Regional Transformational Opportunities in the Highlands and Islands

REPORT

May 2025

Quantifying the potential of major investment projects and understanding associated enablers.

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HIREP
HIE
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Iomairt na Gàidhealtachd 's nan Eilean

Contents

1 Introduction

Context

1.1 The Scottish Government's National Strategy for Economic Transformation (NSET)[1] sets out a vision to:

> *'create a wellbeing economy: a society that is thriving across economic, social and environmental dimensions, and that delivers prosperity for Scotland's people and places.'*

1.2 It highlights the need to build on Scotland's sectoral strengths including energy and life sciences, while developing strengths in space, decarbonisation and technology to achieve this vision. The Just Transition strategy enforces the ambition for Scotland to pivot to sources of renewable energy to help achieve net zero carbon emissions by 2045. The just transition to net zero is identified as one of the greatest economic opportunities for Scotland over the next decade and the Highlands and Islands will be central to this.

1.3 The Highlands and Islands Regional Economic Strategy 2025-2035[2], recently published by the Highlands and Islands Regional Economic Partnership (HIREP), recognises that the region is in a unique position with an abundance of the natural and infrastructure assets that are critical to achieving Scotland's climate ambitions and supporting the transition to clean, green sources of energy. It also recognises that transformational change and action will be necessary to ensure that economic and social benefits are captured for people, communities and businesses in all parts of the region. Its vision for the region in 2035 is:

> *'The Highlands and Islands is a dynamic, connected, resilient and prosperous region with a balanced and growing population and a vibrant economy, embedding community wealth building, leading Scotland's transition to net zero, and enhancing our natural environment.'*

1.4 The region is an international exemplar in renewable energy and other younger and emerging technologies vital to Scotland's sustainable economic transformation such as space, hydrogen, and harnessing natural capital, such as through carbon sequestration or hydro energy, for social, economic and environmental gain.

1.5 The scale of opportunity for the Highlands and Islands has never been greater and is supported by policy drivers regionally, in Scotland and at the UK level.

The Regional Transformational Opportunities

1.6 Highlands and Islands Enterprise's Strategy and Operating Plan 2023-2028 sets out its vision for the region to be:

> *'... a leading net zero region with a dynamic wellbeing economy, which benefits its growing population and makes a contribution to Scotland.'*

[1] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[2] https://highlandsandislandsrep.scot/strategy/

1.7 The strategy outlines nine Regional Transformational Opportunities (RTOs), some of which were identified as potential 'game changers' in research undertaken in 2019 on behalf of the Convention of the Highlands and Islands (COHI). The RTOs are defined as opportunities that will deliver clear and substantial shifts and major cross cutting impacts at scale, rather than more localised and incremental changes.

1.8 This study has focused on six of the nine RTOs and these are: offshore wind; green hydrogen; marine energy; space: marine biotechnology and processing; and life sciences, digital health and social care. Although not RTOs included within HIE's strategy, onshore wind and pumped storage hydro projects are included in the mapping and impact assessment, given the scale of potential activity and impacts they can deliver. Natural capital is also included, given the disproportionate role the region has to play in maximising Scotland's carbon sequestration potential, as highlighted in HIE's 2024 study on establishing a Greenhouse Gases inventory for the Highlands and Islands. This could happen at a transformative scale and contribute to net zero objectives.

1.9 The study does not cover all activity in the region. For example, opportunities associated with evolving our more established sectors of food and drink, tourism, and the creative industries are outwith the parameters set (such as the expansion of the Machrihanish Dunes resort in Kintyre, marine tourism projects such as the marina expansion at Ardrossan and step-ashore facilities for Arran and Cumbrae, and distillery developments across the region). Opportunities that are very early stage or of small scale (those that are non-transformational or have less than £1.5m investment value) are also not included such as a new timber manufacturing and processing facility in Forres or the proposed development of various local hydro-electric stations. However, the study does recognise the catalytic impacts that achieving our regional transformational opportunities will have on other sectors of importance, with growth driving further growth and aspiration.

Objectives

1.10 This study aims to provide an evidence base of the current activity, strengths, challenges, and opportunities for the RTOs in the Highlands and Islands, considering the period 2025-2040. The specific study objectives are to:

- Identify and map the strategic projects/investments which are likely to drive substantial economic change in the Highlands and Islands;
- Quantify the anticipated combined economic impact of the opportunities identified to illustrate the nature and scale of regional opportunity and model a range of scenarios to demonstrate resultant outcomes and impacts;
- Identify the critical enablers upon which successful delivery of each opportunity depends and explore interlinkages and co-dependencies within and across transformational opportunities;
- Take a place-based approach to a gap analysis to provide localised and aggregate estimates of the likely volume/scale of requirements for people (labour and skills), housing, transport and other supporting infrastructure and services at local and regional level;
- Identify priority activities within and across the region to enable realisation of opportunities.

Methods

1.11 The study was delivered using a comprehensive and mixed methodology including secondary and primary research. It comprised:

- A comprehensive review of literature and data relevant to the region, the RTOs and the context;
- A programme of consultations with sector specialists, industry, public sector stakeholders and key informants. A total of 43 consultations were completed.
- An extensive exercise to gather available data and information about current and proposed projects in the Highlands and Islands relevant to the RTOs.

1.12 For the purposes of this study, 'the region' is defined by the Highlands and Islands Regional Economic Partnership (HIREP) geography – the local authority areas of Highland, Moray, Argyll and Bute, Orkney, Shetland, and Na h-Eileanan Siar, along with Arran and the Cumbraes from North Ayrshire.

1.13 The data and analysis presented in this report is based on the projects and investments identified during the fieldwork period of April to December 2024, with the quantification reflecting the project status and associated information at this point in time.

The report

1.14 The final report is structured as follows:

- **Chapter 2** highlights the scale of the opportunity for the region and demonstrates the potential for transformation.
- **Chapter 3** describes the detail of the possible economic impacts and the implications of different scenarios and policy interventions.
- **Chapter 4** considers the spatial aspect of potential investment and impacts associated with this investment.
- **Chapter 5** provides an overview of the necessary supporting infrastructure and enablers for the RTOs covering transport, grid capacity and connection, ports and harbours, and planning.
- **Chapter 6** focuses on the offshore wind RTO.
- **Chapter 7** presents the findings for the green hydrogen RTO.
- **Chapter 8** covers the marine energy RTO.
- **Chapter 9** discusses the space RTO.
- **Chapter 10** describes the marine biotechnology and processing RTO.
- **Chapter 11** discusses the life sciences and digital health and social care RTO.
- **Chapter 12** looks at onshore wind and pumped storage hydro.
- **Chapter 13** details additional natural capital transformational opportunities.
- **Chapter 14** provides conclusions and priorities based on the qualitative and quantitative research and analysis undertaken as part of this study.

2 Scale of the opportunity

Introduction

2.1 There have been waves of significant economic opportunity in Scotland at particular points over the last 80 years. The Hydro-Electric Development (Scotland) Act 1943 developed the hydro-electric potential of the Highlands and ensured distribution of electricity across the North of Scotland, including to remote rural and island communities. Between 1943 and 1965, £5.6 billion (2023 prices) was invested in hydro-electric generation, arguably transforming the social and economic fabric of the Highlands. In the 80 years to 2023, total investment stood at £7.5 billion (2023 prices).[3]

2.2 In the 1970s, the oil and gas industry brought significant changes to Scotland and transformed the North East (around Aberdeen), and Shetland as well as some other parts of the Highlands and Islands. Between 1965 and 1980 capital expenditure on exploration and development of oil and gas resources on the UK continental shelf totalled £13.9 billion (1977 prices)[4], the equivalent of around £78bn in 2023 prices. It brought and generated investment, created high value employment, catalysed innovation, supported a hugely valuable supply chain, and led to a significant investment in critical enabling infrastructure.

The opportunity for the 21st Century

2.3 Hydro power and oil and gas were each perceived as presenting a once-in-a-generation opportunity. The Highlands and Islands is now on the cusp of its own transformation, with the additional benefit of economic opportunities being spread across sectors. This mixed-economy model provides a degree of resilience and the opportunity for people to work in a range of sectors and potentially move between them. It also means that supply chain organisations can potentially work across several sectors which will derisk investment and provide more stability.

2.4 Each RTO presents a huge opportunity in its own right, and a number are closely aligned, for example renewable energy generation and green hydrogen. However, the real value will be achieved by pursing these RTOs simultaneously - the combined impact will far exceed what the individual RTOs can deliver and there will be synergies in investment and supply chain development. These synergies will also extend to onshore wind and pumped storage hydro, as highlighted in Chapter 1.

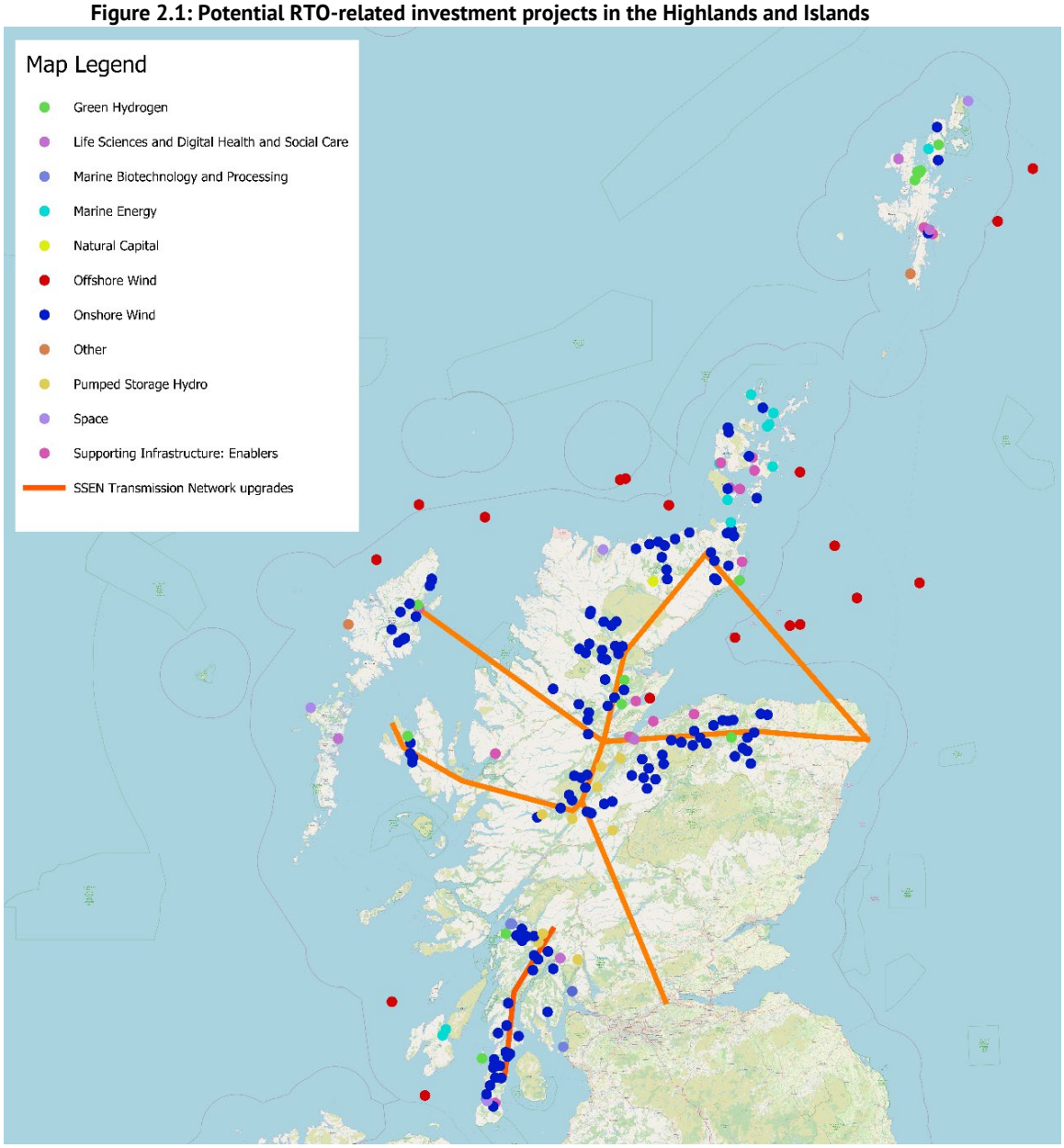
2.5 With over 250 proposed investments, the economic pipeline of the RTOs is unprecedented in the Highlands and Islands, and possibly even Scotland and much of the UK (beyond the South East of England) at this point in time. It far exceeds that witnessed in previously transformational periods for the region, such as those outlined above. Chapter 3 draws on information provided about these projects and details the potential impact of the RTOs. It highlights that over the period 2025 to 2040 there is:

[3] https://www.sserenewables.com/media/kbqnn25w/80-years-of-hydro-generation-summary-note_biggar-economics.pdf
[4] https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/1979/the-financing-of-north-sea-oil-1975-1980.pdf

- a potential £100.35bn of investment;
- 114,040 FTE job years[5] during construction, with around 16,000 jobs annually at peak construction periods;
- a further 17,930 direct operational and maintenance jobs by 2040; and
- a potential GVA of £76.6bn across the full portfolio of projects identified through this research – direct GVA of £41.7bn and £34.9bn indirect/induced GVA.

2.6 Figure 2.1 sets out the location of these projects across the Highlands and Islands.

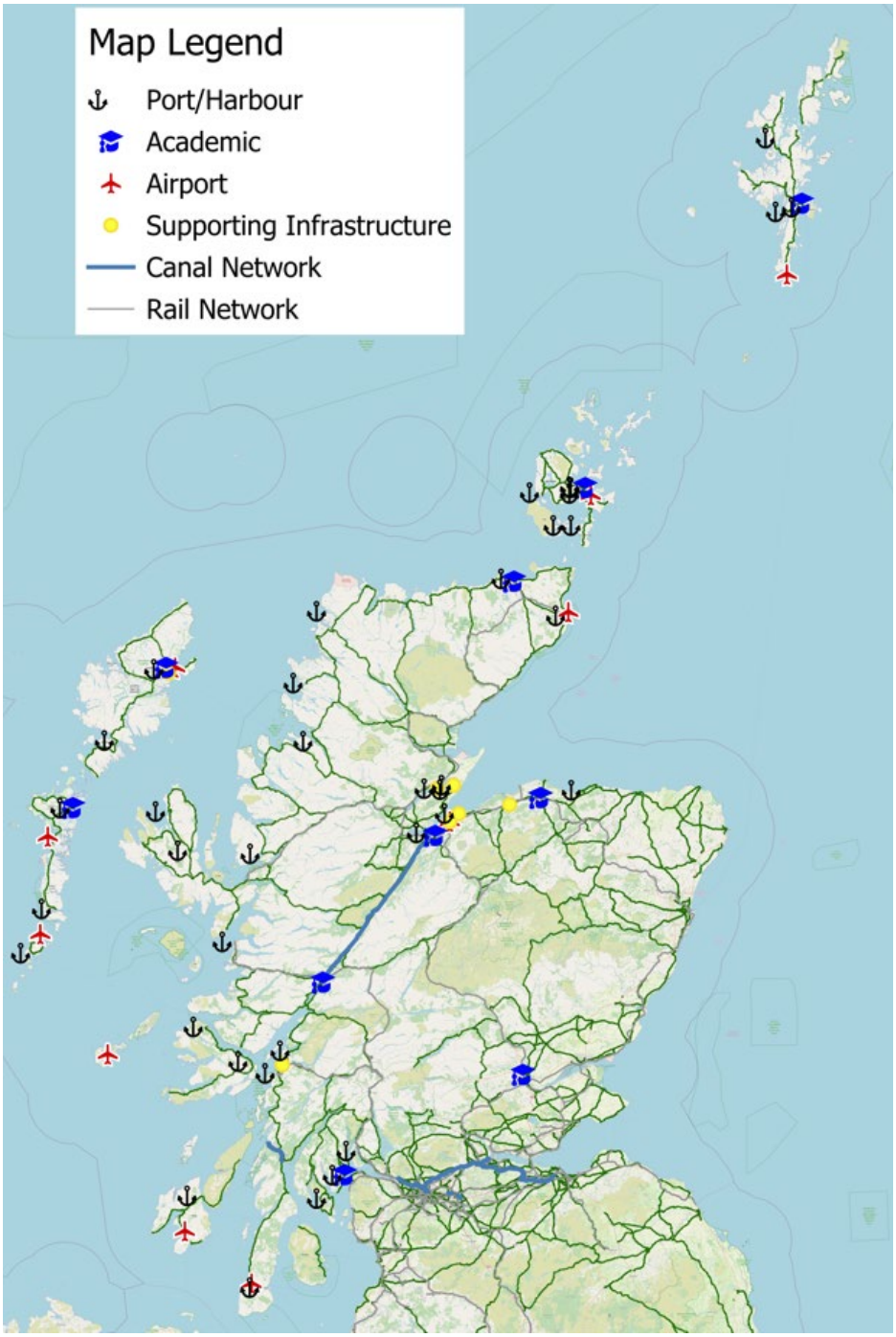
Figure 2.1: Potential RTO-related investment projects in the Highlands and Islands



[5] A job year is one job for one year. If that job lasts two years, that would equate to two job years

2.7 The potential for these projects is supported by a range of existing infrastructure across the region. This includes physical infrastructure such as major ports and harbours, airports, road and rail; it also includes education institutions that will support necessary skills development. A map of key supporting infrastructure is included at Figure 2.2.

Figure 2.2: Supporting infrastructure for potential RTO-related investment projects in the Highlands and Islands



Note: Detail of the supporting infrastructure included in the map is set out in the Appendix, Table A.4.1. This is not an exhaustive list but gives an illustration of some of the key relevant existing infrastructure across the region.

2.8 There are also a range of existing sectoral assets for each RTO that can contribute to the development and success of investment projects (highlighted in subsequent RTO chapters). It is worth noting that investment projects, assets and infrastructure are not mutually exclusive, and in some instances can be both a project and infrastructure (e.g. expansion of port facilities), or sometimes all three.

2.9 This opportunity does not encapsulate everything happening in the region, and it reflects a point in time.[6] What is presented is largely private sector driven (save for some public sector contribution such as to Growth Deal activity and enabling infrastructure such as ports and harbours). Capital expenditure on public sector projects (e.g. schools, roads, hospitals etc) is additional to the impacts presented above. For example, the Scottish Futures Trust indicates that there are 49, general and specialist, engineering projects in the construction pipeline across the region.[7] These 49 projects account for £3.3bn in costs and are primarily infrastructure upgrades to roads, bridges, and ferry terminals. Additional known spend (projects in the public domain but not included in the SFT construction pipeline tool) brings the pipeline of regional public sector investment to around £3.9bn. Alongside this, catalytic impacts are likely for other regional and sectoral activity, with growth driving further growth and aspiration. Both public sector and additional sectoral activity will increase competition for people, skills and the supply chain.

2.10 The RTO projects are fairly well dispersed across the Highlands and Islands as defined by the HIREP geography with notable clusters of activity and investment. However, they do not reach every part of the region. A key consideration is how to make sure that the benefits are distributed fairly and evenly, despite the loci of activity around the clusters.

The risks

2.11 Unsurprisingly, the Highland and Islands is not the only region or country looking to pursue these opportunities, although it has some key advantages which are discussed in detail later in the report. Given this competition, a prompt response is required so that the potential opportunity is not missed or diminished. There needs to be a collaborative, holistic, and place-based approach to planning how the RTOs can be realised and to ensure that the infrastructure and enablers are in the right place, and at the right time. And this must happen at pace. There is an unprecedented opportunity for the wide range of organisations and partners who can and must play a role.

2.12 The research illustrates that there is a time imperative to plan and act on the key enablers and requirements for the RTOs. The Highlands and Islands Regional Economic Partnership (HIREP) and its members will play a key role in maximising the benefits for the region from these opportunities, taking a leadership role as part of its commitment to:

'actively taking forward the region's big economic opportunities and tackling challenges across the Highlands and Islands.' [8]

[6] Fieldwork was undertaken between April and December 2024. The data and analysis reflects the projects and their status at this point in time.
[7] Scottish Futures Trust Construction Pipeline Forecast Tool, December 2024 – https://pipeline.scottishfuturestrust.org.uk
[8] https://highlandsandislandsrep.scot/

2.13 The RTOs are complex. Developing them will cut across a number of departmental and organisational responsibilities and policy areas such as planning, transport, and energy. It will be important for the relevant departments and policy areas to work together rather than in silos and avoid implementing single interventions. Solutions must be integrated and budgets and investment aligned which will require strong leadership, trusted relationships, and new ways of working.

2.14 Chapter 5 discusses the infrastructure requirements covering grid connection, transport, and ports and harbours. Fit for purpose planning processes that move at pace will also be essential and this is reflected in the chapter discussion.

2.15 Use of the region's natural assets will need to be planned and managed responsibly and sustainably to mitigate the environmental impact and ensure that where relevant, these assets are not depleted. There will also be a need to manage and balance the different types of uses and users as RTO projects are developed. Careful consideration must be given to the range of users and interest groups who may be using the same or adjacent space (e.g. in the marine environment), so that the activities can co-exist and ideally, benefit from synergies.

2.16 All of this is achievable, with clear leadership, collaboration, and confident, timely and aspirational decision making. However, a key lever, perhaps ***the*** key lever, will be having the workforce and skills in place to fuel growth of the RTOs across the region. These skills are an economic imperative and of course will also benefit the social fabric and population of the region. In addition, grid infrastructure upgrades, such as that planned through SSEN's Pathway to 2030[9] programme, are essential enabling infrastructure.

[9] https://www.ssen-transmission.co.uk/information-centre/pathway-to-2030--delivering-2030-government-targets-and-the-transition-to-net-zero/

3 Assessing the impact

Introduction

3.1 The study identified 251 investment projects within the RTO parameters being explored for the period 2025 to 2040. Each investment project stands to make a contribution to the realisation of potential benefits under the respective RTOs. Some projects are of such scale that they are transformative in their own right. Others will collectively drive transformational change in the region. It is important to note that this study does not cover ***all*** planned activity in the region. There are other planned projects in the Highlands and Islands – some public sector driven and others private sector led – and many of these will be significant at a local area level. They are, however, beyond the scope for this study.

