	36	42	37	115
Research agreements with industry	412	421	401	1234
Spin-out companies	8	9	7	24

24. Global Innovation Index Database, WIPO, 2021

The Directory of RD&I Supports

KTI's National Directory of Research, Development and Innovation Supports for Enterprise is the definitive roadmap for businesses seeking to innovate through R&D. It provides businesses with a single reference point on the key players, funding available and other resources that might match their specific needs. From a quick first-time interaction through to a deeper engagement, there are funding supports and research expertise available to assist companies of all sizes.

Along with a comprehensive breakdown of research and development funding supports available to businesses, the Directory also includes profiles of over 50 research providers, including Higher Education Institutes and research centres, with which companies of all sizes can connect to advance their R&D goals.

The KTI Directory of Research, Development and Innovation Supports for Enterprise 2021 can be found on the KTI website.

Framework Conditions

Previous sections have already discussed in detail some of the framework conditions required for successful national RD&I performance such as skills, the broad market/economic environment and the R&D tax credit system. Some of the other factors contributing to the environment of enterprise RD&I are detailed below.

Standards and regulations are critical in many areas of enterprise RD&I such as, interoperability standards for ICT products or regulations for health products. Embedding standards and regulatory compliance in research, development and testing processes can reduce time to market, minimise costs, provide competitive advantage and ease access to the global marketplace for new products and services.

For countries, organisations and individuals involved in RD&I across industry, academia and government, there are many benefits of engaging in international standards development for new and emerging technology areas. Standards help build customer trust and confidence in new technologies, enabling the accelerated mass-market diffusion and adoption of related products and services.

At a European policy level there is a strong and increasing focus on integrating RD&I and standardisation to help deliver greater impact from RD&I activities in general and to enable the twin transitions to a digital and green society and economy. Some of the first Horizon Europe calls have entirely focused on improving the integration of 'RDI + Standards' to help drive increased impact and scaling from European funded RD&I activities. Early engagement in international standards development would enable our national RD&I experts to get 'ahead of the curve' in helping to set key global standards in critical emerging technology areas (including Quantum, AI, Blockchain, Cybersecurity, Additive Manufacturing, Sustainable & Renewable technologies etc.).

In its extensive report on SME productivity and entrepreneurship in Ireland, the OECD[25] emphasised the importance of engaging in standards development and use, stating that 'compliance with standards is underplayed as a lever to support SMEs to upgrade their management practices'. The report also recommended that Ireland "Increase policy attention to the role that adopting and developing international standards can play in enhancing SME productivity" and "Increase support for international standards adhesion by SMEs as an additional lever for encouraging upgrading to international best practice business management approaches".

The National Standards Authority of Ireland (NSAI) plays a key role in supporting firms by providing information on current and future standards that can assist in bringing products to market and improving organisational performance. The recent development of a new standards-based 'Innovation Scorecard' represents a novel initiative to support regional SMEs and microenterprises, via the EI-supported LEO regional network, along their innovation journeys. The scorecard, developed by global innovation experts (including experts from Ireland via the NSAI innovation management standards committee), includes best international practice guidance on key topics including 'IP management', 'Idea Management', 'Innovation Partnerships', 'Strategic Intelligence Management' etc. The roll-out of this ISO 56000 Series based innovation management scorecard to SMEs across all regions and sectors will take place over the coming years and will be transformative for innovation management in Ireland.

IP Environment

Ireland has a modern and robust Intellectual Property (IP) regime that rewards creators, supports and encourages greater levels of innovation by businesses and meets wider societal needs. A competitive and fit-for-purpose IP protection regime protects the creation of proprietary knowledge and simultaneously encourages its

25. OECD report, 'SME and Entrepreneurship Policy in Ireland'.

exploitation by rewarding knowledge creators. It is an important driver of innovation leading to economic and employment growth.

The Intellectual Property Office of Ireland (IPOI) raises awareness of the value of IP rights with a view to improving and encouraging the exploitation of IP by Irish microenterprises and SMEs. Where feasible, this is done by utilising co-operation programmes offered by the EPO, EUIPO and EU.

The EU has recognised that European innovators and creators, in particular SMEs, are not always aware of the benefits of integrating IP into their business strategy. To help Irish small and microenterprises capitalise on their intangible assets, the IPOI is co-ordinating a EUIPO "Ideas Powered for business SME Fund" which provides 50% reimbursement on trademark and design application fees and 75% reimbursement towards the cost of an IP pre-diagnostic service which covers all intellectual property rights as well as those that are unregistered/unregistrable (e.g., trade secrets) and company names, domain names, etc.

Knowledge Transfer Ireland (KTI) was established by DETE as the national office that helps business engagement with State-funded research. Supported by Enterprise Ireland, it plays a key role in building enterprise IP capacity and capability in developing research contracts with industry. KTI developed the National IP Protocol on behalf of DETE, which is Ireland's framework for research commercialisation. KTI provides resources that enable the enterprise sector to leverage the commercial potential of Irish research and innovation by connecting businesses with cutting-edge research, expertise, opportunities, and funding supports. This includes providing a suite of free to use template agreements, complemented by practical 'how to' guides to help researchers and enterprises to engage with each other on matters relating to IP, easing the path to research commercialisation. KTI promotes the IP Protocol and use of the KTI resources across the enterprise and public research system and industry and is preparing a revision to take account of the experiences of users.

Access to Finance

Financial support for RD&I is crucial to mitigate the risk of a business activity that is time and labour intensive and very often has an uncertain outcome. Enterprises establishing or substantially expanding their existing RD&I function can avail of a variety of financial incentives to carry out in-house R&D projects and collaborative projects with third-level institutes and industrial partners.

DETE's enterprise agencies offer a suite of funding supports for RD&I designed to help companies grow their sales and employment. These range from innovation vouchers for small businesses at the start of their innovation journey, right up to R&D grants for MNCs conducting large-scale research projects.

RD&I Infrastructure

RD&I infrastructure for enterprise in Ireland is largely based in our network of publicly funded enterprise-facing Research Performing Organisations (RPOs). However, it should be acknowledged that a lot of valuable research and expertise in third level is not found in a centre as 40% of researchers in third level are not in centres. We also have pockets of research excellence that do not necessarily fall within a Centre or Gateway, e.g., immunology in TCD. Our RD&I infrastructure for enterprise is primarily based in the following facilities.

Enterprise Ireland/IDA Ireland Technology Centres help Irish companies and multinationals to work together on market focused strategic R&D projects in collaboration with research institutions. The eight technology centres in the programme are resourced by highly qualified researchers who provide a unique ecosystem for collaboration in areas identified, by industry, as being strategically important.

Enterprise Ireland Technology Gateways are a partnership with the Institutes of Technology and Technological Universities to deliver technology solutions for Irish industry close to their market needs. The 16 gateways are open access points to industry of all sizes to explore research partnerships with academia and link in with wider resources in the Irish research infrastructure.

Enterprise Ireland Campus Incubation funds both business and bio-incubation centres on college campuses across Ireland which provide space and support for start-up companies. Supports include access to mentoring on key aspects of business development, such as market research and finance; proximity to research teams in the college and the use of R&D facilities on-campus. Campus incubation facilities exist across all HEIs in Ireland. There are over 200 companies, employing over 1,000 people based in Irish incubation centres funded by Enterprise Ireland.

The network of 16 SFI Research Centres link scientists and engineers in partnerships across academia and industry to address crucial research questions. The centres support both basic and applied research, spanning a wide range of sectors at varying levels and stages. The centres have signed 900 collaborative research agreements with 470 companies around the world (230 in Ireland)[26] and attract industry which make important contributions to Ireland's economy and expand STEM educational and career opportunities.

There are a number of RD&I centres of scale providing specialist expertise to enterprise across the key national research priority areas of Digital Technologies, Life Sciences, Marine and Food. These institutes include Tyndall National Institute for ICT and underpinning deep-tech, the Marine Institute, Teagasc for food and agriculture, Health Innovation Hub Ireland (HIHI), Irish Centre for High-End Computing (ICHEC) and the National Institute of Bioprocessing, Research & Training (NIBRT). They will soon be complemented by the National Advanced Manufacturing Centre (AMC).

There is an ongoing need to ensure that Ireland has the research infrastructure in place to support the needs of the high value manufacturing sector and to provide SMEs access to expensive digitalisation technologies they may not be otherwise able to afford. Helping SMEs to 'test-before-invest' in HEI linked research performing organisations will encourage SME digitalisation and enhance their R&D intensity. Supporting the RD&I needs of both our most valuable and vulnerable sectors will be a critical factor in considering future research infrastructure investments, as will ensuring easy access for SMEs to this infrastructure.

Intermediary Organisations

There are a variety of intermediary organisations that help companies build the capacity for innovation adoption, identify external resources, and share knowledge among peers.

National Agencies

Enterprise Ireland

Enterprise Ireland is responsible for the development and growth of Irish enterprises in world markets. It works in partnership with Irish enterprises to help them start, grow, innovate and win export sales in global markets.
In this way, it supports sustainable economic growth, regional development and secure employment. EI has numerous programmes to support innovation.

IDA Ireland

IDA Ireland is the State's inward investment promotion agency and works to attract foreign direct investment (FDI). The agency partners with potential and existing investors to help them establish or expand their operations in Ireland, with the aim of

26. SFI Annual Report 2019

Case Study: Orbsen Therapeutics – NUI Galway

Orbsen Therapeutics, a NUIG spin-out company, produces stem cells that are more highly purified and more effective than those prepared using competing technology. The company has been helped as it develops by the team in the technology transfer office (TTO) at the university. The Ignite West TTO provided numerous early stage business supports from exploration of the broad technology concepts to accessing crucial business networks and providing incubation space. This enabled Orbsen to develop a lean and cost-effective start-up business model.

Ignite West TTO also linked the company with the best in field in terms of intellectual property and patenting supports, which was key to securing strong protection of the company's proprietary technologies.

"NUI Galway has provided an outstanding environment for this enterprise to grow, with access to world-class research infrastructure and a critical and unique focus on advanced manufacturing, clean room technology and GMP [Good Manufacturing Practice] production. There is nowhere else in Ireland, and few places in Europe, where this type of translational commercial effort could take place," said Professor Frank Barry of NUI Galway who, along with Professor Timothy O'Brien, founded the company.

Orbsen Therapeutics has been active in clinical trials, partnering with NUI Galway and international academic and industry partners. The company has been extremely successful in highly competitive EU research programmes.

In 2020, Orbsen announced the beginning of a phased clinical trial for the treatment of acute respiratory distress syndrome (ARDS) in COVID-19 patients with 80-90% of COIVD-19 deaths related to this acute respiratory failure.

The NUIG Technology Transfer Office is supported through the Enterprise Ireland Technology Transfer Strengthening Initiative programme (TTSI) managed by KTI.

job creation and increased expenditure in the Irish economy. IDA Ireland supports investment throughout all regions of Ireland, including through the provision of strategic property solutions and helping to develop their clients' R&D activity in Ireland. Typically, 30% of IDA Ireland' new FDI investment wins each year have been R&D related in companies connected to SFI supported research teams.

Knowledge Transfer Ireland

Knowledge Transfer Ireland (KTI) was established by the Department of Enterprise, Trade and Employment (DETE) as the national office that helps business engagement with State-funded research. Through the KTI website companies can find in one place:

- searchable information on research expertise and technology licensing opportunities, as well as an interactive map of all the Higher Education Institutions and other Research Performing Organisations, Research and Technology Centres, including up-to-date contact details for the right people to talk to;
- an RD&I Funding Tool that is a searchable resource detailing the current funding offers available;
- model agreements which simplify contracting between enterprise and State research organisations (e.g. licensing agreements, collaboration agreements, confidentiality agreements);
- practical guides that explain intellectual property, considerations in legal contracts and State aid issues in RD&I;
- information on upcoming events to source new contacts and opportunities to innovate KTI is also responsible for the National IP Protocol, which describes the practical framework that underpins how industry can benefit from State-funded research and development and related government policy.

Local Enterprise Offices

The 31 Local Enterprise Offices (LEOs), located in Local Authority offices nationwide, are the 'first-stop-shop' for advice and guidance, financial assistance and other supports for anyone intending to start or grow a business. The LEOs can offer direct grant aid to microenterprises (up to 10 employees) in the manufacturing and internationally traded services sector which, over time, have the potential to develop into strong export entities. Subject to certain eligibility criteria, the LEOs can provide financial assistance

The LEOs also provide soft supports such as training and mentoring and provide a 'signposting' service in relation to all relevant State supports available through agencies such as Revenue, the Department of Social Protection, Education and Training Boards, the Credit Review Office and Microfinance Ireland. The LEOs can also offer advice and guidance in areas such as Local Authority rates, Public Procurement and other regulations affecting business.

In the RD&I space, the LEOs are supported by Enterprise Ireland through their expertise and offers such as Agile, RD&I, IP Start, Innovation Vouchers and Innovation Partnerships.

For microenterprises digitalisation is being progressed through the Trading Online Voucher scheme and the development of a Digitalisation voucher. Green supports are delivered under Green4Micro – a new initiative to help prepare small businesses for the low-carbon, more resource efficient economy of the future through free advice and technical support.

Science Foundation Ireland

SFI is the national foundation for investment in research in the areas of science, technology, engineering, and mathematics (STEM) to assist the development and competitiveness of industry, enterprise and employment in Ireland. It also promotes and supports STEM education and engagement to improve awareness and understanding of the value of STEM to society and to support the STEM careers pipeline. SFI seeks to foster academia-industry interactions by building strategic partnerships with industry to perform cutting-edge, industry-informed STEM research through dedicated programmes such as the SFI Research Centres and Industry Fellowships.

SFI aims to create research and innovation hubs for industry and academic engagement across the regions, so that real-world impacts of knowledge transfer are better realised. SFI plans to increase its horizon scanning and foresighting activities to better respond to medium and long-term enterprise sector needs.

National Digital Research Centre (NDRC)

The NDRC is Ireland's national accelerator for early-stage digital enterprises and an example of an intermediary organisation that helps companies build the capacity for innovation adoption, identify external resources, and share knowledge among peers.

Clusters and business networks

In the private sector there are also a number of industry organisations and industry-driven clusters that support the knowledge-sharing, networking and collaboration necessary for innovation diffusion. These include Chambers Ireland, Ibec and IRDG.

Channels

Academic-Business Collaboration

Productive collaboration between the enterprise sector and the public research system is essential if the full value of investment in the public research system is to be realised. A concerted effort has been made over the last ten years to increase the breadth and depth of collaboration through tailored financial supports and the work of Knowledge Transfer Ireland (KTI). KTI, which is based within Enterprise Ireland and co-funded by the Irish Universities Association, plays a key role in connecting enterprise with academia through their network of Technology Transfer Offices located in every HEI in the country, and their Technology Transfer Strengthening Initiative (TTSI) which supports HEIs to bring fresh ideas from the research environment to the attention of existing industry.

Outside of the work of KTI there are other targeted and novel initiatives to drive academic/business collaboration including the SFI Strategic Partnership Programme, which aims to support research initiatives of scale through collaboration between a range of potential partners including companies, charities, philanthropic organisations, higher-education institutes and international funding agencies; and the Disruptive Technologies Innovation Fund which facilitates collaboration between Ireland's research base and industry in support of the development and adoption of new disruptive technologies and applications, which will in turn help build new technologies for world markets and strengthen the competitiveness of the enterprise sector.

Researcher Careers and Mobility

It is globally accepted that talented people are a critical factor in innovation. Clear career pathways for researchers help them to maximise their personal potential and, as a consequence, help to maximise the return on Ireland's investment in innovation and research. Effective structured progression will also add up to more than the sum of its parts, with people being encouraged to grow their leadership as well as their research capabilities, and as they are given increased autonomy allied with increased responsibility for the delivery of outcomes.

Mobility is a vital element of a researcher's development. As well as international mobility between research institutions, intersectoral mobility between industry and academia forges important linkages between research and innovation performers. In order to encourage cutting edge research and the further growth of Ireland's competitive advantage, there must be strategic links between our research community and our industry base. Intersectoral mobility provides researchers with the opportunity to gain first-hand experience in a commercial research environment while also providing industry with access to highly specialised trained researchers from academic institutions. Ireland is committed to expanding existing schemes to facilitate mobility and knowledge transfer to increase the number of researchers from public research programmes being placed in industry. These schemes include SFI Industry Fellowships, IRC Employment based Postgraduate and Enterprise Partnership Programmes, HEA initiatives and the ongoing support of the EURAXESS Ireland Office.

The challenge around human capital development for research and innovation was highlighted in national innovation policy including Innovation 2020 and its successor Impact 2030. Increasing the pipeline of PhDs was an important goal under Innovation 2020, which led to the development of successful initiatives such as IRC funding new postgraduate scholarships, the HRB launching new collaborative doctoral awards for clinicians, and SFI directly funding postgraduate students and also launching a the SFI Centres for Research Training.

Knowledge Intensive Business Services

Knowledge-intensive business services (KIBS) are companies that provide inputs - based heavily on advanced technological or professional knowledge - to the business processes of other organisations. The KIBS sector encompasses a range of activities such as computer services, research and development (R&D) services, legal, accountancy and management services, architecture, engineering and technical services, advertising and market research, among others.

Perhaps the best indicator for measuring Ireland's KIBS environment is the numbers employed in knowledge intensive firms. A recent report published by the European Centre for Policy Reform and Entrepreneurship[27] analysed the share of the working-age population across Europe employed in highly knowledge-intensive enterprises. The report shows that Ireland is the Western European nation with the strongest rate of growth in such enterprises, with an increase of 25% since 2014 and hosting one of the strongest concentrations of knowledge jobs in Europe. During COVID-19, the number of knowledge intensive jobs decreased massively in Europe. However, Ireland was an exception, which not only maintained its knowledge-intensive occupations but also managed to increase them. During 2020, the number of knowledge intensive jobs in Ireland increased by 600. The long-term trend is a steady rise in knowledge-intensive firm employment. Between 2012 and 2020, Ireland added 75,000 knowledge intensive jobs. Out of these, 29,000 have been created in ICT, 22,000 in tech, 18,800 in advanced services and 5,300 in creative professions.

Barriers to Innovation Diffusion

According to the European Commission's 2020 Country Report, Ireland's research and innovation system has many strategic weaknesses that need to be addressed. These underlying weaknesses are acting as significant barriers for innovation diffusion in Ireland, particularly in the Northern and Western Region (NWR) as evident from the region's recent status as a "Moderate Innovator" as per the 2021 "Regional Innovation Scoreboard". Some of the most significant barriers for innovation diffusion in Ireland include:

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27. The Geography of Europe's Brain Business Jobs: 2021 Index - European Centre for Policy Reform and Entrepreneurship

Disruptive Technologies Innovation Fund (DTIF)

The Disruptive Technologies Innovation Fund (DTIF) was established in 2018, as part of the National Development Plan and committed €500 million in funding over the period to 2027 for co-funded collaborative projects involving the enterprise and research sectors. DTIF projects focus on the development and deployment of disruptive technologies to deliver new solutions through investment in the development and implementation of innovative products and services that will alter markets, or the way business operates.

Since 2018, DTIF invested €235 million in 72 collaborative disruptive innovation projects with strong commercialisation potential under the first three calls of the Fund. These projects cover areas such as life sciences, medical devices, ICT, artificial intelligence, manufacturing and environmental sustainability. Funding to each project is allocated over three years subject to reaching agreed milestones, with €35.4 million disbursed to projects by the end 2020.

Each project is a collaborative partnership of between 2 and 13 research and enterprise partners. SME participation in every project is essential. SMEs constitute the largest grouping of partners within the consortia. They also represent most lead applicants and are leading 27 of the 43 projects.

DTIF complements other innovation initiatives available from Enterprise Ireland and funding agencies of other Government Departments such as Science Foundation Ireland.
Unique characteristics of this fund include its focus on "disruptive", relatively high-risk innovation, the scale of funding involved and its focus on collaboration including with SMEs. The 270 project partners involved in consortia to date are located in 15 counties across Ireland, with over half operating outside Dublin.

- Lack of collaboration between indigenous enterprises and multinational companies in RD&I;
- Low level of investment in research and development (R&D) activities by indigenous enterprises;
- Low levels of public R&D expenditure;
- Lack of awareness of R&D tax credit initiative and RD&I supports among SMEs;
- The complexity of the RD&I support environment (some stakeholders have indicated that the amount of support initiatives offered are confusing to navigate).

As pointed out previously, RD&I investments by indigenous firms are much lower compared to multinational companies. This lack of investment is limiting indigenous enterprise's productivity growth and widening the performance gap between domestic-owned firms and foreign-owned firms. Such investment trends are consistent on a macro level, with relatively low levels of R&D investment – in both the private and public sectors – highlighted as a continued concern for the Irish economy.

Another underlying barrier to innovation diffusion is the lack of awareness of Ireland's R&D tax credit, which provides a relatively high proportion of total public support for companies undertaking R&D activities. The "KPMG Innovation Monitor"[28], found a lack of awareness of the R&D tax credit scheme among SMEs surveyed, with just 50% of them being aware of the incentive.

Lack of awareness of other RD&I resources was identified in a 2019 KTI survey[29] which found over half (59%) of respondents had not used KTI R&D tools when engaging with RPOs. KTI was established to make it easier for enterprises to engage with the RPO sector and provides the tools and resources to make finding, funding, and interacting easier. The survey generally concluded that there is a very considerable and largely untapped source of potential partnerships for HEIs and that it is currently very difficult for smaller businesses to navigate the research landscape in Ireland and to understand how they might benefit from the wealth of IP and expertise on offer in RPOs.

Consultation Findings for Innovation Diffusion

Stakeholders were asked in the public consultation paper:

- what the barriers for innovation diffusion in Ireland are;
- how could these barriers be broken down;
- if there are regional differences in these barriers;
- what channels for diffusion are used by their businesses or sectors;
- how can we enhance collaboration between industry and the higher education sector?

Channels for Diffusion Used

Innovation diffusion was covered by many sectors in their public consultation submissions, ranging from higher education institutions, enterprises, departmental programmes and energy utility companies. All agreed that existing innovation diffusion (as fostered by universities, start-ups and SMEs across the regions, through either

28. Innovation Monitor 2019 - KPMG
29. KTI Annual Review and AKTS 2019 - Knowledge Transfer Ireland

clusters or designated sites such as RPOs) is strong in Ireland. All referred to such collaboration as a positive experience. This is reflected in the 2021 Global Innovation Index[30] which ranked Ireland first in knowledge diffusion.

The KTI directory of RD&I supports summarises how business supports are shared across ten universities, nine institutes of technology, 16 SFI Research Centres, eight Enterprise Ireland. This highlights how well developed the innovation diffusion system in Ireland has become.

All submissions commended existing departmental targeted business development programmes, such as KTI, the LEO competitive fund, innovation partnerships and EI's technological gateway programme, which aim to increase SME engagement in R&D and export activity, along with collaboration between cluster members, education institutions and support agencies in the regions. In terms of driving disruptive innovation, it was pointed out how the Disruptive Technologies Innovation Fund (DTIF) helps improve the innovation diffusion landscape while contributing to improving the competitiveness of indigenous enterprise. These supports are outlined in more detail further in the chapter.

In addition to these initiatives, EU programmes are seen as providing additional funding for companies to perform research activities, which in turn can lead to further collaboration with partners across the EU, providing an arena for large companies to increase international co-operation along the value chain while providing smaller companies with the opportunity to establish or expand their international networks of partners or potential customers.

Channels for innovation diffusion are also expanding in other areas. For instance, according to KTI annual surveys, the technological higher education sector now accounts for over 50% of business access to research and expertise and 24% of collaborative research and consultancy agreements with non-commercial entities. Accordingly, it is felt that TUs/Institutes of Technology are in a strong position to contribute to enhanced innovation diffusion under a revised S3.

Barriers to Innovation Diffusion and How to Tackle Them

The two main barriers to innovation diffusion are time and knowledge of how collaboration best works. The complexity of the innovation system and optimising connections between programmes were also highlighted.

Manufacturing industry, for example, is largely focused on short-term economic gain. It was pointed out that companies often think in six-month horizons while RPOs prefer to undertake research programmes of at least two-years duration. As such, the time required to develop disruptive innovations, new value chains and new products is a hard sell to many enterprises. It was noted that indigenous SMEs, in particular, lack the personnel and financial resources to dedicate to longer term, strategic research and development for their future products. The establishment of public resources to provide a service to deal with this for individual enterprises could help to address the gap and is supported by DTIF. Online peer networks, which require little time to engage with, and audits of potential carried out by external advisers could also tackle these barriers, demonstrating the benefits involved in innovation diffusion.

A related barrier highlighted by submissions was a knowledge gap in how collaboration works. It was highlighted that a common complaint from smaller companies is how difficult it can be to navigate all the options for academic-industry engagement. A company might have an idea for a product or process but lacks the expertise to investigate and develop it further. Guidance to understand the benefits

30. Global Innovation Index Database, WIPO, 2021

of working with RPOs to explore possibilities and develop innovative solutions is, therefore, essential. Lowering the barriers to engagement between industry and research, coupled with the intelligent and creative use of existing supports, would assist in innovation diffusion.

A potential solution to overcoming some of the above issues lies in KTI; the remit of which includes helping enterprise negotiate a complex collaboration landscape. Increased visibility of the role of KTI is necessary, as is adding a cohort of collaboration advisers to their Technology Transfer Offices, who can discuss tailored options with companies.

Optimising connections between enterprise programmes, such as the Regional Enterprise Development Fund, and research projects would also help overcome this barrier. It was pointed out that restrictive funding parameters around RD&I support programmes can limit participation of businesses including SMEs, start-ups, and pre-profit companies. The forthcoming national clustering policy and enabling framework, along with the revised S3, is seen as the best way to provide the structure to connect the various elements of collaboration of companies and research institutions.

Several submissions argued that, as many SMEs have not made the digital transformation necessary to be competitive on a local, national or international scale, this lack of digital know-how meant that they could not compete at the most basic levels during the COVID-19 lockdowns. To overcome this, the European Digital Innovation Hubs are seen as a valuable forthcoming programme to create awareness of digital innovation opportunities.

Enhancing Collaboration Between Industry and Higher Education Sector
All submissions agreed that, generally, there appears to be a good relationship between higher education/research institutions and MNCs. It was pointed out in several submissions that the growth of industrial partnerships with HEIs has generated additional complexities and workloads for the HEIs in managing partnerships, legal agreements, business development and training researchers in innovation and entrepreneurship. Resources to deal with this greater demand need to be put in place with supports extended to increase the capacity of the third level sector to engage in knowledge transfer activities.

Several submissions pointed out that for Ireland to achieve its ambition to be an innovation leader, there needs to be a strong talent pipeline and multiple channels for collaboration. Suggestions to enhance collaboration include promoting a high degree of collaboration across RPOs to facilitate cross-centre linkages; supporting the creation, management and exploitation of intellectual property (IP); facilitating the fluid mobility of researchers between academia and industry to support the transfer of knowledge, as well as creating a national research internship programme to bring research skills to specific innovation projects.

Several submissions called for greater collaboration between MNCs and indigenous SMEs through better functioning clusters in various technology areas. Clusters can act as powerful vehicles for effective knowledge transfer. Submissions pointed positively to existing enterprise supports in this area such as Enterprise Ireland's initiative to foster the development of industry clusters based in the technological higher education sector. The forthcoming national clustering policy and framework will aim to maximise the impact of clustering as a policy tool to support promoting clustering and linkages between enterprises and higher education institutions, collaborative innovation, knowledge sharing and maximising spillovers.

Other measures to enhance collaboration between the higher education and SME sectors include creating a national research internship training programme to bring research skills to SMEs for specific innovation projects; the continued funding of TTOs in the HEIs under the Technology Transfer Strengthening Initiative (TTSI); increased use of national template agreements to simplify and speed up contracting with higher education institutes, as well as to bring more consistency for companies and innovators; collection and publication of information on the facilities, equipment and supports available to companies to access within the third level and State-funded research base at national and regional level; the need to orchestrate existing and emerging capacities in regional areas and to raise the profile nationally and internationally; continuity of industry-academic collaborations beyond a completed project to help companies to bring a project's innovations to market; and the expansion of R&D tax credits to cover a wider variety of innovation activities.