3.2 This chapter sets out the anticipated impacts arising from these 251 projects considering:

- The total investment value (£);
- Total employment in FTE job years across the development, construction and installation (DCI) phase of projects;[10]
- Estimated number of direct operational and maintenance jobs;
- Estimated direct GVA (£); and
- Estimated indirect/induced GVA (£).

3.3 Data for investment values, development timescales, construction or capex phase employment, and operational employment was sought, but not available for all projects. Data gaps were addressed using proxies or estimates based on a range of different data sources, including industry intelligence. Analysis is based on the projects identified and associated information available at the point in time of the research fieldwork (April to December 2024) and will not reflect subsequent changes. It is also important to note that operational and maintenance jobs are additional to those that may already be in existence and relate directly to the project/investment and not to the wider supply chain. Full details of the approach and methodology and additional in-depth analysis is presented in Appendix A.1.

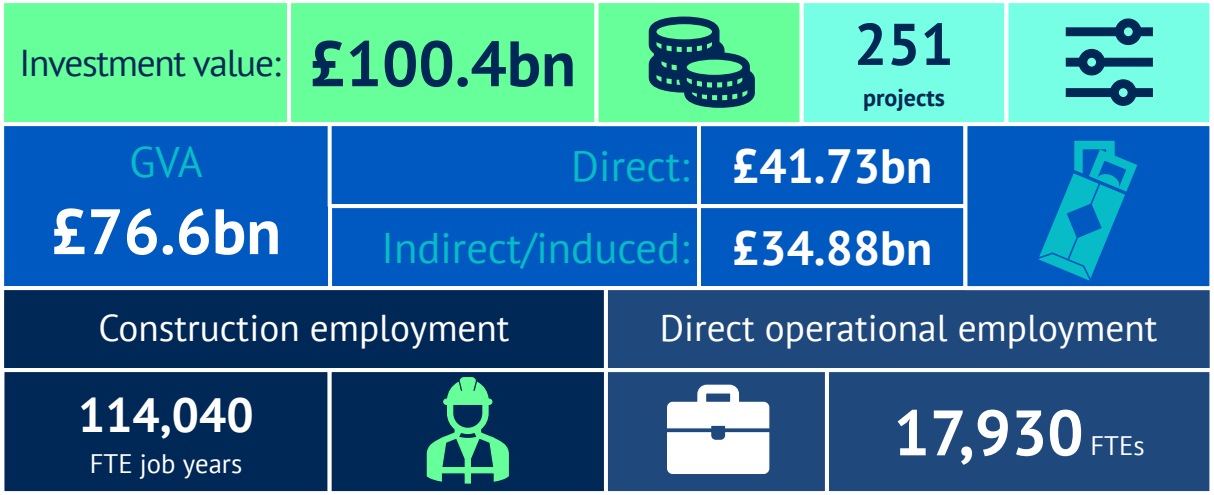
The regional potential

3.4 The potential investment pipeline across the 251 projects totals **£100.35bn**. This is an unadjusted total impact. It is based on the raw project data collected and assumes each project will progress as planned and to the scale stated. This reflects the overall 'economic opportunity' for the region. However, it is acknowledged that in reality delays to some projects are inevitable and the scale of opportunity may not be fully realised. In recognition of this, status-adjusted impacts are presented later in the chapter.

[10] A job year is one job for one year. If that job lasts two years, that would equate to two job years.

3.5 In terms of employment (expressed in FTE job years), it is expected that the total construction employment will be over **114,000** FTE job years. At its peak, there will be approximately 16,000 construction jobs annually. Around a further **18,000** direct operational and maintenance jobs are anticipated by 2040. Overall, there is estimated to be direct GVA of **c.£41.73bn**, and an additional indirect/induced GVA of **c.£34.88bn**, over the impact period.

Figure 3.1: Potential regional investment through RTO projects



Sectoral split of RTO investment

3.6 Investment in terms of value is dominated by offshore wind (£40.58bn, 40% of total investment) followed by supporting infrastructure: grid (£20.0bn, 20%; Table 3.1). However, other RTOs have significant and growing contributions to make. Together, pumped storage hydro (13.15bn, 13%), onshore wind (£10.89bn, 11%) and green hydrogen (£9.10bn, 9%) account for a further third of investments.

3.7 When considering construction employment, there is a greater spread of opportunities across the RTOs. Onshore wind accounts for just under a fifth (23%) of the total job years (26,320 job years), while pumped storage hydro (18,000 job years) and offshore wind (17,830 job years) each account for around 16% and green hydrogen 15% (17,580 job years). Onshore wind (6,260 direct FTE) and supporting infrastructure: enablers (5,760 direct FTE) account for the largest share of operational employment.

Table 3.1: Unadjusted project impacts by RTO/sector

Sector	Total Investment (£)	FTE Job Years (DCI)	Estimated Direct GVA (£)	Estimated Indirect/ Induced GVA	Direct, additional operational employment
Offshore Wind	£40.58bn	17,830	£19.40bn	£16.63bn	1,870
Supporting Infrastructure: Grid	£20.00bn	4,280	£6.79bn	£5.82bn	-
Pumped Storage Hydro	£13.15bn	18,000	£4.46bn	£3.83bn	220
Onshore Wind	£10.89bn	26,320	£3.70bn	£3.17bn	6,260
Green Hydrogen	£9.10bn	17,580	£4.67bn	£3,65bn	3,170
Marine Energy	£2.86bn	12,580	£1.35bn	£752.0mn	70
Supporting Infrastructure: Enablers[11]	£1.91bn	7,490	£647.2mn	£554.8mn	5,760
Life Sciences and Digital Health and Social Care	£449.4mn	2,060	£212.2mn	£181.4mn	120
Natural Capital	£400.0mn	2,900	£53.7mn	£76.1mn	-
Space	£84.3mn	690	£40.3mn	£34.6mn	150
Marine Biotechnology and Processing	£39.3mn	160	£12.6mn	£10.8mn	120
Other[12]	£892.8mn	4,160	£395.1mn	£165.9mn	210
Total Highlands and Islands	**£100.35bn**	**114,040**	**£41.73bn**	**£34.88bn**	**17,930**

Note: FTE job years and operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.
It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

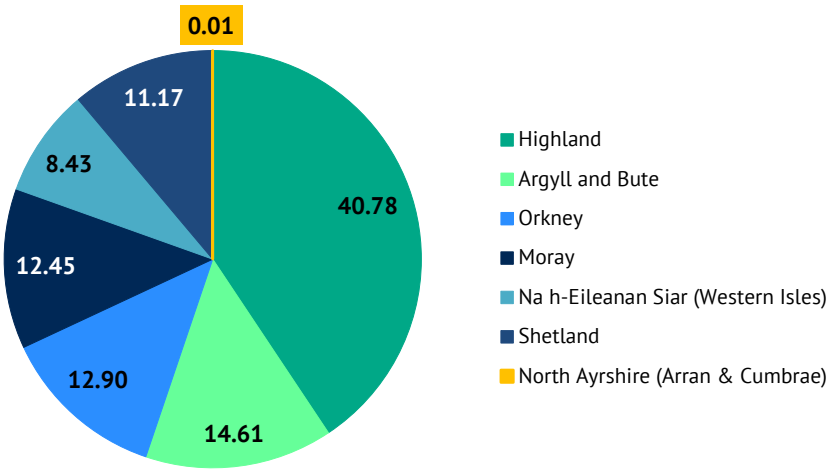
Geography

Local authority breakdown of potential investment

3.8 Overall, projects are generally well dispersed across the region's local authority areas. Figure 3.2 and Table 3.2 show that Highland accounts for more than two-fifths (44%) of the 251 projects (110 projects), and 41% of total potential investment, whilst Argyll and Bute accounts for 20% of projects and 15% of total potential investment.

[11] This typically includes harbour upgrade/expansion investment, research and innovation facilities, and sectoral hubs/business premises
[12] Other projects include the Clyde Engineering & Innovation Cluster development, and significant, innovative aquaculture projects.

Figure 3.2: Potential investment (£bn) by local authority



3.9 The remainder is fairly well distributed across the other local authority areas of Orkney (13%), Moray (12%), Shetland (11%) and Na h-Eileanan Siar (8%). As shown by Table 3.2, some areas have a disproportionately high level of potential investment relative to population, notably our island local authorities (Orkney, Shetland and Na h-Eileanan Siar). The level of investment in Arran and Cumbrae is lower, reflecting the smaller geographic area covered and the dominance of more traditional sectors within these local economies, the activity for which is outwith the scope of this particular study.

Table 3.2: Unadjusted project impacts by local authority area

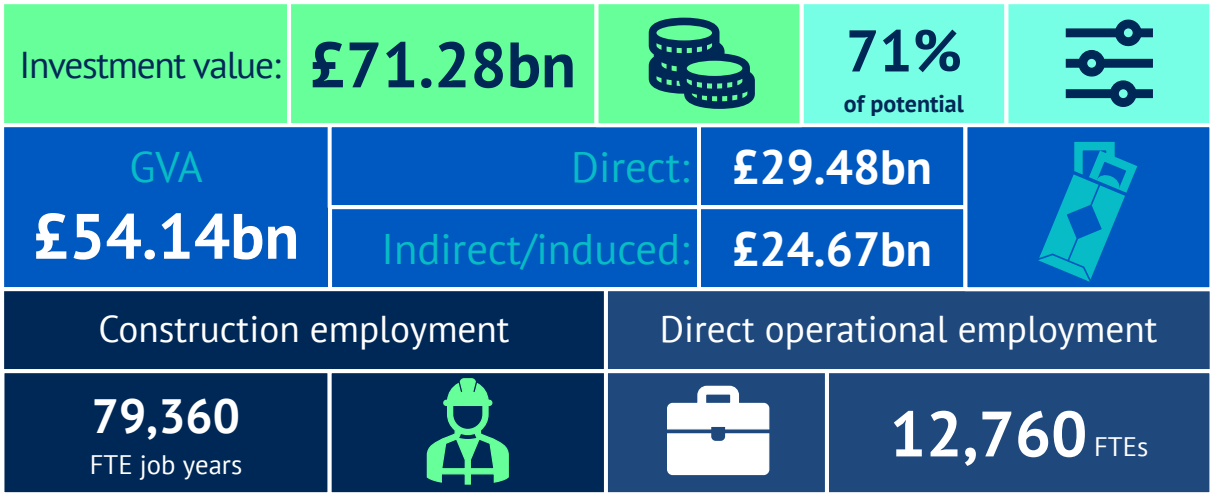
Area	Projects	Total investment (£)	FTE Job Years (DCI)	Estimated Direct GVA (£)	Estimated Indirect/ Induced GVA	Direct, additional operational employment	*Share of total investment*	*Share of population (2022 MYE)*
Highland	110	£40.78bn	59,080	£15.37bn	£12.98bn	11,450	41%	48%
Argyll and Bute	49	£14.61bn	13,710	£5.93bn	£5.08bn	1,720	15%	18%
Orkney	28	£12.89bn	11,960	£6.24bn	£4.84bn	830	13%	4%
Moray	24	£12.45bn	8,370	£5.42bn	£4.64bn	1,210	12%	19%
Shetland	19	£11.17bn	11,560	£5.09bn	£4.29bn	1,150	11%	5%
Na h-Eileanan Siar	20	£8.43bn	9,330	£3.68bn	£3.04bn	1,550	8%	5%
Arran and Cumbrae	1	£10.5mn	40	£3.4mn	£2.9mn	20	<1%	1%
Total Highlands and Islands	**251**	**£100.35bn**	**114,040**	**£41.73bn**	**£34.88bn**	**17,930**	-	-

Note: FTE job years and operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

Adjusting for project status

3.10 The total potential investment pipeline set out in Figure 3.1 does not consider the current development status of projects. A range of factors may negatively impact on project delivery meaning that not all projects will come to fruition. Some early-stage projects may have a relatively low likelihood of being developed at the outset, with the certainty of the investment being realised increasing as projects progress along the development life cycle. Given the differences in status across the project portfolio, it is likely that actual investment levels realised across the portfolio of projects under consideration will be lower than the overall 'economic opportunity' outlined earlier.

Figure 3.3: Project investment pipeline impacts – status-adjusted



3.11 To account for this, an adjustment has been made to the total investment pipeline and associated impacts using a set of factors to reflect project status and the likelihood of project progression and completion.[13] This 'status-adjusted' estimate reduces the total investment pipeline to **£71.28bn**, around 71% of the overall opportunity. Consequently, anticipated construction employment is **79,360** job years. GVA is £54.14bn (**£29.48bn** direct GVA and **£24.67bn** indirect/induced GVA). Direct operational and maintenance jobs are estimated to be around 12,760 FTEs with supporting infrastructure: enablers (4,4309 jobs, 35%) and onshore wind (4,170, 33%) each accounting for around a third of the jobs.

3.12 As for the overall 'economic opportunity', offshore wind accounts for the largest share of investment once adjusted for status (c.£27.51bn, 42% of total investment), followed by supporting infrastructure: grid (c.£16.0bn, 20%). Onshore wind accounts for almost a quarter of construction employment (18,410 job years). Pumped storage hydro, green hydrogen and offshore wind each account for over 12,000 job years and collectively account for almost half (47%) of construction employment.

[13] The following adjustment factors were applied on a project-by-project basis; further detail can be found in Appendix 1: Unknown/Early stage – 50%; Scoping/pre-application – 60%; Planning/consenting phase – 70%; In development – 80%; Pre-operational – 100%.

Table 3.3: Status-adjusted project impacts by RTO/sector

Sector	Total Investment (£)	FTE Job Years (DCI)	Estimated Direct GVA (£)	Estimated Indirect/ Induced GVA	Direct, additional operational employment
Offshore Wind	£27.52bn	12,320	£13.16bn	£11,28bn	1,250
Supporting Infrastructure: Grid	£16.00bn	3,420	£5.43bn	£4,66bn	-
Pumped Storage Hydro	£9.15bn	12,950	£3.10bn	£2,66bn	160
Onshore Wind	£7.39bn	18,410	£2.51bn	£2,15bn	4,170
Green Hydrogen	£6.84bn	12,270	£3.52bn	£2,74bn	2,280
Marine Energy	£1.85bn	8,170	£872.0mn	£487,2mn	40
Supporting Infrastructure: Enablers	£1.44bn	5,690	£488.4mn	£418,6mn	4,430
Natural Capital	£320.0mn	2,320	£43.0mn	£60,8mn	-
Life Sciences and Digital Health and Social Care	£226.0mn	1,030	£106.9mn	£91,2mn	60
Space	£72.5mn	560	£34.7mn	£29,7mn	130
Marine Biotechnology and Processing	£28.1mn	110	£9.0mn	£7,7mn	90
Other	£448.8mn	2,090	£198.4mn	£83,6mn	150
Total Highlands and Islands	**£71.28bn**	**79,360**	**£29.48bn**	**£24.67bn**	**12,760**

Note: FTE job years and operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.
It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

3.13 The largest areas for investment included Highland (£29.54bn, 41% of total investment), Argyll and Bute (£10.48bn, 15%) and Orkney (£9.45bn, 13%). This is the same pattern as for the overall opportunity. Highland and Argyll and Bute account for the largest share of both construction and operational employment. As with unadjusted impacts, the island local authorities (Orkney, Shetland and Na h-Eileanan Siar) have a disproportionately high level of potential investment relative to population.

Table 3.4: Status-adjusted project impacts by local authority area

Area	Projects	Total investment (£)	FTE Job Years (DCI)	Estimated Direct GVA (£)	Estimated Indirect/ Induced GVA	Direct, additional operational employment	*Share of total investment*	*Share of population (MYE 2022)*
Highland	110	£29.54bn	42,230	£11.09bn	£9.42bn	8,360	41%	48%
Argyll and Bute	49	£10.47bn	9,680	£4.28bn	£3.63bn	1,150	15%	18%
Orkney	28	£9.45bn	8,550	£4.58bn	£3.52bn	560	13%	4%
Moray	24	£8.91bn	6,000	£3.86bn	£3.31bn	800	13%	19%
Shetland	19	£7.48bn	7,080	£3.38bn	£2.86bn	760	11%	5%
Na h-Eileanan Siar	20	£5.41bn	5,810	£2.31bn	£1.93bn	1,120	8%	5%
Arran and Cumbrae	1	£5.3mn	20	£1.7mn	£1.4mn	10	>1%	1%
Total Highlands and Islands	**251**	**£71.28bn**	**79,360**	**£29.48bn**	**£24.67bn**	**12,760**	**-**	**-**

Note: FTE job years and operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

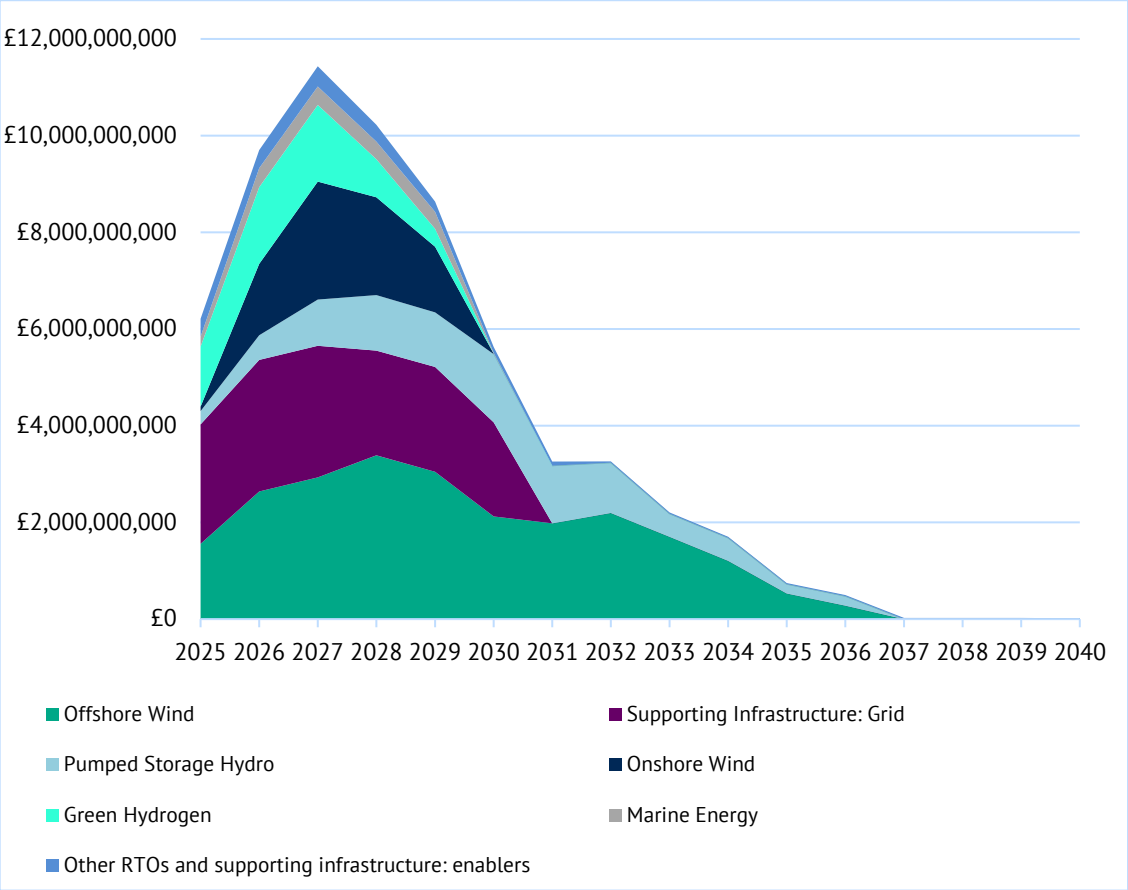
3.14 Figure 3.4 sets out the profiled status-adjusted project investment during 2025-40. Available project information indicates that most investment impacts are scheduled to occur during the first five years of the time period, i.e. 2025-30. Beyond 2030, the majority of anticipated project investment is accounted for by offshore wind and pumped storage hydro projects. Whilst the Highland Council area accounts for the largest proportion of spend overall, and during the period 2025-30, investment from projects in and around Shetland account for an increasingly larger proportion in later years, from 2031-36.

3.15 However, it should be noted that a 'flat' spend profile was assumed for all projects under consideration, given the variance in availability of different project information. Additionally, there is a considerable element of optimism bias reflected in the data provided by investors, which is then reflected in the data profiling. This means that, as projects progress and come to fruition, the timeline investment profiles for projects and RTO sectors will be flatter and stretched over a longer time period. In the absence of any other evidence, no adjustments or assumptions have been made to the investment timelines. Doing so would introduce too much subjectivity, which could be misleading in terms of interpreting the findings.

3.16 It is also worth noting that this investment timeline shows the currently known investments only – that is, the 251 projects identified in this study – for the period 2025 to 2040 (based on fieldwork undertaken between April and December 2024). There will continue to be investment projects announced and added to the investment pipeline for the region – e.g. addressing recommendations for further offshore and onshore network upgrades as outlined in the National Energy System Operator's Beyond 2030 report[14], as well as other cycles of energy related investment such as repowering of onshore wind farms, subsequent bidding rounds for ScotWind, further upgrading of conventional hydro-electric schemes to pumped storage hydro, etc. In some respects, the timeline presented can be considered a reflection of what may be required to stimulate longer-term investment in the region. If the potential investment can be positively influenced here, then this will make future, longer-term investment seem a more attractive proposition for developers, given the right conditions.

[14] Beyond 2030 | National Energy System Operator

Figure 3.4: Investment over time (2025-40) by RTO sector, status-adjusted



Other RTOs and supporting infrastructure: enablers includes enablers; natural capital; life sciences and digital health and social care; space; marine biotechnology and processing; other.

Policy scenarios

3.17 Realising the benefits of the 'economic opportunity' open to the region requires the right policy environments and appropriate sequencing. A series of scenarios were modelled, based on the status-adjusted estimates, to explore potential impacts if an optimal policy environment is not achieved, and if appropriate support or interventions are not secured at the right points in time. These scenarios are merely illustrative, designed to demonstrate the impact various policy, regulatory, infrastructure and other potential factors may have in 'switching on' certain project investment levels and timescales. The switches are drawn from the range of enablers identified through the consultation phase of the study and will be familiar to those living and working in the region, as well as to regional and national policy makers and strategic actors. The switches include:

- Legislation and regulation, including planning and consenting;
- Grid connection;
- Evidence-based skills and workforce planning;
- Infrastructure, including ports and harbours, housing, transport and communication;
- A helix approach to collaboration;
- Supply chain stimulation; and
- Research and innovation.