Supporting Innovation Diffusion with S3

Through S3 Implementation Group co-operation, developing new funding streams through ERDF and feeding into Impact 2030: Ireland's Research and Innovation Strategy, S3 will stimulate enhanced innovation diffusion and represent the specific sectoral RD&I needs of the regions in national conversations.

Knowledge Transfer Ireland (KTI) and the Technology Transfer Strengthening Initiative (TTSI) programme will continue to be important drivers and supports for engagement between industry and the HEIs. The network of TTOs funded by the TTSI will be particularly important in the context of supporting the emerging Technological Universities to maintain the investment in skills and capacity to date and to assist companies and innovators with access to research outputs and expertise. Assisting the next generation of knowledge transfer priority at both national and regional level is a major of the next cycle of ERDF.

S3 supports national and inter-institutional initiatives such as developing a research infrastructures database, a new research infrastructures roadmap and ensuring that publicly funded research infrastructure is seen as a national asset to be shared by and across institutions, industry and regions. There may be a general need for co-ordination and scaling of research institutions in Ireland in order to increase capacity. It will be critical to encourage national level co-operation of relevant agencies to bring MNCs, SMEs and research performing bodies together to build a small number of sectoral areas of research excellence. The S3 Implementation Group will work with DFHERIS to ensure these priorities are considered in the delivery of Impact 2030: Ireland's Research and Innovation Strategy.

There is also a need for developing entrepreneurial and innovation skills for, and within, enterprise to support commercialisation of RD&I. This includes supporting postgraduate and post-doctoral researchers in developing skills which can enable them to transition between academic and industry environments. The S3 IG will work to ensure the importance of skills for RD&I is reflected in national skills strategies.

A lack of information on and connection between existing supports and institutions was considered a major issue for stakeholders. Collection and publication of information on the facilities and equipment available to companies to access within the research base at national and regional level would be beneficial. They would also benefit from national connection as the majority of specialist areas are not unique to one region and the pool of founders and investors are nationwide. At a smaller scale, improved functionality via the KTI website for companies and innovators to search for research expertise would also improve access to information on innovation. Increased supports for companies to build that capacity and capability internally combined with increasing the awareness for companies of the research and supports available within the third level another state funded research organisations would be beneficial.

4.5 International collaboration on RD&I

What do we mean by International Collaboration?

To form a robust Smart Specialisation Strategy, it is necessary to look beyond Ireland itself and recognise what others are doing. To specialise in something, it is vital to know how a country's strengths and priorities relate to those of others. While it might not be possible or appropriate to do the same thing that others are concentrating on, there might be opportunities to collaborate and build synergies with other countries.

International co-operation maximises the impact of international and national investment in research and innovation. It contributes to the development of Ireland as a research and enterprise partner, underscoring and enhancing the excellence of our research and innovation system and facilitating engagement with the Irish diaspora. A key plank of our engagement in international co-operation is participation of our researchers and enterprise in the EU Framework Programmes for Research and Innovation. Ireland has performed well in winning competitive funding under these Programmes, the majority of which is secured by our HEIs, with the balance being won by enterprise and public bodies.

DFHERIS has policy responsibility for the majority of Ireland's international RD&I collaboration initiatives. New metrics, targets and actions for these initiatives have been set out in Impact 2030: Ireland's Research and Innovation Strategy.

International Collaborative RD&I Initiatives in Ireland

Building long lasting and meaningful relationships with international partners of excellence is important to drive Ireland's RD&I performance. Research and innovation are increasingly international and collaborative endeavours. There are a number of strands to Ireland's international collaboration:

- Participation in the EU R&I framework programmes – this is the most effective mechanism for the Irish R&I community to collaborate with their counterparts in other countries. Ireland has drawn down €1.18 billion in competitive funding under Horizon 2020 to September 2021. The new programme, Horizon Europe, was officially launched in February 2021 and will have a budget of €95.5 billion for the seven-year period, 2021-2027;
- Bilateral co-operation with a small number of countries – this helps build innovation capacity, facilitate researcher mobility and allow for economies of scale. Strong partnerships are already in place with the US, the UK and China;
- Membership of the key International Research Organisations (IROs). Ireland is a member of the ten key IROs – the European Space Agency, the European Southern Observatory, the European Molecular Biology Laboratory, the European Molecular Biology Conference, EUREKA, COST, CECAM, EOSC, ELIXIR and LOFAR.

DFHERIS, through Science Foundation Ireland, is delegate to the ESFRI (European Strategy Forum of Research Infrastructures) which aligns itself to S3 across Europe. SFI has a number of international facing programmes which include our bilateral programmes with the UK. SFI 2019 Research Outputs data reflects 2,894 international collaborations in 75 countries and 71% of academic-to-academic collaborations being with partners overseas.

The Irish Research Council also manages/supports academic international research partnerships in Arts, Humanities and Social Sciences as well as managing some of the research framework programmes including the Irish Marie Skłodowska Curie Office and the ERA-Net partnerships.

Horizon Europe

Horizon Europe is the new EU research and innovation framework programme which will have a budget of around €95.5 billion for 2021-2027. Similar to Horizon 2020, Horizon Europe comprises a three-pillar approach based around excellent science, industrial competitiveness and innovation via the European Innovation Council.

While Horizon Europe is designed to build on the success of Horizon 2020, it includes several new features which include the establishment of the European Innovation Council (EIC) as a one-stop shop to support innovation, new missions with ambitious and measurable goals, more streamlined partnerships, enhanced opportunities for synergies with Cohesion policy programmes and a commitment to maximise the innovation potential across the, EU especially in lagging regions.

DFHERIS has overall lead responsibility at Ministerial/Departmental level for Horizon Europe engagement and chairs a High-Level Group of all the relevant Government Departments and Research Funders which oversees and co-ordinates implementation of Horizon Europe. A National Support Structure is led by the enterprise agency, Enterprise Ireland, to maximise participation by researchers and companies in Horizon Europe.

Ireland performed well in the previous Framework Programme, Horizon 2020, especially when adjusting for the size of our research base, and the country is on track meet our €1.25 billion national drawdown target.

Ireland had 4,944 SME applications under Horizon 2020, with an SME Net EU contribution of €306.1 million. The top preforming thematic area for Ireland was the Marie Sklodowska-Curie Actions (research fellowships) and our highest number of collaborations were with Spain (4,998 collaborations).

Impact 2030: Ireland's Research and Innovation Strategy sets out Ireland's overall ambition for Horizon Europe.

Interreg Europe

Interreg Europe helps regional and local governments across Europe to develop and deliver better policy, including through funding policy research and innovation. The Irish Regional Assemblies are actively involved in managing Interreg Territorial Co-Operation Programmes and have noted that Interreg project collaborations with RSES implementation and follow-through are yielding significant benefits to the regions, assisting economic sectors and stakeholders in enterprise and RD&I. Some recent examples of Interreg projects include:

- FIRESPOL, which addresses the financial barriers currently impeding greater investment in the generation and storage of Renewable Energy Sources (6 EU partner regions includes Southern Region);
- DEVISE, which aims to transfer technology provided by SMEs and start-ups in the ICT sector into Smart industry sectors including marine and manufacturing across 10 EU partner regions (includes Northwest);
- Next2Met, an innovative interregional exchange project which aims to increase the attractiveness – for knowledge, opportunities, and capital – of regions located close to metropolitan areas (6 EU partner regions includes EMR).

In addition, the Southern Regional Assembly is the Irish Partner on COHES3ION, an interregional project which aims at improving the performance and impact of S3 and linked ERDF Regional Operational Programmes, in terms of delivery of innovation by Research & Innovation actors. This will be achieved through integration of the regional dimension into S3 governance and policy mix, contributing additionally to regional cohesion in terms of growth and jobs.

All-Island Initiatives

Ireland has deep societal, cultural and economic relationships with Northern Ireland that are further deepened by a series of joint RD&I and enterprise initiatives. These are driven by several organisations, both North and South, but most notable in the RD&I space is the work of InterTradeIreland, Science Foundation Ireland and the Higher Education Authority, as well as the INTERREG VA and the new PEACEPLUS Programme.

InterTradeIreland (ITI)

InterTradeIreland helps small businesses in Ireland and Northern Ireland explore new cross-border markets, develop new products, processes and services and become investor ready. As one of the cross-border bodies, ITI is funded by the Department of Enterprise, Trade and Employment (DETE) and the Department for the Economy (DFE) in Northern Ireland.

In addition, ITI administer the US-Ireland R&D Partnership, facilitate access to Horizon funding and is the lead partner in Interreg Co-Innovate to increase the number of businesses participating in cross-border, transnational or interregional research projects.

ITI also has an established all-island cluster development support program which aims to solve common problems and identify joint opportunities that exist in Ireland and Northern Ireland.

Science Foundation Ireland

As mentioned earlier in this section, SFI has a number of international facing programmes these including bilateral programmes with the UK and Northern Ireland. In Shaping our Future - the SFI strategy to 2025 – SFI commits to expanding North-South research collaboration and articulate ambitious plans for all-island research centres and other research partnerships which will support the Programme for Government mission of 'A Shared Island'.

Higher Education Authority (HEA)

The HEA's new €40 million North-South Research Programme was launched in August 2021 and aims to support the deepening of links between higher education institutions, researchers and research communities. The programme is a collaborative scheme arising from the Government's Shared Island initiative and it is being delivered by the HEA on behalf of DFHERIS. It will support proposals in and between any disciplines in science, medicine, engineering, technology, arts and humanities including areas of creative practice and social science.

INTERREG VA

The INTERREG VA Programme is one of 60 cross-border programmes operating across the EU, which are designed to overcome issues that arise due to the existence of a border. The programme area includes the six Border counties of Ireland, Northern Ireland and part of Western Scotland. INTERREG VA focuses on four areas that are seen as crucial for job creation and growth: supporting cross border initiatives to strengthen research and innovation, preserving and protecting the shared environment, promoting sustainable mobility across the borders and enhancing cross-border collaboration for the provision of quality health and social care services.

The current INTERREG VA programme runs from 2016 to 2022. DETE has responsibility for funding projects under the Research and Innovation strand of the current INTERREG VA programme, together with our counterparts in Northern Ireland, the Department for the Economy.

PEACEPLUS

PEACEPLUS is a new EU cross-border programme that will contribute to a more prosperous and stable society in Northern Ireland and the Border Region of Ireland. The programme will achieve this by funding activities that promote peace and reconciliation and contribute to the cross-border economic and territorial development of the region. It will build upon previous PEACE and INTERREG Programmes. The PEACEPLUS programme is expected to open during Q2 2022 and will run until 2027.

Government Departments, North and South, have been providing input into the development of the programme by outlining key priorities and areas for intervention as well as identifying a pipeline of project activity that could be taken forward under the programme. The draft programme was approved by the Government, the Northern Ireland Executive, and the North South Ministerial Council in October 2021, with six thematic areas identified. Under thematic area two 'Delivering Economic Development & Transition', DETE is responsible for Irish involvement with the SME Development & Transition, and the Innovation Challenge Fund.

The proposed SME Development and Transition programme will build upon existing investments to support SMEs to operate at scale through cross-border collaboration. It will enhance growth and competitiveness of SMEs and increase job creation, resulting in the development of a stronger, more innovative and collaborative cross-border SME base, which will deliver higher levels of productivity, exports and sustainable employment in a post-Brexit, post COVID-19 economic landscape.

The Innovation Challenge Fund will support high-level, commercially focused RD&I within key growth sectors. It will support major innovation projects, which will create lasting local and national economic and social benefits, as well as enhancing cross-border research and innovation capacities and the uptake of advanced technologies.

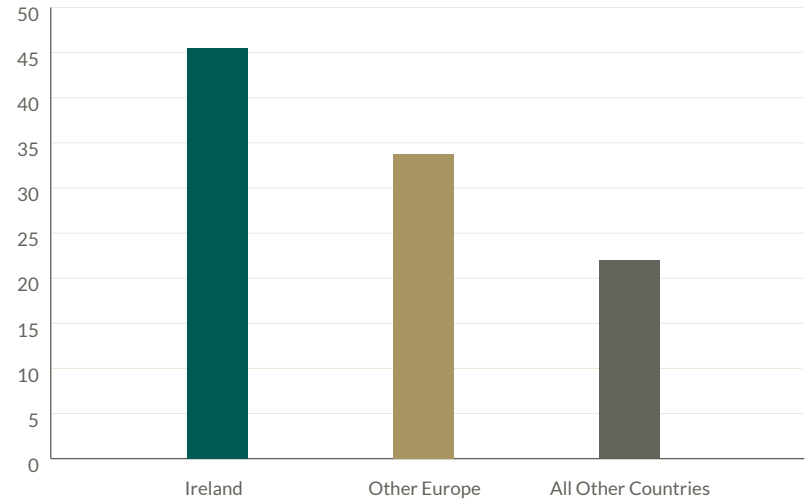
International Collaboration for Enterprise RD&I

Participating in international collaborative research brings benefits that accrue not only to our researchers but also to our enterprise base. The benefits include access to shared infrastructure and facilities, and collaboration in addressing research challenges. Partnerships with other companies and research institutes outside Ireland can provide huge benefits to Irish based companies. This has been successfully achieved through Horizon 2020 and will be extended in Horizon Europe. Membership of EU led cluster groups such as the European Cluster Collaboration Platform can, not only help Irish companies get insights into potential future emerging technologies, but also foster networking opportunities and international co-operation in order to address cross-sectorial challenges.

Of all technologically innovative enterprises in Ireland, 50.8% indicated that they engaged in some co-operative activity when developing their innovations with 33.7% indicating that they co-operated with partners in other European countries[31].

31. Innovation in Irish Enterprises 2018 - CSO - Central Statistics Office

Figure 4.3: Location of Co-Operation Partner for Technologically Innovative Enterprises 2016-2018



Source: CSO Ireland

In addition to the enterprise aspects of the Framework Programmes mentioned above, there are number of enterprise specific international research collaboration programmes in Ireland.

EUREKA Programme

EUREKA is the world's biggest public network for international co-operation in R&D and innovation. Eureka is open to SMEs, large companies, universities and research organisations, offering opportunities to combine expertise, exchange knowledge and enhance resources. EUREKA projects focus on the R&D of close-to-market products, processes or services. EUREKA has a number of sub-programmes such as cluster and network projects.

Enterprise Europe Network (EEN)

The EEN is the world's largest support network for SMEs and helps Irish companies to make the most of business and technology opportunities in the EU and other major global markets. In partnership with the EEN, Local Enterprise Offices across the country can support SMEs in becoming more knowledgeable and competitive in global markets, leading to greater international business opportunities.

European Space Agency (ESA)

Ireland has a thriving space technology sector, supported by our membership of the European Space Agency (ESA) which allows Irish companies and researchers access to a €6.5 billion per annum research-performing organisation, the largest in Europe. The number of companies engaged with ESA in Ireland has grown by almost 60% in the last five years from 55 in 2015 up to 87 in 2020 and is expected to exceed 100 by 2023. The establishment of an ESA Business Incubation Centre (BIC) in 2017 has played an important role in achieving these results. The BIC, led by Tyndall National Institute, is based across five regional locations and focuses on supporting new and existing companies to turn space-connected business ideas into commercial ventures.

Engagement with space brings wide ranging opportunities for Irish research community and industry. It offers a commercial opportunity as a growth sector in its own right, it supports the development of applications in non-space domains such as health, transportation, agriculture and climate, and it acts as an enabler of high performance and reliability technologies in sectors such as automotive, aerospace, advanced manufacturing, telecommunications, energy, biotechnology and more.

European Digital Innovation Hubs

As part of the proposed Digital Europe Programme (2121- 2027), the European Commission and EU Member States will establish a network of European Digital Innovation Hubs (EDIHs) to support businesses and the public sector in their digital transformation and to promote the adoption of the latest advances in cybersecurity, Artificial Intelligence (AI) and High-Performance Computing.

The EDIHs will be "one stop shops" that help companies (notably SMEs) and the public service become more competitive in their business/production processes, products or services by providing access to technical expertise and experimentation, so that organisations can "test before invest". EDIHs will also provide innovation services, such as financing advice, and the training and skills development necessary for a successful digital transformation.

Ireland has designated four EDIHs, which includes an AI hub, to compete in the EC confined call for the EDIH network. The call launched in Q4 2021 with the hub network set to become operational in Q3 2022.

Space Strategy for Enterprise

In June 2019, Ireland's first National Space Strategy 2019-2025 was published, representing Ireland's intention to actively engage in Space 4.0, the dawn of a new era in the space sector characterised by increased private sector investment and interaction between governments, the private sector, and society. The vision of the strategy is for Ireland to develop 'an economically sustainable and expanding space-active industry, delivering quality jobs for the economy of tomorrow. The delivery of the goals set out in the strategy is underpinned by a target to increase public and private investment in ESA by 50% by 2025.

Digital Europe Programme (DIGITAL)

Digitalisation of enterprise is increasingly recognised as a significant opportunity for driving productivity and growth in economies internationally. The EU has placed digitalisation of industry as a key component as it develops a long-term vision for the EU's industrial future. It recognises digital transformation is at the core of the next industrial revolution and that boosting the uptake of digital technologies along and across industrial value chains and promoting firm growth is key to Europe's growth and competitiveness. The European Commission estimates that digitalisation of manufacturing could add €110 billion per year to Europe's industry base. A forthcoming initiative under DIGITAL will see the development of a network of European Digital Innovation Hubs to support businesses and organisations in their digital transformation and to disseminate the latest advances in cybersecurity, Artificial Intelligence (AI) and High-Performance Computing (HPC). Ireland intends is set to have four hubs in this network, which will be operational by Q3 2022.

European High-Performance Computing Joint Undertaking (EuroHPC) and European Competency Centre (EuroCC)

Ireland is a founding member of EuroHPC, a European Union initiative which will build supercomputing and data infrastructure and support RD&I in the domain. The Irish Centre for High-End Computing (ICHEC) is the National EuroHPC Competence Centre (EuroCC).

In 2020, ICHEC launched its EuroCC Academic Flagship and SME Accelerator programmes, securing matched EU funding to provide leading-edge HPC services to Irish users from industry, academia and the public sector. Through this initiative, Ireland will have access to European HPC infrastructure, allowing Irish researchers and SMEs to access Europe's most advanced supercomputers. It will also bring opportunities for possible future collaborations with other EuroHPC participating states, including shared infrastructure access, upskilling and increased RD&I activities. The SME Accelerator will also allow SMEs to co- locate existing staff with the EuroCC over a 6-month period, allowing them access to HPC technical skills and infrastructure. The SME will be assisted to produce a technical solution model aimed at the optimisation of either an existing business process and modelling, or the development of new business processes and modelling.

ICHEC also hosts a Quantum Learning Platform to facilitate application development, research and innovation, training and education in the field of Quantum Computing, contributing to Ireland's smart economy. Quantum Computing is a rapidly emerging area of technological development that is of significant interest to the Ireland's regions.

European Cluster Collaboration Platform

According to 2020 Eurobarometer survey, 28% of enterprises in Ireland are organised in clusters, which is higher than the EU average of 14%. There are ten Irish clusters active on the European Cluster Collaboration Platform, an initiative of the European Commission funded by COSME, which highlights European cluster organisations with an aim to driving inter-country partnerships.

Important Projects of Common European Interest

Important Projects of Common European Interest (IPCEI) are large-scale, multi-country projects for global state-of-the-art innovation to address market or systemic failures in particular sectors. IPCEIs features projects with a dedicated focus on R&D as well as First Industrial Deployment (FID). By their nature, IPCEIs often entail significant technological and / or financial risks and require joint, well-co-ordinated efforts and transnational investments by public authorities and industries from several Member States. Currently, Ireland participates in co-ordinated initiatives for Batteries, High Performance Computing, and Microelectronics. Over the course of this strategy, we will continue to develop our national approach to participation in the IPCEIs, including considering further areas of national sectoral importance.

US-Ireland R&D Partnership

The US-Ireland R&D Partnership is a unique initiative involving funding agencies across three jurisdictions, the US, Republic of Ireland & Northern Ireland, to increase the level of collaborative R&D among researchers and industry across the three jurisdictions. The Partnership achieves its goals through tri-partite research projects in which the funding agencies fund the elements of research undertaken in their own jurisdiction. Importantly, the Partnership must add significant value to each research programme above that achievable by the PI in each jurisdiction working alone. Since its launch in 2006, the partnership has raised €110.164 million and funded 67 projects.

Consultation Findings for International Collaboration on RD&I

The consultation paper asked stakeholders to consider:

- In what areas of research or industry sectors does Ireland have an international competitive advantage;
- In what areas or sectors should Ireland concentrate its international research collaboration activity;
- What supports do these areas or sectors need to be competitive on a world stage;
- How can Ireland's regions use Ireland's international links and memberships to support their strengths and emerging areas of future opportunity?

Research/Industry Sectors in which Ireland has an International Competitive Advantage

In general, submissions were positive about Ireland's competitive advantage in international collaboration on RD&I, pointing to how Ireland is world-class in areas including pharmaceuticals, MedTech, AgriTech, FinTech, ICT and cybersecurity, as well as food and drink. More specifically, Ireland has international competitive advantage in research areas such as geosciences and integrating large volumes of variable renewable generation into the power system. Submissions underlined that the value add of RD&I at pre-production activity and post-production services has increased over the past 50 years across the complete end-to-end production cycle.

Using International Links and Memberships to Support Strengths and Emerging Areas of Future Opportunity

All submissions which dealt with this consultation area agreed that partnerships with other companies and research institutes outside Ireland provide significant benefits to Irish-based companies. Several submissions highlighted how important it will be to concentrate on areas which will be important for Ireland in the future such as climate change, offshore electricity generation and decarbonisation, along with other areas which will have significant international implications such as quantum engineering and microprocessor production. Increased participation by Irish enterprise in IPCEI in cutting-edge sectors was promoted in several submissions.

The need was highlighted for Ireland to embrace a greater diversity of funding and co-funding options in international research collaboration, particularly with the recent agreement on an EU recovery budget of €1.8 trillion earmarked to support

investment. While it was felt research funding is generally well-balanced, it is important to ensure the Irish RD&I ecosystem is sufficiently robust and dynamic to meet future challenges. Working alongside this, an online information centre on EU funding for Irish enterprise was suggested to assess, analyse and pursue funding sources. It was highlighted that funding programmes tend to be designed to address specific challenges which can be short-term focused. Consideration should be given to address funding for longer term challenges and potential. While targeting EU funding to support RD&I is important, it was argued that it should not be a substitute for national investment. National funding structures should be optimised to catalyse success in Europe. Areas where Ireland does not have as much expertise will require international collaborations to be leveraged.

All submissions welcomed the proposed use of smart specialisation strategy to develop synergies between Horizon Europe and other EU smart growth-related instruments and programmes, including the Connecting Europe Facility, LIFE, Digital Europe, and EU4Health and the new EU Cohesion Programmes 2021-2027. The Shared Island agenda could potentially secure funding under PEACEPLUS, the new €1 billion cross-border EU programme focusing on Northern Ireland and the Border counties.

Supporting International Collaboration with S3

It is intended, over the lifetime of this strategy, that the S3 Implementation Group (S3 IG) will work to identify opportunities to collaborate and build synergies with other countries in the enterprise RD&I space. For the first time, the S3 IG will bring together regional and national policymakers in the enterprise RD&I space, thus bridging a previous gap in Irish policymaking. It is intended that this will lead to better and more coherent outcomes for Irelands participation in EU and international programmes and that regional level recommendations will 'feed up' into the national policymaking space.

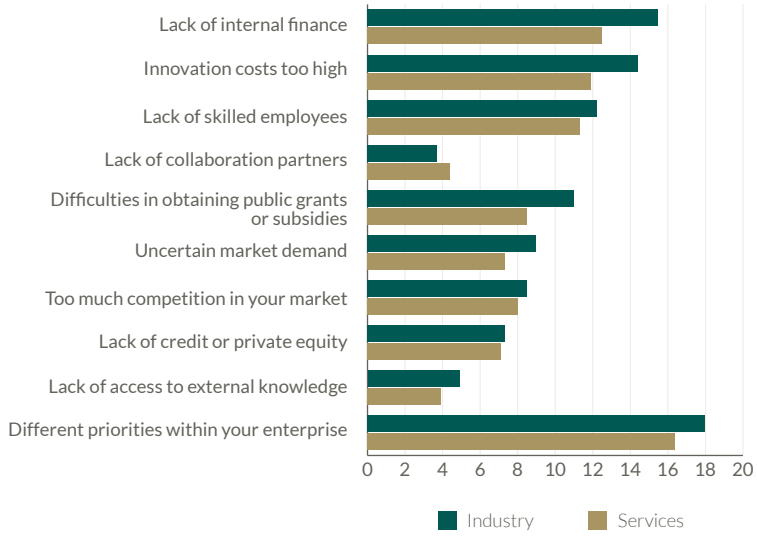
There is scope to develop better synergies between Horizon Europe and other EU smart growth-related instruments and programmes to build capacity and advantage. More consideration also needs to be given to ways to blend or align EU Programme funding, such as from the Digital Europe Programme (DIGITAL), to improve and develop RD&I eco-systems.

Linked into to these goals is the need to build capacity in the SME and HEI base to identify funding sources and to prepare professional and robust applications for competitive international R&D funds.

4.6 Improving the National Enterprise Research and Innovation System

As discussed under the national innovation overview, Ireland is considered a strong innovator[32]. However, there is opportunity for improvement, as Ireland continues to lag other EU countries in the level of investment in RD&I and there is a significant innovation gap between large MNCs and indigenous SMEs.

Figure 4.4: Factors Hampering Innovation Activities by Sector 2016-2018



Source: CSO Ireland

There is scope to improve the innovation potential of Irish SMEs by addressing some of the hampering factors to RD&I activity, which can include lack of funds, innovation costs and lack of skilled employees. Even though grant aid exists, innovation policy emphasises tax credits to stimulate firm-level R&D investments. These tax credits are effective but might not be as useful to start-ups and innovative young firms in emerging sectors. There may be other tools needed such as loan guarantees, risk finance instruments or initiatives for developing innovation capabilities. Improved RD&I grant initiatives could be explored, which would also address the low government R&D funding levels. Recent, novel RD&I grant initiatives such as the Disruptive Technologies Innovation Fund have bolstered Ireland's direct funding intensities, and the popular take-up of such instruments demonstrate the demand in Ireland's economy for such modes of intervention.

The most recent CSO Innovation Survey asked which factors had a high degree of importance in hampering enterprise innovation. The main factor cited, for both the Industrial (18.0%) and Selected Services sectors (16.4%), was different priorities within the enterprise. This was followed closely by lack of internal finance.

32. European Innovation Scoreboard

Consultation Findings for Improving the National Enterprise Research and Innovation System

Stakeholders were asked:

- Which RD&I initiatives have been successful for your sector/region? Which programmes should continue? Which RD&I programmes for enterprise are not working?;
- How do we generate a stronger, unified ecosystem approach to RD&I across the country to strengthen the visibility of our RD&I supports?;
- How do we target RD&I spend in a way which maximises impact for the economy, and which addresses the market failure evident in low RD&I in the indigenous SME sector?

Successful RD&I Initiatives and Challenges

Submissions agreed that, while Ireland is considered a strong innovator in the EU context, it falls behind other EU countries in terms of the level of investment in RD&I. In short, public expenditure on RD&I has not kept up with increasing business investment in the area, resulting in Ireland scoring significantly below the EU average for government investment in research and innovation. Furthermore, the COVID-19 pandemic brought the need for greater investment in the research ecosystem into sharp focus.

While submissions warned this could undermine Ireland's reputation as a hub for cutting-edge RD&I, all agreed that existing initiatives have been positive and successful. Such initiatives comprise both national and EU funded projects, including regional funds such as the Western Development Commission Investment Fund, SFI Research Centres, EI's Technology Centres, Gateways and Innovation Partnerships, Interreg and Horizon 2020. Some submissions stated that funds provided through innovation vouchers, while welcome, need to be increased, along with the expansion of existing RD&I tax credits. It was pointed out how the Disruptive Technology Innovation Fund (DTIF) programme has successfully brought SMEs, MNCs and research and academia together to work on common projects.

How to Generate a Stronger, Unified Ecosystem Approach to RD&I

The driving forces identified in the submissions which could be used to generate a stronger and more unified RD&I ecosystem are the Technology Transfer Offices and regional RPOs. Submissions noted the need to bring together large companies, SMEs and HEIs to identify common areas for research and development; collaboration on shared innovations when they are developed; an extended system of mentoring of SMEs by larger firms; the development of supply-chain partnerships; and more comprehensive funding mechanisms. Several submissions placed an emphasis on cross-collaborative approaches to RD&I with policymakers, research institutions, academia, communities and industry to address cross-sectoral areas such as enterprise, energy and transport. Cross-disciplinary collaboration could best be achieved through the creation of hybrid innovation clusters and hubs.

Several submissions placed an emphasis on cross-collaborative approaches to RD&I with policymakers, research institutions, academia, communities and industry to address cross-sectoral areas such as enterprise, energy and transport. Cross-disciplinary collaboration could best be achieved through the creation of hybrid innovation clusters and hubs. Aligning entrepreneurial supports with the national hubs network would improve awareness, visibility and engagement, as well as providing a stimulating culture to allow new initiatives to be tested before scaling internationally.

How to Target RD&I Spend to Maximise Impact

Many submissions highlighted reasons for the low uptake of RD&I in the indigenous SME sector. Long-term sustainability, both financial and staffing, of many successful existing programmes is one challenge. This could be addressed through a combination of financial supports and training, as well as continued assistance for HEIs to work with companies to realise the full potential of innovation partnerships. Other factors included a lack of awareness of the potential benefits of RD&I, the focus on a firm's immediate survival, a lack of dedicated personnel and time on the part of senior management, as well as concerns over costs against return and loss of market share. In turn, potential partnerships between SMEs and HEIs were largely untapped. It is also difficult for smaller businesses to navigate the research landscape in Ireland and to understand how they might benefit from the wealth of IP and expertise on offer in RPOs.

Stakeholders felt that a 'place-based' emphasis generates value by identifying and connecting the many local examples of RD&I excellence which exist across the country (e.g., in clusters and Institutes of Technology) which are often not very visible. By connecting these efforts, the country can help to overcome both market size challenges and reduce fragmentation of effort. In addition, this can also support Ireland to create a stronger presence and profile as an EU R&I 'front-runner', improving opportunities to boost innovation efforts with EU partners of choice.

Suggestions on how best to maximise RD&I spend centred on refining funding models and tax credits, along with developing an organisational structure to better utilise collaboration between research and enterprise.

Submissions called for increased infrastructure investment and industry-academia collaboration, along with financial supports for SMEs, such as feasibility grants and enhanced tax supports for R&D, to encourage their innovation, as well as to build connections and capability. Other proposals in this regard included increasing links between MNCs based in Ireland and indigenous SMEs through incentives and enterprise-led networks for innovation and skills development collaboration; better sharing of publicly funded research and innovation projects; using the Technological Universities to translate public investment into business investment in RD&I; create leadership programmes to deliver immersive innovation training to support industry and entrepreneurs to build an innovation culture and gain insight to emerging technologies.

Supporting Improved RD&I with S3

S3 will meaningfully support the national RD&I system by the adaptation of supports with a regional dimension through ERDF. This will involve supporting the regional enterprise ecosystem in strengthening projects to boost regional enterprise innovation and growth and address regional disparities, including through leveraging strengths and developing key skills in regional clusters.

By supporting regionally based SMEs working collaboratively with other partners, ERDF will drive digitisation, green economy opportunities, and relevant technological advances; and in so doing improve their competitiveness and potential for growth and internationalisation. It is intended that ERDF will contribute to increasing research intensity in SMEs, jobs in SMEs, and SME engagement with the public research system.

Furthermore, by supporting the regional innovation ecosystem ERDF will enable stakeholders to improve their relevant offerings and address unique regional challenges and thereby improve the national innovation ecosystem as a whole. This is in line with the nine Regional Enterprise Plans.

Delivering a National Clustering Policy

Ireland's current enterprise support framework promotes collaboration, clustering and linkages between enterprises and between Higher Education Institutions and enterprises. Clustering is also a strategic focus for both Enterprise Ireland and IDA Ireland as a mechanism to promote balanced regional growth and to strengthen enterprise linkages and spillovers.

With a distinctive mix of global players, innovative Irish enterprises, leading Higher Education Institutions and a growing landscape of clusters and networks, Ireland has an opportunity to strengthen and build on these collaborations and clustering through increased co-ordination by the State. The 2019 OECD Report on SME and Entrepreneurship Policy in Ireland also recommended that Ireland develop a national cluster policy via a long-term collaborative process involving national and regional policymakers. Accordingly, there is a strong case to develop a national clustering policy as a core component of our Enterprise Policy which can fully realise the economic potential from clustering.

Ireland's forthcoming National Clustering Policy and Framework is due to be completed in Q2 2022 and aims to:

- Maximise the impact of clustering as a policy tool to support the delivery of national enterprise policy objectives and economic recovery, competitiveness and, including enterprise productivity, competitiveness, and resilience; facilitating access to global markets; promoting FDI; promoting linkages and collaborative innovation, knowledge sharing and maximising spillovers; and accelerating decarbonisation and digital transition;
- Create the necessary conditions and appropriate financial support models that foster the emergence and the development of value-creating and sustainable cluster organisations of scale; and
- Maximise the development of international business linkages at EU level and beyond, on a cluster-to-cluster basis including through EU Strategic Value Chains and associated Important Projects of Common European Interest (IPCEI) and through the development of all-island and cross-border clusters.

The European Commission has identified clusters as having the potential to be key delivery instruments for national and regional smart specialisation strategies and, without prejudicing the outcome of the National Clustering Policy and Framework, it is expected that there will be many areas of crossover and synergy between it and S3. For example, the identification of regional sectoral strengths, capabilities and opportunities through the Regional Enterprise Plans will provide an important platform for future cluster development initiatives. In addition, the ERDF Operational Programme for 2021-2027 may present opportunities for the funding of clusters and S3 recognises the importance of funding and support for our cluster networks.

Supporting RD&I in the New Technological Universities

The new network of Technological Universities (TUs) will be a critical component of the higher education infrastructure, in particular in a regional context. A defining strength for TUs will be their development of a strategic focus on deepened, distinctive, internationally recognised and inherently technological research underpinned by robust basic or theoretical research.

TU research will be closely linked to innovation and human capital and skills development. It will be aligned to the needs of the economy, flowing from their connectedness, and collaboration with local, regional, national and international partners, enterprise and employers more generally. The TUs will develop a unique market-led research offering, which will build on the priorities and regional sectoral specialisations identified in the S3. Their presence will remove ambiguity as to who to approach and collaborate with on particular sectors and will provide a more streamlined industry/academic research collaboration experience.
The NRRP plans to invest in the Technological Universities Transformation Fund, which is expected to contribute to tackling regional disparities by building capacity in education and training in regionally based technological universities.

The emerging TU system has enhanced research targets to achieve so as to meet their legislative obligations. There is strong potential to use ERDF to leverage the strong relationships that TUs have with their local industry base and their national reach based on their established expertise through enhancing their capacity to engage. In turn this will drive an increase in knowledge transfer within the TU system over and above that of the existing individual Institutional members. Over the lifetime of this strategy, Ireland will seek support to develop the R&I capacity and capability of the TU sector.

Driving Collaboration and Clusters Through Investment in Disruptive Technologies
The Disruptive Technologies Innovation Fund (DTIF) makes a significant contribution towards improving the national innovation space, with tangible funding directed towards emerging and enabling technologies. The fund is designed to encourage collaborative research though a stipulation that each project must have three partners, at least one of which must be an SME. RPO participation is also encouraged. While DTIF does not have a targeted regional focus the de facto location of lead partners is dispersed across all regions in Ireland. These tend to be close to seats of learning, and/or educational or research institutes.

Evaluations of DTIF so far have been positive, acknowledging its value in delivering high-risk, high-return innovations and offering Irish companies a route to compete in (and potentially disrupt) global markets through collaboration on large, cutting-edge research projects.

To date, the vast majority of DTIF projects have been in the medical or ICT sectors, which is reflective of the strength of these industries in Ireland. Sectors of key or emerging importance for the country – such as Advanced Manufacturing and Climate/Sustainability – are eligible for DTIF, but somewhat underrepresented. The DTIF management team, in consultation with Enterprise Ireland and other stakeholders, is exploring ways to improve the level of participation from other sectors, thereby fostering innovation in these industries, driving new enterprise research collaborations and contributing to cluster development.

Improving the Visibility and Accessibility of RD&I supports

It is a priority to create a business environment that is conducive to business start-up, including SMEs, and sustaining growth throughout all phases of their lifecycle. The Regional Assemblies will aid and support enterprise development agencies in the removal of obstacles to starting and scaling a business and with key stakeholders to create an enterprise ecosystem that stimulates a pipeline for growth.

The requirement for investment to enhance the digitalisation capacity of the regions is evident however there are many facilities and opportunities available across the region not being optimised due to lack of visibility or complexity of accessing. This lack of communication and signposting was noted as a barrier throughout the stakeholder consultation. The S3s will endeavour to communicate the need for an easily navigable RD&I system at appropriate fora and advocate for a reduction in the bureaucracy and complexity of supports.

The Regional Assemblies and the Regional Enterprise Plan Steering Committees are key stakeholders in the regional S3 process. The Regional Enterprise Plans (REPs) are important vehicles in translating national level policies and strategies, including S3, into regional and local impact. Smart Specialisation was one of the four thematic areas considered during development of the REPs to 2024, alongside resilience and recovery, transition to a low-carbon economy and new ways of working.
Smart Specialisation is one of the key economic principles adopted in each of the statutory Regional Spatial and Economic Strategies (RSESs) developed by the Regional Assemblies. It is intended that the S3 will complement the work of the RSESs in creating an effective place-based market-led business ecosystem, allowing all regions to fully utilise their competitive advantages with respect to enterprise innovation and to fully maximise growth in their economies. Accordingly, the priorities identified by the REPs and RSESs are central to this strategy.

5 Overview of Regional Strategic Priorities Under Smart Specialisation

5.1 Economic Overview of the Regions

All EU countries are divided into regions for administrative purposes and for determining the regional eligibility and co-financing rates for support from funds such as the ERDF. The regions are called NUTS (Nomenclature of Territorial Units for Statistics). Ireland is divided into the following NUTS regions:

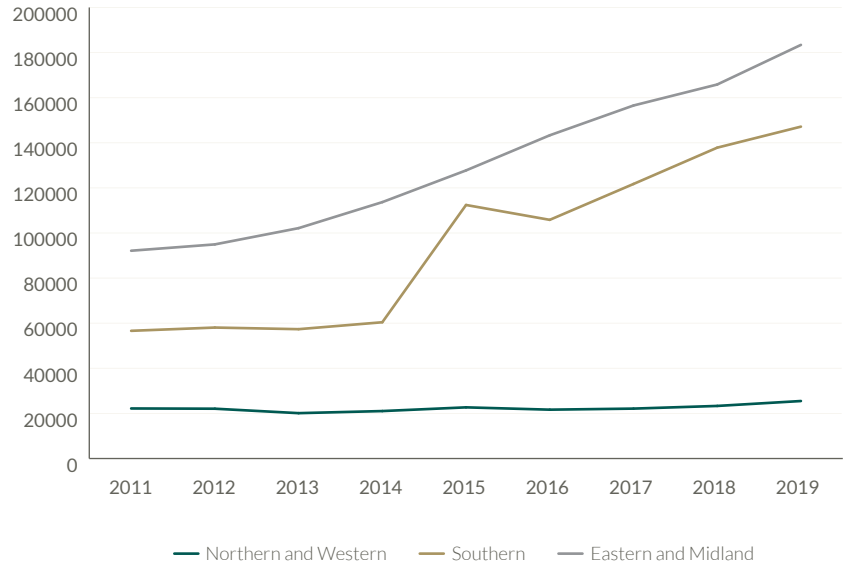
- NUTS 1 – Ireland (1 region)
- NUTS 2 – Regional Assemblies (3 regions): Northern and Western Region (NWR), Eastern and Midland Region (EMR) and Southern Region (SR).
- NUTS 3 – (8 regions): Midlands, Mid-East, West, Dublin, Mid-West, Border, South-West, South-East.

Across the EU, the European Commission classifies regions within the Union as either being a "Less Developed Region", a "Transition Region" or a "More Developed Region", based on their GDP per head of population relative to the EU27 Average. The Commission recently re-classified the NUTS 2 NWR from a "More Developed Region" to a "Transition Region" taking account of economic performance in recent years. Available data estimates that the NWR's GDP per capita was 78% of the EU average, which was 7 percentage points lower relative to the region's corresponding ratio in 2009, and 27 percentage points lower compared to the region's previous peak of 105% as of 2006.

Figure 5.1: NUTS 2 Regions in Ireland

Source: CSO Ireland

Figure 5.2: Total GDP by NUTS 2 Regions

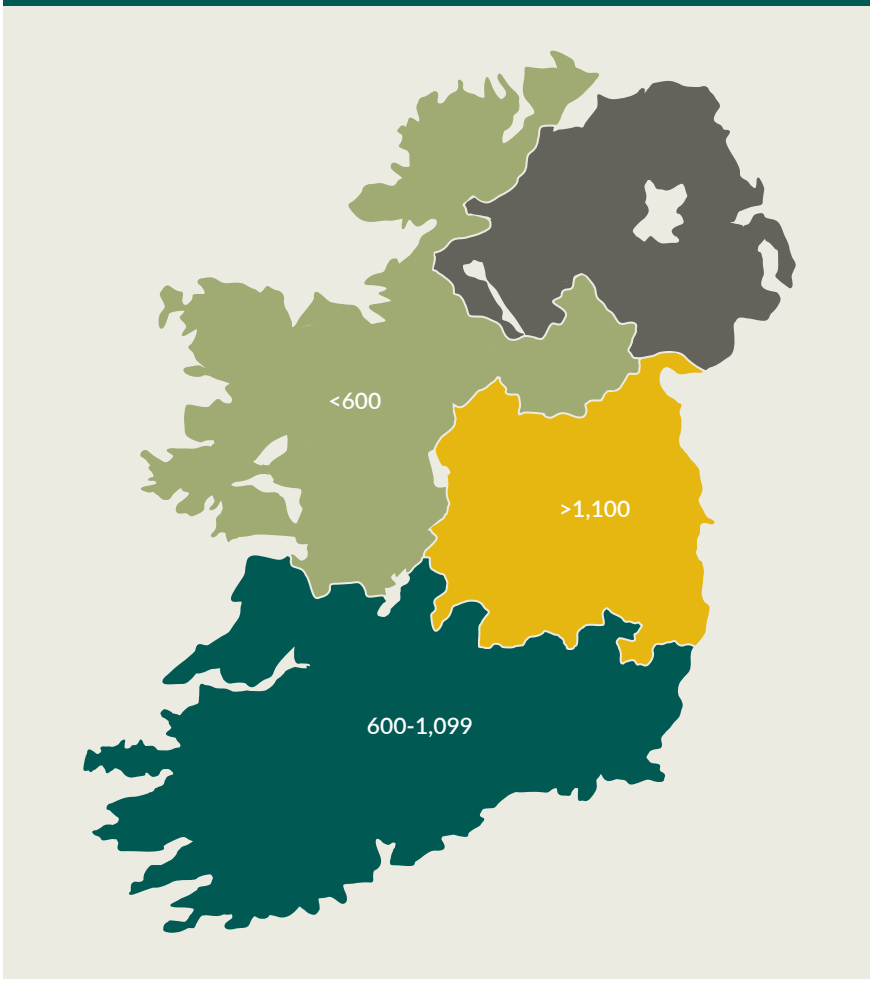


Source: Eurostat Regional economic accounts 2021 Eurostat - Data Explorer

The Greater Dublin Area historically has witnessed an overconcentration of population and employment. The consequence of this historical trend has been reflected in the European Commission's 2019 and 2020 Semester Country Reports for Ireland, with the Commission noting that regional disparities in Ireland are among the highest in the EU and are increasing. Although the degree of disparity across the country is accentuated when based on GDP/GDP per capita due to the distortive effects of multinational corporation profits in the data, it is nonetheless critical that the potential for economic growth in the NWR is realised and that there is an overall lift in its economic performance and sustainable job creation so as to restore the region to the status of a 'more developed region'. There are particular challenges to be overcome given the NWR's rural structure, and relatively peripheral and border location. Addressing regional disparities will also have the effect of relieving unsustainable pressures in the Greater Dublin Area that risk undermining the overall performance of the national economy.

These challenges are reflected in regional innovation spending. Total innovation spending in the EMR was in excess of €3.8 billion in 2016-2018 which accounted for 70.3% of all expenditure. The remaining 29.7%, which accounted for €1.6 billion of the total spend, was spent in the SR (€1.1 billion or 19.4%) and in the NWR (€560 million or 10.3%). Up to 59% of all innovation spending in the EM region can be attributed to in-house R&D, while the corresponding figure for the SR was 44.5%.

Figure 5.3: Total Innovation Expenditure by Region (€m) 2018



Source: Eurostat.

5.2 Key Sectors

RD&I activities are central to ensuring a resilient and internationally competitive enterprise base. RD&I contributes significantly to employment, export and investment growth; the competitiveness of indigenous enterprise; embedding the FDI base; and the creation and application of new knowledge and technology spill overs. It is for these reasons that we are seeking to better understand the enterprise innovation potential in each of the regions, and how we can help develop that potential in key sectors. As a small country, Ireland cannot be a leader in all areas of enterprise RD&I. Achieving innovation leadership in key sectors where we can sustain a competitive edge is the basis of current government innovation policy.

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.

Multinational-dominated exports of pharmaceuticals, medical goods and ICT products and services are continuing to grow despite the pandemic, contributing Ireland's robust GDP. With continuing pressure on global food production showing no sign of easing, as well as the growing environmental crisis, the demand for AgriTech products and services will continue to grow in the years to come across the globe. Ireland is in a good position to build advantage in this sector as a net exporter of food products. There are strong enterprises for each strength area of the three regions. These are supported by regional RD&I ecosystems and a higher education sector providing a pipeline of talent for enterprise.

Research Prioritisation

Research Prioritisation, introduced by the Government in 2012, aligns the majority of competitively awarded public investment in research with 14 priority areas and is the existing mechanism for ensuring that Ireland optimises the opportunities arising from science and technology developments and disruptions. The current Research Prioritisation areas were identified in 2017 further to a horizon scanning report, a technology futures report and a series of consultation events. These areas, valid until 2023, broadly comprise ICT; Health and Wellbeing; Energy, Climate Action and Sustainability; Food; Manufacturing and Materials; and Innovation in Services and Business Processes.

Many areas significant for Research Prioritisation emerged as significant in the S3 consultation. In particular, on the ICT front, the subsectors of quantum computing, cybersecurity, AI, blockchain, HPC, edge computing and DNA-based data storage were highlighted as areas of current and future opportunity.

Cross-Sectoral RD&I and Addressing Grand Challenges

While Research Prioritisation and sector specific RD&I remain important, innovations are increasingly built from diverse domains and expertise. This means that smart specialisms are not necessarily bounded by sectors and some of the best innovation can come from a cross-sectoral approach. While this S3 will identify regional sectoral specialisms, it should be noted that we also need to encourage creative dialogue that brings in different disciplines and expertise to address the challenges in S3, and to encourage, fund and manage resulting collaborations.

Note on Retail and Tourism

While S3 is a strategy for targeting our research, development and innovation polices towards technological advancement and developing the sectors of greatest economic and social importance (principally the high-tech and export traded sectors), it is noted that the Retail and Tourism sectors are also key employment generators for the country as a whole, and for rural locations in particular. Taken together, Retail and Tourism are the most employment intensive sectors in the country. Relevant national strategies are aimed at supporting and driving future endogenous sustainable growth in these sectors in order to support local and regional economies, which makes strategies for these sectors strongly aligned with the strategic objectives of the S3.

Tourism

In 2019, Tourism was worth over €9 billion in total to our economy and supported 260,000 jobs across the country. Tourism has been a leading job creator in this country over the last decade, especially in rural communities. With almost 70% of tourism jobs located outside of Dublin, it is the only employer of note outside of agriculture in many areas.

The Government's Tourism Policy Statement, "People, Place, and Policy – Growing Tourism to 2025', affirms its commitment to place tourism as a key element of economic strategy, with development in the tourism sector reflecting the highest standards of environmental and economic sustainability. The policy also recognises the important role that tourism plays as a driver of rural economies and commits to a

continued focus on the potential of tourism to facilitate rural development. The policy statement is implemented through a series of biennial Action Plans. Tourism is also addressed on a regional basis through regional tourism strategies, such as Ireland's Hidden Heartlands, Ireland's Ancient East, the Wild Atlantic Way, as well as broader strategies such as Survive to Thrive and Regional Spatial and Economic Strategies and Regional Enterprise Plans.

The outbreak of COVID-19 resulted in the Tourism Action Plan 2019-2021 being put on hold, with policy focus shifting to the sector's adjustment and recovery. A range of 5-year Destination and Experience Plans are being developed and implemented across the country, - by Fáilte Ireland. The COVID-19 pandemic placed a spotlight on the need for both attractions and activity providers to dramatically improve their online booking capability in particular.

The Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media (DTCAGSM) is committed to developing more sustainable, responsible and resilient tourism policies and strategies, including:

- promoting new technologies, digitalisation, ICT and data-sharing to enhance the performance of tourism businesses and the value of tourism destinations;
- understanding and meeting the growing and emerging needs of tourism consumers and adapt to their uses and practices;
- enriching the end-to-end tourist experience;
- improve tourism development planning and the smart management of tourism flows, as well as provide seamless travel, easier communication and integrated tourism development.

Fáilte Ireland, a body under the aegis of DTCAGSM, has launched a new Digital That Delivers programme that will see an initial investment of €6 million in the specialised training and digitisation of visitor attractions and activities across Ireland in 2021. Fáilte Ireland is seeking to partner with up to 500 attractions, activities, and day tour providers in year one and over 1,350 visitor experiences overall.

Retail

Population density is significant to the viability of retail and locally traded services. Attraction of investment to a region for manufacturing, etc, relies on many factors. We acknowledge the role locally traded businesses can play in placemaking to attract investment, which in turn lends to a "rising tide raises all boats" element. If the rest of the economy is positive and growing, then there is a spillover spend into locally traded services etc. although with potential for difficulties in attracting and retaining employees where other careers become potentially more attractive or lucrative.

Within the Programme for Government[33] the Town Centres First initiative under the aegis of the Department for Housing, Local Government and Heritage (DHLGH), is a strategic approach to town centre regeneration by utilising existing buildings and unused lands for new development, promoting residential occupancy in our rural towns and villages and is within the context of the National Planning Framework[34]. The NPF recognises the crucial importance of balanced regional development, clustered and compact growth, and improved connectivity to deliver economic prosperity and environmental sustainability.

33. Programme for Government: Our Shared Future - 2020
34. National Planning Framework - Ireland 2040 Our Plan - 2018

Linked to placemaking, the Night-time Economy Taskforce[35], under the aegis the DTCAGSM, affords an opportunity for relevant stakeholders from across the night-time culture sector to develop an innovative approach to support and develop a vibrant, diverse, and sustainable night-time economy in Ireland. In September 2021 the Taskforce produced a report with 36 actions to best serve those who work in, and wish to engage with, a vibrant night-time culture.

The aspects of S3 that are intended to support increased digitalisation are applicable to all sectors of the economy, not just those identified as the key RD&I sectors. The digital technologies being developed by the ICT sector in Ireland can be of significant benefit in the digitalisation of Retail and Tourism. There are several ICT projects working with these sectors such as AR/VR tourism and the Propeller Shannon Accelerator, which aims to drive the development of innovative start-ups in the aviation, aerospace and travel tech sectors. S3 supports the ongoing digitalisation of all sectors through the delivery of a variety of digital transformation supports outlined in Chapter 3. S3 supports these cross-sectoral digitalisation initiatives as sub-sectoral activity under ICT.

Publicly commissioned reports, such as the Seanad Public Consultation Committee Report on Small and Medium Sized Businesses in Ireland[36], point out that construction, retail and manufacturing sectors are laggard sectors in terms of SME adoption of digital technologies in Ireland. There is a need for both focused investment in tailored Digital Skills to assist the tourism and retail sectors and there is a need to cultivate an innovation culture to realise new products and maximise the R&D capacity already available to SMEs in third-level institutions and research centres. Delivering and maximising these broad digital and innovation supports will be a focus of this strategy and such supports will be of benefit to all sectors in the country, not just the identified key high-tech and export-oriented sectors.

5.3 Regionally Focused Enterprise Initiatives

DETE's Regional Enterprise Development Fund (REDF), first introduced in 2017 and administered by Enterprise Ireland, supports significant regional initiatives that build on sectoral strengths and/or to better leverage identified resources to improve enterprise capability, in order to help sustain and add to employment at county, regional and national level. There have been three calls under the Fund to date and just under €100 million in funding has been approved across 68 projects, with projects approved in every region. These projects are currently in implementation.

The €17 million Border Enterprise Development Fund (BEDF) was introduced as part of the Government's €28 million Border Stimulus Package in early 2020. The aim of the Fund was to improve the international competitiveness of enterprise in the Border Region in the context of Brexit and other market challenges. Through a competitive call, the Fund sought collaborative, enterprise capability-building projects, to advance entrepreneurship, productivity and innovation in the Border Region. Under the BEDF, 11 projects were approved funding totalling over €17 million with projects approved in each of the Border counties. The projects are currently in implementation.

35. Report of the Night-Time Economy Taskforce - 2021
36. Seanad Public Consultation Committee Report on Small and Medium Sized Businesses in Ireland - May 2019 | Tuarascáil ó Choiste Comhairliúcháin Phoiblí an tSeanaid ar Ghnóthais Bheaga agus Mheánmhéide in Éirinn - Bealtaine 2019 (oireachtas.ie)

5.4 Priorities Under the Regional Spatial and Economic Strategies (RSESs)

The RSESs provide a long-term statutory strategic planning and economic framework for the development of the NUTS 2 regions in line with the National Planning Framework and the economic policies of the Government. The three Regional Assemblies have developed their own RSESs, with each Assembly seeking to optimise regional potential. Each RSES provides an evidence-based and place-based approach for growth and how it will be directed and managed over the next decade. Each RSES addresses issues such as employment, retail, housing, transport, water services, energy, digitalisation, communications, waste management, education, health, sports and community facilities, environment and heritage, landscape, sustainable development and climate change.

The Regional Assemblies are responsible for co-ordinating, promoting and supporting the strategic planning and sustainable development of their regions through the RSESs. The Regional Assemblies are designated Managing Authorities for the ERDF co-funded programmes and also source European funding for regional priorities. They promote co-ordinated public services, monitor proposals which may impact on their areas, and advise public bodies of the regional implications of their policies and plans. The RSESs for each of the NUTS 2 regions, along with their identified priorities, will be discussed further under the regional chapters.

5.5 Priorities under the Regional Enterprise Plans (REPs)

The nine REPs are an integral part of Ireland's enterprise policy, aimed at driving economic growth and sustaining better standards of living throughout Ireland. The first set of REPs to 2020 were launched in early 2019 and built on the success of the previous Regional Action Plans for Jobs which were operational up to the end of 2018. Nine new REPs to 2024 were developed throughout 2021, alongside and in conjunction with the new S3.

As a 'bottom-up' initiative, the Plans complement national level policies and programmes such as Enterprise 2025 Renewed and the National Development Plan. They are informed by regional stakeholders' understanding of unique local strengths and assets, thus enabling more effective translation of national policy into regional and local impact through specific sets of local objectives that best realise these goals.

Nine Regional Enterprise Plan Steering Committees, chaired by private sector businesspeople and comprising representatives of the Local Authorities, LEOs, Regional Assemblies, Enterprise Ireland, IDA Ireland, Regional Skills Fora, HEIs, enterprise champions and others, oversaw the implementation of the Plans. The Committees maintain the Plans as 'live' agendas which aim to be agile and responsive to both new opportunities and also new challenges, such as: Brexit, Climate Action, Digital Economy, and most recently, the COVID-19 pandemic economic impacts.