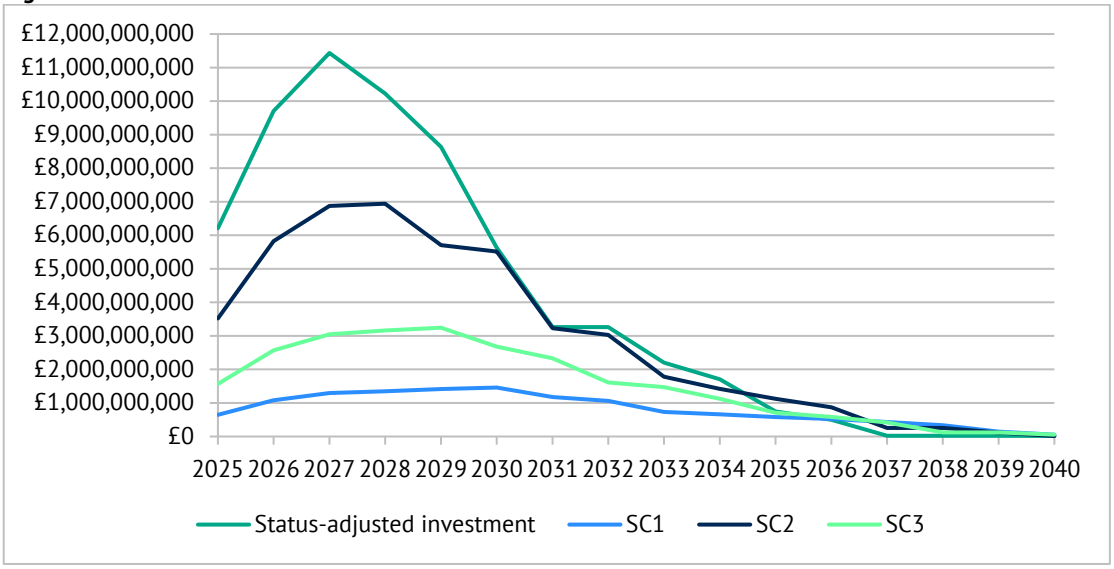
3.18 The scenarios modelled are:

- **Scenario 1**: The status quo of the existing policy/regulatory environment, **plus grid upgrade constraints** – this impacts energy-related sectors that are dependent on grid upgrades to a greater extent than others, and this has been reflected in the scenario's modelling adjustments;
- **Scenario 2**: 'Policy on' – an improved but **less-than-optimal policy environment**, coordinated workforce planning, supporting infrastructure and enablers and a **short time frame** for switch-on (e.g. 18-24 months). Barriers to grid infrastructure and capacity upgrades are minimal; and
- **Scenario 3**: 'Slower policy on' – an improved but **less-than-optimal policy environment**, co-ordinated workforce planning, supporting infrastructure and enablers but **delayed time frame** for switch on. Barriers to grid infrastructure and capacity upgrades are minimal.

Range of impacts

3.19 Figure 3.5 shows the investment profile of each modelled scenario and illustrates that there is a considerable difference between the scenarios with total project investment ranging from £13.89bn (Scenario 1) to £50.75bn (Scenario 2). This emphasises the importance of the correct policy support.

Figure 3.5: Investment over time under each scenario

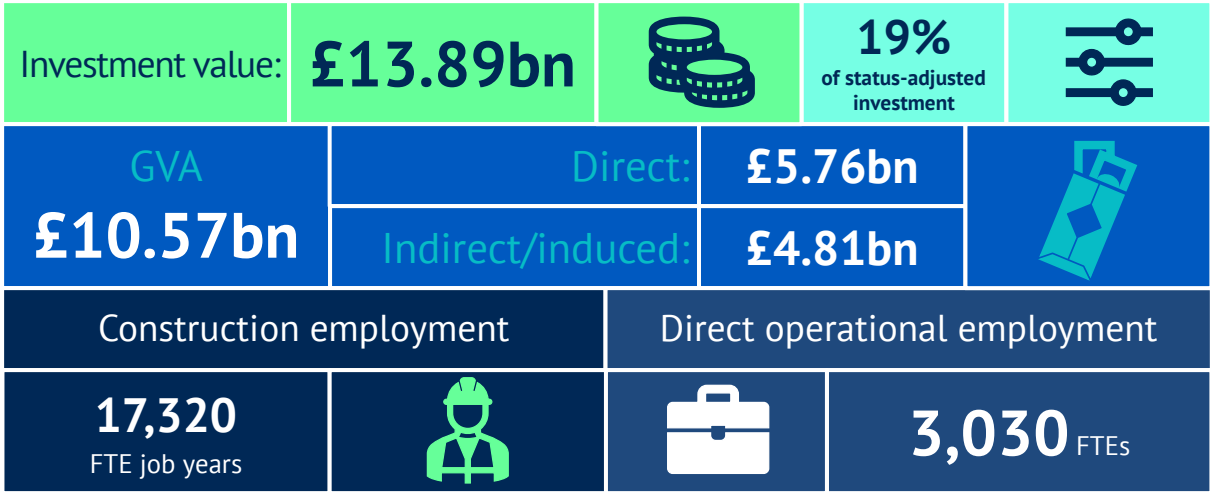


Scenario 1: Status quo plus grid upgrade constraints

3.20 Total investment under this scenario is expected to total £13.89bn, which equates to less than a fifth (19%) of the status-adjusted project investment total. Offshore wind is anticipated to account for the largest share of investment, and onshore wind the largest share of construction employment. Total estimated construction employment under Scenario 1 is just over 17,300 FTE job years. Total estimated GVA is just over £10.5bn (direct, indirect and induced). By 2040, under Scenario 1 it is estimated that there may be just over 3,000 jobs as a result of projects entering their operational phase, with supporting infrastructure: enablers accounting for the largest proportion of these (c.34%).

3.21 This scenario illustrates how critical the planned grid infrastructure upgrades are for unlocking and enabling development in the region. Without this, many projects, particularly those related to energy, are simply not viable. The profile of investment is extended, with the majority occurring over the period 2025 to 2033, and some anticipated to occur beyond 2040.

Figure 3.6: Project investment pipeline impacts – Scenario 1



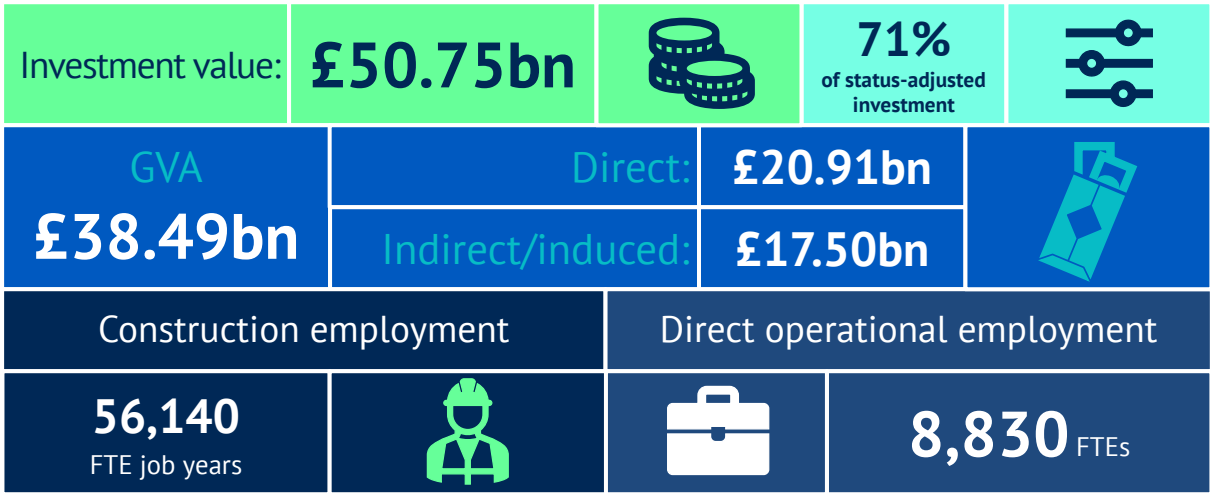
Scenario 2: Policy on, short time frame for switch on

3.22 Total investment under this scenario is expected to total £50.75bn, which equates to around 71% of the status-adjusted project investment total. As with the previous scenarios, offshore wind (38%) and supporting infrastructure: grid (24%) projects are anticipated to account for the largest share of investment. Total estimated construction employment under Scenario 2 is over 56,100 FTE job years.

3.23 Total estimated GVA is almost £38.5bn (direct, indirect and induced). By 2040, under Scenario 2 it is estimated that there may be over 8,800 jobs as a result of projects entering their operational phase, with supporting infrastructure: enablers and onshore wind accounting for the largest share of these (over 2,900 FTEs each).

3.24 The majority of impacts are expected to occur between 2025 and 2031, decreasing considerably after this. As with the unadjusted scenario, impacts after this point are largely associated with offshore wind and pumped storage hydro.

Figure 3.7: Project investment pipeline impacts – Scenario 2



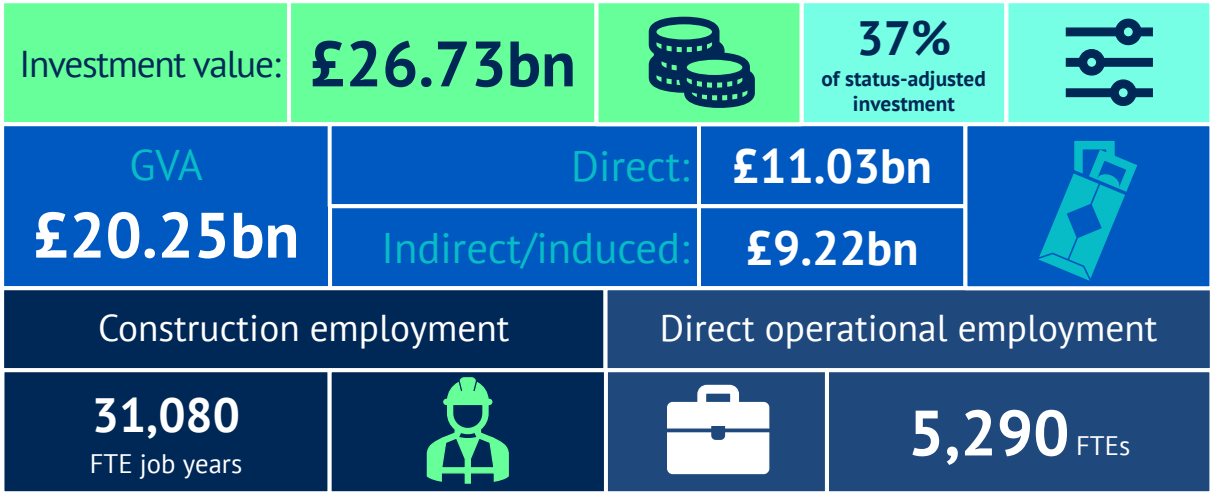
Scenario 3: Policy on, delayed timeframe for switch on

3.25 Under Scenario 3, total investment is anticipated to be c.£26.73bn, around 37% of the status-adjusted investment total. Again, the investment pattern across RTOs remains fairly consistent with offshore wind (38%) and grid infrastructure (22%) projects accounting for the largest shares of investment. Total estimated construction employment under Scenario 3 is over 31,000 FTE job years.

3.26 Total estimated GVA is around £20.25bn (direct, indirect and induced). By 2040, under Scenario 3 it is estimated that there may be almost 5,300 jobs as a result of projects entering their operational phase, with supporting infrastructure: enablers (over 2,150) and onshore wind (more than 1,500) accounting for the largest shares.

3.27 The majority of impacts are anticipated to occur between 2025 and 2033, with a considerable decrease thereafter. The one exception to this is offshore wind, which dominates until around 2039.

Figure 3.8: Project investment pipeline impacts – Scenario 3



Summary observations

Table 3.5: Scenario summary

Scenario	Assumptions/basis	Investment Value (£bn)	FTE Job Years (DCI)	Total GVA (£bn)	Direct, additional operational jobs (by 2040)
Overall opportunity	All projects progress as planned and to the scale stated	100.35	114,040	76.6	17,930
Status-adjusted	Adjusted to reflect likelihood of project progression and completion, based on current status.	71.28	79,360	54.14	12,760
Scenario 1	No substantive change to current policy, legislative or regulatory frameworks, but barriers to delivery of planned electricity grid upgrades.	13.89	17,320	10.57	3,030
Scenario 2	'Policy-on' – short to medium timeframe (18-24 months) associated with policy 'switches' essential for catalysing or unlocking investment.	50.75	56,140	38.49	8,830
Scenario 3	'Policy-on' – as per Scenario 2 but switch on over a delayed or over a longer time period.	26.73	31,080	20.25	5,290

3.28 When considering the range of impacts and scenarios set out above, it must be stressed that these are provided *for illustrative purposes only*. They are intended to demonstrate the scale of the potential investment in the Highlands and Islands, and what may be realised – or not – under certain conditions. Though it may be unrealistic to assume that all identified projects will come forward and be fully developed as planned, there is undoubtedly scope to realise a significant number of projects.

3.29 There is a significant pipeline of investment identified (unadjusted, £100.35bn; status-adjusted £71.28bn). Whilst it is recognised that this is not expected to arise from an exhaustive list of investment projects, it nevertheless represents a transformational level of potential investment. It is arguably a portfolio of investment that is on a different scale to many other parts of the UK. Even under the more modest scenario (Scenario 3), investment levels are over £26bn.

3.30 However, without considerable efforts to address barriers to development and ensure that the right conditions are in place to create the conditions for final investment decisions to be made, many of the projects identified through this research will not come to fruition.

3.31 Importantly, as demonstrated through Scenario 1, planned grid infrastructure upgrades are essential for unlocking and enabling development, since many projects and RTO sectors are reliant on grid connectivity. Without this, many projects are simply not viable.

4 People and place

Introduction

4.1 The research has highlighted the scale of the confirmed and proposed activities in the region, and these will require a substantial uplift in the size of the workforce across the Highlands and Islands as a whole, and in some specific areas. As an example, as well as the current investment projects' construction employment, SSEN Transmission estimates that its on-site workforce will likely peak in autumn 2027, at around 5,000 and the vast majority of these will be located in the Highland Council area.[15]

4.2 This chapter examines where skills will be needed but importantly, how residents and businesses of the Highlands and Islands can benefit from the employment opportunities that will flow from the RTOs. It also explores the potential impact on critical supporting infrastructure such as housing and access to services.

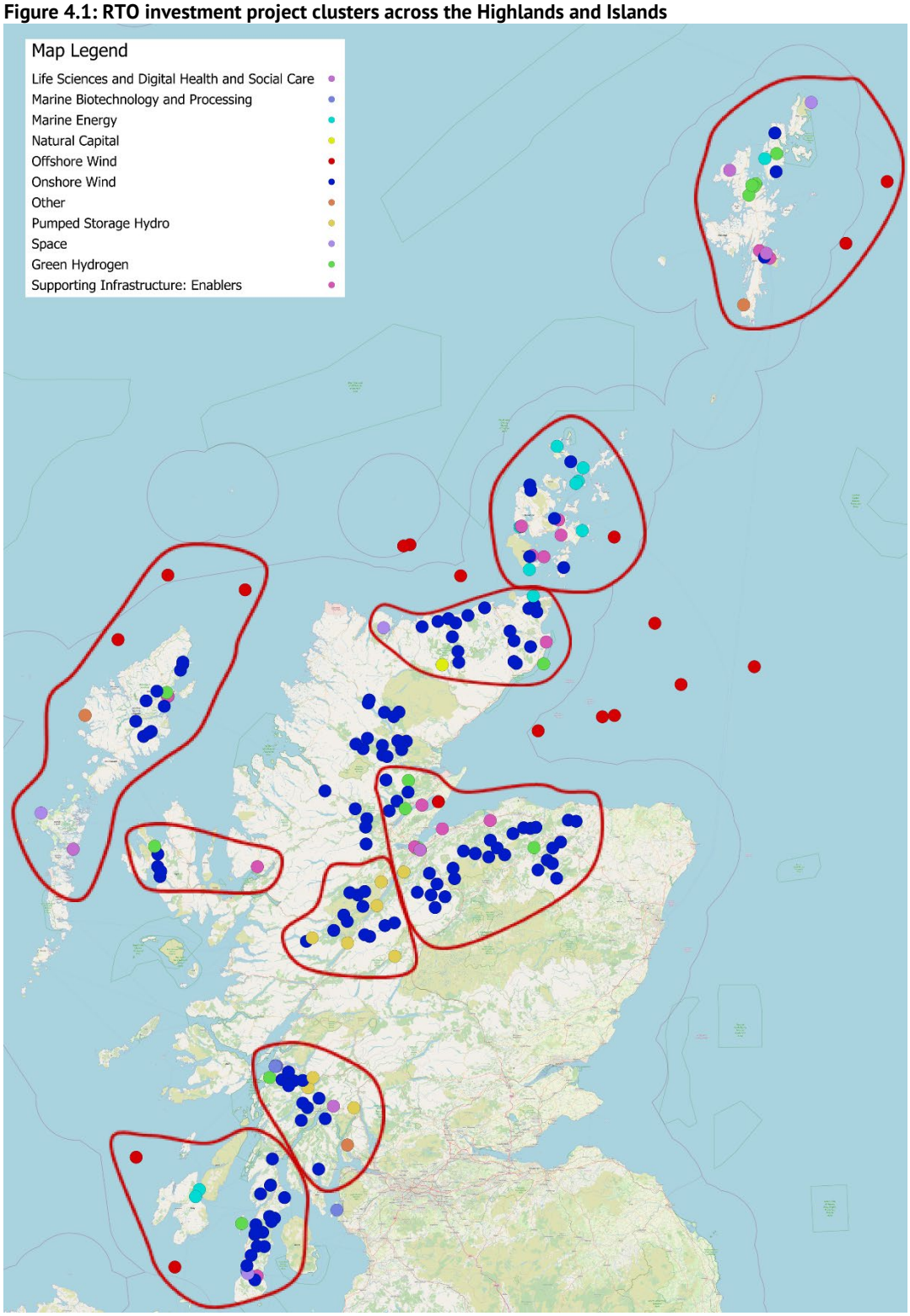
Clusters of activity

4.3 There is some clear clustering of potential investment activity across RTO sectors. As Figure 4.1. shows, there are clusters around:

- Orkney and Shetland – marine energy, in Orkney, and onshore wind and offshore wind, in both;
- Na h-Eileanan Siar – onshore and offshore wind - mainly focused on Lewis, but with some investment in Uist;
- The Great Glen – typically energy-focused around onshore wind and pumped storage hydro;
- Inner Moray Firth, stretching towards Moray - a mix of energy-related investment, supporting infrastructure, and significant onshore wind activity;
- Caithness and North Sutherland - a mix of energy-related investment and significant onshore wind activity;
- Oban and Lorn – primarily onshore wind and pumped storage hydro; and
- Kintyre and Islay – significant onshore wind activity and some marine energy projects
- Skye and Wester Ross – onshore wind and supporting infrastructure.

[15] https://www.ssen-transmission.co.uk/globalassets/documents/stakeholder-annual-engagement-plan/ssen-transmission-annual-engagement-plan-202425/ssen-transmission-housing-strategy-2024.pdf

Figure 4.1: RTO investment project clusters across the Highlands and Islands



4.4 These clusters, though loosely defined, help illustrate where opportunities will be focused and thus implications exist for employment and supply chain activities. Careful planning will be required around what needs to happen in and around these clusters to support the RTOs, for example in relation to workforce, skills, housing, and other supporting infrastructure. However, it is equally important to note that the geographical boundaries of the clusters are fluid, and the reach of both upstream and downstream opportunities is far more extensive. This principle also extends to workforce and skills.

4.5 To maximise the transformational potential and in line with Scottish Government employment and skills policy, it is vital that there is early consideration and planning on how the benefits and opportunities can be fairly dispersed across the region to spread the breadth of the economic and social impacts.

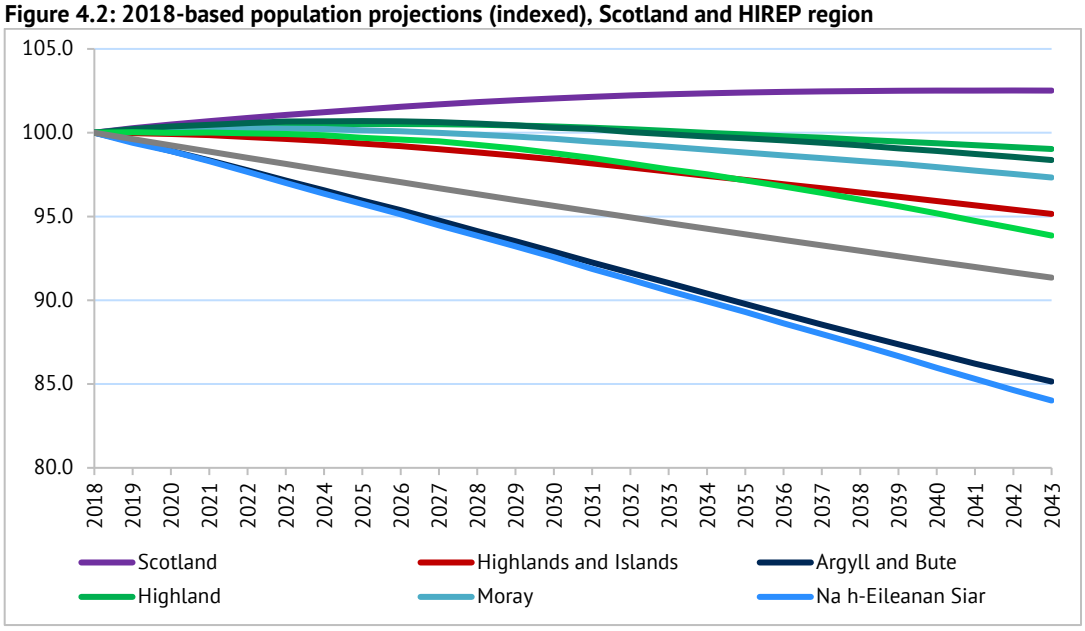
4.6 The RTOs will be a significant lever to enable people in the Highlands and Islands to access high quality, reliable employment and remain in or for some, return to the region. They will also be important for population attraction. For education and learning providers, the nature and scale of this transformational investment presents an opportunity to innovate their offer and grow provision in response to industry-need.