While each REP has considerable discretion as to the final composition of its plan, each was asked to consider four priority thematic areas and derive achievable actions based on those. The thematic areas identified for the new cycle of REPs are:

- Resilience and recovery;
- Climate and transition;
- Smart specialisation;
- Regional Competitiveness and Placemaking.

5.6 Intellectual Property and Areas of Regional Specialism

The number of patents in a given region can be considered a proxy for areas of regional strength and signify technology areas where regions are at the cutting edge. Analysis for the SR explored this.

It analysed the technological profiling for the Southern, Eastern and Midland, and Northern and Western regions, using patent filings at EPO during the period 2015-2019, which were retrieved from the OECD REGPAT database (Jan-2021). It used the location data for inventors to examine the technological capabilities of the three NUTS 2 regions, with the underlying assumption that the inventor's location is a relevant proxy to the regional areas where technology and knowledge creation activities were carried out. It split the number of patent applications between the regional locations of inventors for each of WIPO's 35 technology fields. A detailed breakdown of this data is contained in Figure 5.4.

The growth of patenting activities varies greatly across technological fields and patent activity points to regional differences in terms of potential specialisation. These are explored in the regional analyses.

Figure 5.4: Global Patent Growth Rates by WIPO Technological Field (2018-2019), Relative Regional Performances in Terms of Patent Activity (2015-2019), and Pop-Performing Regions in Each Field.

	Overall Percentage Growth Global Patents (2018-2019)	Southern	Eastern and Midland	Northern and Western	Total Europe	Top Performing Regions in Each Area		
Digital communication	19.60	44	168	27	12183	2423	Stockholm	Sweden
Basic communication processes	13.90	20	11	1	2357	328	Oberbayern	Germany
Other consumer goods	10.50	12	26	8	9776	887	Oberbayern	Germany
Materials. metallurgy	10.20	8	8	2	10979	879	Oberbayern	Germany
Computer technology	10.20	46	173	82	14609	2013	Ile-de-France	France
Control	8.30	29	37	12	10378	1275	Oberbayern	Germany
Optics	7.40	7	16	22	6603	985	Ile-de-France	France
Transport	6.60	17	25	48	27828	3336	Oberbayern	Germany
Electrical machinery. apparatus. energy	5.50	43	33	21	28693	2323	Stuttgart	Germany
Telecommunications	5.30	31	85	14	5583	918	Oberbayern	Germany
Machine tools	4.80	20	10	5	13566	1624	Stuttgart	Germany
Pharmaceuticals	4.40	49	107	28	13332	1565	Ile-de-France	France
Measurement	3.80	51	91	22	24994	2143	Oberbayern	Germany
Audiovisual technology	3.40	9	22	32	7371	660	Ile-de-France	France
IT methods for management	2.70	20	145	15	3635	495	Ile-de-France	France
Biotechnology	1.70	51	64	19	11417	1231	Ile-de-France	France
Other special machines	1.50	35	38	39	20304	1362	Oberbayern	Germany
Handling	1.40	25	13	21	14390	1186	Emilia-Romagna	Italy
Medical technology	0.90	168	204	257	19185	2688	Noord-Brabant	Netherlands
Chemical engineering	0.90	42	59	22	13811	1053	Ile-de-France	France
Furniture. games	0.50	12	18	16	8080	673	Detmold	Germany
Food chemistry	-0.20	33	20	3	3456	322	Région lémanique	Switzerland
Surface technology. coating	-0.20	9	13	4	8715	582	Düsseldorf	Germany
Organic fine chemistry	-0.50	16	43	11	15058	1605	Darmstadt	Germany
Semiconductors	-0.60	29	21	4	5993	636	Darmstadt	Germany
Thermal processes and apparatus	-0.60	10	21	6	8126	703	Oberbayern	Germany
Environmental technology	-1.10	11	19	4	6691	609	Ile-de-France	France
Analysis of biological materials	-1.50	19	26	8	4414	497	Ile-de-France	France
Textile and paper machines	-1.90	5	13	4	7100	432	Düsseldorf	Germany
Macromolecular chemistry. polymers	-2.10	5	32	6	10368	1215	Düsseldorf	Germany
Basic materials chemistry	-2.10	11	64	7	15230	2062	Düsseldorf	Germany
Mechanical elements	-2.20	10	17	5	18825	1585	Stuttgart	Germany
Civil engineering	-2.30	20	29	9	14950	1047	Arnsberg	Germany
Engines. pumps. turbines	-3.90	19	33	6	15554	1565	Stuttgart	Germany
Micro-structural and nano-technology	-9.50	5	2	0	862	84	Ile-de-France	France
Total		**941**	**1706**	**790**	**414416**			

Source: OECD REGPAT-2021 and SRA calculations.

6 Regional Economic Context and Priority Sectors for the Northern and Western Region

6.1 Economic Context – Northern and Western Region

Economic Overview

In Q4 2021, total employment in the NWR amounted to 423,100, which accounted for 17% of Ireland's employment base. By 2040, it is estimated that the region's employment base will expand to around 450,000. Employment in both high-tech and knowledge-intensive services is below the national average in the NWR with the share of high-tech employment at only 5%. This is reflective of the relatively rural nature of the region as a whole and its corresponding low population density and is also indicative of a relatively higher dependence on lower value economic sectors in the region. Productivity (GVA per worker) in the NWR stands at 98% of the EU average. However, the number of IDA Ireland client companies based in the region has risen over the past decade, from 136 companies in 2009 to 174 in 2019 and the overall unemployment rate in the region is currently (Q1 2022) below the average for the State. GDP per capita in the NWR stood at 78% of the EU average in 2019 and has been growing at a slower rate than the rest of the EU.

Regional Status, Differences and Challenges

The NWR has been designated as a "Transition Region", "Lagging Region" and "Moderate Innovator" by the European Commission, the European Parliament's Committee on Regional Development and the European Commission's Regional Innovation Scoreboard respectively. The reasons given for the decisions behind these designations highlight the challenges facing the NWR.

The European Commission downgraded the NWR from its previous status as a "More Developed Region" to a "Transition Region" for the funding period of 2021 to 2027. It is the only region in Ireland to be classified as such. This was due to the fact the region's GDP per head of population continues to lag the EU average.

The difference between the richest and the poorest NUTS 3 area in Ireland in terms of GVA per capita doubled between 2000 and 2016 although the degree of difference can be accentuated by the impact of multinational companies in the better performing regions. With the location of globally competitive multinational companies around Dublin and Cork, these areas offer increasingly favourable business and innovation environments compared with more rural and remote areas such as those found in the NWR. The European Commission stated existing regional differences raised concerns about whether the trend of increasing disparities can be reversed in the near future[37]. The European Parliament's Committee on Regional Development categorised the NWR as a "Lagging Region"[38] - facing specific development challenges across a host of areas, including relatively lower productivity and educational attainment, as well as a weaker skills base and business environment.

In terms of labour productivity, the latest estimates from the CSO show that the NWR's GVA per employee was the lowest out of the three NUTS 2 regions in Ireland in 2019 although the degree of difference is accentuated due to the effect of large multinationals in the data for the better performing regions. Between 2012 and 2019, employment in higher value knowledge-intensive services and high/medium-high manufacturing accounted for only 23.8% of total jobs created in the region.

37. European Commission Country Report Ireland 2020
38. Research for REGI Committee - EU lagging regions: state of play and future challenges | Think Tank | European Parliament (europa.eu)

Between 2012 and 2019, employment in higher value knowledge-intensive services and high/medium-high manufacturing accounted for only 23.8% of total jobs created in the region. The NWR faces several significant challenges with digital infrastructure from the lack of access to digital technologies to relatively lower prevalence of basic digital skills, as well as below average levels of employment in digital industries. The third level attainment rate in the NWR stood at 47% in 2020, slightly below the State average of 51%. In 2020, 9.8% of adults in the NWR took part in lifelong learning activities. While this is higher than the EU 27 average of 9.2%, it is lower than the average for Ireland at 11% and notably lower relative to other leading regions across the EU.

According to the 2019 European Regional Competitiveness Index, the NWR is ranked as the 177th most competitive region in the EU. In this regard, its peer regions include Nord-Pas de Calais, Bourgogne, Umbria, Sachsen-Anhalt and Mecklenburg-Vorpommern. The region records a similar performance across a host of competitiveness indicators including infrastructure, innovation, education, and technological readiness but underperforms relative to its peer regions with respect to labour market efficiency and market size.

Digitalisation and Green Transformation

The lack of access to high-speed broadband in Ireland, particularly in rural communities, has been cited in recent European Commission Country Reports for Ireland as a contributing factor to regional imbalances with respect to skilled labour, productivity and competitiveness. The NWR, with the highest proportion of rural communities, is particularly affected by this issue.

Of the three NUTS 2 regions of Ireland, households based in the NWR recorded the lowest level of access to fixed broadband in 2020, with a connection rate of 76%. This was considerably lower compared to the State average of 85%. In conjunction with the lack of access to high-speed broadband, it should be noted that the Country Reports also highlighted how relatively low levels of basic digital skills in the Irish workforce were acting as a barrier for greater uptake of innovation, with this issue of particular relevance to the NWR. Although relevant regional statistics are not readily available, the lack of basic digital skills in the region is evident from the fact that:

- 25% of individuals based in the NWR never used the internet as of 2020 (State average 6%);
- 60% of individuals based in the NWR used the internet daily in 2020 (State average 84%);
- 47% of individuals based in the NWR used the internet to exchange information and services with government and public administrations in 2020 (State average 62%);
- 53% individuals based in the NWR used the internet to order goods or services for private use in 2020 (State average 74%).

The digital transformation of the NWR's economy will be central to the implementation of the NPF, the RSES, and the Government's rural development strategy Our Rural Future which aims to – among other things – reduce the gap in urban-rural digital connectivity. In transitioning to a more digitally oriented economy, the NWR is currently facing a number of significant challenges, ranging from the lack of access to digital technologies, low levels of basic digital skills and below average levels of employment in digital industries.

Additionally, ongoing and tailored investment is required to deliver a digital just transition for the Region, to ensure readiness for impacted businesses, and to understand and address employment vulnerability resulting from digitalisation.

The transition to a low-carbon economy provides a major opportunity to revitalise the NWR's economy and enhance the quality of life offering of the region. Such a transition provides opportunities to generate sustainable employment in areas such as renewable energy, RD&I activity, productivity and efficiency gains; while building climate resilience, enhancing natural assets, supporting sustainable settlement and mobility patterns and improving the quality of life of for citizens.

Regional, Spatial and Economic Strategy for the NWR

Launched in 2020, the statutory Regional, Spatial and Economic Strategy (RSES) of the NWR brings together spatial planning and economic policy to provide a long-term, statutory, strategic investment framework for the region and will assist in the implementation of the NPF, as public bodies and local authorities also have to ensure that their plans and programmes are consistent with the RSES.

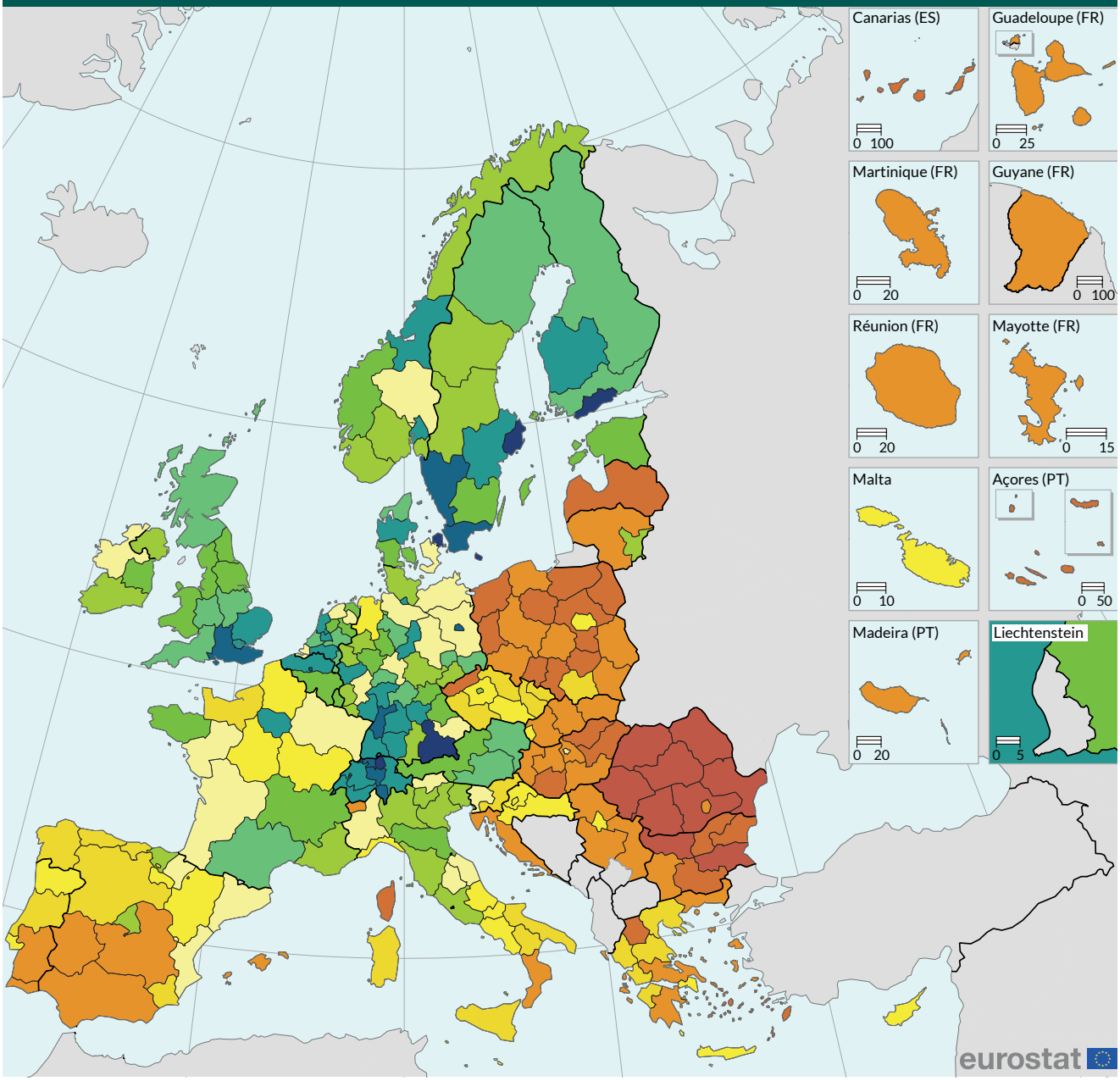
By focusing on a wide range of interconnected strategic areas – such as population growth, sustainable housing patterns, transport mobility, health, education and social services, economic development and climate change – the RSES of the NWR collectively identifies the region's assets, opportunities and challenges, providing an overarching policy response in the form of Regional Policy Objectives. In doing so, the RSES of the NWR aims to achieve sustainable population and employment growth up to 2032, while supporting the NWR's ambition to become a region that is "Urban", "Connected", "Smarter", "Specialised" and "Green", consolidated by a settlement strategy focusing on "People and Places". It thus has a very close fit with S3.

6.2 Innovation Context

Overview

Although the previously mentioned challenges associated with RD&I performance were outlined at a national level, it seems that the culmination of these trends have notably affected the NWR's innovation capacity, as evident from the latest trends in terms of research and innovation. In the 2021 results of the European Commission's "Regional Innovation Scoreboard", the NWR is now the only NUTS 2 Region in Ireland to be classified as a "Moderate Innovator+" – recording an innovation index score between 70% and 100% of the EU average – whereas the SR and EMR are classified as being "Strong Innovators" i.e., regions with an innovation index score between 100% and 125% of the EU average.

Figure 6.1: Eurostat: Regional Innovation Scoreboard, 2021



For Cyprus, Estonia, Latvia, Luxembourg and Malta, performance group membership is identical to that in the EIS 2021 report. For these countries, the corresponding colour codes for the middle sub-group of regions have been used.

Source: Eurostat

Although the region's overall innovation index score has improved since 2014, the NWR continues to record notable weaknesses - relative to the EU average in 2021 - in terms of:

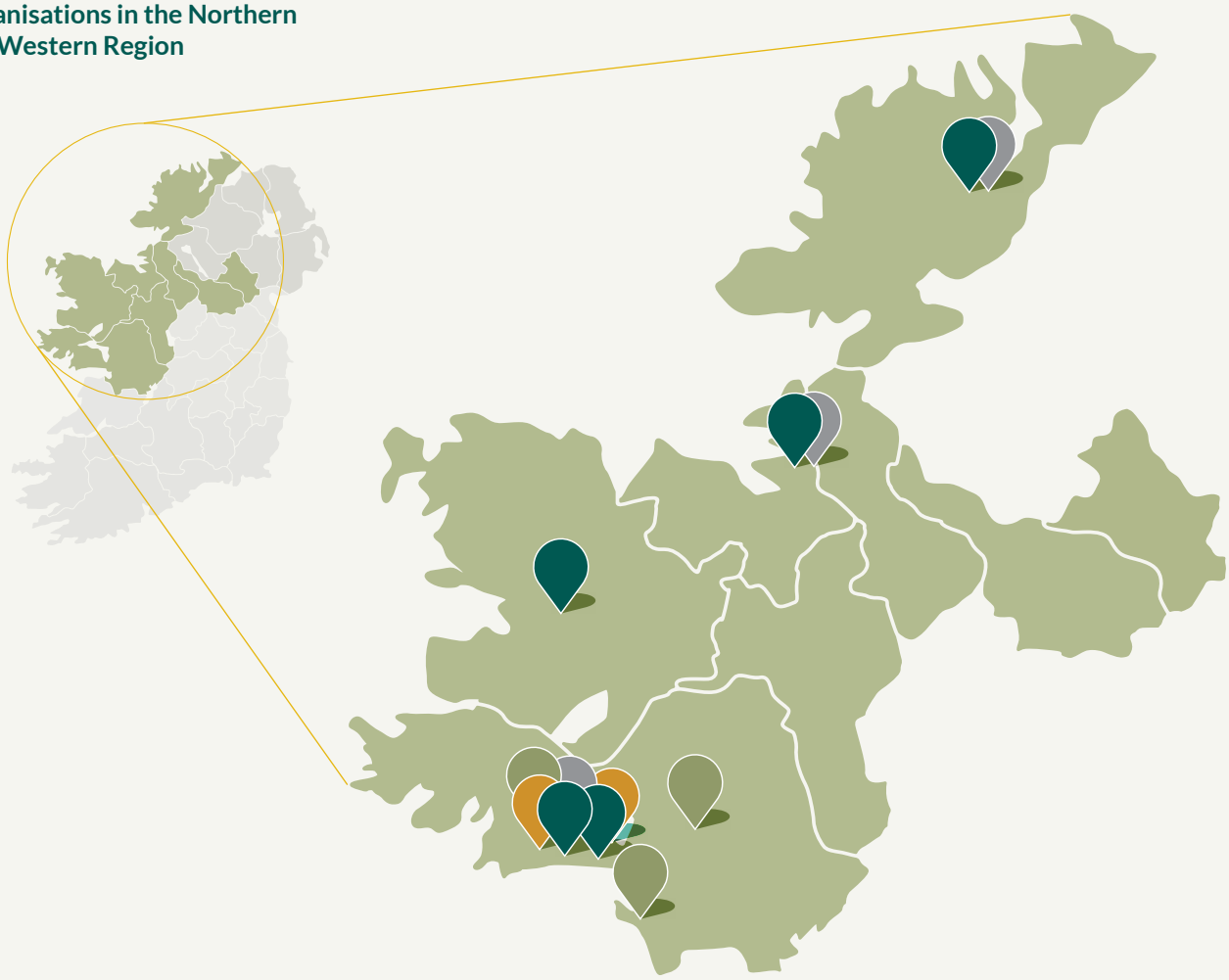
- Research and development expenditure in the private sector;
- Research and development expenditure in the public sector;
- Employed ICT specialists;
- Employment in knowledge-intensive activities;
- Patent applications;
- Trademark applications;
- Design applications.

Regional differences were also evident in recent trends in R&D activity and R&D staffing levels by the private sector. In 2019, the total level of private sector expenditure on R&D recorded in the NWR stood at €277.3 million, representing a decline of 15.7% relative to the corresponding base year in 2017. Out of the three NUTS 2 Regions, the NWR was the only region to record a decline in expenditure over this period. Furthermore, in 2019 a total of 3,506 people were engaged as R&D staff in the private sector in the NWR, accounting for 0.8% of the region's labour force. This was below the corresponding share for Ireland (1.1%). Relative to the base year of 2017, the total number of people engaged as R&D staff in the private sector in the NWR fell by 16.3%, whereas the corresponding figure for the State showed growth of 1% over this period.

One of the development challenges facing the NWR includes the need for more investment in regional RD&I facilities and programmes to address the lagging productivity of domestic enterprises and to improve the resilience of its economy to external shocks. The NWR has a noticeable advantage in start-up incubation, as noted in consultation, indicating potential for good absorptive capacity for increased RD&I investment. The lower cost of living and attractive hub initiatives are key factors leading to a significant amount of start-up activity in the North West. In Galway, the start-up ecosystem, includes ATU's iHubs (also in Castlebar), the Galway Technology Centre, NUIG's new innovation district and the Halo Business Angel Network (HBAN) MedTech syndicate. The majority of start-ups in Galway are in ICT (especially ICT for Financial Services) and MedTech. In Donegal, the Local Enterprise Office recently launched the Scale-X technology accelerator for start-ups with potential for fast growth in ICT, FinTech, health science, medical and other tech-based industries. There is potential to create a digitally connected innovation corridor connecting existing, emerging and new incubation spaces (including Portershed, Building Block Sligo etc.) that will attract businesses and industries working in the ICT and MedTech sectors and will network start-ups to develop potential scale and R&D partnerships.

**Figure 6.2: NUTS 2 North West Region -
Galway, Mayo, Roscommon, Sligo, Cavan, Monaghan, Donegal, Leitrim**

Key Research Performing Organisations in the Northern and Western Region



Higher Education Institute (HEI)
NUI Galway
Atlantic Technological University, Castlebar
Atlantic Technological University, Galway
Atlantic Technological University, Letterkenny
Atlantic Technological University, Sligo

National Institutes and Facilities
Teagasc Research Centre (Rural Economy)
Marine Institute
ICHEC (High Performance Computing)

SFI Research Centre
Curam (Medical Devices)
Insight (Data Analytics)

Technology Gateway
MET (MedTech)
PEM (Engineering)
WiSAR (IoT)

6.3 Sectoral Overview

This section outlines the main sectoral areas of strength and emerging opportunity which were identified during consultation. It also takes into consideration the following factors:

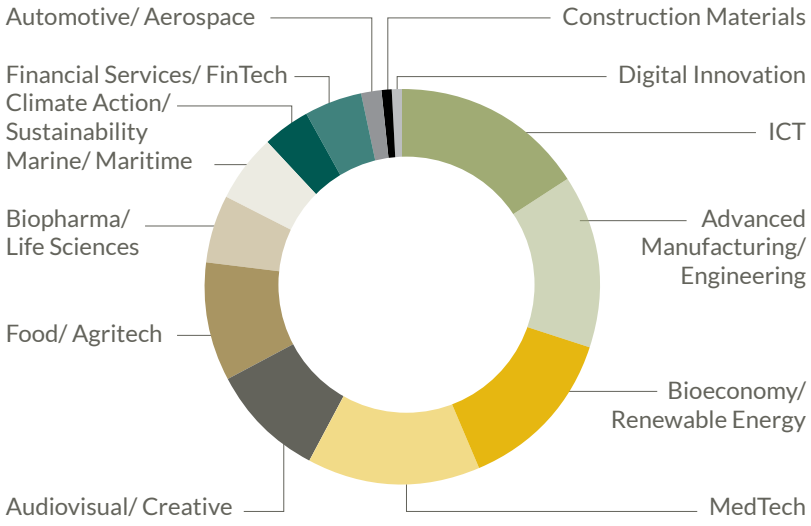
- IDA Ireland companies in the region;
- Enterprise Ireland investment in the region;
- RD&I resources including SFI Research Centres, Enterprise Ireland Technology Gateways, Enterprise Ireland and IDA Ireland Technology Centres, and National Institutes for Research and Development;
- Current cluster activity in the region;
- CSO trade and employment statistics;
- An analysis of sectoral strengths as identified in the RSESs.

Consultation Findings

Stakeholders were asked to identify the existing sectoral strengths and emerging areas of opportunity in the NWR. 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:

- MedTech;
- Life Sciences;
- ICT;
- Food/AgriTech;
- Marine;
- Financial Services;
- Climate Action/ Sustainability;
- Manufacturing;
- Audio visual/Creative.

Figure 6.3: Identified Sectoral Strengths and Opportunities for the NWR



Source: DETE - Smart Specialisation Public Consultation

While all stakeholders agreed with those identified by DETE a number of additional sectors and sub-sectors were identified by stakeholders as significant based on their understanding of the strengths, ongoing capacity and knowledge of future changes in the region. Sectors identified by stakeholders in which the region has either existing or emerging strengths are included if the sector is or has the potential to be a high-

tech export traded sector. This means that tourism and retail, despite being identified for every region, are excluded in this analysis. This does not mean that these sectors are unimportant for the future development of the region, but that these are not areas in which there are the same levels of scalable economic and R&D potential. An overview of the sectors referenced in consultation is presented in Figure 6.3

6.4 Identified Sectoral Strengths and Emerging Opportunities

In terms of employment the NWR has several noticeable areas of strength, although these vary by county. Manufacturing is particularly important in the region, with every county being above the average share of 6.10% employment in manufacturing. Construction and Tourism were also generally significant. By contrast, the region's share of employment in more high-tech areas such as ICT, Financial Services and Professional and Scientific Activities are all below the national average. This makes the region more dependent on lower value economic sectors.

Across the West, there is a globally recognised cluster of health sector multinationals and indigenous companies, supported by active research assets, infrastructure and property solutions such the SFI Centre for Research in Medical Devices (CÚRAM) and the Medical & Engineering Technologies (MET) Gateway at ATU, among others. For the North West, key sectors of economic advantage include high value manufacturing (Pharmaceutical, Medical Devices and Engineering) along with ICT services, including software development and deployment for Financial Services/ Insurance. The Food and Marine sectors are also significant for the region. In addition, there are long-standing strengths in the audio visual and creative sectors.

As noted previously, Tourism and Retail are of significant importance for the country as a whole and, in particular, for the NWR. The Wild Atlantic Way touring route has become a national asset, delivering substantial economic benefits to the NWR and the entire western seaboard. Along this route, there are numerous regional destination towns – such as Galway City, Sligo Town, Letterkenny, Ballina, Westport and Donegal Town (identified as Key Destination Towns) – and tourism assets and natural amenities – such as the region's historical sites, beaches, lakes, rivers, walkways, greenways and blueways – which will continue to support visitor numbers across the region in the coming years. The Hidden Heartlands brand – which covers west of Cavan Town, Leitrim, Galway and Roscommon – and the Ancient East brand – which covers East of Cavan Town and Monaghan – can also enhance the economic performance of the NWR's economy over the coming years.

As this strategy is based on setting priorities for research investment for and enhancing the R&D capacity of regions, the sectoral aspect of S3 will focus on sectors that are R&D intensive and with a strong globally traded, export focus in areas where Ireland can build a competitive advantage. Based on our consultation findings and the economic analysis of the region undertaken. The identified areas of sectoral strength and potential opportunity are:

- Advanced Manufacturing and Engineering;
- Audio visual/Creative;
- Marine and Blue Economy;
- Renewable energy, Climate Change mitigation and sustainability;
- AgriFood and AgriTech;
- ICT and ICT Services;
- Life sciences, Med Tech and Medical Devices.

Advanced Manufacturing and Engineering

The NWR has an acknowledged expertise in advanced manufacturing and engineering. As previously indicated, the region has an above average share of employment in manufacturing – much of this in high-tech manufacturing for the Medical Devices sector in the West.

The subsector of transport engineering and manufacturing also has significant capacity in the region – this includes vehicle and parts manufacturing. New opportunities are coming from the autonomous vehicle cluster in Shannon extending its influence on the NWR and Atlantic Technological University (ATU) Sligo offering a Master of Engineering in Connected and Autonomous Vehicles (the first European HEI to do so). This has occurred with the background of government plans to expand infrastructure and investment in the next generation of vehicles, with Budget 2021 increased funding for the transition to electric vehicles including over €100 million for EV grants and charging infrastructure.