The need for skills

4.7 As outlined in Chapters 2 and 3, there is potential for up to 114,040 FTE job years[16] during construction, and up to 17,930 jobs during the operational lifespan of the identified projects. Accounting for the likelihood of projects coming forward based on estimated current project status (discussed in Chapter 3, and also in Appendix A.1), the status-adjusted estimates still suggest a potential for over 79,000 FTE job years during construction, and almost 13,000 operational jobs. At the peak of anticipated construction activity, there may be more than 16,000 construction jobs in any one-year period.

4.8 This need for workforce and skills will have a significant impact on the demographics of the region as a whole, and on those of local areas. Current 'policy-off' population projections show that the population in the Highlands and Islands is projected to decrease by 5% (almost 24,000) between 2018 and 2043 (as shown in Figure 4.2), with particularly sharp declines in Na h-Eileanan Siar (16%) and Argyll and Bute (15%). By 2040, the total population in the region is anticipated to be around 474,800 (decreasing from c.492,000 currently).

Figure 4.2: 2018-based population projections (indexed), Scotland and HIREP region



Source: National Records of Scotland (2025)

[16] An FTE job year is a measure of employment, equivalent to one person being employed full time for an entire year. Since construction jobs are assumed to be temporary, construction employment impacts are expressed as FTE job years.

4.9 Assuming that all employment arising from the delivery of the project pipeline identified through this research is additional[17] and that all projects come forward in line with anticipated timelines,[18] then there would be a peak temporary increase in working age population of around 6% regionally (around 16,270) in 2027, ranging from c.5% in Argyll and Bute (2,000) to almost 15% in Orkney (1,800). The long-term increase in working age population resulting from operational employment is estimated to be around 5% regionally (c.12,760) by 2040, ranging from c.3% in Argyll and Bute (1,150) to 9% in Na h-Eileanan Siar (1,120) (see Table 4.1).

Table 4.1: Estimated temporary and operational uplift in the Highlands and Islands (% based on working age population) from RTO project pipeline, 2040

Area	2040		Temporary increase in working age population during peak construction		Long-term increase in working age population based on operational employment requirement	
	All ages	Working age	N	%	N	
Argyll and Bute	74,873	41,400	2,000	+4.8%	1,150	+2.8%
Highland	234,050	136,454	9,260	+6.8%	8,360	+6.1%
Moray	93,560	54,039	890	+1.7%	800	+1.5%
Na h-Eileanan Siar	23,065	12,430	940	+7.6%	1,120	+9.0%
Orkney Islands	21,948	12,312	1,800	+14.6%	560	+4.6%
Shetland Islands	21,884	13,003	1,370	+10.5%	760	+5.8%
Arran and Cumbrae	5,449	3,130	10	+0.3%	10	+0.4%
Highlands and Islands	***474,829***	***272,768***	***16,270***	***+6.0%***	***12,760***	***+4.7%***
Scotland	**5,574,675**	**3,475,498**				

Source: ekosgen calculations based on: 2018-based sub-national population projections for Scotland (NRS, 2025), local authority data for North Ayrshire, and status-adjusted estimated employment impacts from identified project pipeline. Employment uplift figures rounded to the nearest 10. Totals may not sum due to rounding.

4.10 The figures outlined above do not include any spouses/partners and/or other family members who may accompany the new workers and so the population increase driven by the RTOs will likely be higher. It also does not include any additional employment arising from supply chain impacts for the project pipeline or in any other regional activity, including in sectors beyond the scope of this study (e.g. food and drink, tourism, and creative industries).

4.11 Nor does the data take into consideration the anticipated replacement demand for skills in construction, or replacement demand in other sectors. According to Skills Development Scotland's (SDS) 2024 Regional Skills Assessment,[19] there is an expected replacement and expansion demand of 31,700 across the Highlands and Islands by 2027 (28,000 replacement demand, and 3,700 expansion demand), accounting for around 8.5% of Scotland's total replacement and expansion demand. Assuming replacement demand does not extend to the workforce required for these investment opportunities (analysis suggest much of it relates to sectors outwith the study parameters), and that expansion demand does not factor them in, then replacement and expansion demand within the region could be markedly higher, potentially in the region of 45,000 to 50,000 over the short to mid-term.

[17] Here it is assumed that employment is additional for illustrative purposes. However, in practice, it is likely that they may be at least some displacement of existing employment, or deadweight where existing employment is used to fulfil labour requirements on pipeline projects.
[18] As discussed, it is likely that some projects will be slower and may be delayed.
[19] https://www.skillsdevelopmentscotland.co.uk/what-we-do/skills-planning/regional-skills-assessments

4.12 SDS's construction sector skills assessment[20] suggests that the construction workforce in Scotland is likely to grow by 2.8% to 207,600 between 2024 and 2027 (regional level data is not available). This compares to overall workforce growth of 1.9%. Nationally, replacement and expansion demand is anticipated to be around 22,000 (around three-quarters of this being replacement demand), with around 2,000 of this relating to the Highlands and Islands. Again, these forecasts are likely to considerably underestimate sectoral growth associated with the investments outlined in this study.

4.13 The existing pipeline of skills supply is showing signs of growing but is insufficient to meet the expected demand for skilled workers that will come from RTO project construction and operation. It is also important to note that the labour market in the Highlands and Islands is already tight and there are some key skills shortages – for example in specific construction and engineering roles, and roles specific to renewable energy developments - and so effective workforce planning, skills development and skills attraction will be vital in meeting RTO labour market requirements.

4.14 There is a growing pipeline of apprenticeship starts in construction and engineering across the region: there were 913 starts in construction and engineering frameworks in 2023/24, a 20% increase since 2021/22 (Table 4.2). Additionally, there were 102 starts on other frameworks of relevance to RTO projects, a 14% increase since 2021/22. However, this increase is below what is required to meet anticipated demand – and not all apprentices will go directly to work on RTO projects in future.

Table 4.2: Modern Apprenticeship starts in HIREP area, 2021/22-2023/24

	2021/22		2022/23		2023/24	
	Construction/ Engineering MAs	Total RTO-related MAs	Construction/ Engineering MAs	Total RTO-related MAs	Construction/ Engineering MAs	Total RTO-related MAs
Argyll and Bute	84	109	101	120	135	167
Highland	417	464	463	508	487	526
Moray	119	136	138	147	145	171
Na h-Eileanan Siar	57	57	69	69	67	67
Orkney Islands	27	27	26	26	19	19
Shetland Islands	60	60	49	49	60	65
Highlands and Islands	**764**	**853**	**846**	**919**	**913**	**1,015**
Total MA starts	*2,346*		*2,464*		*2,661*	
% of total MA starts	*33%*	*36%*	*34%*	*37%*	*34%*	*38%*

Source: SDS (2025). MA starts not available for Arran and Cumbrae

4.15 Similarly, there has been a modest increase in Further Education (FE) enrolments across the region, whilst Higher Education (HE) enrolments have remained relatively static (Table 4.3). Whilst the growth in the FE pipeline is somewhat encouraging, a stronger pipeline of skilled entrants to the workforce is required.

[20] https://www.skillsdevelopmentscotland.co.uk/media/rleiealf/sectoral-skills-assessment-construction.pdf

Table 4.3: FE and HE enrolments at University of Highlands and Islands, 2021/22-2023/24

	2020/21	2021/22	2022/23	2023/24
FE enrolments				
Construction and Engineering	2,518	2,748	2,816	2,972
Other RTO-related subjects	3,790	5,259	9,914	6,467
Total	**6,308**	**8,007**	**12,730**	**9,439**
HE enrolments				
Architecture	215	158	153	155
Combined and General Studies	180	183	196	199
Computing	569	463	393	432
Engineering and Technology	1,054	1,115	1,069	1,138
General and others in Sciences	75	58	78	98
Geographical and Environmental Studies	165	157	144	138
Physical Sciences	133	124	107	105
Subjects Allied to Medicine	1,069	1,100	1,077	1,038
Total	**3,460**	**3,358**	**3,217**	**3,303**

Source: UHI (2024)

4.16 The need for a skilled workforce is a cross-cutting requirement for all the RTOs and they share many similar skills needs, particularly in construction phases (for both general and specialist construction and engineering skills) but also in operations and maintenance (e.g. service technicians, skilled machine operatives) and the supply chain (e.g. transport and logistics). As noted above, skills shortages will be exacerbated by the fact that there is a tight labour market in the Highlands and Islands with some particular hot spots such as in Shetland. There is and will continue to be stiff competition for skills between the RTOs and with other sectors and there is an urgent need for a well-planned, strategic skills system response to the need for skills in terms of volume and specific types. There are already good examples of education-industry engagement, however there is uncertainty about exactly what skills will be needed, in what volume, and when. This introduces an element of risk for partners in the skills system, in particular funders and providers.

4.17 The peak annual construction worker requirement of 16,270 and operational employment of 12,760 highlights a considerable employment deficit. The existing construction workforce in the region stands at approximately 12,250 (2023 data) and has grown by approximately 14% in the period from 2021. If over 16,000 workers are required at peak construction periods, this suggests either rapid growth is required in the sector, or considerable reliance on imported contractors from outside the region, and possibly even outside of Scotland, for construction and development phases. While the latter may be the optimal approach for contractors and developers, ideally this should be minimised to ensure benefits can be realised and retained locally, or at least within the region. For this to happen, there is a need to consider how best to disperse employment opportunities to connect the available workforce to the opportunities, and to look at how the sector can be scaled up. This may require innovative and potentially radical solutions.

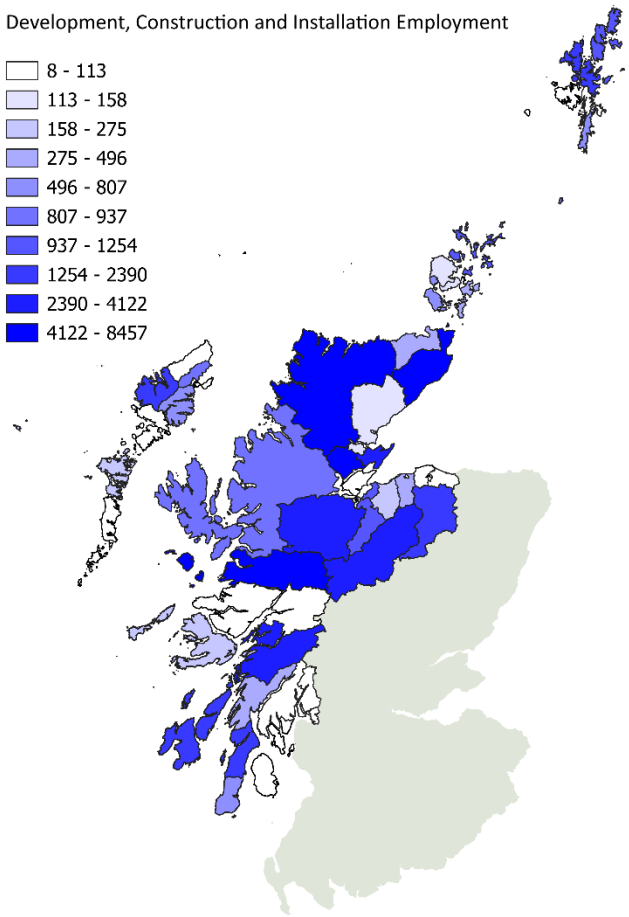
4.18 Therefore, it is imperative that people are not only encouraged to stay in or return to live and work in the Highlands and Islands, but pro- actively attracted to the region as there will be competition with other parts of the country for these workers.

4.19 Additional analysis of employment by project location provides insight on where jobs may be located, at the local authority ward level. It is important to note that they may not be evenly dispersed across the ward but rather concentrated in small localities. Figures 4.3 and 4.4

map estimated construction and operational phase employment arising from the planned projects, by ward. It should be noted that these maps do not account for any employment arising from offshore wind projects which exist outside of ward boundaries (though these jobs are included in calculations presented in Table 4.1).

4.20 The level of status-adjusted cumulative development and construction employment is split into ten deciles. The lowest (8-113 job years) is white, and the following nine increasingly darkening; the highest (4,122-8,457 job years) is dark blue in Figure 4.3. The map indicates that there will be a concentration of new temporary employment in a number of areas in the region, for example in Shetland North, in Sgìr Ùige agus Càrlabhagh (Uig and Carloway) in Na h-Eileanan Siar, along with Cromarty Firth, and North, West and Central Sutherland in the Highland Council area.

Figure 4.3: Anticipated local-level location of construction employment

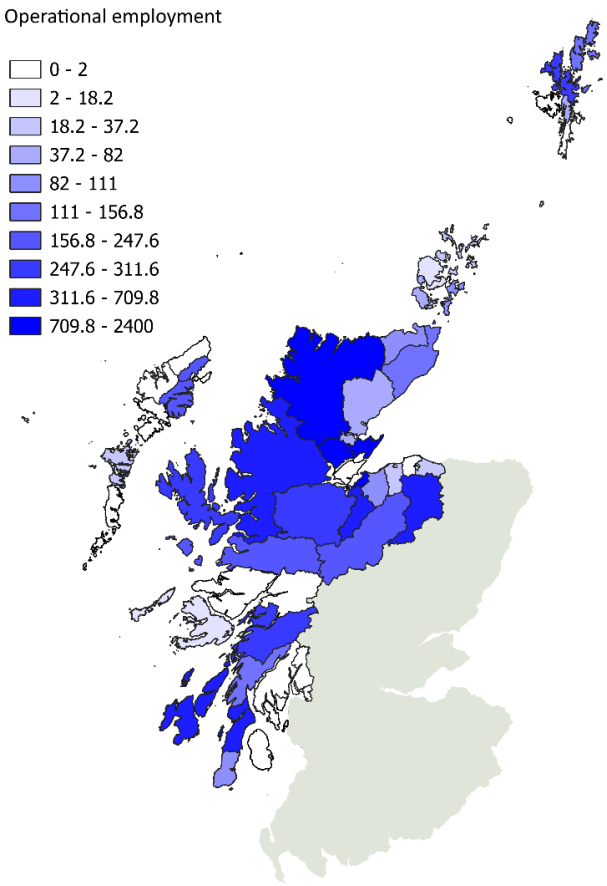


4.21 Similarly, Figure 4.4 sets out the anticipated location of operational and maintenance jobs across the Highlands and Islands. Again, the lowest (0-2 jobs) is white, and the following nine increasingly dark; the highest (709.8-2400 job years) is dark blue.

4.22 It shows that there will be a concentration of permanent operational employment in a number of areas in the region, for example in Culloden and Ardersier, Cromarty Firth and Tain and Easter Ross in Highland, as well as Speyside Glenlivet in Moray, and Kintyre and some of the Argyll islands in Argyll and Bute.

4.23 As the maps illustrate, employment locations associated with these transformational opportunities are not necessarily in close proximity to centres of population. There will be a need to connect the available workforce to these employment opportunities, so that the labour force in the region has the ability to take advantage of such opportunities, and local people can benefit. This will help alleviate reliance on imported contractors from outwith the region or outwith Scotland – though given the scale of the opportunity, there will likely still a place for such contractors. These maps give an indication of where additional temporary and permanent housing may need to be located to support realisation of the RTOs.

Figure 4.4: Anticipated local-level location of operational employment



Housing

4.24 With a need for more workers, and at the scale outlined above, the region will need more housing to accommodate the workers and where relevant, their families but there are already challenges with the provision of, and access to housing in the Highlands and Islands. In May 2024, the Scottish Government declared a 'national housing emergency', with Argyll and Bute council already having done so, and Highland Council having declared a 'housing challenge'. Lack of housing results in adverse social impacts, but it is also recognised as a major and persistent barrier to economic development. For example, the Shetland Islands previously struggled to accommodate a large inflow of construction workers required for projects such as the Viking Wind Farm. This impacted on the private rental market, causing significant challenges for residents.[21]

[21] https://www.shetland.gov.uk/downloads/file/6420/shetland-housing-needs-and-demand-assessment

4.25 There are around 275,000 dwellings in the Highlands and Islands, 10% of all dwellings in Scotland. The distribution of housing across local authority areas broadly reflects population distribution, with Highland accounting for the greatest share of properties followed by Argyll and Bute and Moray. Two-thirds (66%) of dwellings are owner-occupied, slightly higher than the rate nationally (63%). There is a lower proportion of social housing stock than nationally (18% versus 23%) but a similar level of private rented accommodation (both 13%).[22]

Table 4.4: Total dwellings

	Number of dwellings	% of all dwellings	Population share (2022)
Argyll and Bute	52,234	19%	18%
Highland	128,213	47%	48%
Moray	48,185	18%	19%
Na h-Eileanan Siar	15,936	6%	5%
Orkney Islands	12,351	4%	4%
Shetland Islands	12,044	4%	5%
Arran and Cumbrae	5,623	2%	1%
Total Highlands and Islands	**274,586**	**100%**	**100%**

Source: Energy Savings Trust Home Analytics Database 2023; NRS Small Area Population Estimates Mid-2022

4.26 Housing availability in the Highlands and Islands is heavily impacted by second homes and vacant properties, which together account for around 9% of the overall housing stock (4% nationally). Sub-regional variation is evident, and levels of second homes and vacant properties are even more marked in some parts of the region, including Arran and Cumbrae (28% of dwellings), Na h-Eileanan Siar (14%) and Argyll and Bute (11%).

Table 4.5: Vacant dwellings and second homes, 2023

	Number of vacant dwellings	Number of second homes	Total vacant properties and second homes	% of dwellings that are vacant	% dwellings that are second homes
Argyll and Bute	2,324	3,232	**5,556**	4.7%	6.6%
Highland	5,530	3,751	**9,281**	4.5%	3.0%
Moray	1,802	790	**2,592**	3.8%	1.7%
Na h-Eileanan Siar	1,209	857	**2,066**	8.0%	5.7%
Orkney	651	470	**1,121**	5.6%	4.0%
Shetland	868	178	**1,046**	7.5%	1.5%
Arran and Cumbrae	221	1,029	**1,250**	4.9%	22.8%
Total Highlands and Islands	**12,605**	**10,307**	**22,912**	**4.8%**	**3.9%**
Scotland	*92,443*	*24,041*	*116,484*	*3.4%*	*0.9%*

Source: National Records of Scotland (NRS), Small Area Household and Dwelling Estimates 2023
Note: Analysis is based on council tax records and so excludes dwellings liable for non-domestic rates (mainly short-term lettings that are let out for more than 140 days per year).

[22] Energy Savings Trust Home Analytics database, 2023

4.27 Some employers in the region have responded to housing challenges by investing in housing for staff to ensure they have the workforce they need e.g. Mowi Scotland, an aquaculture company, has worked with local communities to create affordable housing in Rum, Muck and Colonsay.[23] This type of co-investment and co-operation between employers, local authorities and communities has been successful in tackling short term issues, and is encouraged as part of a broader range of housing delivery approaches. However, it is not a viable region-wide solution and lack of housing supply remains a major market failure that must be addressed.

4.28 An interesting model is being developed by SSEN Transmission. It aims to provide 1,000 homes in the north of Scotland[24] as part of its Pathway to 2030 programme to upgrade the transmission network. SSEN recognises that Workers' accommodation will be required to deliver the proposed projects and is committed to creating a legacy in the communities that will host its workforce. SSEN will build housing for its workers which it will then pass over to the local authority to enhance the supply of local housing and support local housing need. Discussions are ongoing with local authorities, including Shetland Islands Council, about building housing for workers involved in the construction of cables connecting Sullom Voe to two wind farms.[25] This is a model that could potentially be replicated to meet short term need and satisfy longer term demand. Another option may be the development of fully serviced sites which host temporary accommodation during construction, that are then 'unlocked' for housing once construction is over, as the enabling infrastructure and site services are already in place.

4.29 SSEN are also working with Orkney Islands Council to provide capital investment to support owners of empty homes to bring them back into use, initially by SSEN to provide temporary accommodation for project managers. They are also creating individual serviced housing plots to be used in the short-term by SSEN for temporary worker accommodation, and then latterly to provide self-build sites for local residents.

4.30 Also in Shetland, in late 2024, the Scottish National Investment Bank (SNIB) announced a £730,000 investment in DITT Construction Ltd. This is to support the construction of six one-bedroomed homes in Lerwick designed for key workers and young professionals – a group that has been identified as finding it difficult to find affordable accommodation in Shetland.[26] Once completed, the houses will be purchased by Shetland Islands Council and rented out.

4.31 The delivery of affordable housing across Scotland is supported by the Scottish Government's Affordable Housing Supply Programme (AHSP)[27] alongside funding by affordable housing providers such as registered social landlords and local authorities. The AHSP comprises a range of funding mechanisms to enable affordable housing providers to deliver homes of social rent, mid-market rent and low-cost home ownership to support delivery of Local Housing Strategies. Between 2007-2008 and 2024-2025 there were 10,645 social and 4,564 affordable house completions across the region[28] through the AHSP, around 11% of the Scottish total.[29] In addition to the AHSP, the Rural and Islands Housing Fund (RIHF)[30] provides support to community

[23] https://mowiscotland.co.uk/2021/03/12/creating-affordable-housing-for-island-communities/
[24] SSEN North of Scotland area includes Argyll and Bute, Highland, Orkney, Shetland, Na h-Eileanan Siar, Moray, Aberdeenshire, Angus and Perth and Kinross.
[25] https://www.shetnews.co.uk/2024/10/22/ssen-build-homes-workers-giving/
[26] Shetland's first mid-market rental homes investment | Scottish National Investment Bank
[27] Affordable Housing Supply Programme - More homes - gov.scot (www.gov.scot/policies/more-homes/affordable-housing-supply/)
[28] Data is only published at local authority level and so the regional figure excludes data for Arran and Cumbrae.
[29] Affordable Housing Supply Programme: quarterly updates on approvals, site starts and completions - gov.scot
[30] Rural and Islands Housing Funds - More homes - gov.scot (www.gov.scot/policies/more-homes/rural-housing-fund/)

groups, landowners and businesses wishing to deliver affordable homes in rural Scotland. This includes feasibility funding of up to £15,000. As at April 2025, 266 homes across 69 sites had been approved, are underway or have been completed across the Highlands and Islands through the RIHF. One further project for 11 homes is currently being revised.[31]

4.32 The Scottish Government's Rural and Islands Housing Action Plan 2023[32] supports the delivery of the Scottish Government commitment to deliver 110,000 affordable homes in Scotland by 2032, at least 10% of which (11,000) will be in rural and island areas to help retain and attract people to these communities. The actions in the plan will continue to require strong collaborative working and joint action across sectors to enable the delivery of more homes for our rural and island communities to thrive.

4.33 In April 2023, the Scottish Government announced a five-year fund or up to £25m as part of the ASHP to enable Registered social landlords and local authorities to acquire homes for key workers where they are required.[33] As at April 2025, 26 units across Scotland have been supported.[34]

4.34 Private sector housing development tends to be concentrated in more urban or accessible rural parts of the region than remote rural locations. When viewed at local authority level overall, this can mask the acuteness of housing challenges in these more peripheral communities. Several factors are discouraging investors from funding housing projects in more rural or island locations. Construction costs can be up to 30% higher in rural areas compared to urban, exacerbated by additional transport costs, although costs of materials have also risen markedly impacting the sector as a whole. [35] Rural housebuilding is also impacted by issues of the availability of credible land for development, including scarcity of appropriate land with the requisite infrastructure to support larger housing developments.[36] They are also more costly because housing need can be dispersed, often requiring fairly small pockets of housing development rather than large scale projects. Capacity within existing affordable and private housing developers to progress developments is also a challenge. As reflected in the HIREP strategy[37], there is a need to consider and raise awareness on where housing policy and regulation could usefully be rural proofed and adjusted to allow local authorities to more flexibly use their funding to respond to island and rural needs.

4.35 Small and medium sized home builders operating in Scotland are key to the delivery of housing in rural and remote areas. However, a report by Homes for Scotland[38] found that the number of SME home builders in Scotland fell from around 333 in 2016 to 133 in 2023. Similarly, the volume of new build sales by SMEs has reduced to an annual average of round 1,800 homes compared to around 3,400 over the 2006-2018 period. The research highlighted that for rural developers, planning obligations, the high cost and challenges of infrastructure delivery and increased financial risk were particular barriers to delivery.

[31] Rural and Islands Housing fund: list of approvals - gov.scot (www.gov.scot/publications/rural-housing-projects-list-of-approvals/)
[32] Rural and islands housing: action plan - gov.scot
[33] https://www.gov.scot/news/affordable-housing-initiative-for-key-workers/
[34] Scottish Government – Housing Planning and Rural Team
[35] https://www.heraldscotland.com/news/24439768.rural-voice-not-heard-scotlands-housing-crisis/
[36] Highlands and Islands Enterprise | HIE
[37] regional-economic-partnership-strategy-2025-2035.pdf
[38] Homes For Scotland Report on SME Home Building Sector

4.36 Community land ownership has opened up opportunities for communities in the region to engage in housing development in response to local need, with the support of organisations such as the Communities Housing Trust. However, they too can face barriers in doing so, including in accessing appropriate funding streams and in meeting the often-challenging timescales associated with the funding they are able to secure, navigating the complexities of developing housing and also in the ongoing management of the housing stock.[39] Challenges can be exacerbated where community groups are entirely reliant upon volunteers.

4.37 Finding a sustainable solution to the region's housing challenges will support the realisation of the RTOs. It will also enhance the longer-term supply of housing and so bring wider benefits to the region. Considering housing as a key enabler of the RTOs and economic growth presents an opportunity to increase the supply of social housing alongside other types of tenure and so deliver sustainable strategic benefits. It is also an opportunity to continue to think innovatively about housing supply solutions, including use of empty homes, and the types of houses that are built, for example net zero homes.

4.38 Innovative approaches to housebuilding will undoubtedly need to be part of the solution. Modular construction methods could support faster and more affordable construction, and companies such as Modular West on the Isle of Barra are responding to the need for more streamlined construction processes in Na h-Eileanan Siar. Scotland's construction innovation centre, BE-ST, is also responding to the challenges faced by the sector, initiating collaborations between industry and academia, and supporting innovative new practices in doing so.

Regional housing demand and supply

4.39 As planning authorities, local authorities are responsible for producing local development plans that set out the long-term vision for their areas, considering new homes, workplaces, services and facilities, and looking at where development should and should not happen. Local authorities also have a statutory duty to prepare a Local Housing Strategy (LHS)[40] around every five years, setting out the strategic housing priorities based on an assessment of housing need and demand (HNDA). They are also required to prepare an annual Strategic Housing Investment Plan (SHIP) in collaboration with local housing delivery partners setting out housing investment priorities over a five-year period with priorities aligned with those set out in their LHS.

4.40 HNDA data has been used to provide an illustrative assessment of regional housing need and demand. The timeframes covered by the HNDAs does vary across the local authorities,[41] nevertheless, the cumulative picture does provide an indicative estimate of existing need and demand. Local authorities produce a range of estimates within their HNDAs for a 20-year period, and for the purposes of this analysis, growth scenarios have been used to ensure that potential opportunity and aspiration is reflected. However, it should be noted that these may not necessarily align with the official need and demand estimates taken forward by local authorities to inform their LHS. The total demand has been annualised evenly across years to provide an estimate of average annual need and demand. This suggests that across the region there is:

- An existing backlog of around 12,700 housing units;
- Annual average need for around 2,336 housing units.

[39] From as yet unpublished research from HIE on Community Wealth Building in the Highlands and Islands
[40] https://www.gov.scot/publications/local-housing-strategy-guidance-2019/pages/2/
[41] Given that HNDAs cover different timeframes, for the purposes of this analysis, figures from the most recent assessment for each have been used to calculate the regional overview.

Table 4.6: Estimated regional housing need and demand

	Backlog/ Existing need	Total requirement (incl. backlog/existing need)	Annual average requirement
Argyll and Bute	850	2,235	112
Highland	8,600	16,964	1,696
Moray	2,160	6,730	337
Na h-Eileanan Siar[42]	508	510	51
Orkney	198	1,837	92
Shetland	391	970	49
Arran and Cumbrae	-	-	-
Total Highlands and Islands	**12,707**	**29,246**	**2,336**

Source: HNDAs for each Local Authority[43]. Data for Arran and Cumbrae specifically is not available within the North Ayrshire HNDA and so is not included in the regional total.

Note: The total requirement for Highland and Na h-Eileanan Siar is for a 10-year period and so has been annualised over a 10-year period to calculate the annual average requirement. For all other local authority areas, the total requirement is based on a 20-year period and has been annualised over 20-years to calculate the annual average. This assumes an even distribution of need and demand across all years.

4.41 An estimate of housing need and demand for Arran and Cumbrae is not available from the wider North Ayrshire HNDA. North Ayrshire Council has established the Arran Housing Task Force to quantify demand for affordable housing on Arran and identify issues that may be limiting economic growth. The Task Force undertook a survey 'The Arran Housing Survey' in early 2025, to understand the housing requirements of Arran households, employees/employers on the island, landlords, second homeowners, empty homeowners, short-term let owners, and those wishing to move to the island. The results are currently being analysed and will be used by North Ayrshire Council and the Arran Task Force to help shape future housing provision on the island.

4.42 In terms of housing supply, there was an average of 1,470 *private sector* completions annually across the region between 2019-20 to 2023-24, a total of 7,350 housing units.

Table 4.7: Regional private new build completions 2019-20 to 2023-24

	2019-20	2020-21	2021-22	2022-23	2023-24	Total completions 2019-20 to 2023-24	Average number of completions per year
Argyll and Bute	210	131	120	137	100	**698**	140
Highland	906	729	1021	916	763	**4,335**	867
Moray	289	188	254	278	270	**1,279**	256
Na h-Eileanan Siar	48	44	59	59	136	**346**	69
Orkney	69	57	63	55	64	**308**	62
Shetland	84	44	46	58	68	**300**	60
Arran and Cumbrae (A&C)						**84**	17
Total Highlands and Islands	**1,606**	**1,193**	**1,563**	**1,503**	**1,401**	**7,350**	**1,470**
Total excluding A&C						***7,266***	***1,453***

[42] HNDA estimates are underpinned by the NRS 2018 population estimates which project decline for Na h-Eileanan Siar and therefore the total requirement reflects the backlog need which is expected to be cleared over a 10-year period. The LHS provides a more realistic indication of what could be developed, setting out a target of 310 units over the next five years. The HNDA figure has been used in modelling for this research for comparability with the approach used for other local authority areas.

[43] Argyll and Bute HNDA 2021 (Scenario 4); Highland 2024 updated 10-year HNDA (as set out in Highland Housing Challenge Committee Paper); Moray HNDA 2023 (Scenario 3); CNES HNDA 2023 (Scenario 3); Orkney HNDA 2023 (Principal +0.5% scenario)); Shetland HNDA 2022 (Scenario 7).

Source: Scottish Government Private New Build Completions by Local Authority; Data for Arran and Cumbrae provided by North Ayrshire Council based on private sector completions between 1 April 2019 and 31 March 2024. Data not available for individual years.

4.43 Over the same period (2019-20 to 2023-24), there were around 3,250 social sector housing completions across the region, an average of 650 per year.

Table 4.8: Regional social sector new build completions 2019-20 to 2023-24

	2019-20	2020-21	2021-22	2022-23	2023-24	Total completions 2019-20 to 2023-24	Average number of completions per year
Argyll and Bute	60	77	16	68	287	**508**	102
Highland	333	189	542	409	185	**1,658**	332
Moray	78	102	133	109	98	**520**	104
Na h-Eileanan Siar	76	28	22	147	6	**279**	56
Orkney	8	0	64	6	28	**106**	21
Shetland	24	27	12	18	48	**129**	26
Arran and Cumbrae (A&C)			52			**52**	10
Total Highlands and Islands	**579**	**423**	**841**	**757**	**652**	**3,252**	**650**
Total excluding A&C						**3,200**	**640**

Source: Scottish Government Social Sector New Build Completions by Local Authority; Data for Arran and Cumbrae based on data provided by North Ayrshire Council.

4.44 The most recent local authority SHIP data suggests a regional pipeline of affordable housing supply of around 5,170 units across more than 217 sites over the next five-years. This is substantially higher than the 3,252 social sector completions across the region over the last five years (2019-20 to 2023-24).

Table 4.9: Pipeline affordable housing supply over the next five years (2025/26 to 2029/30)

	Number of Sites	Number of Units
Argyll and Bute	46	1,170
Highland	99	2,070
Moray	34	1,041
Na h-Eileanan Siar	26	243
Orkney	n/a	437
Shetland*	9	160
Arran and Cumbrae**	3	50
Total Highlands and Islands *(number of sites excludes Orkney)*	**217**	**5,171**
Total excluding Arran and Cumbrae *(number of sites also excludes Orkney)*	***214***	***5,121***

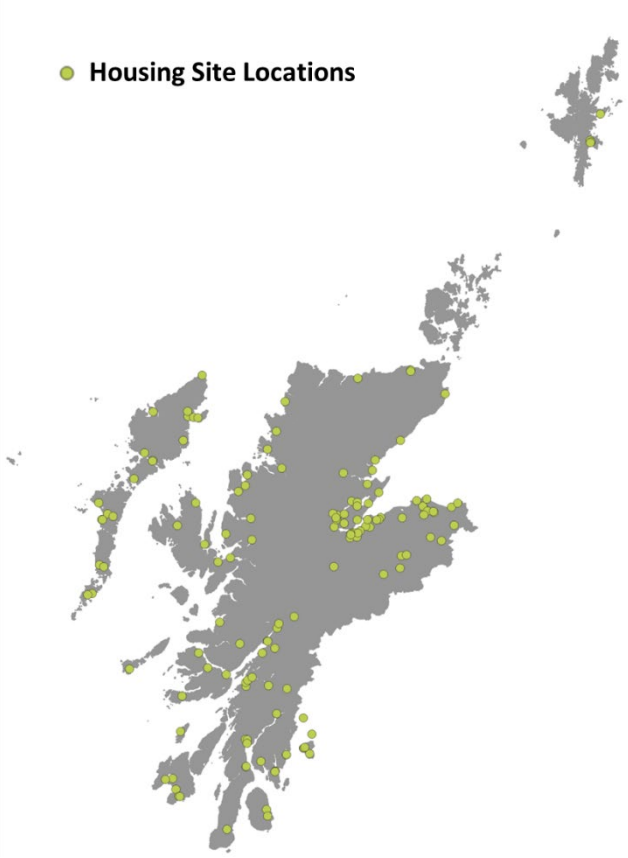
*Source: Latest Strategic Housing Investment Plan for each Local Authority.[44] Data on the number of sites for Orkney is not currently available. *The number of sites in Shetland is based on the 129 units planned under the ASHP as set out in appendix 1(b) of the SHIP, whereas the number of units also includes projects started but not yet completed for which the number of sites was not specified in the SHIP.*
Note: Acquisitions/off-the-shelf purchases included in the SHIP data are counted as one site in each relevant local authority e.g. for Arran and Cumbrae, 1 of the 3 sites noted is for the purchase of 6 properties through the buy-back programme.

[44] Argyll and Bute SHIP 2025/26-2029/30; Highland SHIP 2025-2030; Moray SHIP 2025-26 -2029/30; Na h-Eileanan Siar SHIP 2025/6-2029/30; Orkney SHIP 2025-2029; Shetland SHIP 2025/26-2029/30; North Ayrshire SHIP 2025-2030 plus data from NAC.

4.45 Based on the annual requirement data presented at Table 4.6, it is estimated that there is a regional housing need and demand of around 11,680 housing units over the next five years. Should private and social sector completions continue at current levels, we could expect around 10,466 completions regionally over this period, leaving an additional requirement for around 1,214 housing units, primarily within the Highland Council area.[45] However, this is ***before*** additional housing requirements to support realisation of the RTOs are factored in and gives no assessment of locational aspects beyond the topline local authority level.[46]

4.46 SHIP data suggests that there is a reasonable spread of pipeline affordable housing supply across the region, broadly reflecting population share at the council level (Figure 4.5). Around two-fifths of the total units (40%) are located in Highland, although much of this is within the Inner Moray Fifth area. Around a fifth are in Argyll and Bute (23% of units) and Moray (21%). Island areas tend to have a higher volume of smaller sites, as may be expected. In Shetland, developments are concentrated around Lerwick. Developments in Arran include 26 units in Springbank, 18 in Lamlash and a further 6 housing units purchased through the buyback programme.

Figure 4.5 Location of planned affordable housing development sites as set out in local authority SHIPs (2025/2026 to 2029/2030)



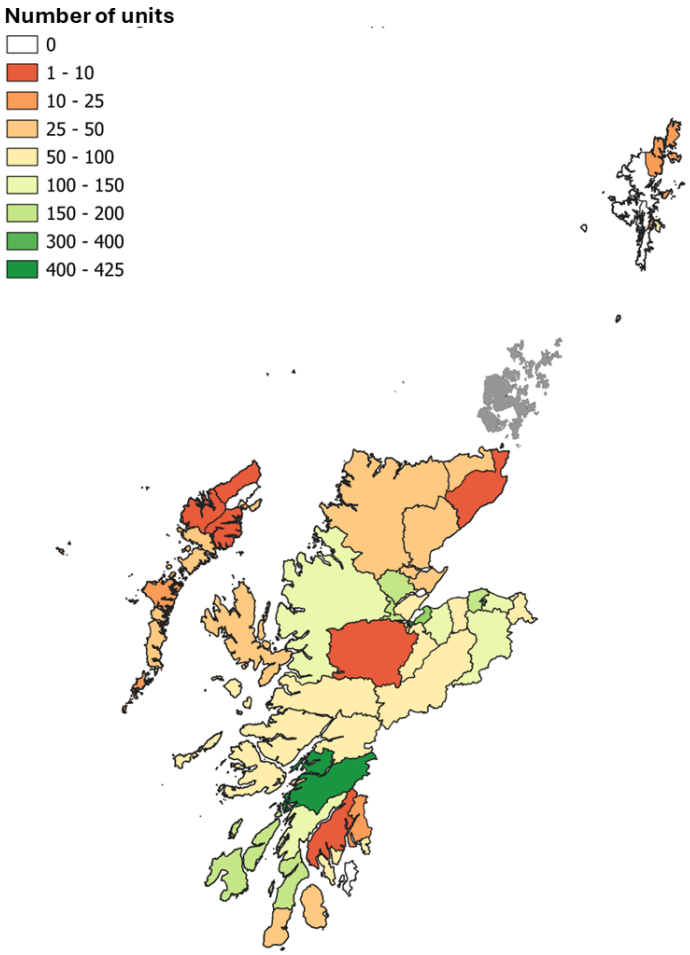
Source: Latest SHIP for each Local Authority. Site level data for Orkney not available. The number of sites in Shetland is based on the 129 units planned under the ASHP as set out in appendix 1(b) of the SHIP.

[45] Estimates exclude completions for Arran and Cumbrae.

[46] As noted above, demand estimates are based on growth scenarios outlined in HNDAs for each local authority. For the purposes of this analysis, it is assumed that these don't already factor in growth attributable to the RTO projects identified. However, there may be a small degree of double counting where related growth has already been captured.

Note: Acquisitions/off-the-shelf purchases are not mapped as individual site locations were not available.

Figure 4.6: Volume (by ward) of planned affordable housing developments as set out in local authority SHIPs (2025/2026 to 2029/2030)



Source: Latest SHIP for each Local Authority. Site level data for Orkney not available. The number of units in Shetland is based on the 129 planned under the ASHP as set out in appendix 1(b) of the SHIP.
Note: Acquisitions/ off-the-shelf purchases are not mapped as individual site locations were not available.

4.47 The maps provide a good illustration of the location of planned affordable housing developments, and for the most part the locations align fairly well with the locations of the RTO projects and investments identified through this research. However, even accounting for potential private sector or other affordable or social sector provision, the scale is not sufficient to address the additional need likely to be required to support the development of potential RTOs across the region. This study, based on the status-adjusted scenario, estimates that the working age population needs to increase by 12,760 people by 2040 to accommodate operational and maintenance jobs related to the potential RTO projects and investments outlined (12,750 excluding Arran and Cumbrae). The vast majority of jobs are expected to be in place by 2030 (around 9,000 jobs) and almost all (12,230 by 2035), although this does include some considerable optimism bias in terms of investment timescales as noted in Chapter 3. But nor does it reflect other catalytic impacts and growth opportunities that are likely to emerge and further increase workforce demand and add to housing need.

4.48 Modelling has been undertaken to consider the potential housing requirement to support the population uplift associated with RTO projects and investments alongside current projected need and demand. Addressing RTO need and demand over both a five- and ten-year period has been considered, reflecting the potential pace of delivery required to support the realisation of the RTO opportunities. Key assumptions applied to the modelling include:

1. Housing need and demand associated with the identified RTO projects is *not* already captured in the HNDAs, and therefore not included in the annual requirement calculated at Table 4.6. This may mean there is a small degree of double counting where population growth assumptions used in HNDA calculations overlap with that for the RTO projects;
2. Assumes one home for each additional person. This reflects the assumption that given the tightness of the regional labour market, where jobs are filled by existing residents, this will in turn create replacement demand which will necessitate population attraction and associated housing need and demand. An alternative scenario, based on 0.7 homes per worker has also been explored for the 10-year timeframe, providing a range estimate in terms of potential need and demand;
3. Private and social sector housing supply continues at current levels (based on the average number of completions over the five-year period 2019-20 to 2023-24);
4. Considers population uplift associated with *direct* RTO jobs only and does not account for housing need and demand associated with related supply chain opportunities or other sectoral growth outwith the scope of this study and not already captured in HNDAs.

4.49 Considering delivery over a five-year period suggests a total potential housing need and demand of around 24,430 units across the region to accommodate existing requirements as well as those associated with the RTOs (Table 4.10). Housing supply over the next five years is estimated to be around 10,466 units, which would meet just over two-fifths of this demand (43%). This suggests an additional 13,965 housing units could be required over the next five years. This would be around 12,000 units if all developments planned in local authority SHIPs are delivered over this timeframe.

4.50 The extent to which the estimated housing supply (of both social and private sector housing) over the next five years will contribute to the overall demand varies across local authority geographies (ranging from 36% in Highland to around 73% in Moray). However, the figures only provide a high-level overview and don't account for the distribution of supply within and across local authority areas, or the updated housing planning and delivery that will take place over this time period. Nor do they factor in where communities themselves may respond to demand, although this is not expected to be of significant scale. It will be important to ensure developments are of the right scale and in the right places to support realisation of economic opportunity.

Table 4.10: Estimated regional housing need and demand including RTO requirements – 5-year timeframe – 1 home per worker

	Existing backlog and demand (5-year period)	RTO housing need and demand	Total demand estimate (5-year period)	Estimated supply from social and private sector over next 5 years	% of demand met by potential supply	Additional need
Argyll and Bute	559	1,150	**1,710**	1,206	71%	500
Highland	8,482	8,360	**16,840**	5,993	36%	10,850
Moray	1,683	800	**2,480**	1,799	73%	680
Na h-Eileanan Siar	255	1,120	**1,380**	625	45%	755
Orkney	459	560	**1,020**	414	41%	605
Shetland	243	760	**1,000**	429	43%	570
Arran and Cumbrae						
Total Highlands and Islands	**11,680**	**12,750**	**24,430**	**10,466**	**43%**	**13,965**

Source: HIE analysis based on available data. Note totals may not sum due to rounding.
Note: Estimates for Arran and Cumbrae are not included as it was not possible to determine demand for this geographic area.

4.51 Assuming that the RTOs become operational over a longer time scale, and not the five-year period currently suggested by many of the developers, then it seems prudent to consider what housing delivery could look like over a ten-year period, arguably a more realistic timeframe for delivery. This then indicates a total estimated need and demand of around 36,110 housing units across the region over the next 10-years. Assuming supply of private and social sector housing continues at current levels, around 20,930 housing units are likely to be completed over this timeframe. This suggests an additional 15,180 housing units could be required over the next 10 years.