Manufacturing in the Border Region tends to be lower skilled and is most exposed to Brexit, internationalisation, automation/industry 4.0 and digitalisation, new technologies and the low-carbon economy. In 2021 a Border Region Manufacturing Cluster initiative was established to increase the engagement and connectivity of the three border IoTs – Sligo, Dundalk and Letterkenny – with the economy and industry overall, and with manufacturing SMEs and micro/small companies throughout Counties Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth. The primary aim of the cluster is to drive increased productivity and encourage the uptake of Industry 4.0 technologies.

RPOs supporting Advanced Manufacturing and Engineering in the region include:

- The Applied Polymer Technologies (APT) Technology Gateway in Athlone, which specialises in additive manufacturing and composite materials with a particular focus on polymers;
- The Precision Engineering and Manufacturing (PEM) Technology Gateway in Sligo, which provides industry-focused R&D of precision engineering, manufacturing and materials technologies and innovation across all TRLs;
- The Medical and Engineering (MET) Technology Gateway in Galway offers a range of applied technologies relevant to companies in the product engineering and design application phase across the MedTech, Engineering and Lifesciences sectors;
- Digital Manufacturing Futures Centre in ATU Sligo represents an opportunity for the digitalisation of manufacturing in the region and could form part of an advanced manufacturing 'triangle' with SFI Confirm in Limerick and IMR in Mullingar.

Audiovisual/Creative

The NWR, and particularly Galway, has a thriving creative sector with significant potential for expansion over the coming years. Since 2008 the sector's direct employment has grown by 11.7% and employed 12,871 by 2017, with a value to the region of €729 million.

The West is home to 20% of Ireland's large-scale audiovisual studios and leading animation studios. Commercial immersive tech studios and music enterprises are also planned in the region. Immersive technology in creative industries, while nascent, is on the rise with companies in the West/Atlantic Economic Corridor moving to establish studios and pivot services for cross-sectoral purposes. This includes games/audiovisual/animation/design crossing over with MedTech, pharma, tourism, and education. Over 40% of Ireland's postgraduate software engineering underpins this growing ecosystem in the West offering opportunities for RD&I in creative tech and cross-sectoral innovation, which is also championed by the ATU CCAM.

Marine Energy Test Sites in the NWR

Ireland has a unique Marine Energy test site infrastructure allowing developers to move from laboratory test facilities at the Lir National Ocean Test Facility in Cork to a quarter scale test bed in Galway Bay and to a full test facility at the Atlantic Marine Energy Test Site (AMETS) near Belmullet, County Mayo.

The SEAI is developing AMETS to facilitate the testing of full-scale ocean energy converters both wind and wave, in an open ocean environment. It is located off Annagh head, west of Belmullet in County Mayo and will be connected to the national grid. AMETS will provide for full scale test opportunities in extreme Atlantic conditions and is intended as the ultimate test site for pre-commercial stage devices. The site will be focused on wave energy and will provide two separate test locations at various depths of water to allow for a range of devices to be tested. It is envisaged that the test site will provide a grid connected national test facility, to which full scale wave energy converters could be coupled during their final stages of pre-commercial development. The test site will comprise both onshore and offshore components.

The Western Development Commission (WDC) is particularly active in this space and aims to create a globally recognised creative sector which contributes directly and indirectly to the growth of the region. This has been supported by numerous initiatives with regional and national partners which have grown the regions creative economy. Other regional actors such as NUIG, Design and Craft Council, IFB, TG4, ÚnaG, The Arts Council and Creative Ireland have collaborated to provide and intend to identify new products, and through innovation and sustainable efforts intend to develop opportunities in emerging areas such as digital realisation, design and smart utilisations.

Marine and Blue Economy

The Atlantic is a key natural asset in the region and an integral part of the coastal economy. In the NWR, the marine and blue economy encompasses fishing and aquaculture; export and important transportation; coastal tourism; marine renewable energy and the blue bioeconomy. The Marine Ireland Industry Network, based in Galway, is an active player in the region supporting a community of over 400 stakeholders to showcase Irish marine capabilities.

An area that is rapidly emerging for the NWR is Marine Energy. The region has an opportunity to take advantage of its position on the Atlantic seaboard to develop significant capacity in the marine renewable sector. In the past, the primary focus within the State has been on land-based renewables, however, with technology advances in tidal energy, and off-shore wind becoming more cost-effective, this focus is likely to shift. Off-shore renewables will be critically important if Ireland is to meet the energy targets set out for 2030. Wave energy, tidal energy, and offshore wind energy will continue to expand in line with technological advances and subject to feasibility, and environmental assessment. It should be noted that the degree to which the region can take advantage of these commercial opportunities will be dependent on many factors, including but not limited to, R&D output, technological advances, feasibility and environmental assessments and the enhancement and connection of the region's electrical grid network to future offshore wind energy sites. This potential is evident through the RSES of the NWR which aims to examine the potential of the region's ports to expand facilities to give them enhanced regional significance in areas such as renewable energy. Additionally, the RSES supports the further examination of the feasibility of pursuing the designation of Galway Port and Killybegs Port as EU TEN-T Ports.

The Blue Bioeconomy encompasses economic activities and value creation based on sustainable and smart use of renewable aquatic resources, transforming these resources into a wide variety of products and services such as food, feed, biobased materials, and bioenergy. This expansive and productive natural marine environment contributes substantially to the Irish economy (annual turnover of approx. €6 billion), through sustainable marine industries such as fisheries, aquaculture, seaweed harvesting, blue biotechnology and marine and coastal tourism. A marine research cluster furthering the goals of the Blue Bioeconomy is planned to incorporate the Údaras na Gaeltachta facility at Páirc na Mara, currently under development in Cill Chiaráin, NUI Galway Carna Campus Laboratories, and an aquaculture site in Beirtreach Buí near Carna. This cluster will form part of a national aquaculture research cluster which includes the Marine Institute facilities at Newport, County Mayo. The Marine Innovation and Development Centre (MIDC) will provide specialist training and business development supports, along with world class research, testing and enterprise development facilities for the marine sector provided by ATU and NUI Galway.

RPOs supporting the Marine Economy in the region include:

- The Marine Institute (Galway and Newport) - the State agency responsible for marine research, technology development and innovation. They fund active research projects such as SmartBay, SmartCoast and Smart Catchment Projects to safeguard Ireland's unique marine heritage through research and environmental monitoring;
- The Marine Innovation Development Centre, Páirc na Mara, supports the development of marine start-ups, early-stage companies, and existing businesses and provides access to R&D facilities at ATU and NUI Galway;
- The Marine and Freshwater Research Centre (MFRC) at ATU conducts research to enhance the management of marine and freshwater ecosystems.

Renewable Energy, Climate Change Mitigation and Sustainability

Through an array of economic and environmental benefits, the transition to a low-carbon economy provides a major opportunity to revitalise the NWR's economy and enhance the quality of life in the region. The strengths of the NWR in marine renewable energy were outlined in the above section, but there are further strengths and potential opportunities in other aspects of renewable energy, climate change mitigation and sustainability such as: Energy Efficiency Technologies, Climate Monitoring Technologies, Onshore Wind Energy, Solar Energy, Sustainable Agriculture and Bioeconomy Practices, Carbon Sequestration, Hydrogen Production, Afforestation Services and Environmental Engineering and Ecosystem Services.

Energy Efficiency Technologies: Based on the latest available CSO statistics, it is clear that there are ample commercial, employment and environmental benefits available to the NWR in utilising energy efficiency technologies in improving the relatively low BER of the region's built environment. The capacity to improve the region's BER performance, and thereby supporting sustainable employment creation in the region's energy efficiency sector, is evident from the fact that only 20% of domestic buildings audited in Ireland registered a BER between "A" and "B", with below-average proportions found in all of the counties of the NWR. Similar regional trends were also evident for audited non-residential buildings.

Wind Energy: The NWR has an installed onshore wind energy capacity of 1,502 MW as of July 2020, representing 35.1% of Ireland's installed wind energy capacity, thereby highlighting the existing strength of the region's onshore wind energy sector. Considering the future economic and environmental benefits associated with offshore wind energy and given the region's existing expertise in wind energy production, the NWR is well positioned to utilise potential opportunities in this regard. However such opportunities will be dependent on the delivery of sufficient improvements to the region's grid infrastructure.

Carbon Sequestration: Carbon sequestration is the process of capturing CO2 from the atmosphere and storing it in plant material or soil and is considered an essential tool in contributing to Ireland's net carbon balance in the coming years. Given the nature of its industry, the Agriculture and Forestry sector is primed to take advantage of this process and since the NWR has an above average reliance on these sectors, the region is well positioned to take advantage of opportunity in this sector. As of Q1 2021, Agriculture, Fisheries and Forestry accounted for 8.8% of total employment within the NWR, which was well above the corresponding State average of 4.7%.

Looking towards the next generation of indigenous enterprise, it will be important to embed the green mindset into the start-up development journey. The use of zero carbon environmental operational practices and business models will need to be integrated into enterprises as they grow and scale. It is anticipated that this will become a standard part of entrepreneurial education in the long term and obliviate the need to retrofit measures to reduce or eliminate environmental and climate

impacts. Developing an initiative to encourage the emergence of born-sustainable, born-circular start-ups is a key action of the West REP.

Agrifood and AgriTech

Given the broadly rural nature of the region, it is widely accepted that Agriculture and Food production are high-level sectoral strengths of the NWR. The agrifood sector is of particular importance to Counties Monaghan and Cavan – accounting for over 60% of Monaghan's employment with 90% of the food produced within the county exported. Sub-sectoral specialisms that exist in the NWR range from mixed farming, fishing and aquaculture to crop and vegetable production. Using technology and technological innovation (AgriTech) to improve the efficiency and output of food production will be central to developing the innovative capacity of the region. There is potential to develop Ag-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.

The NWR's AgriTech sector hosts an array of strategic assets and capabilities which will play a key role in the future growth of these sectors, such as the BIA Innovator Campus (a novel food entrepreneurship space in Athenry with food production units and co-working kitchens), the Monaghan Bio-Connect Innovation Centre (a food sector R&D and networking facility) and NUI Galway's research partnership with the Dairy Processing Technology Centre (undertaking R&D to improve the competitiveness and sustainability of the dairy industry).

ICT and ICT Services

There is considerable overlap between the ICT and Financial Services/FinTech sectors in the region, accordingly we will be discussing them together.

In terms of the Information, Communications and Technology (ICT) sector, Galway has the largest concentration of these types of firms in the NWR, with significant clusters also located in Letterkenny and Athlone. Galway also has an innovative ICT start-up environment with initiatives such as the Portershed, a collaborative incubation space between the public sector, private sector and educational institutes. In general, employment in ICT has increased in the region since 2011, particularly in Galway and Donegal, highlighting the increased importance of the broad sector.

The interface of Financial and ICT Services (FinTech) plays a far smaller role in the region's labour market than nationally (5.4% of total employment in the NWR compared with 9% nationally) but its influence in the region is significant and growing. Letterkenny has by far the highest share of residents working in the sector in the region – reflective of a number of FinTech MNCs operating in the town. At 14.3% of total employment, it is the eleventh highest of Ireland's 200 towns and cities, with most of the towns with a higher share surrounding Dublin city.
In March 2018, following the launch of the report The Skills Needs of the ICT and FinTech Sectors in the Northwest by the North-West Regional Skills Forum (NWRSF), the Donegal ICT/FinTech Working Group came together as a collaboration between industry and education and training providers in Donegal to promote the studying of and working in ICT and FinTech in the county – this has the potential to drive further employment and opportunities in FinTech in the region.

RPOs supporting the ICT sector in the region include:

- The Irish Centre for High-End Computing (ICHEC) at NUI, Galway is Ireland's national centre for High-Performance Computing (HPC) providing e-infrastructure, services and expertise to academia, industry and the public sector;
- INSIGHT, the SFI Research Centre for Data Analytics, is one of the largest data analytics centres in Europe. The campus at NUI Galway has a particular focus on AI;

- WiSAR, the EI Technology Gateway for Wireless Solutions is based in ATU Letterkenny. It provides solutions to Irish industry for the Internet of Things (IoT) using expertise in wireless, embedded systems and power electronics.

Life Sciences, MedTech and Medical Devices

MedTech and health sector manufacturing are prominent industries in the NWR, with notable activity in Letterkenny, Athlone, Carrick-on-Shannon, Castlebar and Sligo. However, it is Galway that has a globally recognised cluster of medical device manufacturers - both multinationals and indigenous companies - supported by active research assets, infrastructure and property solutions such the SFI Centre for Research in Medical Devices (CÚRAM) and the Medical & Engineering Technologies (MET) Gateway at ATU. Ireland employs the highest number of MedTech personnel per capita in Europe, employing 32,000 people over 300+ companies and leading in many areas of the sector; for example, Ireland is the global leader in the production of drug-eluting stents and 75% of global orthopaedic knee production comes out of Ireland.

It is crucial that the NWR retains its competitive edge in MedTech by continuing to adapt to meet opportunity. MedTech as a sector has been resilient during the COVID-19 crisis, however, the future challenge will be adapting to the new era of remote monitoring, biosensors and connected devices that is being accelerated by the pandemic. There may be an opportunity to deepen the links between Ireland's ICT and MedTech research and industry bases to create a competitive R&D capacity to develop and retain high-skilled research jobs in the region.

Linked to developing this ICT/MedTech interface - a new Digital Health Industries Cluster based in ATU and funded by Enterprise Ireland, is facilitating intercompany and inter-agency collaboration in the digital health sector and maximising the potential of an existing pocket of research excellence. However, this sector is extremely vulnerable to disruptive technologies and rapidly changing global trends, as well as competition from emerging economies, e.g., in Asia. Therefore, further action is needed to futureproof digital health and ensure a framework is in place to promote resilience of indigenous start-ups and encourage their scaling in the region.

Galway, Mayo and Roscommon have a globally recognised cluster of Life Science multinationals, both international and indigenous. The complex biologics manufacturing aspect of life sciences is a growing area - this is a high-value, rapidly expanding market with recent investments by large MNCs in Westport, Sligo and Loughrea. The sector is further bolstered by many start-ups, which are particularly active in cardio-vascular applications.

Life Sciences innovation in the NWR is underpinned by specialised programmes and initiatives, including Bioexel, Bioinnovate, EIT Health, and Health Innovation Hub Ireland and strong clustering is exhibited in the Galway area, with solid potential for clustering in Mayo and Roscommon. Stakeholders within the sector have expressed the view that more formal co-ordination is needed, beyond networking and informal linkages, to raise the level of ambition, stimulate additional entrepreneurs and provide additional structures. In the longterm, the lack of alignment and co-ordination between actors could have a negative influence on the development of the innovation ecosystem in the NWR. A more sophisticated strategy, such as orchestration or choreography, is needed, to maintain the vibrancy, vitality, and wealth creation of the regional Life Sciences ecosystem.

7 Regional Economic Context and Priority Sectors for the Eastern and Midland Region

7.1 Economic Context – Eastern and Midland Region

Economic Overview

The EMR which includes the Dublin city region is the main driver of growth in the Irish economy, performing relatively well across several key economic indicators. In Q4 2021, total employment in the EMR amounted to 1.283 million, which accounted for 51% of Ireland's employment base. By 2040, it is estimated that the region's employment base will expand to around 1.34 million. Notwithstanding this, there are intra-regional variations that are noted below.

Third level attainment rates in the EMR stood at 51% in 2019, which was above the corresponding State average of 47%. Encouragingly, third level education enrolments in the region have risen from just over 93,987 in 2009 to just over 121,083 in 2019.

In 2018, out of 269,687 SMEs operating in Ireland, 137,049 were based in the EMR. Dublin had the highest number of SMEs at 87,773. As of 2019, a total of 1,549 companies were supported by the IDA Ireland, with the majority (62.3%) located in the EMR[39]. Of the 245,096 IDA Ireland supported jobs in the State, just over half (130,538) were located in the EMR.

Regional Status, Differences and Challenges

Despite experiencing significant growth in recent years, a key economic development challenge facing the region's economy is relative internal disparity – especially the Mid-East and Midlands regions in comparison to the neighbouring Dublin city region. While employment in both high-tech and knowledge-intensive services is above the national average in the EMR overall, the Mid-East and the Midlands NUTS 3 regions have below average proportions of jobs in these sectors. The Midlands, for example, is far more reliant on relatively lower value-added activities in sectors such as agriculture, accommodation and food services. The EMR is the most export-oriented NUTS 2 region in Ireland, recording an export intensity of 79.7% which was above the State average of 77.4%. However, the Mid-East has an export intensity of 63.6%, making it the only NUTS 3 region in the EMR with an export intensity rate below the State average. Both the Mid-East and Midlands have higher levels of relative deprivation than the State average as measured by the CSO.

Disposable income levels vary significantly in the EMR, with the difference in disposable income per capita between Dublin and the Midlands increasing from a gap of €3,201 per capita in 2009 to a gap of €9,028 in 2019.

Further challenges for the EMR are also evident from several economic indicators – including but not limited to the distribution of urban centres, research and innovation capacity, skills, and digital infrastructure.

As host to the Dublin city region, the EMR performs well in the 2019 European Regional Competitiveness Index at 89th place in the EU, providing particularly favourable conditions in terms of technological readiness, higher education and lifelong learning and health. In this regard, its peer regions include Île de France; Stockholm; Hamburg; London and its commuting zone; Stuttgart; Bruxelles and its commuting zone; Amsterdam and its commuting zone; and Bremen. The region records a similar performance across a host of competitiveness indicators including infrastructure, innovation, education, and technological readiness but underperforms relative to its peer regions with respect to labour market efficiency and market size.

39. Data from IDA Ireland quoted in EMRA submission

Just Transition in the Midlands

In March 2019, it was estimated that approximately 4,000 households in the Midlands could be impacted – either directly or indirectly – by the phasing out of peat extraction and closure of the ESB's Shannonbridge and Lanesboro Power Stations; a significantly large impact considering the Midland's total employment base amounted to 140,200 as of Q4 2020.

Tailored investment to deliver a just transition for the wider Midlands area of the EMR is being delivered under the DECC National Just Transition Fund. The Fund was made available in 2020 to support communities transitioning to a low-carbon economy, with a focus on retraining workers and generating sustainable employment in green enterprise across the region.

Funding of €84 million will be allocated to Ireland from the EU Just Transition Fund by the European Union over the period 2021 to 2027, supported by additional co-funding from the Exchequer of up to 50%. For Ireland, the purpose of the JTF is to improve the labour market in regions facing particular difficulties due to the phasing out of peat production.

In addition to the National and EU Just Transition Funds, the Government has approved funding for Bord na Móna's large-scale peatlands restoration project, which will see Bord na Móna reassign employees from peat harvesting activities into rehabilitation operations, while supporting and restoring the biodiversity of the peatlands. This plan and the National Parks and Wildlife Service Peatlands Scheme will support 350 jobs.

Digitalisation and Green Transformation

As of 2020, 90% of households based in the EMR recorded a fixed broadband connection rate, which was the highest out of the three NUTS 2 Regions and above the State average of 85%. That said, broadband connectivity rates varied on a sub-regional level, with households based in the Midlands recording a below average connection rate of 80%.

In terms of digital skills, the EMR is the leading NUTS 2 Region in Ireland, with the region home to some of the largest ICT companies in the world, as evident from the region's above average reliance on jobs in Information and Communications Activities (7.8% employment versus State average of 6% in Q4 2020). Notwithstanding this, tackling relatively low levels of basic digital skills will be an ongoing development challenge for the region, as evident from the fact that:

- 65% of individuals based in the EMR used the internet to exchange information and services with government and public administrations in 2020, which is higher than the State average (62%) but lower compared to leading regions in Denmark, Norway and Sweden (comparison regions in Europe);
- 84% of individuals based in the EMR used the internet to order goods or services for private use in 2020, which is higher than the State average (74%) but lower relative to comparison regions in Europe;
- 78% of individuals based in the EMR used internet banking in 2020, which is higher than the State average (69%) but significantly lower relative to comparison regions in Europe.

Given that the EMR is Ireland's largest and most urbanised NUTS 2 Region and considering the compact growth targets set out in the NPF and the RSESs, the need to promote sustainable transport, including walking and cycling is a significant priority. Entwined with these challenges is the need to address high commute times experienced by residents of the EMR. The highest one-way commute times in Ireland were recorded in each of the NUTS 3 Regions of the EMR namely, the Midlands (29 minutes), Dublin (31 minutes) and the Mid-East (34 minutes), all above the state average of 28 minutes in 2019. Decarbonising the private transport sector also represents a significant development challenge for the EMR. EV and Hybrid vehicles only accounted for 22% of all new private cars licensed for the first time in the Region in 2020, although this was above the State average (19.7%).

The decarbonisation of the EMR's residential market represents a significant development challenge. Although the EMR – specifically in Dublin and the Mid-East – recorded above average proportions of households with a BER between A" and "B", these proportions continue to remain notably low; with lower proportions recorded in rural counties in the Midlands. Households in Dublin and the Mid-East were generally not dependent on using solid fuels as their household's heating fuel source.

Regional, Spatial and Economic Strategy for the EMR

The RSES for the EMR was adopted in June 2019 and sets out the long term spatial, economic and climate policies for the Region within the context of an investment framework. The RSES provides a:

- Spatial Strategy – to manage future growth and ensure the creation of healthy and attractive places to live and work;
- Dublin Metropolitan Area Strategic Plan (MASP)– to ensure continued competitiveness of Dublin and a supply of strategic development for sustainable growth;
- Economic Strategy – that builds on the region's strengths to create a strong economy and jobs, that ensures a good living standard and economic opportunity for all;

- Climate Action Strategy – to accelerate action and ensure a clean and healthy environment, sustainable transport, and green infrastructure;
- Investment Framework – to prioritise the delivery of infrastructure and enabling services by Government and State agencies.

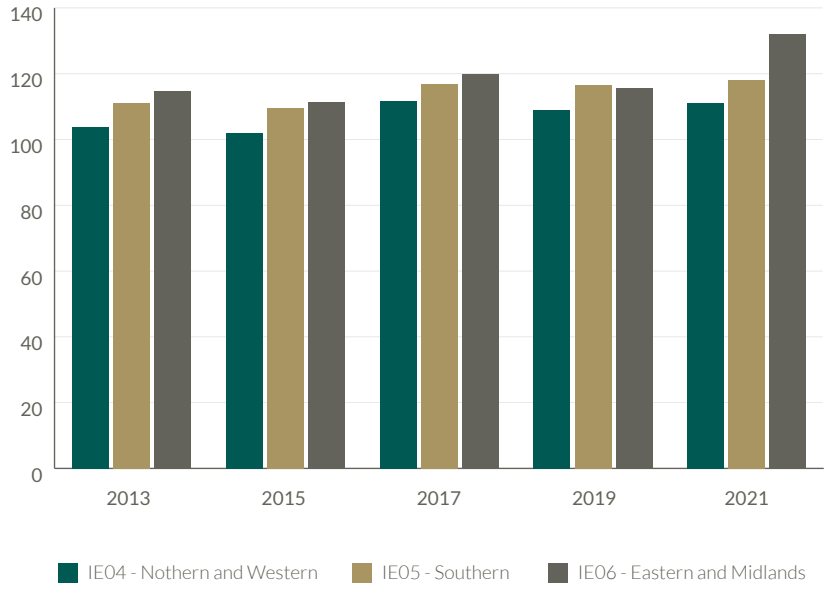
The Economic Strategy of the RSES is based on five key principles, including Smart Specialisation and a strategic approach to Clustering, not only to reinforce Regions in their most advanced industrial sectors but also to diversify their economic bases in a smart way, in areas with the most socio-economic potential. This is underpinned by orderly growth as set out in the RSES Spatial Strategy, investment in Placemaking to create appealing places to attract and retain talent, and future-proofing to build economic resilience to external shocks and challenges.

7.2 Innovation Context – Eastern and Midland Region

Overview

In the EU Regional Innovation Scoreboard 2021, the EMR is considered a "Strong Innovator" performing above both the State and EU average and improving its performance year on year. Relative to the EU average in 2021, the region performs strongly across innovation indicators such as employed ICT specialists and innovative SMEs collaborating with others. The region performs poorly in non-R&D expenditure in business and public sectors, employment innovative enterprises, PCT patent and trademark applications.

Figure 7.1: European Innovation Index Performance Between 2013 and 2021



Source: CSO/Eurostat

Enhancing the EMRs research and innovation capacity is in line with the RSES and with the Indecon ERDF Needs Analysis Report, which highlighted the need for measures to support an increase in R&D expenditure and supports to increase collaboration between industry and HEIs. Development challenges relating to the Irish RD&I system as a whole include the level of expenditure on R&D, the structure of public support for business R&D and the level of co-operation between enterprises and research bodies. Some of these challenges are reflected in the EMR's performance with respect to the EU Regional Innovation Scoreboard (RIS).

Support for the HEIs and Further Education and Training (FET) providers are key to tackling skills deficits, supporting skills development and reskilling/ upskilling opportunities. As of 2020, 55% of adults in the EMR had a third level qualification, which was 4 percentage points above the State average of 51%. That said, such results varied on a NUTS 3 Regional level, with Dublin recording the highest third level attainment rate out of the eight NUTS 3 Region, with a rate of 62%, with below average rates recorded in both the Mid-East (48%) and the Midlands (40%). Notably, the Midland's third level attainment rate was the lowest out of all NUTS 3 Regions.

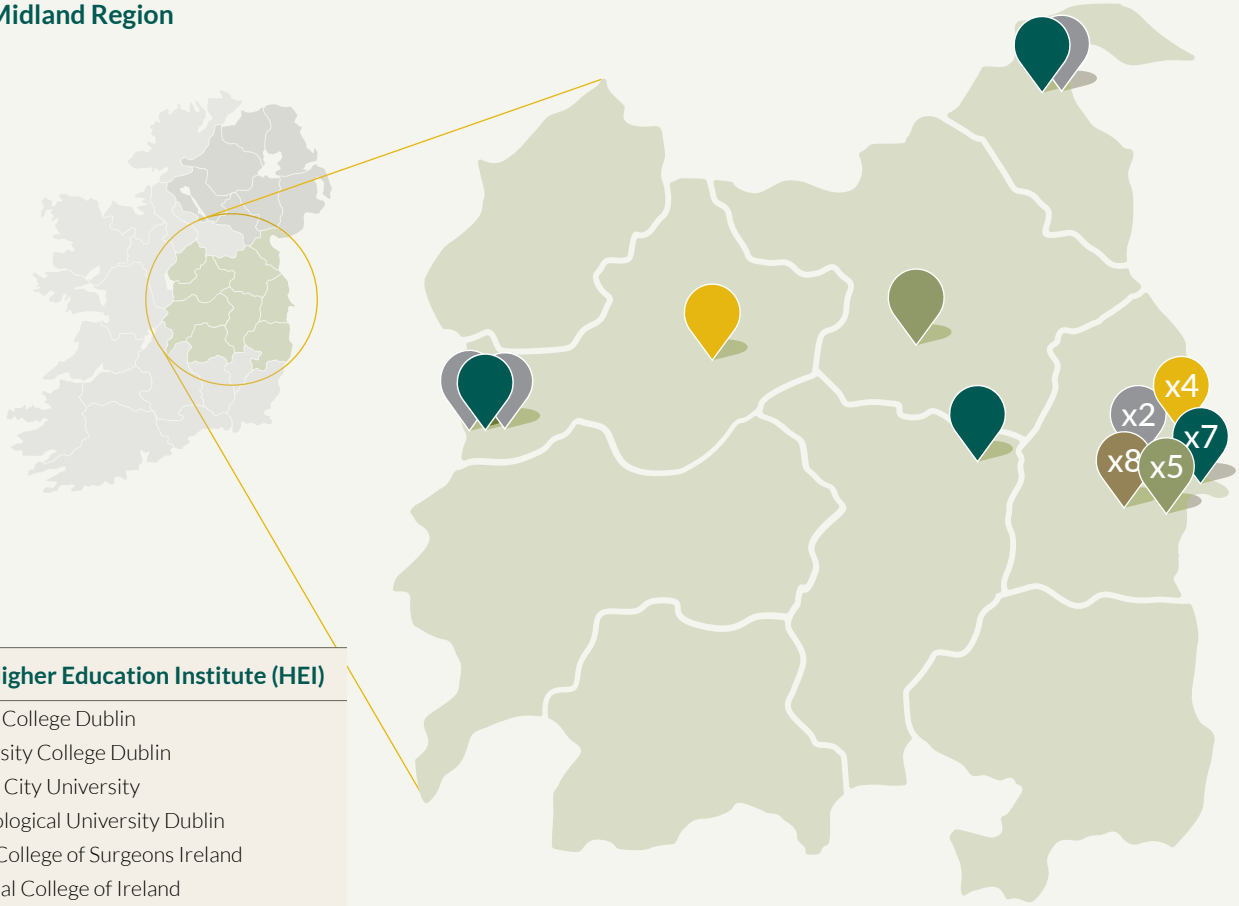
Higher lifelong learning participation rates will be instrumental to ensuring that the EMR's economy continues to be based on knowledge intensive and high-skilled services and activities. In 2019, 14.5% of adults in the EMR took part in lifelong learning activities, higher than the State average (12.6%) and the EU 27 average (10.8%), but notably lower relative to other leading regions in Sweden, Finland, Denmark, France, Iceland, the Netherlands and Norway. Although some progress has been made in addressing skills development in Ireland, skills deficits – particularly digital skills – remain a significant development challenge facing the EMR.