4.52 Again, the extent to which the estimated housing supply will contribute to the overall demand varies across local authority geographies and doesn't reflect the distribution of need and demand and supply within and across local authority areas, nor updated planning and delivery that will occur over this period. For Highland, the estimates broadly align with analysis undertaken by Highland Council in 2024 which estimated a requirement for 24,000 new homes over the ten years leading up to 2034. This is largely driven by the Inverness and Cromarty Firth Green Freeport (ICFGFP), and other energy infrastructure.[47] The RTO requirements will capture need associated with the ICFGFP, alongside that for other RTO opportunities across the Highland Council region.

[47] Addressing the housing challenge | The Highland Council (www.highland.gov.uk/news/article/16128/addressing_the_housing_challnege)

Table 4.11: Estimated regional housing need and demand including RTO requirements - 10-year timeframe – 1 home per worker

	Existing backlog and demand (10-year period)	RTO housing need and demand	Total demand estimate (10-year period)	Estimated supply from social and private sector over next 10 years	% of demand met by potential supply	Additional need
Argyll and Bute	1,118	1,150	**2,265**	2,412	107%	**-150**
Highland	16,964	8,360	**25,325**	11,986	47%	**13,340**
Moray	3,365	800	**4,165**	3,598	86%	**565**
Na h-Eileanan Siar	510	1,120	**1,635**	1,250	76%	**385**
Orkney	919	560	**1,480**	828	56%	**650**
Shetland	485	760	**1,245**	858	69%	**385**
Arran and Cumbrae						
Total Highlands and Islands	**23,360**	**12,750**	**36,110**	**20,932**	**58%**	**15,180**

Source: HIE analysis based on available data. Note totals may not sum due to rounding.
Note: Estimates for Arran and Cumbrae are not included as it was not possible to determine demand for this geographic area.

4.53 As set out in paragraph 4.48, the analysis above assumes that each additional worker will create a new household, in essence accounting for the aspiration for increased population attraction and retention across the region. However, in reality, the required number of homes per worker may be lower. Orkney Council commissioned a study considering the needs of keyworkers and essential workers moving to Orkney.[48] It indicated that around 0.7 homes would be required per incoming worker. Applying this to the regional RTO housing need and demand would suggest a requirement of around 8,920 homes associated with these projects, a total of 32,285 over the next 10-years when including the projected existing need and demand. Again, should private and social sector completions continue at current levels this would provide around 65% of the need and demand leaving an additional requirement for around 11,355 homes over the next 10-years.

Table 4.12: Estimated regional housing need and demand including RTO requirements - 10-year timeframe – based on 0.7 homes per worker

	Existing backlog and demand (10-year period)	RTO housing need and demand (at 0.7 homes per worker)	Total demand estimate (10-year period)	Estimated supply from social and private sector over next 10 years	% of demand met by potential supply	Additional need
Argyll and Bute	1,118	800	**1,920**	2,412	126%	**-490**
Highland	16,964	5,850	**22,815**	11,986	53%	**10,830**
Moray	3,365	560	**3,925**	3,598	92%	**325**
Na h-Eileanan Siar	510	790	**1,295**	1,250	96%	**45**
Orkney	919	390	**1,310**	828	63%	**485**
Shetland	485	530	**1,015**	858	85%	**155**
Arran and Cumbrae						
Total Highlands and Islands	**23,360**	**8,920**	**32,285**	**20,932**	**65%**	**11,355**

Source: HIE analysis based on available data. Note totals may not sum due to rounding.
Note: Estimates for Arran and Cumbrae are not included as it was not possible to determine demand for this geographic area.

[48] Item 06_Essential Workers Housing Strategy and Funding Case committee report March 2024 version

4.54 Overall, this suggests that there is a regional housing need and demand of around 32,300 to 36,100 housing units over the next 10-years. Should private and social sector supply continue at current levels, this would meet around 58%-65% of this requirement. As such, there could be an additional requirement of between 11,355 and 15,180 housing units. In terms of absolute numbers, the 'gap' is greatest within the Highland Council region, as well as Orkney and Moray.

4.55 While this analysis of housing demand and supply is based on the data available to us, its imperfections are recognised and is only intended to provide an illustration of what might be required to ensure an adequate supply of the right housing tenure, in the right places, and at the right times to support realisation of the region's economic potential. SHIP data only provides part of the picture, and assessment of planned private sector developments was not possible as the data was not readily available. Alongside this, new developments will be coming onstream, that are not reflected in current SHIPs and future LHS's will be updated to reflect changing need and demand. An example of this is Hebridean Housing Partnership's proposals to build a major new housing scheme in Sandwick outside Stornoway in Lewis. With 160 semi-detached homes planned over several phases, and an aim to submit a formal planning application later this year, this kind of development will go some way to addressing housing shortfalls in part of Na h-Eileanan Siar. There will be many other examples of this.

4.56 Never-the-less, the analysis clearly illustrates that along with affordable housing provision from local authorities and other housing providers, a continuing private sector response, that exceeds current levels, will be critical in ensuring an appropriate volume and mix of housing tenure. Re-purposing existing stock, for example by bringing empty homes back into use, will also be important in helping to address supply challenges. With around 12,600 vacant dwellings across the region (of which around 7,300 are classed as long-term empty), there is significant potential for these to contribute to addressing the housing challenge. However, it is recognised that re-purposing of empty homes is not always straightforward, and that significant investment is likely required to bring such properties up to the required energy efficiency standards associated with a just transition to net zero.

4.57 Reflecting this, the Scottish Government is investing £2m in 2025-26 and £1.3m in 2026-27 through the Scottish Empty Homes Partnerships to support local authorities to drive down numbers of privately owned empty homes. In addition, sixteen local authorities, including Orkney Islands, Shetland Islands and Comhairle Na Eilean Siar have been offered match funding to recruit designated empty homes officers. Local authorities also have the power to either charge up to 100% premium on second homes, grant a discount or remove a discount in all or parts of their council area to help encourage re-purposing of empty homes.

4.58 It will be important that the housing implications associated with the RTO projects identified within this research are considered and reflected in the evidence used to inform future HNDAs and LHS complied by local authorities. Additional analysis may be required to more clearly understand timeframes, and the nature and type of housing required. It will also be important to ensure housing is prioritised in the areas most pivotal to the realisation of economic opportunity, while also addressing existing need elsewhere.

4.59 Local authorities have a critical role to play in housing supply, but also in the broader planning process. This includes through the preparation of Local Development Plans (as noted above) that help deliver the strategic approach and policy objectives set out in the National Planning Framework (NPF 4),[49] including requirements for the identification of land for housing (Housing Land Audits). NPF 4 takes a long-term approach to looking to 2045 and guides spatial development, sets out spatial principles, regional priorities, national developments and national planning policy. It sets out the minimum amount of land, by reference to the number of housing units, that Local Development Plans (LDPs) are expected to provide across the planning authority area for a ten-year period. The availability of land will need to be assessed in terms of how it aligns with the additional housing demand requirements, both in terms of overall provision, but also in terms of locations. New allocations of land may need to be considered to support development in the right places and at the right points in time. It is therefore important that there is collaboration between local authority housing, planning and economic development officials to ensure close joint working in support of housing, economy and place ambitions.

4.60 While the analysis presented only considers operational employment, there is also a need for a strategic approach to consider what housing is required in construction phases across the region. There will be peaks in employment during the construction phases, and requirements will reduce as the project moves into operation and maintenance - but there will still be a need for housing. It will be important to achieve the right balance between the provision of temporary accommodation for peak employment stages, and permanent accommodation that will meet the future needs of industry, local areas and the region. Whilst for some construction projects, Portakabin[50], Snoozepod[51] or Bunkabin[52] solutions may work for short-term or small-scale projects, they are less appropriate for other developments and bring little real benefit to host communities. There is an opportunity during project construction phases to use the need for accommodation as a lever for constructing permanent housing stock as opposed to temporary accommodation, or for installing services to help de-risk future housing development. This will require cooperation and co-investment between industry, the public sector and housing developers.

4.61 It is clear that housing provision in the region needs to be scaled up at pace to support the realisation of economic opportunity. This presents both an opportunity and a challenge for the region's construction sector, which is already under significant and competing pressure given the crucial role it will also play in taking forward these economic opportunities. Alongside this, achieving net zero aspirations in terms of existing domestic and commercial properties across the region will require retrofitting of considerable scale, given their age and condition. Skills development within the construction sector needs to take account of the multiple and multi-faceted opportunities ahead, with scaling up of the sector vital to their realisation.

Access to services

4.62 While housing availability and affordability is one very important factor in supporting population growth, there are also others to consider. This includes access to services, which is a critical factor in supporting population growth aligned with the RTO opportunities. The anticipated population growth will place additional strain on places, some with already relatively poor service provision.

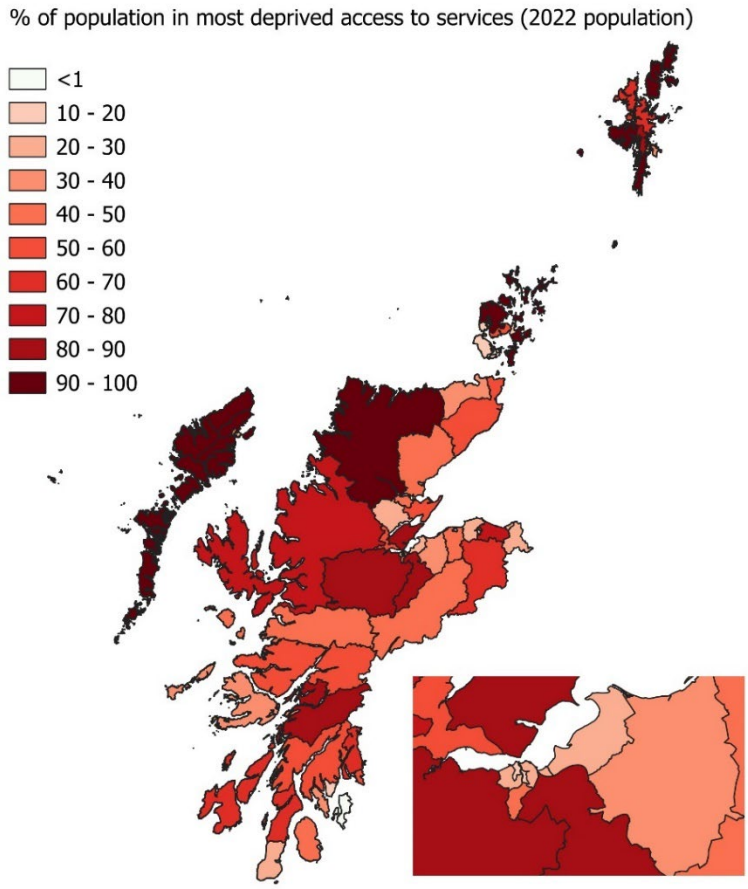
[49] National Planning Framework 4 - gov.scot
[50] https://www.portakabin.com/gb-en/solutions/site-accommodation-and-site-cabins/
[51] https://www.nixonhire.co.uk/hire/p/snoozepod-sleeper-welfare-cabin
[52] https://www.bunkabin.co.uk/

4.63 The Scottish Index of Multiple Deprivation (SIMD)[53] is used to identify areas of multiple deprivation in Scotland. It looks at the extent to which small areas (datazones) in Scotland are 'deprived' in terms of income, employment, education, health, access to services, crime and housing. It provides a relative area-based measure of deprivation ranking datazones from most to least deprived.

4.64 The access to services domain considers drive times to key facilities such as GP surgery, post office, school (primary and secondary), petrol stations and retail centres. It also takes broadband connectivity into account (defined as providing a minimum 30Mbit/s download speed). Just under half of datazones in the region (47%) are in the most deprived quintile in Scotland in terms of access to services, with just over half (51%) of the region's population living in these areas. However, as illustrated in Figure 4.6, there is substantial variation across the region with levels of deprivation most marked in some of our more remote, rural and island areas.

4.65 Some of the ward areas with the highest levels of expected operational and maintenance jobs, or where this is driving the greatest population increases, are also those with relatively poor access to services.[54] This includes North, West and Central Sutherland in Highland, Sgìre nan Loch and Loch a Tuath in Na h-Eileanan Siar, and the North Isles in Shetland.

Figure 4.7: Proportion of population (by ward) located in the lowest quintile of SIMD Access to Services domain



Source: Scottish Government, SIMD 2020

[53] Scottish Index of Multiple Deprivation 2020 - gov.scot

[54] Note jobs may not necessarily be evenly dispersed across the ward but rather concentrated in small localities.

4.66 As demand increases in some areas, this may have positive implications in terms of the viability of services (such as education, health, public transport, community facilities and retail) which have been eroded as populations have declined. Admittedly, the causal nature of the relationship between declining service provision and declining population is complex and can be attributed in part to an intersection of factors on the demand side, as well as to new and innovative ways of delivering some services. It can also be hard to make a case to resurrect services, such as schools, once they have closed. Regardless of this, restoring or enhancing service provision and access can add to the attractiveness of place and place-based planning will be critical in terms of ensuring that provision of services is sufficient to address the needs of growing populations. Transport and transport connectivity is discussed more in Chapter 5.

5 Achieving the potential

Introduction

5.1 As indicated in Chapter 2, to support the realisation of the RTOs and ensure that the value is captured and fairly distributed in the Highlands and Islands, there are a number of supporting infrastructure requirements. There needs to be sufficient housing of the right sort, in the right places, and at the right times, as discussed in Chapter 4. There must also be the necessary transport links on land and at sea (and to some extent air), and there must be port capacity and capability for construction phases as well as for operations and maintenance. There will also be a requirement for other facilities, services and infrastructure such as schools, childcare, healthcare, mobile and digital connectivity and electrical connectivity and infrastructure.

5.2 It is not the intention of this report to provide a detailed plan for each of these types of infrastructure. There is already significant planning processes and activity locally, regionally and nationally. Rather, the RTO research and analysis can add insight into key dependencies between what the opportunities are, and what is needed to realise them.

5.3 The mapping of RTO projects, proposals and assets highlights the need to consider infrastructure in specific localities, but also, where there are opportunities to ensure that the benefits are fairly distributed across the region, including the benefits of enhanced infrastructure. This chapter focuses on the key enablers of transport, grid capacity and connection, and planning.

Supporting infrastructure and enablers

Transport infrastructure

5.4 Transport is a critical enabler for all RTO sectors, and this extends across all major transportation modes including inter-island ferries. The scale of development means that across the road, rail, air and sea transport network there will be increasing demand for capacity to transport people, equipment, and materials. For some projects the nature of transport links means there may be constraints to how, when and what construction materials and equipment can be delivered. For example, the sheer size of equipment needed for some pumped storage hydro schemes means that there may be additional challenges in getting required heavy engineering machinery on and off site. Further, the level of development proposed by successful ScotWind leasing developers in the waters around the Highlands and Islands means that there may be competition for port capacity and handling services, between offshore wind developments and other sectors.

5.5 The upgrading of key arterial routes such as the A9 and the A96 will be ever more pressing with the uplift in commercial and heavy goods vehicles linked with the project development in the region. It is unarguable that this upgrading will be essential if we are to maximise the benefits from the RTO investments with the region. The A9 dualling between Perth and Inverness[55] and the A96 dualling between Inverness and Aberdeen[56] are amongst Scotland's largest transport infrastructure programmes. However, the A9 and A96 dualling programmes have

[55] https://www.transport.gov.scot/projects/a9-dualling-perth-to-inverness/
[56] https://www.transport.gov.scot/projects/a96-dualling-inverness-to-aberdeen/

been beset by delays. In 2023, Scottish Government Ministers announced a 10-year delay to the overall completion of the A9 dualling programme, pushing it back to 2035. In 2024, Transport Scotland awarded an £185m contract for the Tomatin to Moy project, with the 9.6km section expected to be completed in 2027. The build contract for Tay Crossing to Ballinluig is expected to be awarded in summer 2025, and the procurement process for Pitlochry to Killiecrankie is also expected to begin in summer 2025.

5.6 In respect of the A96 dualling programme, the Scottish Government recently indicated that they remain in favour of full dualling but stepped back from the previous commitment to fully dual the A96 by 2030. Transport Scotland is in the final stages of acquiring land required to construct dualling between Inverness and Nairn (including Nairn bypass), along with the adjacent A9/A96 Inshes to Smithton project. Also, the Draft A96 Corridor Review[57] (November 2024) has suggested bypasses for Elgin and Keith. The progression of these bypasses to dual carriageway standard should be viewed as early priorities.

5.7 Along with the A9 and A96, the clustered nature of development sites means that improvements to the A82 may need to be accelerated. This is particularly the case where the A82 runs through Fort William and much of Lochaber and towards Inverness, as well as in regard to improvements on the 10-mile Tarbet-Inverarnan stretch along the side of Loch Lomond – a preferred route for which was identified in 2015 but the timeline for construction remains uncertain. Improvements to the A85 will also be needed with the limitations of the road already impacting on the ability of heavy goods vehicles to transport machinery and equipment to support the development of Cruachan Phase 2.

5.8 The A83 from the Rest and Be Thankful running south to Campbeltown will need to continue to be a priority given opportunities opening up in Kintyre. In December 2024, the Scottish Government published draft orders for both the long-term and medium-term solutions to address the landslide issues at the A83 Rest and Be Thankful. The A890 to Kishorn and the A87 across Skye are also stretches of road that are currently operating beyond capacity and are likely to experience significant increases in traffic volumes as the RTOs in these areas come onstream. Road networks on some islands could also see added pressures and require improvements as a result of increased activity.

5.9 Alongside road upgrades, there is a programme of investment in the region's rail infrastructure. There are longer term ambitions[58] to electrify the Highland Main Line and the Far North Line as far as Tain, with proposals to switch to alternative fuels for power units on the remainder of the Far North Line, Kyle of Lochalsh Line and the West Highland Line. This will support the decarbonisation of the rail network in the region.

5.10 While capacity has improved on the Highland Main Line and Aberdeen-Inverness Line, journey times and frequency have not improved. The second Strategic Transport Projects Review (STPR2) includes commitments to enhance the Highland Main Line corridor and redevelop Inverness Railway Station. However, regarding key rail commitments from the first STPR in 2008, to date there has not been substantial progress towards delivering the stated goals for a 3-hour average journey time to/from Inverness and the Central Belt. Similarly, for the Aberdeen-Inverness Line there has been a long-stated commitment to improve the overall average journey time to two hours. However, journey times have in fact increased since 2008. The recent Draft A96 Corridor

[57] A96 Corridor Review | Reports, Assessments and Publications | Transport Scotland
[58] https://www.transport.gov.scot/publication/national-transport-strategy-2/

Review has indicated that there continues to be a good case for reducing end-to-end journey times to two hours on the Aberdeen-Inverness rail line and suggests line speed improvements. On the Far North Line, Kyle of Lochalsh Line and the West Highland Line journey times are less competitive than road alternatives. With overall travel levels likely to increase in the coming years as the economy of the north of Scotland grows, it is important that journey times and frequency are improved to ensure that rail is an attractive option for travellers – encouraging greater use of sustainable public transport and easing pressures on key arterial roads such as the A9 and A96.

5.11 The Highlands and Islands continues to have air links between Inverness and the important hub airports of Amsterdam, Heathrow and Gatwick. However, air connectivity to other parts of the UK has worsened overall since the pandemic with the loss of some routes. As RTO projects come on stream, there is likely to be an increase in demand for business air travel to, and within the region, particularly for workers during construction phases. Therefore, good connectivity to hub airports and locations in the rest of the UK will become increasingly important, as will air services to the region's islands.

5.12 Across the RTOs, there is significant activity on islands. Ferries provide essential transport taking goods, services and people to and from islands as well as between islands, and there is finite capacity. The issues faced by some communities and industries in recent years due to the challenges posed by CalMac's ageing fleet underlines the critical importance of ensuring that there is resilience and capacity in the region's ferries network, especially given that many of these services are lifeline services. With many ferries already operating to, or beyond capacity at some points in the year, this could continue to be a significant limiting factor in some locations. Aligned to this, increases in island population during construction phases is likely to increase demand on passenger ferries as well as create additional demand for goods, services and materials. Capacity on the routes to Lewis, Harris, Orkney and Shetland in particular will need assessed and additional freight services potentially made available so that movement can be accommodated at key points, and of the required capacity. Investment in parking and laydown areas at ports for additional freight may also be required. The day-to-day requirements of ferry transport cannot be displaced by construction activity.

5.13 Progress is being made in addressing the challenges of CalMac's ageing fleet. The MV Glen Sannox recently entered service on the Arran route and its sister ship, the MV Glen Rosa is expected to be delivered for service on the same route in September 2025.[59] Four other new major vessels for the CalMac fleet are currently being built in Turkey. The first of these is not expected to be completed until the end of June 2025 at the earliest, the remaining three vessels scheduled for delivery at six-month intervals thereafter[60].

5.14 In March 2025, Caledonian Maritime Assets Ltd (CMAL) appointed the lead contractor for the first phase of the Small Vessel Replacement Programme, which will see the build of seven loch-class electric ferries. It is expected that the first of these vessels will be delivered in 2027.[61] CMAL's other live projects include planning and design work for two new Northern Isles freight vessels, a new Mallaig-Lochboisdale Vessel project and a number of port/terminal infrastructure works.

[59] https://www.bbc.co.uk/news/articles/c1mrdy0p104o
[60] Letter from CMAL providing Interim update
[61] SVRP: Lead Bidder Identified for Small Vessels Contract | CMAL Caledonian Maritime Assets Ltd

5.15 Shetland Islands Council, through its inter-island transport connectivity programme,[62] is actively pursuing options for fixed links for some of its islands, with tunnels being considered for Bressay, Fetlar, Unst, Whalsay and Yell. Consultants have been commissioned to deliver a robust strategic business case and outline business case for the inter-island transport network to inform decisions on future connectivity between Shetland's islands.

5.16 There may be some scope to augment road, rail and water transport through repurposing legacy infrastructure, for example, through the use of inland water transport such as the Caledonian Canal. However, there are also limitations associated with this. (See Chapter 12 for details on the transport barriers and opportunities associated with pumped storage hydro).

5.17 Transport infrastructure upgrades are not only critical for existing businesses and communities, they are vital for proposed developments and their supply chains. They have an important role to play in enhancing the region's attractiveness for both workforce attraction and inward investment.

5.18 The regional transport partnerships HITRANS and ZetTrans are responsible for establishing the transport priorities for their respective regions and have set these out in regional transport strategy (RTS) documents, while local transport strategies (LTS) by local authorities are also critical in setting out transport needs and priorities. In their development, updating and delivery these strategies, along with other key transport plans and strategies at local, regional and national levels, should consider the transport implications associated with the RTO projects identified in this report.

Digital connectivity

5.19 High quality and reliable digital connectivity is critical for the RTOs to achieve their potential. The need for this will only increase across the RTOs, their supply chains, and in enablers such as transport, logistics, and ports. It has long been recognised that improving the digital infrastructure of the Highlands and Islands is key to ensuring the long-term future of the region.

5.20 Widespread access to fast and reliable broadband is a necessity for boosting business and helping to underpin economic growth and drive productivity. The availability of superfast broadband throughout the region has grown significantly with over 86% of all premises in the region now able to access services at over 30 Mbps, and almost 40% able to access Ultrafast (>100 Mbps) broadband speeds.[63,64] Continued investment through the Scottish Government's R100 programme[65] is required to ensure increased broadband speeds and 100% coverage.

5.21 Mobile network providers have committed to minimising the number of 'not spots' in rural areas in comparison to urban areas for both 4G and 5G coverage. It is estimated that 81% of the Highlands and Island's landmass has good 4G outdoor coverage from at least one mobile network whilst only 11% has good 5G outdoor coverage.[66] [67] The Shared Rural Network[68] aims to eliminate not-spots, but there remains a strong debate around the potential impact of the programme on the region's rural landscape and wilderness areas.

[62] Inter-Island Transport Connectivity Programme – Shetland Islands Council
[63] Note figures are based on the Highlands and Islands Enterprise Region so exclude Helensburgh and Lomond.
[64] https://labs.thinkbroadband.com/local/?area=HIE
[65] https://digitalconnectivity.campaign.gov.scot/about-r100
[66] Connected Nations update: Spring 2024 - Ofcom
[67] Data is based on local authority data and so excludes Arran and Cumbrae
[68] https://srn.org.uk/

Grid capacity and connection

5.22 The National Energy System Operator (NESO)'s Pathway to 2030 sets the blueprint for enabling the UK and Scottish Government's 2030 offshore wind targets towards net zero of 50GW and 11GW, respectively. Through the Pathway to 2030 project, SSEN has estimated that £7bn of investment will be required in onshore electricity transmission infrastructure across the north of Scotland which feeds into a wider package of work (over £20bn) to upgrade the north of Scotland transmission network.[69]

5.23 Interconnecting undersea cables are a crucial part of energy infrastructure as they allow energy to be exported and imported between countries. Analysis by Ofgem and NESO has concluded that Great Britain (GB) will become a net energy exporter by 2030 due to growing renewable energy generation.[70] GB already has nine operational interconnectors providing almost 10GW of capacity to France, Belgium, the Netherlands, Ireland, Norway and Denmark. Five new undersea energy links were approved by Ofgem in November 2024 to further boost links to overseas energy markets, with all projects expected to be completed and operational by 2032. In addition, two new electricity undersea highways from Scotland to England will be operational by 2030. Construction has commenced on the first of the two, a £4.3bn 2GW subsea cable from Peterhead in Aberdeenshire to Drax in North Yorkshire, the longest high voltage direct current (HVDC) cable in the UK.[71] Consultation is about to commence on the second, which will connect Fife with Norfolk.

5.24 HVDC transmission cables connecting Orkney, Na h-Eileanan Siar and Shetland to the Scottish mainland and UK electricity grid cables form a crucial part of the SSEN Transmission's Accelerated Strategic Transmission Investment (ASTI) programme, mentioned earlier. Investments into interconnectors increase opportunities for exporting and growth in the Offshore Wind sector and strengthen Scotland's infrastructure assets.

5.25 These grid improvements are seen as paramount to a successful energy transition in the region, although there are wider opportunities for delivery of energy systems that can handle some of the extra transmission that offshore wind and marine energy developments provide. This includes the use of green hydrogen systems, using electrolysis to develop hydrogen. Offshore wind farms have the potential to become future production hubs for green hydrogen production at scale to meet increasing demand, with either electricity transmitted to an onshore electrolyser to then produce hydrogen on land, or producing the hydrogen via an offshore electrolyser to then transport hydrogen onshore. Both options reduce demand for grid capacity, although currently use of onshore electrolysers is less expensive than offshore electrolysers.[72] To be developed as an opportunity at scale, electrolysers need to become more efficient with current commercial electrolyser units limited to 5MW of power. Modular approaches have been introduced as a remedy to this, involving grouping electrolysers together - this would also lend itself better to offshore electrolyser solutions.[73]

[69] 'Pathway to 2030' – Delivering 2030 Government targets and the transition to net zero - SSEN Transmission

[70] https://www.ofgem.gov.uk/press-release/empowering-great-britain-clean-and-flexible-energy-future-next-generation-interconnectors

[71] https://www.nationalgrid.com/media-centre/press-releases/groundbreaking-ceremony-marks-start-construction-ps43bn-electricity-superhighway-between-scotland

[72] https://about.bnef.com/blog/offshore-wind-to-hydrogen-sounds-a-starting-gun/

[73] https://www.ramboll.com/net-zero-explorers/offshore-hydrogen-at-scale

5.26 While there is scope for alternative offtake routes to use energy locally without it being fed into the grid, there are limitations to this as the user needs to be within a reasonable distance from where the energy is generated. Offshore examples include where wind energy is used as a power source for oil and gas extraction to decarbonise production.[74] In a number of areas, small and sometimes community owned wind turbines and other small-scale energy assets are used to provide power to local users[75] and there is the potential for tidal stream energy to be deployed in a similar way. However alternative offtake routes are not a total replacement for grid connection; they are an additional way of transporting and using energy.

5.27 Critically, the scale of energy-related developments and those that depend on enabling grid infrastructure mean that grid upgrades to increase capacity are fundamental to the realisation of proposed RTO developments. Without this increased capacity, the scale of impact associated with projects not progressing is stark, as demonstrated in Scenario 1 set out in Chapter 3. This indicates that less than 20% of the status-adjusted project investment total could come forward in the absence of adequate grid capacity.

5.28 Even with the required grid infrastructure, transmission charges are at a scale (and still increasingly volatile) that they can be prohibitive and act as a disincentive to investment in renewable energy development. This issue must be examined as a matter of urgency. The charges for renewable energy projects located in the north of Scotland levied through the Transmission Network Use of System (TNUoS) charges are the highest in the UK. Since the approval of ScotWind in 2021, TNUoS charges have more than trebled in the north of Scotland with predicted further increases. These higher charges create several challenges including: commercial viability of renewable energy projects, price volatility eroding asset value, investment uncertainty as a result of the charge volatility, and hindering net zero target achievement as a result of the increased costs discouraging renewable energy development. Ultimately these challenges call for a change in the TNUoS charging regime to reduce volatility and dampen amplified charges faced by northern generators. A proposed move to a cap and floor mechanism could put a temporary limit on TNUoS charges for generators subsequently reducing investment uncertainty and supporting the financial stability of renewable energy projects.

5.29 The UK Government are undertaking a Review of Electricity Market Arrangements (REMA)[76] which has involved two extensive public consultations in 2022 and 2024. REMA aims to identify the reforms which are necessary to support decarbonisation of the power system by 2035, while improving energy security and reducing the UK's exposure to volatile global fossil fuel markets, and lowering energy bills for consumers.

5.30 As part of REMA, the UK Government are considering a locational pricing approach splitting the GB electricity market into zones, with rates for electricity varying depending on local supply and demand.[77] The logic behind zonal pricing is that the locational price signals would encourage generation to locate near energy demand, and vice-versa, with volatile pricing helping demand act more flexibly.

[74] https://www.sciencedirect.com/science/article/pii/S1876610212011228
[75] https://scene.community/case-studies/onecarluke-energy-club
[76] Review of electricity market arrangements (REMA) - GOV.UK
[77] Zonal pricing in Great Britain: Assessing the impacts of the transition to a zonal market

5.31 A 2023 report for the Scottish Futures Trust[78] agrees that reform of existing market mechanisms are necessary but sees maintaining attractive market conditions as being key to delivering a just transition and ensuring long-term lower prices for consumers. It outlines a number of proposals aimed at boosting investor confidence and driving capital expenditure in both offshore and onshore wind developments, to help deliver lower, stable pricing for consumers while accelerating achievement of net zero targets.

5.32 In March 2025, a range of offshore wind developers, supported by industry trade bodies, formally expressed concern to the Scottish and UK Governments about zonal pricing proposals.[79] A letter to the First Minister and Prime Minister warned investment could be halted and projects left unviable by the 'unmanageable risk' of such proposals. The developers perceive that price volatility would, at minimum, increase the capital cost for wind projects and that this would negate any potential savings from zonal pricing.

5.33 Subsequently, there has been significant pressure from the renewable energy industry for the Government to find a less disruptive and balanced solution. To mitigate the potential negative impacts of zonal pricing, Ofgem has proposed an alternative incremental approach called Reformed National Market (RNM). This would deliver most of the associated benefits of zonal pricing without the market disruption. This proposal has consensus from industry as the most effective way to achieve REMA's objectives and help to secure the economic opportunity around renewable energy in the region.

Ports

5.34 To enable growth in key sectors, there must be adequate port infrastructure in the Highlands and Islands. This includes quays of the right size, depth, and strength to handle heavy loads, and landside facilities such as storage and staging areas, heavy-lifting capabilities, laydown areas and good transport links, vessel support and docking facilities of the right length and depth, and transport and logistics infrastructure. They also need reliable power supply for equipment, along with technical and maintenance facilities to support assembly, maintenance and repair. Increasingly, ports need digital and communications infrastructure for co-ordinating complex logistics scheduling, and for real time, reliable communications between ships, construction crews and port authorities. Ports can also make use of robotics, drones and unmanned aerial vehicles for surveying, monitoring, and inspecting facilities and equipment.

5.35 Recognising that ports are a critical enabler to unlocking growth, there has and continues to be investment in ports and harbours in the Highlands and Islands including Buckie, Stornoway Deepwater Terminal, and a number of sites within the Inverness and Cromarty Green Freeport (ICGFP) zone. The Scottish Government has recently announced funding of £150m in capital investment for 2025/26 for the offshore wind sector with overall strategic investment of up-to £500m, over five years, which is expected to boost private investment in the sector by up to £1.5bn.[80]

[78] sft-rema-report-a-vision-for-scotland-november-2023
[79] Letter to the Prime Minister and First Minister - Review of Electricity Market Arrangements (REMA)
[80] £150 million for offshore wind - gov.scot

5.36 The Strategic Investment Model (SIM) was established by the Scottish Offshore Wind Energy Council (SOWEC) to develop a collaborative framework for Scottish Offshore Wind projects along with the Scottish Government and its agencies.[81] The SIM launched a Stage One call for proposals in 2023 for port infrastructure and strategic supply chain projects to be built in Scotland. A total of 38 projects with a potential capital value of £6.5bn successfully completed Stage One and 32 of these projects are now listed by the SIM Working Group. The remaining six have requested confidentiality at present.

5.37 The Scottish Offshore Wind Port Alliance (SOWPA) is a progressive and collaborative forum of the country's leading port locations and enabling infrastructure facilities targeted at optimising the opportunities from offshore wind. SOWPA is represented by leading offshore wind energy ports across Scotland, which hold expertise across the full offshore wind value chain from manufacturing and fabrication through to marshalling, assembly and operations and maintenance. SOWPA was established in an effort to increase Scotland's port capability profile on an international scale, and to increase collaboration and knowledge sharing between ports to secure large-scale projects in fixed and floating offshore wind for Scotland. Recognising the critical enabling role of ports in the industrialisation and deployment of offshore wind and in supporting wider supply chain development, SOWPA provides a clear signal to industry on their members' willingness to work together with the collective ambition to accelerate the deployment of offshore wind and support the national energy transition.

5.38 In upgrading and developing ports in the region it will be important to plan for future expansion and development of offshore wind, marine energy, aquaculture, and other marine based activities. This must not displace existing port activity and the requirements of other sectors for port capacity and handling services now and in the future.

5.39 In addition, ports must be designed to be adaptable and scalable so that they can accommodate increasing demand driven by sector growth, and changes in need due to emerging and developing technologies. It will therefore be important to be cognisant of innovations in port infrastructure and management. Examples include:

- Automated and Autonomous Systems: Automation and autonomous technologies, such as automated guided vehicles (AGVs).
- Digital Twin Technology: Digital twins provide a virtual replica of port facilities and operations, allowing ports to simulate different scenarios and optimise processes.
- Smart Logistics and Inventory Management Systems: These enable ports to track the movement of components, manage storage areas, and coordinate with offshore installation schedules.
- Energy Management Systems: EMS integrate renewable energy sources, optimise energy consumption, and manage energy storage systems.
- Cyber-Physical Systems: CPS integrate physical operations with digital technologies, allowing for real-time monitoring and control of port activities.
- Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies can support training and maintenance operations.

[81] https://www.offshorewindscotland.org.uk/news/2024/february/20/sim-projects-published-highlighting-offshore-wind-sector-priorities-for-supply-chain-and-infrastructure/?returnUrl=%2Fnews%2F%3FcurrentPageId%3D31337%26page%3D1%26showAllResults%3Dfalse

- Remote Monitoring and Control Systems: enable ports to oversee operations and equipment from a centralised location, improving response times and operational efficiency.

Planning

5.40 Consultations with stakeholders and developers emphasised the critical role of planning in progressing transformational opportunity. Planning is seen as a challenge across a number of sectors, in particular those where there is anticipated to be significant capital expenditure on buildings, facilities and equipment such as for offshore and onshore wind, battery storage facilities, energy transmission lines, pumped storage hydro and the development of ports and harbours. There are of course also planning implications for new housing developments, transport and other assets and enablers.

5.41 The planning process is generally considered to be lengthy and very often, complex. This can delay projects which can be costly for developers and create investor uncertainty. It can also make it difficult to have a clear and confirmed timeline to ensure all resources are in place at the right time to start construction. In addition, the process for obtaining, and type of planning consent required, can vary across projects and sectors. Some, such as wind farms and battery storage of over 50 MW, require planning consent from Scottish Government Ministers. For others, consent is granted via local authorities. Planning consent for grid connections operates on a queueing system.[82]

5.42 Planning decisions generally lie with local government although strategically significant planning decisions can be taken by Scottish Ministers if deemed appropriate and necessary. Within planning, health and safety is an important factor for many sectors, for example with hydrogen and battery storage. It can be difficult for local authorities to respond to this given the nascency of the activity and lack of relevant prior skills and knowledge.

5.43 Local authorities do not always have sufficient capacity to consider and process applications efficiently. There is a concern that there will be a 'bottleneck' of applications in some areas driven by RTO-related activities in, for example, wind energy, pumped storage hydro, green hydrogen, etc. as well as for natural capital activities such as peatland restoration. If there is not adequate capacity, then there is a risk that decisions will be delayed. Whilst this will impact on the RTOs themselves, it may also cause frustration in other sectors and in communities where there is a knock-on impact on other planning applications. It is important to consider this as part of social licence and community buy-in, although this should be captured through the statutory consultation process required as part of planning considerations.

5.44 Ports have relatively wide planning rights, taking account of laydown space, warehousing and other facilities and infrastructure. Ports have specific permitted development rights (PDR) that allow for certain developments without full planning applications which is not always the case for other types of developments.[83] Ports also have unique consultation requirements with planning authorities which may not be as stringent for other types of developments.[84]

[82] Electricity Infrastructure Consenting in Scotland: options assessment
[83] https://www.gov.scot/publications/review-permitted-development-rights-phase-2-consultation/pages/4/
[84] https://www.gov.scot/publications/scottish-government-review-permitted-development-rights-phase-2-consultation-analysis-report/pages/5/

5.45 The Scottish Government has driven a significant refresh of planning in Scotland based on the Planning (Scotland) Act 2019 which led to the National Planning Framework in 2023.[85] However, it is acknowledged by the Scottish Government and partners that these changes will take time to bed in and that the outcomes and impacts will be felt over time, rather than immediately.

5.46 It is clear from the research that the planning system as it stands, with its current capacity and complexity, remains a challenge. There needs to be a swift resolution to this to ensure that there are no unnecessary delays that impact on the RTOs and mean that Scotland risks losing competitive advantage. Consenting processes and timelines for electricity infrastructure must be accelerated. Although there has been a significant refresh of the planning system, it may be beneficial to review planning in this particularly complex area to identify where processes could be simplified and combined with this, to ensure that staff involved in planning consent have the knowledge and skills to operate effectively in this complicated environment.

5.47 The Scottish Government states that it is committed to improving planning processes by supporting practice and boosting skills and capacity in local authorities. It has established the Scottish Government Planning Hub to support and speed up planning decisions and address planning constraints in local authorities.

5.48 In January 2025 the Scottish Government published guidance to help planning authorities prepare Masterplan Consent Area (MCA) schemes.[86] In essence, MCAs will allow local authorities to identify and state what development they want to happen in a particular area and based on that, set the right conditions to drive this strategically and attract investors. It covers housing development as well as commercial and other types of developments, including mixed use.

[85] National Planning Framework 4
[86] Masterplan Consent Areas: guidance - gov.scot

6 Offshore wind

Headlines

- In 2022, the UK had the largest offshore wind installed capacity in Europe and the second highest globally, following China.
- Offshore wind energy generation is moving into deeper waters further out to sea and so there is a drive for floating offshore wind.
- The sector contributed around £2bn to the Scottish Economy in 2022, supporting around 15,000 FTE jobs. This highlights the value of the wider supply chain.[87] Projections estimate that offshore wind could generate £3.1bn of GVA in 2030 and £874m in 2050.[88]
- Offshore wind RTO projects and investments identified in this study represent an overall potential investment of around £40.58bn across the region. If all projects progress as planned, this could create around 17,830 FTE jobs in development and construction phases and around 1,870 direct operational and maintenance jobs.
- Planning consent, grid connections and charging policy, port infrastructure and energy storage, will be key to maximising the regional potential of offshore wind.
- With a strong pipeline of projects, it will be critical to ensure there is an adequately skilled workforce across the manufacturing, construction and operations and maintenance phases.
- Supply chain stimulation will be important to secure large scale inward investment manufacturing opportunities, such as floating foundation and turbine manufacturing, and to ensure businesses are ready and able to contribute to the associated supply chains.
- The Scottish Offshore Wind Energy Council's (SOWEC) Strategic Investment Model (SIM) has highlighted significant investment opportunities in both port and harbour infrastructure as well as supply chain developments.
- Investment project activity in offshore wind is spread across the region with clusters of supporting infrastructure around the Inverness and Cromarty Firth Green Freeport, on the West coast and in the Northern Isles.

Context

6.1 Scotland, and the Highlands and Islands in particular, is a market leader in the field of offshore wind. The UK, including Scotland, has the largest installed capacity of offshore wind in Europe, with significant potential still to be realised.

6.2 The two types of offshore wind turbines are fixed and floating. Fixed-bottom turbines are best suited to waters less than 60m deep. However, winds are stronger and more consistent further offshore and in deeper waters with almost 80% of the world's offshore wind potential occurring in waters in excess of 60m. This has led to the development of floating offshore wind turbines designed to be effective and resilient in these harsher environments. Floating offshore

[87] https://fraserofallander.org/wp-content/uploads/2023/12/The-Economic-Impact-of-Scotlands-Renewable-Energy-Sector.pdf
[88] Ibid.

wind is substantially increasing the ability to harness offshore wind power and, in response, there has been increasing traction for this type of technology in Scotland.[89]

6.3 There is a very supportive policy environment for offshore wind in Scotland and the UK, recognising the pivotal role it has to play in reducing Scotland's carbon emissions and reaching net zero by 2045. Scottish Government has set a target to increase offshore wind capacity to 11GW of energy installed by 2030.[90] There are several key policies and strategies at national and regional levels that are directly relevant to the Offshore Wind sector including the Sectoral Marine Plan for Offshore Wind Energy[91], the Green Industrial Strategy (GIS)[92] and the Offshore Wind policy statement.[93] Table A.2.1 in Appendix A.2 provides an outline of the key policies relating to offshore wind.

6.4 While there is a broadly positive policy environment that is currently helping to drive and facilitate the development of offshore wind, a key consideration is how to evolve policy to enable delivery of projects to meet UK targets and ambitions. Critical policy issues include planning and consenting, grid access and charging, people and skills and market certainty.

Current project activity

6.5 As of April 2025, there was a total of 46 offshore wind developments in Scotland, with a total potential capacity of 45,600MW (Figure 6.1). [94] Nine of these projects are now fully operational with a total capacity of around 3,847MW. This includes the world's first floating offshore wind farm, the 30MW Hywind Scotland pilot park, which has been in operation since 2017[95] and Moray West, which became fully operational in April 2025 with a total capacity of 882MW.[96] A further six developments with a potential capacity of 2,682MW are currently under construction or consented.