Key Research Performing Organisations in the Eastern and Midland Region

This section outlines the key RPOs that are relevant to the sectoral and research landscape in the EMR. These institutions have been listed based on the important role they play in supporting research and development, innovation, and economic growth across the region, highlighting their importance for the S3 process in Ireland. It is important to note that the categorisation of key individual research centres and technology centres are based on the location of the host institution; although these centres have developed key partnerships with other institutions and agencies outside of their respective NUTS 2 Regions.

**Figure 7.2 NUTS 2 Eastern and Midland Region -
Dublin, Kildare, Meath, Wicklow, Louth, Longford, Laois, Offaly, Westmeath**

Key Research Performing Organisations in the Eastern and Midland Region



Higher Education Institute (HEI)

- Trinity College Dublin
- University College Dublin
- Dublin City University
- Technological University Dublin
- Royal College of Surgeons Ireland
- National College of Ireland
- National College of Art and Design
- NUI Maynooth
- Dundalk Institute of Technology
- Technological University of the Shannon

National Institutes and Facilities

- NIBRT (Bioprocessing)
- Health Research Board
- ICHEC (High Performance Computing)
- NSAI National Metrology Lab
- Teagasc Research Centre (Food)
- Teagasc Research Centre (Animal Bioscience)

SFI Research Centre

- FutureNeuro (Neurological Disease)
- I-Form (Manufacturing)
- BiOrbic (Bioeconomy)
- iCRAG (Geoscience)
- CONNECT (Networks)
- Insight (Data Analytics)
- ADAPT (AI)
- AMBER (Materials)

Technology Centre

- Meat Technology Centre
- Learnovate (Learning Technology)
- CeADAR (AI)
- Food for Health
- Irish Manufacturing Research

Technology Gateway

- Crest (Coatings)
- MiCRA (Bio Diagnostics)
- CREDIT (Energy and Renewables)
- APT (Polymers)
- COMMAND (Connected Media)

7.3 Sectoral Overview

This section outlines the main sectoral areas of strength and emerging opportunity which were identified during consultation. It also takes into consideration the following factors:

- IDA Ireland companies in the region;
- Enterprise Ireland investment in the region;
- 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;
- Current cluster activity in the region;
- CSO trade and employment statistics;
- An analysis of sectoral strengths as identified in the RSESs.

Consultation Findings

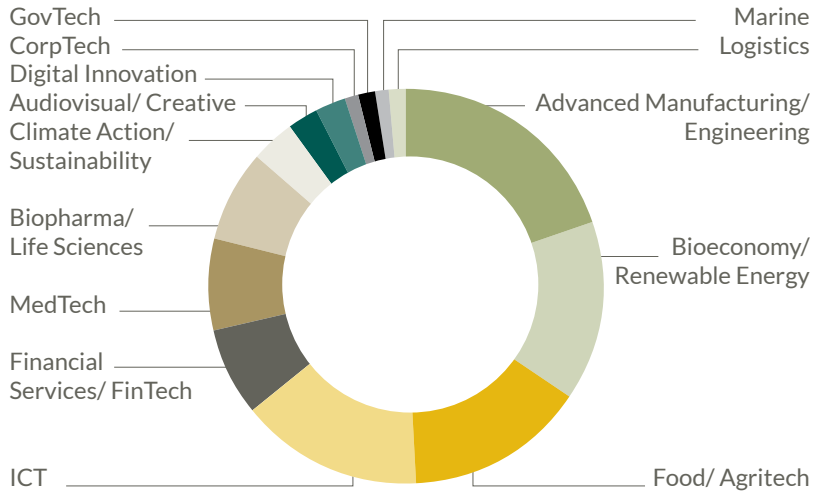
As in other regions, stakeholders were asked to identify the existing sectoral strengths in the EMR along with the new and emerging areas of opportunity in their region. These were areas which could develop critical mass over the next seven years, creating new enterprises, employment, exports and value 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 7.3.

Figure 7.3: Identified Sectoral Strengths and Opportunities for the EMR



Source: DETE - Smart Specialisation Public Consultation

7.4 Identified Sectoral Strengths and Emerging Opportunities

As Ireland's capital with international visibility, Dublin plays a key role as a location of choice for mobile investment. Dublin, as a national economic driver, is the only city in Ireland with international scale and competes with other cities based throughout Europe and internationally. It hosts a variety of enterprises including a large concentration of multinationals, many universities, institutes and research centres, as well as a young and well-educated population. All these features translate into a strong capacity to attract FDI, drive new business formation, and attract organisations dedicated to R&D. Dublin offers employment across a range of sectors and key industry focused research areas. Its main sectoral strengths are in ICT, Financial Services and Biopharma/Life Sciences. Notable cluster organisations have emerged in Dublin in the areas of MedTech, International Financial Services, GeoScience and ICT.

The Mid-East has well-established and growing concentrations of activity among multinational and indigenous companies in sectors such as ICT and Advanced Manufacturing. There is a diverse agrifood sector in the region encompassing microenterprises through to companies of significant scale; in addition to food technology and innovation facilities such as the Boyne Valley Food Innovation District, Boyne Valley Food Hub and Teagasc Grange. Wicklow and the East Coast have an established screen creation sector with an internationally recognised screen industry cluster.

The North East has a strong financial services sector along the M1 Payments Corridor and a significant manufacturing sector. There is also significant employment and research capability in Health, Energy and Sustainability. DkIT hosts the CREDIT EI Tech Gateway for Energy Efficiency.

The Midlands has particular strengths in Life Sciences, ICT, International Financial Services and Engineering. The region also has demonstrated capabilities in manufacturing processes and technologies as demonstrated by the expertise of the

Irish Manufacturing Research (IMR) facility and the academic/training programmes of the Technological University Shannon (Athlone) in this area. A notable clustering initiative in the region is the Engenuity Engineering Cluster to support market-led innovation, stakeholder collaboration and trade development in Midlands engineering companies.

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.

Advanced Manufacturing/Engineering

Ireland's manufacturing sector employs almost 232,000 people[40] and accounts for over 34% of national GDP, well above the European average of 15%[41]. While manufacturing activity is well dispersed nationwide, in the EMR there is a particular amount of activity in manufacturing for Life Sciences, chemicals and engineering.

Advanced Manufacturing in the EMR is supported by several RPOs with an extensive research infrastructure. These include the Irish Manufacturing Research (IMR) Technology Centre based in Mullingar and Rathcoole; the Advanced Processing Technology Research Centre in DCU; I-Form, the SFI Research Centre for Advanced Manufacturing based in UCD, and AMBER, the SFI Research Centre for Advanced Materials and BioEngineering in TCD. The close proximity of the Applied Polymer

Technologies (APT) Technology Gateway in Athlone, with its experience in additive manufacturing, is an additional asset to the wider Midlands region. The sector is also broadly supported by the Engenuity engineering network based in the Midlands.

Manufacturing is a bigger relative source of employment in the Midlands than nationally, with 18% of workers employed in manufacturing industry, compared to a national average of 12.5%[42]. The previously identified challenges of digitalisation, green transformation, and the need to adopt new Industry 4.0 technologies are well understood in the region. IMR's Mullingar facility is an active and engaged RPO in addressing the digitalisation and sustainability challenges for the Midlands manufacturing base. In addition, as part of the last cycle of REPs, the Midlands Advanced Manufacturing Action Plan has been produced to ensure the Midlands Region becomes known internationally as a centre of excellence in advanced and sustainable manufacturing and as an ideal location for manufacturing companies to establish and grow their business and exports. The actions seek to build on Government and agency policies and support infrastructure, including Industry 4.0 and balanced regional development, as well as to strengthen existing Midlands business networking and collaboration.

40. Labour Force Survey (LFS) Employment Series - CSO - Central Statistics Office
41. National Income and Expenditure Annual Results - CSO - Central Statistics Office
42. Midlands Advanced Manufacturing Action Plan 2021-2024

Audiovisual/Creative

Ireland's audiovisual and animation industry is currently worth more than €1 billion to the Irish economy, with an ambition under the Creative Ireland Programme to increase the number of full-time industry employees to 24,000 and to grow its gross value to €1.4 billion. The audiovisual and creative industry sectors in the EMR are well established with considerable creative industry assets including national broadcasting infrastructure and sizable film studios. The sector benefits from a number of advantages, including a strong established track record in screen production and clear and transparent government support across film tax credits and cultural funding. Within film production, the thriving and prolific animation sector is a significant contributor to the creative economy in the EMR.

The game development industry exists at the crossroads between the ICT and audiovisual/creative sectors and now encompasses AR/VR and app technologies. Globally the sector has annual revenues that exceed $300 billion[43], higher than the film and music industries combined. The importance of this sector to Ireland led to the proposed introduction of a digital gaming tax credit in Budget 2022. Dublin is home to a large number of game development MNCs and indigenous start-ups. There is a considerable amount of research activity under way in Ireland's academic research community that is directly relevant to the sector, including artificial intelligence, sensor technologies and user interfaces, behaviour analytics, information security, business models, multilingual digital content management, games engines, etc.

Bioeconomy/Renewable Energy (including Climate Action/ Sustainability)

This is a broad sector in the region, supported by bioeconomy initiatives and significant new energy capacity, including in wind energy. It also supports the growing Geoscience sector.

Bioeconomy

There is a notable opportunity for the Midlands to develop significant capacity in the low-carbon economy and to support the employment of green technologies in enterprise. The new Empower Eco Hub (based in the former Bord na Móna complex in Lough Boora, County Offaly,) will establish the first social enterprise business model in the Midlands that integrates natural resources, enterprise, biodiversity, community, and social innovation with lifelong learning. The Empower Eco system will cluster Ireland's first connected regional ecosystem of sustainability, enterprise and eco-innovation projects in the Midlands. It has also secured funding to develop and launch Ireland's first dedicated sustainability business accelerator Accelerate Green which will establish a pipeline of investible propositions in the sustainability and climate action sector. There is good potential to position Empower Eco as an international innovation hub and living labs complex for the low-carbon economy. Other related initiatives in the Midlands include the Cube at Portlaoise, which will be a multi-point incubation hub for the development of a Low-carbon Centre of Excellence, and new windfarm projects at former Bord na Móna peatlands.

Bioecomony RD&I in the EMR is supported by BiOrbic, the SFI Research Centre for the Bioeconomy in UCD. Their researchers work on selectively separating and extracting valued compounds from renewable materials, converting those resources into novel bio-based products and processes, delivering market and industry scalable sustainable resources.

43. Gaming: The Next Super Platform – Accenture report 2021

Biorefining and Bioconversion

The Biorefining and Bioconversion market consists of various forms of agricultural and forest biorefining, including feedstock, products and segment (energy, chemicals, botanicals and fuels). The global Biorefining and Bioconversion market was estimated to be worth $659 billion in 2016. This is a growing area in the EMR (particularly Wicklow) and supports the strong agricultural base of the region.

Renewable Energy

Renewable Energy in the EMR is focused on energy storage (particularly new battery storage technologies) and wind energy. The offshore Arklow Wind Bank is the second largest wind farm in Ireland in terms of capacity. Raheenleagh in Wicklow, Mount Lucas in Offaly and Gortahaile in Laois also provide considerable capacity in wind energy. Codling Wind Park, based in the sea between Greystones and Wicklow town, represents one of the largest energy infrastructure investments in Ireland this decade and is set to become one of Ireland's largest offshore wind farms. Developing additional onshore renewable energy facilities remains important in addressing Ireland's renewable energy obligations and increasing security of supply. While there may be some perceivable negative impacts, planning authorities should weigh these against the significant positive contributions such projects make. The deployment and integration of indigenous renewable energy technologies will act to drive research and boost innovation in the energy sector, enabling our Regions to become leaders in sustainable renewable energy generation. In the EMR this research activity is delivered by the CREDIT Technology Gateway - a Renewables, Energy Optimisation and Energy Storage research group based in Dundalk IT that applies emerging technologies, expertise and specialist knowledge across the energy and renewables sector to help innovative businesses and companies succeed in the introduction of new and improved processes, products and services.

Geosciences Sector

Geothermal energy is a growing area for both research and innovation and industrial applications (focused on 'deep' and multi-user geothermal resources rather than domestic applications). This is now widely used globally for direct heating and cooling for industrial process as well as residential and commercial applications. Geological Survey Ireland (GSI) and Sustainable Energy Authority of Ireland (SEAI) have been supporting RD&I in this sector with input from SFI research centre, Irish Centre for Research in Applied Geosciences (iCRAG), the university and SME sectors. This is also supported by an effective cluster. DECC is developing a policy and regulatory framework for geothermal energy to support its use as a secure, environmentally sustainable and cost-effective source of renewable energy.

Biopharma and Life Sciences (including MedTech)

Ireland is a major global centre for Biopharmaceutical manufacture and supply. In 2019 Ireland was ranked the 5th largest exporter of biopharmaceutical medicines globally with exports of €80 billion. More than 45 members of BioPharmaChem Ireland, the representative body for the biopharma and chemical sectors, are based in the EMR.

Manufacturing excellence in biopharmaceuticals is a hallmark of Ireland's success in the sector. This is constantly driving growth and Ireland has seen continued capital investment averaging at €1 billion per annum over the last 10 years. The biopharma industry is expected to grow at a rate of 10.6% between 2020 and 2027[44]. The COVID-19 pandemic has put the biopharma industry at the centre of global attention with substantial investments in innovation and digitalisation to improve cost and time effectiveness.

44. Biopharma Market to grow at 10.6% CAGR between 2020 and 2027 (pharmaadvancement.com)

One of the major support infrastructures for the Biopharma sector in Ireland is the National Institute for Bioprocessing Research and Training (NIBRT), a global centre of excellence for training and research in bioprocessing based in Dublin and an attractor for MNCs in the region. Other RPO support in EMR comes from the MiCRA Biodiagnostics Technology Gateway, based in TU Dublin which delivers solutions for companies in animal/human diagnostics, environmental, agrifood and bio/pharmaceuticals sectors.

Financial Services/FinTech

The EMR has a well-established capacity in FinTech, especially in Dublin and along the east coast. It remains well positioned to see increased FinTech investment post Brexit from banks and financial institutions choosing Ireland as the base for their European operations. This activity is, and will continue to be, significantly supported by the Dublin/Belfast Fintech Corridor, a cross-border cluster organisation connecting UK and EU banking supported under ITI's Synergy programme.

Regulatory Technology (the management of regulatory processes within the financial industry through technology), or RegTech, is a growing opportunity for the sector, with the pandemic seeing companies seeking to digitise processes quickly while managing their regulatory requirements. There is also opportunity to capitalise on the region's ICT and AI capacity to link LegalTech and RegTech and develop new solutions for the corporate services industry.

Within Dublin, the International Financial Services Centre (IFSC) is critical to the sector. More than 430 international operations are based in the IFSC, and a further 700 managed entities approved to carry out business under the IFSC programme. The IFSC is home to half of the world's top 50 banks and insurance companies.

Food/AgriTech

There is a diverse agrifood sector in the region encompassing microenterprises through to companies of significant scale in addition to food technology and innovation facilities. The region typifies the ambition of Food Wise 2025 – 'Local Roots Global Reach' and acts as a base for some of Ireland's leading indigenous and high growth food businesses. The sector is also supported by key infrastructure, including food technology and innovation facilities such as the Boyne Valley Food Innovation District, Boyne Valley Food Hub and Teagasc Grange.

The Boyne Valley Food Innovation District is a notable collaborative cluster initiative for the Mid-East and North-East regions that supports food and drink SMEs and talent to achieve their commercialisation and scaling potential. The Boyne Valley Food Hub is a flagship project of the district to develop an innovation-rich hub to accelerate growth and yield business impact through collaboration, innovation, and clustering, thereby facilitating the development of scalable, sustainable and profitable food businesses across the Mid-East and North-East regions.

Fortified and Functional Foods

Fortified and functional foods are an emerging opportunity for the EMR. Globally, fortified/functional food sales topped $267 billion, and naturally healthy food sales were $259 billion in February 2020. With EMR's high quality agricultural base and multiple RPOs the region is in a good position to benefit from this global trend.

ICT

ICT is a significant economic sector for Ireland. It has strong capacity in the EMR with several globally significant MNCs having their European operational bases in the region. Activity in the sector is broad from semiconductor manufacturing to software development. RD&I activity is significant and supported by numerous RPOs such as:

- The COMAND Technology Gateway in Athlone concentrates on the research and development of prospective interactive media technologies focused on: cross-platform applications, mobile media cloud, 3D sensing, and the interoperability for the Internet of Things;
- CONNECT is the SFI Research Centre for Future Networks and Communications and is based in TCD in Dublin. Its mission is to research and develop innovative solutions for the communications challenges facing society including in IoT, 5G/6G networks and future communications services;
- Insight, the SFI Research Centre for Data Analytics is one of the largest data analytics centres in Europe. Based in UCD it undertakes high-impact research, seeks to derive value from Big Data and provides innovative technology solutions for industry and society by enabling better decision-making;
- ADAPT, the world-leading SFI Research Centre for AI-driven Digital Content Technology, based in TCD, combines the expertise of researchers at seven higher education institutions with that of industry partners to produce ground-breaking innovation in digital content that is revolutionising the way people interact with content, systems and each other.
- CeADAR, based in Dublin, is a market-focused technology centre that drives the accelerated development and deployment of data analytics and machine intelligence (DA&MI) technology and innovation. The Centre's work focuses on developing tools, techniques and technologies that enable more people, organisations and industries to use analytics and machine intelligence for better decision making and competitive advantage.

Strengths that can be further developed and new opportunities for ICT in the region include:

Artificial Intelligence

The current ecosystem around AI is well developed in the EMR, with a highly established and robust FDI, SME and research base. Some new activity in the region includes the Tangent AI accelerator programme, AI for climate research through the Terrain-AI project led by Maynooth University and CeADAR's work on AI for zero-defect manufacturing. Ireland has strong AI adoption rates. Among EU Member States, Ireland recorded the highest share of enterprises that used AI applications in 2020[45], with uptake set to increase significantly in the next three years. In addition, the EU is setting ambitious targets for AI aiming to have 75% of EU companies using Cloud/AI/Big Data by 2030 and transforming Europe into the global hub for trustworthy Artificial Intelligence. However, increased global competition in AI markets will make it increasingly difficult for the region to defend its strong track record. The current multidisciplinary focus of AI research and the strong network of AI testbeds is an attribute of the region and 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 available to enterprises to encourage increased take-up of AI solutions.

ICT for Smart Grids/Smart Cities

The RSES identifies the need to prioritise the systematic integration of ICT in the planning, design, operations and management of our cities, towns, and villages. This requires the roll-out of Smart Grids and Smart City initiatives that promote collaboration between public, private and research sectors to develop new technology and data driven solutions to urban challenges.

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45. Artificial intelligence in EU enterprises - Products Eurostat News - Eurostat (europa.eu)

Specifically, this includes the enhancement of Smart Dublin, which aims to promote the Dublin region as a world leader in the development of smart city technologies using open data, along with innovation districts such as Smart Docklands as a testbed. It includes the further development of smart city programmes in the regional growth centres such as Athlone, Drogheda and Dundalk, and of Smart Communities elsewhere, building on the potential offered by improved rural connectivity and digitisation. It will also build on local enterprise and infrastructure assets to drive innovations around energy, transport, agrifood, tourism and e-services.

Further Capacity Building in Semiconductor Manufacturing

Another area of opportunity in ICT for the region has been highlighted by the recent global shortage of semiconductors, which is having an impact on most manufacturing sectors highlighting the widespread integration of chips into consumer products from cars to toothbrushes. Aside from the current shortage, the global demand for chips is only going to increase in the age of connected and smart appliances. 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 plans to boost chip manufacturing worldwide to address shortages and the EU looking to bolster its semiconductor ecosystem with a plan to produce 20% of the world's semiconductors under the Digital Compass Strategy there is an opportunity for the region to build on its capacity and to engage with opportunities in the EU.

8 Regional Economic Context and Priority Sectors for the Southern Region

8.1 Economic Context – Southern Region

Economic Overview

Overall, the SR economy has performed positively in recent years. In Q4 2021, total employment in the SR amounted to 799,400, which accounted for 32% of Ireland's employment base. By 2040, it is estimated that the region's employment base will expand to around 880,000. The region is expected to continue to expand in line with the European Commission's Economic Forecast for Autumn 2021 with an overall growth rate of 5.1% in 2022 and 4.1% in 2023.

The share of high-tech employment is 8% in the SR while knowledge-intensive services account for 39% of total employment which has driven relatively higher levels of productivity (as measured by GVA per worker) in 2019, with the SR region corresponding to 240% of the EU average. Despite this strong performance, however, the South-East sub-region currently (as at Q1 2022) has the highest unemployment rate nationally at 6%.

Regional Status, Differences and Challenges

Classified as a 'more developed region' according to the EU cohesion policy, the SR ranks 22nd out of all European regions in terms of regional GDP. Regional profiling and benchmarking[46] with other European regions that share similar structural conditions to the SR[47] reveal that although the region has the highest GDP per capita nationally, it also has the lowest real growth rate of regional Gross Value Added (GVA). This can be attributed in part to the presence of MNCs, making the region vulnerable to potential corporate tax reforms indicating the need for more support towards indigenous growth. Benchmarking comparisons also indicate that the SR ranks first in terms of specialisation in high-tech and knowledge-intensive sectors among comparative regions.

According to Eurostat's 2020 figures, the third level attainment rate in the SR stood at 45.6% in 2020, slightly below the State average of 51% and the lowest of all the regions. The participation rate in education and training - lifelong learning - was 9.7%, slightly above the EU 27 average of 9.2% but below the national average of 11%.

In the 2019 European Regional Competitiveness Index, the SR is ranked as the 129th most competitive region in the EU, performing well in terms of technological readiness but less well on infrastructure. In this regard, its peer regions include Hamburg; Oberbayern; Île de France; Stockholm; Stuttgart; Bruxelles and its commuting zone; Amsterdam and its commuting zone; Darmstadt; Utrecht and Bremen. The region records a similar performance across a host of competitiveness indicators including higher education and lifelong learning, technological readiness and business sophistication but underperforms relative to its peer regions with respect to innovation, infrastructure, labour market efficiency and market size[48].

46. Regional benchmarking undertaken by BABLE Consultants on behalf of the Southern Regional Assembly
47. These regions include Southeast, East and East Midlands UK; Alsace, Aquitaine, Rhone Alps and Pays de la Loire France; Vastsverige Sweden; Etela-Suomi Finland and Midtjylland Denmark
48. European Regional Competitiveness Index 2019

Digitalisation and Green Transformation

Households based in the SR registered a fixed broadband connection rate of 83% in 2020, slightly below the State average of 85%. At NUTS 3 regional level, broadband connectivity rates do not vary with households based in the Mid-West, South-East and South-West registering high-fixed broadband connections rates of 81%, 83% and 84%, respectively. Overall, the SR performs well nationally on indicators of digital transformation as indicated by the figures below:

- 88% of individuals in the SR had daily access to the Internet in the past three months, compared to EU average of 80%;
- Up to 77% of individuals based in the SR used the Internet to order goods or services for private use in 2020. Again, while higher than the State average (74%), it is lower relative to leading regions in Denmark, Norway, Finland and Sweden;
- 71% of individuals in the SR used Internet banking in 2020, slightly below the State average of 76% but higher than EU average of 58% and corresponding to that in every NUTS level 2 region of Denmark, Estonia, Latvia, Luxembourg, the Netherlands, Finland and Sweden.

The share of high-tech employment is 8% in the SR while knowledge-intensive services are close to the EU average of 39%. Employment in the high-tech sector was recorded in 2020 at 9% versus 10.5% in the EMR and 5.9% in the NWR.

The overarching need to improve the energy efficiency of the SR's residential sector is evident from the low levels of audited households to register a Building Energy Rating (BER) between "A" and "B". Between 2009 and 2020, only 19% of audited households in Ireland registered a BER between "A" and "B", with the corresponding ratios for households based in the SR – particularly in the Mid-West and South-East – notably low and in most cases below the State average.

Regional, Spatial and Economic Strategy (RSES) for the SR

In line with the NPF and NDP, the RSES sets a 12-year statutory strategic planning and economic development framework for future economic, spatial, and social development of the SR to become one of Europe's most "Creative and Innovative", "Liveable" and "Greenest" Regions. The NPF and RSES targets the region's three cities to grow by over 50% to 2040 as part of a structural realignment in population, homes, and jobs away from the Greater Dublin Area with a 50:50 distribution of growth between EMR, the SR and the NWR.

The economic strategy of the SRA's RSES aims to develop a sustainable, competitive, inclusive and resilient regional economy. With immediate challenges such as COVID-19, Brexit, and potential vulnerabilities for Ireland's enterprise base, the RSES commits to sustaining economic strengths in the immediate term and transforming the enterprise base for longer term resilience while managing potential vulnerabilities. The RSES will achieve this through an approach that involves Smart Specialisation, Clustering, Placemaking, Knowledge Diffusion and Capacity Building.

The Southern Regional Assembly (SRA), as part of the implementation of the RSES, commissioned an Interreg funded Cohesion project with a focus on Smart Specialisation and understanding EDP, which informed aspects of this chapter of S3 and will be used towards the ongoing development of the innovation capacity of the region.

8.2 Innovation Context – Southern Region

Overview

In the 2021 European Commission's Regional Innovation Scoreboard, the SR is classified as a strong innovator, along with the EMR. Although the region's overall innovation index score has improved since 2014, now standing at 118.1, it is just above the EU average of 114.8 and below the State average of 121.3. It continues to record notable weaknesses relative to the EU average in 2021 in terms of research and development expenditure in the private and public sectors; employment in knowledge-intensive activities; and patent, trademark and design applications. However, it scores highly in innovative SMEs collaboration and sales of innovative products.

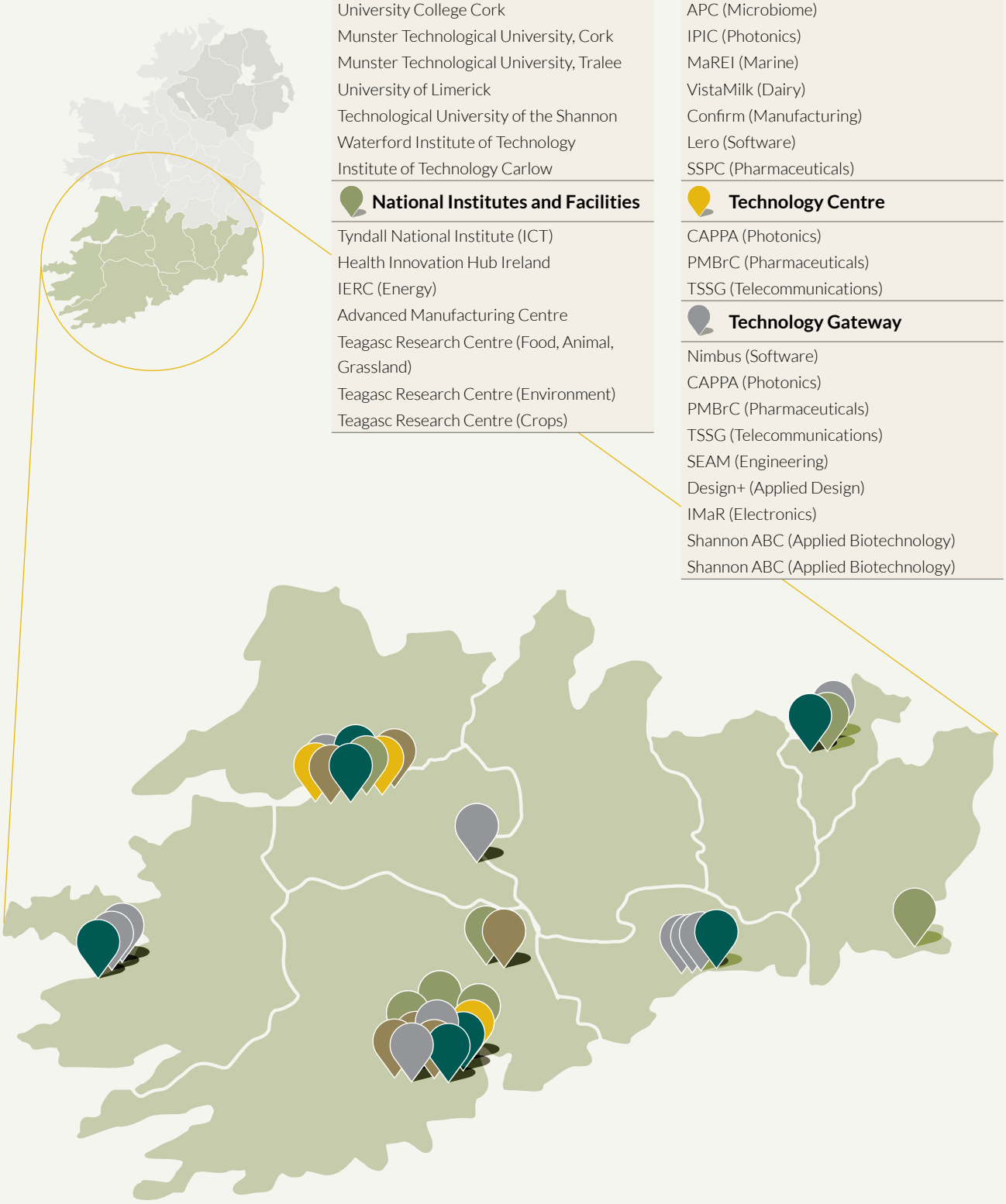
A significant development challenge that has been consistently highlighted is the need for more investment in R&D in the SR; an issue which is notably interlinked with the need to counter lagging productivity levels in domestic enterprises. This issue is of particularly importance for the SR as total business expenditure on R&D[49] in the region amounted to €489 per head of population in 2019, which was below the State average of €662.

Notably, from a labour market perspective, a total of 6,242 people were engaged as private sector R&D staff in the SR in 2019, accounting for 0.79% of the region's labour force[50], which was the lowest ratio out of the three NUTS 2 Regions of Ireland and below the State average of 1.12%.

49. Business Expenditure On Research And Development – CSO – Central Statistics Office
50. Q4 2019 Labour Force - CSO - Central Statistics Office

**Figure 8.1 NUTS 2 Southern Region -
Cork, Kerry, Limerick, Tipperary, Clare, Waterford, Wexford, Carlow, Kilkenny**

Key Research Performing Organisations in the Southern Region



Higher Education Institute (HEI)

- University College Cork
- Munster Technological University, Cork
- Munster Technological University, Tralee
- University of Limerick
- Technological University of the Shannon
- Waterford Institute of Technology
- Institute of Technology Carlow

National Institutes and Facilities

- Tyndall National Institute (ICT)
- Health Innovation Hub Ireland
- IERC (Energy)
- Advanced Manufacturing Centre
- Teagasc Research Centre (Food, Animal, Grassland)
- Teagasc Research Centre (Environment)
- Teagasc Research Centre (Crops)

SFI Research Centre

- APC (Microbiome)
- IPIC (Photonics)
- MaREI (Marine)
- VistaMilk (Dairy)
- Confirm (Manufacturing)
- Lero (Software)
- SSPC (Pharmaceuticals)

Technology Centre

- CAPPA (Photonics)
- PMBrC (Pharmaceuticals)
- TSSG (Telecommunications)

Technology Gateway

- Nimbus (Software)
- CAPPA (Photonics)
- PMBrC (Pharmaceuticals)
- TSSG (Telecommunications)
- SEAM (Engineering)
- Design+ (Applied Design)
- IMaR (Electronics)
- Shannon ABC (Applied Biotechnology)
- Shannon ABC (Applied Biotechnology)

8.3 Sectoral Overview

This section outlines the main sectoral areas of strength and emerging opportunity which were identified during consultation. It also takes into consideration the following factors:

- IDA Ireland companies in the region;
- Enterprise Ireland investment in the region;
- 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;
- Current cluster activity in the region;
- CSO trade and employment statistics;
- An analysis of sectoral strengths as identified in the RSESs.

Consultation Findings

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.

While all stakeholders agreed with those identified by DETE a number of additional sectors and sub-sectors were identified by stakeholders as significant based on their understanding of the strengths, ongoing capacity and knowledge of future changes in the region. Sectors identified by stakeholders in which the region has either existing or emerging strength are included if the sector is or has the potential to be a high-tech export traded sector. This means that tourism and retail, despite being identified for every region, are excluded in this analysis. This does not mean that these sectors are unimportant for the future development of the region, but that these are not areas in which there is the same level of scalable economic and R&D potential.

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.

DTIF: Funding Smart Battery Innovation in the Southern Region

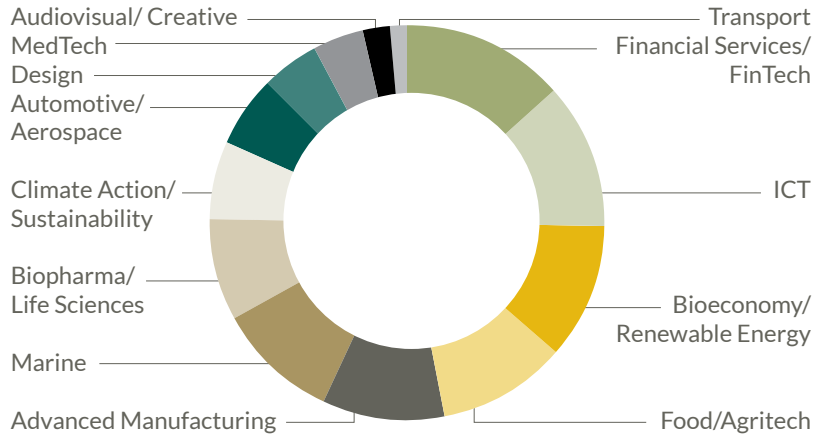
Ireland's Disruptive Technologies Innovation Fund (DTIF) has invested €3.65 million in TRIDENT: A Grid-Ready, Sustainable Sodium-Ion Smart battery for stationary storage.

Partners on the project, which, is being led and co-ordinated by UL's Bernal Institute, are Tyndall National Institute, Analog Devices, and Irish SMEs: mSemicon, ICERGi, Glantreo, TisaLabs and Smart M Power.

The goal of the TRIDENT project is to develop a low-cost, high-performance Sodium-ion smart battery system using entirely sustainable materials and processes.

The TRIDENT smart battery system will be a plug-and-play solution that can be installed in a household utility room and will empower the consumer to take an active role in the energy market, storing energy in times of low demand and selling back to the grid in times of high demand. The innovative solution will introduce flexibility to the energy markets, a key requirement for Ireland if the country is to meet its renewable energy targets.

Figure 8.2: Identified Sectoral Strengths and Opportunities for the SR



Source: DETE - Smart Specialisation Public Consultation

8.4 Identified Sectoral Strengths and Emerging Opportunities

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. An overview of the dominant economic sectors for RD&I, based on our consultation findings and analysis is presented below.

Advanced Manufacturing

The digitalisation of manufacturing processes represents an ongoing challenge and opportunity for Ireland, particularly in the SR with its high concentration of Pharma, MedTech and ICT companies. The SR is especially attractive to global high-tech manufacturing companies due to its connectivity to Europe and North America through water and airways, the strong skills force, and the English language.

Limerick has a strong cohort of advanced manufacturing specific R&D facilities (such as SFI Confirm and AMC) and sector-focused manufacturing R&D facilities (such as PMTC in pharmaceutical manufacturing). Waterford-based SEAM in material science and additive manufacturing complements these facilities as part of a network of high-tech R&D solutions for the region. For the sector to remain competitive increased engagement with R&D and a focus on innovation will be necessary for all enterprises in the region from start-ups to large MNCs. There is an opportunity for the region to clearly articulate its RD&I offering to manufacturing and to drive further digitalisation initiatives.

While all advanced manufacturing technologies are deployed in the region (advanced robotics, additive manufacturing, high performance computing, data analytics, high precision technologies, advanced control systems etc) there are particular specialisms evident in the strongly competitive sub-sectors of Sensor Technology and Networks (supported by research at Tyndall National Institute, SFI CONFIRM, TSSG/Walton Institute) and intelligent systems (support by research at SFI CONFIRM).

Farm Zero C - The World's First Climate Neutral Dairy Farm

Farm Zero C project looks to enable dairy farms to become carbon neutral and resilient in a commercially viable way. As part of the SFI Zero Emissions Challenge, which supports interdisciplinary teams as they develop solutions for Ireland to reach net-zero greenhouse gas emissions by 2050, it is exploring changes to farm practices that boost biodiversity and reduce greenhouse gases. It brings together academic researchers, the dairy industry and dairy farmers themselves.

Farm Zero C, a flagship project for BiOrbic Bioeconomy SFI Research Centre, is based in the Shinagh Farm in West Cork, a dairy demonstrator farm owned by the 4 West Cork Co-ops that supply milk to the Carbery Group, the project research includes studies on how planting different types of grasses and clovers on pastures, reducing fertiliser use and supporting hedgerows can boost biodiversity and soil health, on using renewable energy that reduces greenhouse gas emissions and on how changing what we feed livestock affects how much methane gas they produce.

Dairy farming is economically and socially important for Ireland, but it is also an emitter of greenhouse gases which contribute to climate change.

While Sustainable Manufacturing is also a strong feature of the region, with the ambitious carbon neutrality goal set by the Irish Government, there is a significant opportunity for the further development of energy and waste efficient production and the development of sites that use low energy during operations.

Audiovisual/Creative

In the Mid-West the audiovisual sector is gaining momentum thanks to the promotion efforts of Film in Limerick and the recent establishment of Troy Studios, Ireland's newest and largest studio facility. Many of the region's strengths in software and ICT can help meet the growing demands for advanced digital technologies within the screen industries. The ENGINE Hub is partnering with the film and tech sector and has been developing specialised training facilities to meet the needs of a supply of skills.

Design

Unique among the regions, the South-East has research strength in the design aspect of ICT and engineering, with the EI DESIGN+ Technology Gateway in Carlow and the Centre for Design Innovation Hub (C4D) in Kilkenny enabling companies to conceptualise, innovate, build and test new products and services.

The South East is home to several award-winning companies in the broader design sector and is well-positioned to promote and develop Ireland's capabilities in the creative economy and the more applied aspect of business-related design. According to census data, 2,400 people in the South East have qualifications in Audiovisual techniques and media production, design or craft skills. The design sector is further supported by the presence of the Design and Crafts Council of Ireland and the National Centre for Design and Craft.

Automotive/Aerospace

Shannon is home to the largest aerospace and aviation cluster in Ireland, with over 50 firms and growing. This cluster is supported by Shannon Group's International Aviation Services Centre (IASC) and the Emerald Aero Group. The IASC supports the Propeller Shannon Accelerator programme, a unique aviation and TravelTech programme that supports innovation and start-ups in B2B TravelTech, next-generation airports for passengers, big data, aviation services, drones/UAVs, cybersecurity, satellite tech, and more. Emerald Aero Group is a cluster of Irish companies offering international aerospace solutions in a variety of technologies including precision engineering, additive manufacturing and plastics moulding.

The automotive sector is also significant for the region, supported by the vehicle of the future cluster and SFI's UL-based Lero Software Research Centre. Shannon also hosts the Future Mobility Campus Ireland (FMCI), which creates and delivers future mobility testbed facilities for stimulating RD&I in Autonomous Connected Electric Shared Vehicles (ACES), including Connected and Autonomous Vehicles (CAV) in Ireland.

Investments in the relevant technologies across the mobility landscape are continuing to accelerate. The global market is expected to reach $91 billion by 2026. Europe's ambitious climate goals are also pushing the sector forward with increased investments in the transition towards more sustainable mobility representing a significant opportunity for the high-tech and research oriented automotive/aerospace sector in the region.

Expansion of Tyndall National Institute

Tyndall National Institute in Cork is one of Europe's leading research centres in ICT R&D, and the largest research facility of its type in Ireland. It sits in a unique position nationally at the mid-point between traditional HEI research activities and industry interface.

Tyndall works with industry and academia to transform research into products in its core market areas of electronics, communications, energy, health, agritech and environment. With a network of over 200 industry partners and customers worldwide, it is focused on delivering societal and economic impact from excellence in research. Tyndall is home to a research community of 600 people of 52 nationalities, including a considerable number of industry researchers-in-residence.

Tyndall plays a an important role in underpinning the success of the ICT sector in Ireland (the largest single manufacturing sector in the country). This sector is one of substantial economic importance globally, with considerable potential for increasing the level and quality of its economic impact in Ireland. Tyndall's significant level of engagement with SMEs and larger enterprises, the leadership role that it plays in terms of engagement in the EU and/ other international research programmes, is acknowledged as being of real importance to innovation development in Ireland. Tyndall's growth expansion targets objectives will result in a doubling of both activity levels and headcount in the coming years, which will provide Ireland with a research institute of international scale and momentum for the first time.

In recognition of Tyndall's track record in the Irish technology research sector as a key driver of economic impact, the NDP identified the expansion of Tyndall as an investment priority, The NDP committed to upgrading and expanding Tyndall 'to stay at the forefront of new technologies and build on its successful industry engagement model' and to enable it 'to respond to evolving ICT-related technology opportunities' in a fast-changing and competitive environment.

Bioeconomy/Renewable Energy

Bioeconomy

The bioeconomy is critically important in helping Ireland move toward a low-carbon, bio-based and circular economy and society. The sector has experienced significant growth in activity in recent years and is an area of strength for Ireland owing to the natural resources and infrastructure available. In a quest to become more sustainable and resource-efficient, companies of all sizes are diversifying into the production and conversion of renewable biological resources, by-products, and waste streams into value-added products. Bioeconomy encompasses all sectors and systems that rely on biological resources and has the potential to support new jobs and grow Ireland's economy while achieving green targets of reduced carbon emissions and sustainability.

Lisheen in County Tipperary is the country's leading hub for the development of the Irish bioeconomy, hosting the National Bioeconomy campus, a centre designed to work with food companies and other sectors to develop biorefining technologies based on renewable biological resources. Lisheen is one of only six regions in the EU granted the Model Demonstrator Region (MDR) status awarded by the European Commission, for the development of the bioeconomy. The facilities in the campus accelerate ideas to the market, help to de-risk new technologies, attract further investment, and build international links. Its Bioeconomy Innovation and Piloting Facility is a critical infrastructure for scaling technologies that convert Ireland's abundant natural resources to high-value products. Lisheen also hosts the Irish Bioeconomy Foundation, which works to promote the conversion of Ireland's natural land and sea resources to high-value products for the development of a sustainable bioeconomy that is globally competitive and creates local development.

The SR has the potential to deliver an international competitive advantage in region of bioeconomy RD&I. In addition to the extensive Bioeconomy RD&I conducted at Lisheen, the following also support the development of the sector in the region:

- Shannon Applied Biotechnology Centre (ABC) is an EI funded Technology Gateway hosted by TU Shannon and Munster TU, with significant expertise in bioresources detection, identification, characterisation, and valorisation. It collaborates with industry and research centres to deliver this expertise in applied settings;
- The SFI Research Centre BiOrbic is one of the top bioeconomy research centres in the world. While based in UCD, it has extensive research partnerships in the region. BiOrbic works with industry and others to create new products, processes and markets from renewable biological resources and associated waste streams;
- Teagasc supports bioeconomy initiatives in the SR through funding, research and information events such as Bioeconomy Week;
- Renewable Gas Forum Ireland is leading the AgriBio-CNG initiative,which involves the co-ordination and development of a cluster of 6-8 anaerobic digestion biomethane plants in Munster;
- The Circular Bioeconomy Cluster SW, based out of MTU, supports members with research, project development, project partner identification, talent and skills development, market connections, and funding. It has a focus on marine, agriculture and waste-to-value thematic areas.

Renewable Energy

The SR has strong renewable energy resources, including wave, tidal and offshore wind. The South East of Ireland has the best solar resource in Ireland, with average horizontal irradiation levels of over 1000 kWh/m2. Ireland's Energy Hub, located around Cork Harbour, comprises the country's most strategically important cluster of energy infrastructure, businesses and research facilities. The Energy Hub supplies over 25% of Ireland's energy demands, is home to 20% of Ireland's electricity generating capacity and the country's only oil refinery. Many of the largest energy companies in Ireland are represented within the Energy Hub or in the wider Cork region. There is also a strong concentration of engineering service providers in support of these industries.

The proposed redevelopment of ESB's Moneypoint in the Shannon Estuary, from a coal-burning power station to a green energy hub, has the potential to be a key development for the region over the next decade. The Moneypoint site will include a floating offshore wind farm, a wind turbine construction hub, a green hydrogen production, storage and generation facility and the Sustainable System Support facility, set to be the largest of its kind in the world. When complete, the Green Atlantic@Moneypoint facility would have capacity to power 1.6 million homes, save 1.8 million tonnes of CO2 equivalent per year and would allow Ireland to become a net exporter of renewable energy. This development could also present a good opportunity for the SR to become an international hub for Energy Innovation. These opportunities, and the further development potential of the area, are being examined by the recently established Shannon Estuary Economic Taskforce which is due to report on its findings in November 2022.

Energy R&D assets and clusters in the region include:

- The Lir National Ocean Test Facility, a custom designed test facility for laboratory testing of offshore wind, wave and tidal energy devices, and Ireland's only infrastructure for small to medium scale laboratory testing of ocean and maritime systems;
- MaREI, the SFI Research Centre for Energy, Climate and Marine research and innovation;
- The International Energy Research Centre (IERC), an industry-led collaborative research centre in the field of integrated sustainable energy systems based at Tyndall in Cork;
- The Mobile & Marine Robotics Research Centre, UL, conducts research for offshore marine technologies;
- Energy Cork is an industry-driven cluster pursuing co-ordinated actions to strengthen enterprise and employment within the energy sector in the Cork region;
- Shannon Energy Valley is working to create a 'world-class cluster' of sustainable and renewable energy companies between Galway and Limerick;
- Marine Ireland Industry Network (MIIN), while based in Galway, is made up of a diverse array of companies, state organisations, research groups and higher education institutes, working in Ireland's blue economy – including SR based stakeholders such as MaREI and several marine energy SMEs.

Biopharma/Life Sciences

In 2019 Ireland was ranked the 5th largest exporter of biopharmaceutical medicines globally with exports of €80 billion and all of the world's top 10 pharmaceutical companies having substantial operations in Ireland. Approximately. €2 billion is invested in Biopharma R&D by IDA client companies annually. The SR has a strong presence of pharmaceutical companies and RPOs conducting state-of-the-art life sciences R&D. The publicly funded RPOs include:

- The Pharmaceutical Manufacturing Technology Centre (PMTC), an EI/IDA Technology Centre based out of the University of Limerick, is a leading industry informed research centre focused on developing advanced technology solutions for all stages of pharmaceutical manufacturing;
- The SSPC (Science Foundation Ireland Research Centre for Pharmaceuticals) in Limerick conducts research that crosses the pharmaceutical production chain from molecule to medicine, with the objective of gaining a better understanding of mechanisms, controlling processes, and predicting outcomes for the efficient and environmentally sustainable production of safe medicines. It hosts a suite of highly technical equipment, including a state-of-the-art crystallisation, isolation and drying testbed which is the first of its kind globally;
- The PMBrc Technology Gateway on the main South East Technological University campus in Waterford City supports applied R&D activities within the pharmaceutical and healthcare industries allowing companies to embed R&D directly into their activities;
- Pharma R&D in the region is further supported by CONFIRM's Rapid Innovation Unit in Limerick, the SEAM Applied Materials Technology Gateway in Waterford, the HRB Clinical Research Facility in Cork, Cork University Hospital, and Mercy University Hospital. A new biotech innovation hub is also under construction in Cork City.

While the sector in the region is dominated by MNCs, there are several large and medium indigenous companies, and many opportunities for SMEs. There are several funding opportunities available within the sector that companies and research centres can leverage (e.g., Sláintecare Integration Fund, Enterprise Ireland's R&D Fund, Innovation Vouchers and Innovation Partnerships, IRC Enterprise Partnership Scheme, European Funding, etc.).

MedTech

The region's fast-growing capability in medical devices and healthcare is also attracting an increasing number of leading investors who are developing some of the most advanced factories in the region. MedTech is among the world's most innovative sectors in Europe constantly developing new disruptive technologies that are transforming lives. Public RPO support for MedTech in the region is predominantly based around Tyndall's ICT for Health Strategic Programmes which work 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.

Financial Services/FinTech

The SR has developed a strong Financial Services base, through both FDI investment and successful indigenous companies, with Cork now hosting Ireland's second-largest cluster of International Financial Service companies and notable activity in Limerick, Waterford, and Wexford. Activities in the region include:

- International Financial Services (IFS) (Investments, funds, & trading, Ratings agencies, Corp. treasury operations, payments & banking, Insurance, Reinsurance, Lending & SMB finance);
- Digital Industries (FinTech, InsurTech, RegTech, WealthTech, Infosecurity/ Cybersecurity, Blockchain/ Cryptocurrency, PayTech, CX-Tech);
- Aerospace (Aviation financing);
- Global business services -GBS (Analytics & BI, LegalTech, HR & professional services).

The region has wide network of supports for the sector including the NDRC (national start-up accelerator programme), which has a history of supporting early-stage FinTechs and has expanded its activities to Cork, Kerry, and Waterford (at ArcLabs); VC investments for FinTechs (with two of the country's top ten VC investors -both based in Cork); and industry organisations such as the Cork Financial Service Forum and South-East Financial Services Cluster driving the advancement of the industry. RD&I resources include:

- Financial Services Governance Risk and Compliance Technology Centre (GRCTC) a multi-institutional, industry-led research centre hosted by Cork University Business School at UCC;
- UCC's Financial Services Innovation Centre;
- WIT's RIKON centre of innovation in Business Technology Management
- IT Carlow's InsurTech Network Centre Accelerator.

Sustainable Finance

Sustainable finance is the capital required to tackle climate change and includes green bonds, ESG and socially responsible investing (SRI) investments, sustainable infrastructural investments, climate finance, and performance bonds. The growth of Environmental, Social and Governance (ESG) investment is steadily increasing, and Ireland already has a cluster of renewable energy infrastructure fund managers with €7 billion of assets under management. EU developments on sustainable finance (including the Green Deal) represent a significant opportunity for Ireland and the SR to be at the forefront of this growing area.

Food/AgriTech

Ireland has a significant agricultural footprint with about two-thirds of its land devoted to agricultural use which is divided up into 140,000 individual farms. AgriFood is the largest indigenous business and accounts for 5.7% of our GDP.

The agriFood sector in the SR is well developed being home to world-class research centres of excellence and third-level institutes, leading the direction of change in the sector through collaborative research and innovation. The sub-sectors of functional food and high-value ingredients and AgriTech for dairy (enhanced nutrition, novel product development) are well supported by research centres such as Teagasc, VistaMilk, Shannon ABC, TSSG, APC Microbiome Institute and DPTC.

AgriTech for Dairy

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 key players and companies in the Irish dairy industry are concentrated in the SR. The South East and South West have the highest proportion of specialist dairy farms and since the abolition of quotas in 2015, 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.

There are two key R&D centres for the dairy sector in the region:

- Vistamilk – the SFI Research Centre for innovative precision pasture-based dairying - is based in Fermoy and drives innovation and enhanced sustainability across the dairy supply chain by bringing together expertise in the biological sciences, sensor-systems, communications and networking, data analytics, and food processing;
- The Dairy Processing Technology centre (DTPC) is an EI/IDA Technology Centre based in Limerick with a research agenda driven by the long-term growth opportunities for the dairy sector.

Other FoodAgri research centres active in the region include:

- Food for Health Ireland (FHI) - which has produced four new functional components from milk through the combined expertise from State Agencies (EI, Teagasc) and academia (UCD, UCC, UL);
- The APC Microbiome SFI Research Centre in Cork works on gastrointestinal bacterial research which includes work on functional food ingredients;
- BiOrbic the SFI Research Centre for the Bioeconomy, has developed a pioneering dairy farm project Farm Zero C in West Cork;
- The Walton Institute in Waterford houses the Smart Agriculture IoT testbed and is part of the SmartAgriHubs network.

Functional Foods

Functional foods are foods that have a potentially positive effect on health beyond basic nutrition. The global functional food market size is estimated to reach approximately $268 billion by 2027. Due to a greater understanding of human nutrition, research into nutritional solutions and higher value-added dairy products for infants, athletes, and the ageing population has increased. Product development, ingredient interactions, sensory and product analysis, as well as the development of new components and bioactive compounds from environmental and natural sources, are some of the research focuses of companies and top research institutes in the region. Teagasc, VistaMilk, PMBRC Gateway, Shannon ABC, Food@LIT, DPTC and the APC Microbiome Institute (a global leader in microbiome research) are the key public R&D centres that have capacity in functional food research in the region. There is significant potential for the SR to continue to develop their capacity in this sector over the coming years.

ICT

Ireland has become the global technology hub of choice when it comes to attracting the strategic business activities of ICT companies. It is the second largest exporter of computer and IT services in the world, which generates €50 billion in exports annually. The SR has several ICT strengths, in particular sub-sectors owing to its infrastructural capacity and ICT enterprise base. The region is a high performer for semiconductors, with 29 patents in the area between 2015-2019[51], making it one of Europe's leading regions in their manufacture.

The SR has Irelands highest ICT research capacity and infrastructure to support the digitalisation of manufacturing, energy, transport and more traditional sectors such as agriculture and health. The ICT ecosystem in the SR is populated with a complete support network including R&D centres, industry-led cluster groups, venture capital, tech incubators and accelerators, business innovation centres, and multiple entrepreneurial and coworking spaces. There is particular expertise in the sub-sectors of Cybersecurity (especially in the Cork Metropolitan Area), Applied IoT and ICT hardware/electronics (driven by the significant research capacity in the region). There is also growing expertise around SportsTech.

The R&D in the sector is supported by core public research assets such as:

- Tyndall National Institute specialises in integrated ICT hardware and systems and works with industry and academia to transform research into products. Core research includes deep-tech in Photonics and Micro & Nano Systems for consumer electronics, communications and quantum technologies within the energy, health, AgriTech and environment sectors;
- Walton Institute/TSSG in Waterford carries out a wide spectrum of industry-informed research in ICT, particularly technologies enabling communications and information services (includes cybersecurity, VR/AR, precision agriculture, future

51. OECD REGPAT Database 2021

health and intelligent transport);
- MCCI Technology Centre Cork focuses on delivering high impact research for the semiconductor industry;
- IPIC in Cork is the SFI photonics research centre;
- Lero in Limerick is the SFI Research Centre for software, with specialisms in analytics, security and in blended autonomous vehicles;
- Nimbus Gateway in Cork conducts research in cyber-physical systems and IoT. Core application areas include Sustainable Smart Cities, Industry 4.0, Assisted Living and Education;
- The CAPPA Gateway applies light-based photonic technologies to provide near-to-market solutions for industrial partners;
- The IMaR Gateway in Tralee conducts research in Intelligent Mechatronics and Radio Frequency Identification & Internet of Things;
- The SFI Research Centre for Future Networks and Communications (CONNECT), while based in TCD, has core activity at Tyndall leading the 'Responsive Things' theme and a Data Centre located within TSSG which supports network-based research projects in the area of telecommunications networking and cloud computing.

Other research facilities include the SFI Insight's partnership with UCC, Dell IoT Lab, ACORN Centre at TU Shannon and the SIGMA research group at MTU. Clusters include:

- The Cyber Ireland Cluster, based in Cork City, aims to make Ireland a global cybersecurity leader from the point of view of talent and skills, research and innovation, boosting SME exports, and attracting foreign direct investment (FDI);
- The tech cluster it@Cork has more than 220 companies from the tech sector in the SouthWest, it provides support through training, upskilling, networking, and knowledge-sharing opportunities. It also co-ordinates the it@cork Skillnet where companies work collaboratively to share best practice, respond effectively to the specific skills needs of the sector and addresses both technical and non-technical skills needs of members;
- The Crystal Valley Tech Cluster in the South East is an industry-led group to influence the development of the national and regional investment in infrastructure, education, training and economic support. It also promotes the region as a destination for ICT.

Applied Internet of Things (IoT)

This is a crosscutting area of specialisation that taps into the region's research strength in software, ICT, and cyber-physical systems with innovative applications being developed together with the industry. Applied IoT has one of the highest projected market growth rates for the region[52]. The global market was worth $250 billion in 2020 and is projected to reach $1,567 billion by 2025[53].

Nimbus in Cork is the largest IoT Applied Research Centre in Ireland with over 50 full-time researchers and engineers who deliver 70+ applied research projects per year. The Applied IoT Gateway cluster has three gateways in the region (Nimbus, IMaR and TSSG) and has been involved in projects across a diverse range of sectors including, Agriculture, Construction, Healthcare, Transportation, Telecoms, Energy and Pharma.

52. Research conducted by BABLE for the SRA
53. IoT market size worldwide 2017-2025 | Statista

Cybersecurity

Cork is the centre of Ireland's cybersecurity cluster and has proven to be a successful location for both FDI and indigenous companies. Cybersecurity is a rapidly growing industry internationally, with an estimated $248 billion in worldwide cybersecurity spending by 2023 and 0% unemployment (3.5 million unfilled jobs predicted by end 2021)[54]. Ireland has become a significant base of international technology and security companies with:

- Top 5 worldwide security software companies;
- Over 40 MNCs with Cyber Security Operations;
- Over 60 Irish Cyber Security Companies & Start-ups;
- Over 6,000 people working in cyber security industry.

Cybersecurity RD&I resources in the region include Lero, Insight, CONNECT, Walton Institute and MTU. UCC and MTU both offer MSc level courses in Cybersecurity.

Increased regulations on data privacy, more sophisticated scamming and phishing, and growth in identity theft are major trends that will demand sophisticated solutions that will lead to significant job creation within the cybersecurity sector. However, a significant challenge for the cybersecurity sector in the SR, and indeed globally, is the skills shortage.

SportsTech

Sport technologies and innovations have gained popularity both in outdoor and indoor activities, with an expected global market growth of over $41 billion by 2026. In the Mid-West, there is a growing cluster of international SportsTech companies concentrated in the region, which are leveraging data and technology for better insights. The key verticals present in SportsTech in the region are Performance Analytics, IoT, Fan Engagement, eCommerce, Broadcast Technologies, Stadium Tech and eSports. RD&I in the sector is supported by:

- Lero, the SFI Software Research Centre in UL, hosts Ireland's first esports research lab which conducts studies designed to boost performance of international amateur and professional esports players;
- PESS (Physical Education and Sports Sciences) at the University of Limerick has a growing research programme with five priority research areas of Food and Health, Sport and Human Performance, Sport Pedagogy, Physical Activity and Health and Golf Performance;
- The SportsTech Ireland Cluster, based in Limerick, promotes Ireland as a world leading destination for sports innovation and technology through developing a national and international network with a focus on innovation at the intersection of technology and sport;
- The SportX Accelerator, a pre-accelerator programme for founders with sports and wellness start-up ideas in south-west Ireland.

By building on its research strength and innovation ecosystem, the region could become a springboard for a unique new area of specialisation, which intersects with software, ICT, media, health, nutrition, wearables etc.

54. Figures from CyberIreland

Photonics

There is a particular research expertise in Cork in the subsector of photonics, which has key application areas such as communications, displays, sensing, medical and energy. CAPPA (Centre for Advanced Photonics and Process Analysis) is a research centre of MTU which conducts both applied and fundamental research on photonics for applications in areas as diverse as telecommunications, medical devices, food, and pharmaceuticals manufacturing. Photonics is a key area for Tyndall which hosts IPIC, the SFI Centre for Photonics. IPIC is Ireland's centre of excellence for research, innovation and PhD training in photonics. They work closely with over 30 industry partners to develop their next generation products, across Ireland's high growth technology sectors such as ICT and MedTech, supporting their attraction to and growth in Ireland. In addition, they commercialise our disruptive technologies through start-up companies and co-ordinate the Photonics Ireland National Technology Platform.

Quantum Computing

A new opportunity to develop more specialised ICT capacity in the SR presents itself in the context of the expansion of the Tyndall National Institute, the country's largest research centre. Ireland's first dedicated Quantum Computer Engineering Centre (QCEC) will be based at Tyndall's new facility on Cork's North Mall. The rapidly emerging field of quantum computing will have a huge impact on the future of the ICT industry, and in the healthcare and finance sectors. QCEC will upskill Irish researchers in the area of quantum and will develop open innovation and collaboration between academia and industry, while supporting key Irish technology companies and SMEs.

9 S3 Conclusions, Goals and Deliverables

9.1 S3 Overall Conclusions

The public consultation on the new Smart Specialisation Strategy for Ireland provided an opportunity to assess with stakeholders what are regional competitive advantages and future market opportunities, as well as the effectiveness of the current suite of innovation supports. Based on stakeholder consultations, as well as research involved in the development of REPs and RSESs, the key sectors in the regions which have an international competitive advantage based on their ability to compete in global markets comprise:

- Advanced Manufacturing/Engineering;
- Bioeconomy/Renewable Energy/Low-carbon economy;
- AgriFood/AgriTech;
- ICT;
- Financial Services/FinTech;
- MedTech;
- Biopharma/Life Sciences;
- Climate Action/Sustainability;
- Marine/Maritime.

Within these sectors, stakeholders identified niche technology areas with high transformative potential. For example, the EMR specialises in the development of ICT devices and biotechnologies, as well as audiovisual technology. These are dealt with in more detail in each of the NUTS 2 regional chapters.
Several common recommendations were made for all regions by stakeholders to develop each of these sectors. These included:

- greater ICT skills development and enhanced quality and provision of ICT infrastructure;
- the mapping of technological competencies at regional level to define S3 thematic priorities and to identify specific potential technological areas of interest and investment;
- further investment into regional innovation hubs informed by the S3 priorities;
- ensure alignment with S3 and the economic strategies of the RSESs.

Overall, the findings of the S3 analysis and consultations highlights the value of a regional approach to innovation policy development, as well as building on work already undertaken by the three Regional Assemblies to ensure a consistent approach in this regard. The Regional Assemblies are seen as having a key role in implementing such a regional approach to S3 through a place-based focus which would connect many local examples of RD&I excellence. In turn this overcomes both market size challenges and reduces fragmentation of effort, while creating a stronger presence and improved opportunities to boost innovation efforts with EU partners of choice. Consequently, it is suggested that the Regional Assemblies, through their statutory role in implementing RSESs, supporting delivery of Project Ireland 2040 and the ERDF programmes, are ideally positioned to drive an iterative place-based regional dimension to Ireland's S3 implementation. This would, in turn, increase the impact of the national S3 by tapping into local and regional networks.

9.2 S3 Strategic Goals and Deliverables

Considering Ireland's strengths, future challenges and opportunities to 2027 several strategic goals for S3 have been identified. These goals will support Ireland's ongoing efforts to rise to the challenges of the future identified by our stakeholders by supporting the smart specialisation process in all aspects. They are accompanied by high-level deliverables which will ensure these goals are met. These goals and deliverables will be further supported by a more granular list of actions set out in a future annexe. S3 goals and deliverables are:

High Level Strategic Goals

1

Our new Smart Specialisation Strategy for Ireland will link national and regional enterprise and innovation policy, connecting the statutory RSES, Regional Enterprise Plans, Impact 2030: Ireland's Research and Innovation Strategy and other national policies and will bring greater policy coherence at multiple levels of governance.

This will be achieved through:

- Convening a national Smart Specialisation Implementation Group to bring together regional and national innovation policymakers;
- Continuing to focus on identifying linkages and exploiting synergies between relevant national and regional strategies; and
- Providing input, informed by smart specialisation insights, into the development of new strategies and policies over the lifecycle of S3.

2

Smart Specialisation will support the adoption of the European Regional Development Fund in Ireland by supporting policy objective 1 'A Smarter Europe'

This will be achieved through:

- Approval of Ireland's Smart Specialisation Strategy by the European Commission.

3

Smart Specialisation will improve research and innovation capacity in Ireland's regions.

This will be achieved through:

- Increasing the intensity of Business R&D that takes place across all regions, with a particular focus on underperforming regions, through delivering new and enhanced agency interventions with a particular focus on strengthening industry-academic collaborations across Ireland.

4

Smart Specialisation will encourage more regionally dispersed RD&I, strengthen the enterprise base and identify emerging areas of opportunity.

This will be achieved through:

- Leveraging and building on the analysis of regional strengths and emerging areas of opportunity undertaken as part of the development of Ireland's S3;
- Addressing gaps in existing regional innovation infrastructures and systems through new funding, by supporting projects aligned with the nine Regional Enterprise Plans to 2024 (REPs); and
- Seeking out opportunities to enable inter-regional collaboration through the REP Implementation structures.

5

Smart Specialisation will increase the regional uptake of new advanced technologies to increase the reach of the twin green and digital transformation throughout Irish enterprise.

This will be achieved through:

- Enhanced supports prioritising knowledge transfer and industry-academic collaboration, informed by our smart specialisation analysis and findings including interventions with a particular focus on strengthening industry-academic collaborations across Ireland.

6

Smart Specialisation will drive the development of skills needed for enhancing innovation activity across the economy

This will be achieved through:

- New and enhanced supports based on creating the necessary skills for 'needs led' innovation, informed by our smart specialisation analysis and findings

7

Smart Specialisation will encourage the maximising of sectoral strengths through clustering and the scaling of Ireland's existing areas of research excellence.

This will be achieved through:

- Supporting the development of a new National Clustering policy framework through the identification of regional and national sectoral strengths, capabilities and opportunities; and
- Supporting the scaling of Ireland's existing network of national R&D facilities and clusters by establishing a coherent national framework for S3, and by setting out opportunities that exist within Ireland's regions.

8

Smart Specialisation will lead to a greater visibility and coherence of the innovation system in Ireland's regions both nationally and in Europe.

This will be achieved through:

- The establishment of an S3 monitoring implementation procedure and governance at local, regional and national level;
- The incorporation of S3 goals, approach and priorities into the Impact 2030: Ireland's Research and Innovation Strategy;
- Ongoing engagement with S3 in Ireland by the European Commission.

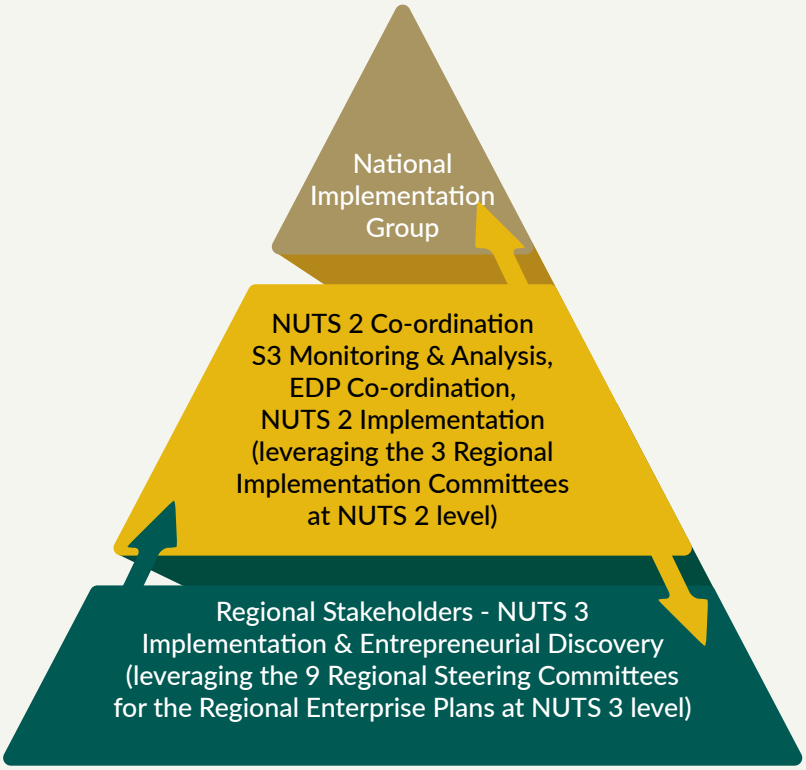
Smart Specialisation deliverables are to be extensively supported by Ireland's ERDF programmes, subject to European Commission approval, that aim to enhance RD&I activity through new collaboration supports, improved HEI R&D capacity and novel innovation grant initiatives. It is also intended to bolster regional entrepreneurship through investment in the Technological Universities, leveraging the role of further and higher education institutions as anchors for enterprise and for regional growth. The ERDF draft programmes have been extensively informed by this strategy and include specific programme level metrics to ensure targeted impact. Supporting the work of these programmes will provide new and additional value for Ireland and push forward future regional and national advantages across a variety of areas.

More broadly, S3 will assist in guiding the focus of a range of other funding mechanisms across Government, including Horizon Europe, aimed at driving increased collaborations across research and innovation, industry and the higher education sector, and in ensuring their alignment with ERDF.

Achieving impact from S3 will require comprehensive governance, monitoring and implementation procedures in order to ensure that its goals and deliverables are met. These are outlined in the next chapter.

10 Governance, Monitoring and Implementation

Figure 10.1: S3 Governance and Monitoring – Three Levels



Smart Specialisation is a place-based innovation policy, aimed at promoting regional innovation and economic transformation by helping regions to focus on their strengths and potential for excellence. It requires higher education and research organisations and business, along with governmental departments and agencies, to identify strengths in a region, build on regional competitive advantages and prioritise support based on where local potential and market opportunities lie. In its creation and execution, Ireland's Smart Specialisation Strategy (S3) strengthens the relationship between the bottom-up Regional Enterprise Plans (REPs), the NUTS 2 level Regional Spatial and Economic Strategies (RSESs), and national enterprise and innovation policies.

Ireland's S3 will be monitored and implemented by a multi-level process involving national and regional stakeholders. An important requirement for a monitoring system is to give insights into innovation performance, participation in networks, collaboration with other companies and research institutes over time to ensure these developments can be monitored and patterns become visible. Accordingly, the entrepreneurial discovery process, EDP, needs to be part of the entire policy cycle where stakeholders are involved from the identification of priorities to their implementation.

ERDF's PO1 'A Smarter Europe', the financial mechanism for S3, which will also act as a source of additionality, has been informed by the process of developing Ireland's S3. This has involved continuous and ongoing engagement throughout S3 consultation and strategy development. The Managing Authorities for the ERDF in Ireland are the NUTS 2 Regional Assemblies which are integral to the monitoring and implementation of S3 at that level and nationally.

10.1 NUTS 1 – S3 National Implementation Group

Membership: Representatives from the Department of Enterprise, Trade and Employment; Department of Further and Higher Education, Research, Innovation and Science; Department of Public Expenditure and Reform; the three NUTS 2 Regional Assemblies; with input from related enterprise and innovation implementation agencies and bodies as required. The National Implementation Group will be chaired by the Department of Enterprise, Trade and Employment.

Role: The National Implementation Group will ensure all enabling S3 criteria are met at national level. It will ensure S3 governance and monitoring structures, along with regional interests within S3, are identified. This will bring additional value to the S3 process by bridging gaps between national policy and regional implementation. The group will also be responsible for ensuring coherence and promotion of S3 principles across the whole of government.

It will oversee the delivery of S3 national and regional strategic priorities by bringing together relevant policy leads, as well as related agencies and bodies directly involved in implementation as required. It will focus on prioritisation and action planning to identify emerging regional consensus on cross-sectoral economic and innovation developments, ensuring continued alignment between national enterprise and innovation policies and S3.

Reporting mechanisms: The national implementation group will meet every six months, based on regular updates from the REPs and Regional Assemblies. Along with their own monitoring results, the national implementation group will prepare a biannual report outlining how S3 is progressing in the national and regional contexts.

10.2 NUTS 2 – Regional Co-ordination

Membership: S3 will leverage the Regional Implementation Groups for the statutorily based Regional Spatial and Economic Strategies (RSESs), which operate at NUTS 2 level. These groups will incorporate S3 into their terms of reference. They are chaired by their respective Regional Assembly, with a variable membership that reflects the differing stakeholders in the regions. This typically includes governmental agencies and HEIs. This ties in with the European Commission recommendation for dedicated regional teams responsible for smart specialisation monitoring and evaluation to enable the strategy to reach its regional objectives.

Role: The three Regional Implementation Groups will have three main roles for S3.

1. Utilise monitoring indicators and tools, such as – but not limited to – the Regional Assemblies "Regional Development Monitor" which is being developed by AIRO, to inform their work on regional innovation trends and developments, monitor progress on S3 implementation, and present findings to the S3 National Implementation Group. This corresponds to the European Commission recommendation to make use of analytical and informative tools.
2. Through participation on the nine REPs Steering Committees, the Regional Assembly member will (a) ensure alignment with national and regional priorities, and support the identification of new regional priority areas based on their analysis, regional insights and focused stakeholder engagement, and (b) gather cross-regional insights and information on S3 related developments and regional level implementation, co-ordinated and reported to the National Implementation Group. These insights will be considered and discussed by the S3 National Implementation Group.

3. Regional Implementation Groups can perform further analysis in relation to selected regional priority areas, co-ordinated and led at NUTS 2 level, as necessary to inform S3 National Implementation Group deliberations and regional level implementation. The groups will also provide implementation support at NUTS 2 level for delivery of S3 national and regional strategic priorities as agreed, and consistent with the work of the National Implementation Group.

Reporting mechanisms: These groups will meet prior to the National Implementation Group's six-monthly meeting to facilitate its reports to the latter. The three regional implementation groups will also report ongoing S3 alignment with ERDF spending and broader results, through indicator monitoring and other research as relevant. This will take the form of a written submission to the National Implementation Group. Additionally, a full mid-term review will take place during the lifecycle of ERDF which will allow for the monitoring of NUTS 2 regional indicators relevant to S3 implementation.

10.3 NUTS 3 – S3 Stakeholder Groupings

Membership: Each of the nine REPs steering committees include stakeholders from across the nine NUTS3 level regions, reflecting the quadruple helix model. While this varies slightly across the regions, it includes regional representatives from each of the region's higher education institutes, Local Authorities, Enterprise Ireland, IDA Ireland, Local Enterprise Offices, Regional Assemblies, the private sector, Regional Skills Forum managers and other stakeholders. Each committee is chaired by a representative from industry and managed by regional programme managers.

Role: It is recognised that the REPs will be important vehicles in translating S3 into regional and local impact. These stakeholder groupings will also ensure regular EDP feedback. Identified S3 priority areas will be an agenda item for discussion led by the Regional Assembly member at the REPs steering committees. The Regional Assemblies will sit on each REP steering committee, ensuring S3 priorities (both agreed and emerging) remain a live consideration at a local level. The REPs are an excellent forum for this engagement as regional and local agents are better equipped to understand regional strengths, identify trends and monitor regional developments.

Reporting mechanisms: S3 will be an item in the mid-term and final REPs progress reports. In addition to these reports, an update will be provided by DETE's Regional Enterprise Plans and Initiatives Unit to the National Implementation Group. The REPs monitoring and reporting structure will allow for S3 goals to be monitored and assessed at this level.

On completion of the REPs in 2024, a new consultation process will commence to develop new Plans, allowing for renewed focused consultations with regional stakeholders. Accordingly, this will allow for S3 to reflect changing directions in regional enterprise.

Appendix 1

National Public Consultation on Smart Specialisation Strategy Contributors

On 13 July 2021, the Department of Enterprise, Trade and Employment sought the views of stakeholders on the development of a Smart Specialisation Strategy for Ireland.

The purpose of the consultation was to collect the views of stakeholders with an interest in the development of the national and regional enterprise innovation landscape, especially businesses or business support organisations, national/regional/local public authorities, as well as research and innovation organisations. The closing date for receipt of submissions was 10 August 2021.

36 submissions were received, of which four came from other Departments, namely the Departments of the Environment, Climate and Communications, Further and Higher Education, Research, Innovation and Science, Public Expenditure and Reform, and Tourism, Culture, Arts, Gaeltacht, Sport and Media.

List of Stakeholders who Submitted to Consultation Process

- Cisco Ireland
- Clare County Council
- CONFIRM-SFI Research Centre for Smart Manufacturing
- Corca Dhuibhne Creativity and Innovation Hub
- Cork Smart Gateway
- Councillor Joe Sheridan
- Department of the Environment, Climate and Communications
- Department of Further and Higher Education, Research, Innovation and Science
- Department of Public Expenditure and Reform
- Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media
- Dr. Geraldine Canny
- Eastern and Midland Regional Assembly
- EirGrid
- Enterprise Ireland
- Gas Networks Ireland
- IBEC
- IDA Ireland
- Institute of Technology Sligo
- Insurtech Network Centre DAC- Carlow IT
- InterTradeIreland
- Ireland Southeast Development Office
- Knowledge Transfer Ireland (KTI)
- LEOs-Enterprise Agencies & Programmes Unit
- Lero, SFI Research Centre for Software
- Midlands Regional Enterprise Plan
- Mid-West Regional Enterprise Plan
- North-East Regional Enterprise Plan
- Northern and Western Regional Assembly
- North-West Regional Enterprise Plan
- Science Foundation Ireland-DFHERIS
- South East Regional Skills Forum
- Southern Regional Assembly/BABLE
- Technological Higher Education Association (THEA)
- Tyndall Institute
- University of Limerick
- Western Development Commission

Appendix 2

List of Acronyms

AI	Artificial Intelligence
AMC	Advance Manufacturing Centre
AMETS	Atlantic Marine Energy Test Site
APT	Applied Polymer Technologies
AR	Augmented Reality
ATU	Atlantic Technological University
BEDF	Border Enterprise Development Fund
BER	Building Energy Rating
BERD	Business Expenditure on Research and Development
CAF	Climate Action Fund
CAPPA	Centre for Advanced Photonics & Process Analysis
CAV	Connected and Autonomous Vehicles
CeADAR	Centre for Applied Data Analytics Research
CECAM	Centre Européen de Calcul Atomique et Moléculaire
COST	European Cooperation in Science and Technology
CPR	Common Provision Regulations
CREDIT	Centre for Renewable Energy at Dundalk IT
CSO	Central Statistics Office
CSRs	Country Specific Recommendations
DAFM	Department of Agriculture, Food and the Marine
DECC	Department of the Environment, Climate and Communications
DESI	Digital Economy and Society Index
DETE	Department of Enterprise, Trade and Employment
DFHERIS	Department of Further and Higher Education, Research, Innovation and Science
DHLGH	Department of Housing, Local Government and Heritage
DkIT	Dundalk Institute of Technology
DPER	Department of Public Expenditure and Reform
DPTC	Dairy Processing Technology Centre
DTCAGSM	Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media
DTIF	Disruptive Technologies Innovation Fund
EC	European Commission
EDIHs	European Digital Innovation Hubs
EDP	Entrepreneurial Discovery Process
EI	Enterprise Ireland
EIC	European Innovation Council
EIT	European Institute of Innovation and Technology
ELIXIR	European Life-Science Infrastructure
EMBL	European Molecular Biology Laboratory
EPA	Environmental Protection Agency
EPPC	Economic and Public Policy Consultancy
ERA	European Research Area

ERDF	European Regional Development Fund
ESA	European Space Agency
ESB	Electricity Supply Board
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Southern Observatory
EOSC	European Open Science Cloud
ETS	Emissions Trading System
EU	European Union
EuroHPC	European High-Performance Computing
EVs	Electric Vehicles
FDI	Foreign direct investment
FET	Further Education and Training
FMCI	Future Mobility Campus Ireland
FMI	Future Manufacturing Ireland
GBARD	Government Budget Allocations for R&D
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI*	Modified Gross National Income
GNP	Gross National Product
GRCTC	Governance Risk and Compliance Technology Centre
GVA	Gross Value Added
HEI	Higher Education Institutions
HPC	High performance computing
ICHEC	Irish Centre for High-End Computing
ICT	Information and Communication Technologies
IDA	Industrial Development Authority Ireland
IERC	International Energy Research Centre
IFS	International Financial Services
IFSC	International Financial Services Centre
IMR	Irish Manufacturing Research
IoT	Internet of Things
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
IPCEI	Important project of common European interest
IPIC	Irish Photonic Integration Centre
IRC	Irish Research Council
IRDG	Industry Research and Development Group
ITI	InterTradeIreland
JTF	Just Transition Fund
KIBS	Knowledge-intensive business services
KTI	Knowledge Transfer Ireland

LECP	Local Economic and Community Plan
LEOs	Local Enterprise Offices
MaREI	Marine and Renewable Energy Ireland
MCCI	Microelectronic Circuits Centre Ireland
MDR	Model Demonstrator Region
MFF	Multi-annual Financial Framework
MFRC	Marine and Freshwater Research Centre
MIDC	Marine Innovation and Development Centre
MIIN	Marine Ireland Industry Network
MNCs	Multinational Corporations
MTCO2e	Metric tons of carbon dioxide equivalent
MTU	Munster Technological University
NACE	Statistical Classification of Economic Activities in the EC
NAF	National Adaptation Framework
NBP	National Broadband Plan
NDP	National Development Plan
NDRC	National Digital Research Centre
NIBRT	National Institute for Bioprocessing Research and Training
NPF	National Planning Framework
NRPE	National Research Prioritisation Exercise
NRRP	National Recovery and Resilience Plan
NSAI	National Standards Authority of Ireland
NTF	National Training Fund
NUTS	Nomenclature of Territorial Units for Statistics
NUTS 1	Ireland
NUTS 2	Southern, Northern & Western and Eastern & Midland Regions
NUTS 3	South-West, South-East, Mid-West, etc
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PESS	Physical Education and Sports Sciences
PI 2040	Project Ireland 2040
PMBRC	Pharmaceutical and Molecular Biotechnology Research Centre
PMTC	Pharmaceutical Manufacturing Technology Centre
QCEC	Quantum Computer Engineering Centre
R&D	Research and Development
R&I	Research and Innovation
RD&I	Research, Development, and Innovation
REDF	Regional Enterprise Development Fund
REPs	Regional Enterprise Plans
RIS	Regional Innovation Scoreboard
RPOs	Regional Policy Objectives

RSES	Regional Spatial and Economic Strategy
S3	Smart Specialisation Strategy
SEAI	Sustainable Energy Authority of Ireland
SEAM	South Eastern Applied Materials Research Centre
SETU	South East Technological University
SFI	Science Foundation Ireland
SMEs	Small and Medium-Sized Enterprises
SOLAS	An tSeirbhís Oideachais Leanúnaigh agus Scileanna
SRA	Southern Regional Assembly
SRI	Socially Responsible Investing
SSPC	Science Foundation Ireland Research Centre for Pharmaceuticals
STEM	Science, Technology, Engineering & Maths
TCD	Trinity College Dublin
TRL	Technology Readiness Level
TTO	Technology Transfer Offices
TTSI	Technology Transfer Strengthening Initiative
TUs	Technological Universities
UCC	University College Cork
UCD	University College Dublin
UL	University of Limerick
VR	Virtual Reality
WDC	Western Development Commission
WEF	World Economic Forum
WIPO	World Intellectual Property Organization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