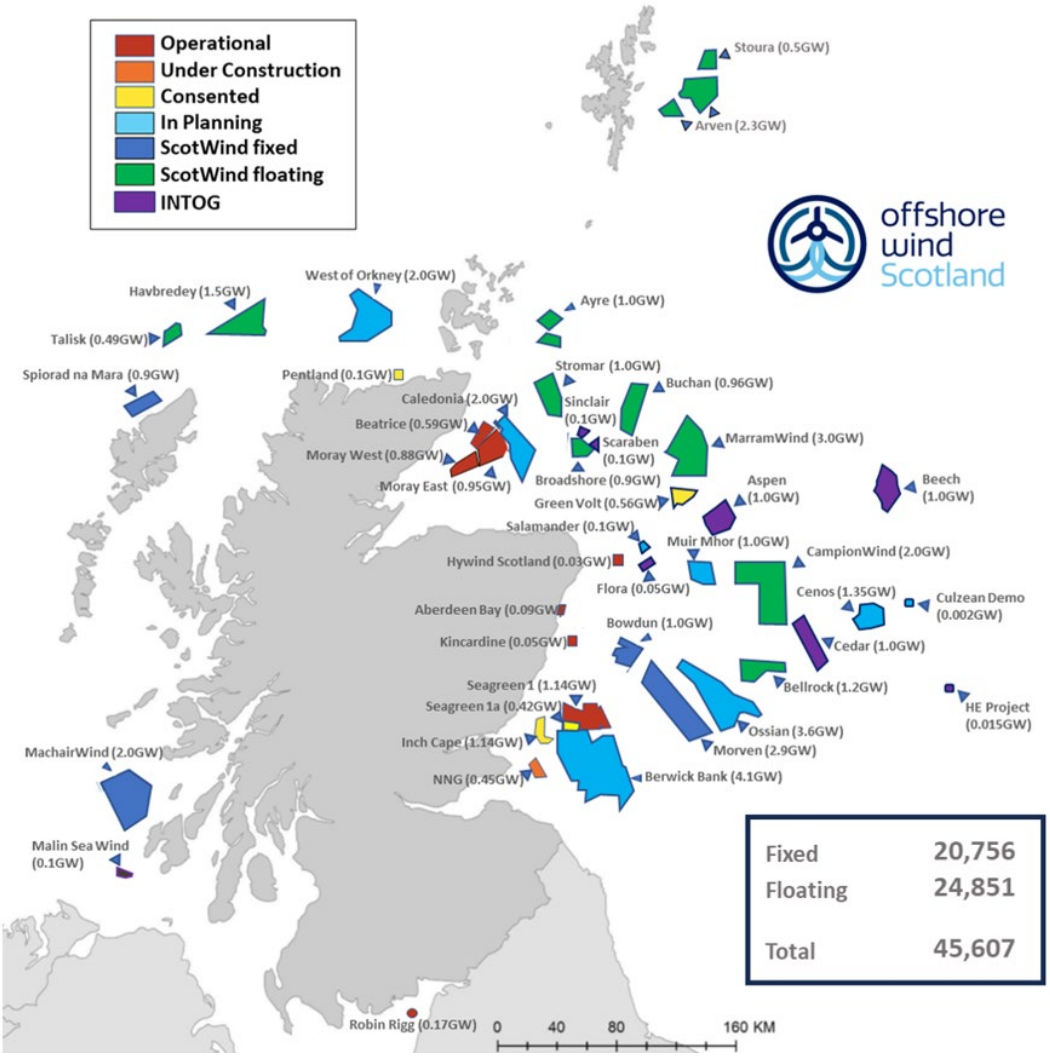
6.6 Beatrice, Moray East and Moray West are all operational offshore wind projects within the Highlands and Islands area whilst several others are in development.

6.7 Alongside current offshore wind capacity, there is a huge pipeline of investment projects in the Highlands and Islands. The investment projects are dispersed across the region with significant supporting infrastructure near Inverness including ports within the Inverness and Cromarty Firth Green Freeport zone. There is also a reasonable amount of supporting infrastructure across island areas.

6.8 As discussed in Chapter 5, there are some infrastructure requirements that must be addressed if the offshore wind potential is to be realised in the Highlands and Islands, in particular ports and their capacity for component manufacture, project construction and installation areas, grid connections and charging. Proper infrastructure planning helps mitigate environmental impacts, making offshore wind projects more sustainable and cost-effective.

[89] https://www.renewableuk.com/news/654282/Global-floating-offshore-wind-project-pipeline-grows-by-one-third-over-12-months-.htm
[90] https://www.gov.scot/news/increased-offshore-wind-ambition-by-2030/
[91] https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/
[92] https://www.gov.scot/publications/green-industrial-strategy/
[93] https://www.gov.scot/publications/offshore-wind-policy-statement/
[94] https://www.offshorewindscotland.org.uk/the-offshore-wind-market-in-scotland/
[95] https://www.equinor.com/energy/hywind-scotland
[96] Moray West becomes fully operational | Offshore Wind Scotland

Figure 6.1: Scotland's offshore wind market (April 2025)[97]



Source: Offshore Wind Scotland, April 2025

[97] https://www.offshorewindscotland.org.uk/the-offshore-wind-market-in-scotland/

Economic contribution and context

6.9 According to RenewableUK, the global capacity of fully operational offshore wind farms has now reached 80.9GW, having increased by 15 per cent over the last year.[98] China are the market leader, currently delivering just over half (51%) of operational capacity.

6.10 The UK currently accounts for almost a fifth (18%) of global capacity, with almost 14.7GW in operation offshore, in 2025.[99] The UK has the largest installed capacity of offshore wind in Europe.

Offshore wind contributed

£2bn

to the Scottish economy in 2022

It has the potential to contribute

£3.1bn

by 2030

6.11 In 2022, in Scotland, there were around 3,100 direct FTE jobs in offshore wind, approximately 1,000 businesses, and sector turnover was £4.2bn.[100] In the same year, the sector contributed Gross Value Added (GVA) of approximately £2bn with imports and exports valued at £1.6bn and £832m respectively.[101] The sector supports around 15,000 FTE jobs across the Scottish economy highlighting the value of the wider supply chain.[102]

6.12 Scenario-based projections estimate that direct FTE jobs in offshore wind, in Scotland, in 2030 could increase to 23,518 and by 2050 this could reduce to 4,436 (a long-term increase from 2022 to 2050 with a peak in the 2030s).[103] The same research estimated that offshore wind could generate £3.1bn of GVA in 2030 and £874m in 2050. The significant increase in offshore wind employment is due to construction and manufacturing jobs in the lead up to 2030 whilst offshore wind farms are being installed.

6.13 The offshore wind RTO projects and investments identified in this study represent an overall potential investment of around £40.58bn across the region over the period 2025 to 2040. This is estimated to create around 17,830 FTE jobs in development and construction phases, falling to around 1,870 direct operational and maintenance jobs. Under the status-adjusted scenario, investment falls to around £27.5bn, with around 12,320 jobs in construction phases and up to 1,250 direct operational and maintenance jobs.

6.14 Based on these projects, the modelling set out in Chapter 3 indicates that peak employment in offshore wind is likely to occur between 2028 and 2029. However, this does reflect some degree of optimism bias in developer consultations and may flatten with an inevitable time lag due to possible delays in consenting, planning, construction, or improvements in grid connectivity and capacity.

[98] Global operational offshore wind capacity grows by 15% in 12 months to 80 gigawatts
[99] Global operational offshore wind capacity grows by 15% in 12 months to 80 gigawatts
[100] https://www.climatexchange.org.uk/wp-content/uploads/2024/03/CXC-Economic-Opportunities-in-Scotlands-Net-Zero-and-Climate-Adaption-Economy-March-2024.pdf
[101] Ibid.
[102] https://fraserofallander.org/wp-content/uploads/2023/12/The-Economic-Impact-of-Scotlands-Renewable-Energy-Sector.pdf
[103] Ibid.

Leasing

6.15 Offshore wind leasing is the process of granting access to the seabed in designated areas for a fee to developers who want to build wind farms. Creating new opportunities to test innovative offshore wind technologies, such as floating offshore wind and HVDC transmission (which improves the efficiency and effectiveness of electricity transmission from wind turbines), is crucial to reaching net zero emissions in Scotland by 2045. To achieve this, and to meet the offshore wind sector deal's targets, there have been two main recent leasing processes in Scotland, ScotWind and Innovation and Targeted Oil and Gas (INTOG).[104]

ScotWind

6.16 Launched by Crown Estate Scotland (CES) in 2020, the ScotWind leasing round aims to benefit Scottish businesses and communities over the long-term as well as providing a major boost to UK clean energy production.[105] The January 2022 leasing round has produced 19 projects with a combined capacity of up to 30GW of clean energy. The projects are a mixture of fixed and floating. A total of £755m in option fees has been generated by successful bidders. This revenue is passed to Scottish Government for public spending.

6.17 A key objective of the ScotWind leasing round is to maximise Scottish supply chain content. In a world first, CES mandated, via the Supply Chain Development Statements, that applicants must outline supply chain commitments, with commitments then updated throughout development as project specifics such as timing and technology become clearer. Latest figures, taking into account all 19 projects, now show initial Scottish commitments total £28.8bn, indicating an average investment in Scotland of £1.4bn per project built and £1bn per gigawatt of capacity built.

INTOG

6.18 INTOG was launched in 2022 to help maximise value from commercial scale deployment of offshore wind farms and to reduce the carbon emissions associated with North Sea Oil and Gas production.[106] In September 2023 there was 5.4GW of INTOG pipeline capacity.[107] Developers were able to apply for seabed rights to build two types of offshore wind project:

- **IN** – Small scale, innovative projects, of less than 100MW; and
- **TOG** – Projects connected directly to oil and gas infrastructure, to provide electricity and reduce the carbon emissions associated with production.[108]

6.19 CES awarded 12 leases in total, five for innovation projects and seven for targeted oil and gas projects (see Figure 6.1).

[104] https://www.gov.scot/publications/onshore-wind-sector-deal-scotland/
[105] https://crownestatescotland.com/sites/default/files/2024-02/ScotWind%20Leasing%20Briefing%20Nov%202023%20PDF.pdf
[106] https://crownestatescotland.com/sites/default/files/2023-11/OSW-factsheet-web-sept23-sector-profile.pdf
[107] Ibid.
[108] https://www.crownestatescotland.com/scotlands-property/offshore-wind/intog-leasing-round

Competition

6.20 Scotland is a key player in the offshore wind industry, and it is important that this is retained in the face of strong global competition. China has around 41GW of offshore wind installed, overtaking the UK (14.7GW) as the world's largest offshore wind producer.[109]

6.21 The UK is Europe's largest offshore wind producer and Germany is second with a total capacity of 8.5GW. A new offshore wind deal for Europe has been proposed by industry to ensure competitive delivery of Europe's growing electricity demand, with annual capacity installations of 15GW required by the 2030s.[110]

6.22 Denmark is a leading European nation in offshore wind with more than 500 companies operating in the industry. It is also a key player in the global turbine manufacturing market.[111] Two Danish companies manufacture offshore wind turbines and have factories in the UK (Siemens Wind Power and MHI Vestas Offshore Wind). The Netherlands and Norway also have significant expertise and activity in offshore wind and are recognised for their innovations in floating offshore wind.

6.23 Scotland also faces competition from other parts of the UK but can benefit from these developments too. The world's most advanced wind turbine test facility will be built in Blyth, Northumberland, (expected in 2028) as part of an £86m investment in wind power research and development facilities.[112]

Drivers of growth

Market drivers

6.24 Key market drivers for offshore wind are ambitions for energy security and the transition to net zero. Organisations are looking to reduce their carbon footprint and central to this is achieving energy efficiency and shifting from fossil fuels to renewable energy. There is also a demand from domestic consumers for more clean energy and a reduction in the use of fossil fuels in the UK energy mix.

6.25 Recent global events have further highlighted the need for a reliable supply of affordable, resilient and sustainable energy for economic prosperity and stability. Interruptions can lead to economic slowdowns, inflation, job losses, and the delivery of essential services.

Innovation drivers

6.26 There has been, and continues to be, a great deal of innovation in offshore wind globally, in the UK, and in Scotland. This includes innovations in infrastructure, technology, supply chain, operations, and maintenance. The need for innovation will continue to drive developments in technologies and supply chains for offshore wind. There are potential synergies between

[109] Half of Global Operational Offshore Wind Capacity in China | Offshore Wind
[110] Industry Calls for Europe to Auction 100+ GW of New Offshore Wind Capacity in Next Decade, Commits to Lowering LCOE by 30 Pct | Offshore Wind
[111] https://www.hie.co.uk/media/13381/the-blue-economy-in-the-highlands-and-islands-report.pdf
[112] https://www.gov.uk/government/news/new-super-wind-turbines-with-blades-three-times-angel-of-the-norths-wingspan-to-be-tested-in-blyth-as-86-million-unveiled-for-groundbreaking-facilit?utm_medium=email&utm_campaign=govuk-notifications-topic&utm_source=d853c3a6-817d-406b-bda8-64c2d04fc9cd&utm_content=daily

offshore wind and other sectors such as aquaculture, fisheries and wave and tidal energy and these will be driven by research and innovation.

6.27 Technological advancements and innovation in turbine design, such as larger and more efficient turbines, reduce the cost per megawatt-hour (MWh) and increase energy yield. Also, developments in floating wind technology allow for installations in deeper waters, expanding the areas available for wind farms. Technological advancements can increase the attractiveness of the offshore wind sector to investors and help increase price competitiveness and viability.

6.28 Recognising this, UK Research and Innovation (UKRI) is providing £85.6 m of capital funding for the Offshore Renewable Energy (ORE) Catapult. The funding will help expand and upgrade ORE's testing facilities and enable the evolution of the next generation of wind turbines in the UK.[113] The Energy Transition Zone in Aberdeen, ORE Catapult's £9 m National Floating Wind Innovation Centre (FLOWIC), delivered in collaboration with ETZ Limited, is designed to contribute to the development of floating offshore wind technology in the UK.[114]

6.29 There is a symbiotic relationship between offshore wind and hydrogen as hydrogen can be used to store energy generated by offshore wind. Innovations in hydrogen production could enable capacity of higher volumes of renewable energy generation.[115] Given that many potential offshore wind sites are not currently connected to the grid, hydrogen production and storage could be a valuable option for moving the energy generated to where it is needed.

Constraints, challenges, and market failures

6.30 Offshore wind is well established sector in Scotland, and there are enormous opportunities in the Highlands and Islands for it to grow - it represents the greatest investment pipeline of the RTOs. However, there are some barriers and constraints that must be addressed if the region is to maximise these opportunities. Key challenges include planning, grid connections, transmission network use of system charging (TNUoS), skills, availability of quayside and port infrastructure and the sequencing of development (what needs to happen, when, and where), housing and international competition.

6.31 As discussed in Chapter 5 there are reports of delays in the planning system and given the scale of the expected pipeline, these are anticipated to increase with bottlenecks of applications and activity. The time taken from planning applications to consent, and the lack of certainty can make it difficult for offshore wind developers to plan and secure the workforce and supplies they will need at the time they will need them. This can increase costs and reduce the likelihood of full-scale development which is crucial to improving grid capacity.

6.32 Other constraints around planning include overcoming visual and environmental impacts and achieving social licence amongst communities for the installation of new transmission lines (pylons and cables). This can be challenging and take time, causing delays in the overall planning process.

6.33 A flourishing offshore wind sector requires there to be reliable connections from where the energy is generated to where it is consumed. There is a great deal of policy activity

[113] https://www.ukri.org/news/86m-investment-to-accelerate-uk-development-of-super-turbines/
[114] https://ore.catapult.org.uk/press-releases/scotlands-first-minister-opens-worlds-first-floating-wind-innovation-centre-in-aberdeen/
[115] https://www.scottish-enterprise.com/media/2wcam1z4/aquaculture-and-floating-offshore-wind-potential-synergies-report.pdf

around this but inevitably, it will take time for new grid connections to be established and operational. As one developer reported:

'The plan for grid connections in 2033 is too far out for turbine suppliers to agree and plan manufacture'.

6.34 This demonstrates the importance of being able to sequence activities and decisions as part of de-risking investment. Orders will only be finalised and placed once the pipeline is secure, and there may, at that stage be time lags in the manufacture and supply of the equipment. For example, there are a limited number of specialised manufacturers that dominate the HVDC subsea cable market; these being NKT, Prysmian and Nexans. These manufacturers are reportedly fully booked until the late 2020s, resulting in significant backlogs for new orders.[116]

6.35 Alongside the grid connection challenges are the considerations around the electricity network pricing policy such as TNUoS and zonal pricing discussed in Chapter 5. These policies have significant potential to constrain offshore wind development with increased transmission charges and capital costs reducing the economic viability of projects. Limiting these barriers and disincentives to development is essential for securing the offshore wind transformational opportunity as it will have a direct knock-on impact on the region's ports and supply chain development, including large-scale manufacturing inward investment.

6.36 Anticipated longer-term shortages in key skill areas and competition from other sectors may pose challenges for sustained growth. Skills gap challenges in STEM and data science are possible whilst the region faces challenges in attracting talent and reskilling its population to pivot to offshore wind. There are some mitigating actions being taken by industry partners including the establishment of a Renewable Energy Training Centre in Inverness by Aurora Energy Services Ltd.[117] It its first year, it delivered 1,600 training modules and will annually train 2,000 workers to support Scotland's net zero transition.[118]

6.37 As with all RTOs, a lack of housing is a constraint to ensuring that there are the right skills, in the right place and that there is a wider infrastructure of services and amenities to attract and retain people in the Highlands and Islands.

6.38 Consultations with key stakeholders indicated that floating offshore wind technology is diverse and developing. Different manufacturers have developed their own range of solutions in terms of hull design. It was highlighted that developers must work closely with suppliers and undertake detailed research and assessment of the range of hull types to make sure they select the right model with the required motion limit so that it is compatible with the environment and conditions. Mistakes could be extremely costly.

6.39 There is a significant amount of activity in offshore wind and there is complexity in terms of what needs to happen and what needs to be in place, for example mechanisms for taking energy to the grid. There is a need for clear, consistent and shared information and knowledge to help plan and sequence activity. Investors in energy projects and the supply chain will aim to mitigate risk and look for confirmed and accurate information of when, for example, consents will

[116] https://www.offshore-mag.com/renewable-energy/article/55240474/shortage-of-submarine-power-cables-poses-threat-to-offshore-wind-market
[117] https://www.hie.co.uk/latest-news/2024/january/15/new-facility-for-renewables-industry-trainees/?returnUrl=%2Fsearch%2F%3FcurrentPageId%3D1157%26keywords%3Daurora%26page%3D1%26showAllResults%3Dfalse
[118] Inverness-headquartered firm is one of UK's fastest growing energy services providers

be in place, ports will be able to service construction and maintenance, and the skills will be available. Education providers need to know what skills will be demanded and when in order to plan provision for the right time. And at the individual level, residents of the Highlands and Islands may be reluctant to undertake skills and training for particular roles until they know the opportunity is confirmed.

6.40 International competition for renewable energy production through offshore wind is another potential constraint to growth for the sector in Scotland and the Highlands and Islands as policy makers in other countries also recognise the value and potential for the sector.

Priorities for action

- Floating offshore wind will be an increasingly important source of renewable energy and capacity will increase rapidly. This must be supported by affordable and timely grid connection and appropriately developed port facilities.
- Smooth, efficient and timely planning and regulatory consents will also be critical. There is anticipation of a substantial uplift in the number and complexity of planning applications coupled with insufficient capacity within planning authorities.
- Beyond the construction phase, there will be substantial activity and employment in operations and maintenance and along with other marine energy types, O&M hubs need to be established in close proximity to ports. This will provide a critical mass of skills, expertise, equipment and facilities, including digital.
- With a strong pipeline of new projects, it will be critical to ensure there is an adequately skilled workforce across the manufacturing, construction, and operations and maintenance phases.
- Supply chain development will be important to ensure the region's businesses are ready and able to contribute and benefit from the growth of this sector.
- Opportunities should be explored for synergies and co-location with other marine uses including marine energy. This will include synergies in a shared supply chain which in turn will provide confidence to suppliers and derisk their investment.
- There is an urgent need for evidence-based skills planning building on exiting collaboration between skills providers and industry. Barriers to investing in skills, such as confirmation of when employment opportunities will come on stream must be tackled and may require public sector intervention and investment.

7 Green hydrogen

Headlines

- Green hydrogen is in its infancy as a fuel source. However, it is estimated that Scotland has the potential to provide up to 10% of Europe's green hydrogen demand by the mid-2030s.[119]
- The green hydrogen sector in Scotland could have the potential to generate around £20bn of GVA and employ over 200,000 people by 2045, by leveraging offshore wind energy and current experience in energy production.[120]
- The Highlands and Islands' potential for renewable energy generation, and levels of constrained energy in particular, as well as and existing pipeline infrastructure makes the region well placed to become an exporter of green hydrogen.
- There is a strong pipeline of green hydrogen projects across the region including production, transportation, storage, and innovation, but significant investment will be required to enable these opportunities. Green hydrogen RTO projects identified in this study represent an overall potential investment of around £9.1bn across the region over the period 2025-2040.
- Scotland was a net exporter of 19.7TWh of electricity to the rest of the UK in 2024 with the majority of this being renewable power.[121] Hydrogen generation offers the opportunity for Scotland to utilise this huge surplus to maximise economic benefit.
- There is currently a lack of infrastructure in place for off takers to utilise green hydrogen at scale in Scotland, as well as a lack of clarity on price, security of supply and skilled workforce to work with hydrogen boilers.
- Without timely showcasing of the country's green hydrogen production capacity, it is possible that Scotland will be left out of green hydrogen developments and will find it challenging to operate on the international market.[122]

Context

7.1 Green hydrogen is a virtually carbon neutral fuel source produced through electrolysis, where water is separated into oxygen and hydrogen to create a fuel source. Production requires a large supply of both fresh water and renewable electricity to fuel the process.

7.2 The UK has the largest offshore wind installed capacity in Europe, and Scotland possesses around 90% of the UK's surface freshwater.[123] Of this freshwater, a significant proportion exists in the Highlands and Islands, with the region containing four of the five largest lochs in Scotland, containing around a third of Scotland's freshwater deposits.[124] There is potential for the region to leverage its own freshwater, and clean energy to become a leading producer and exporter of green hydrogen.

[119] https://www.digit.fyi/new-hydrogen-pipeline-could-create-over-700-scottish-jobs/
[120] https://www.gov.scot/publications/scottish-hydrogen-assessment-report/
[121] Electricity Exports - Energy Statistics for Scotland – Q4 2024 - gov.scot
[122] https://www.crownestatescotland.com/news/offshore-wind-projects-could-help-secure-green-hydrogen-potential
[123] https://www.environment.gov.scot/media/1172/water.pdf
[124] https://www.nature.scot/landscapes-and-habitats/habitat-types/lochs-rivers-and-wetlands/freshwater-lochs

7.3 Green hydrogen is in its infancy as a fuel source, with a lack of international exporters, and limited current infrastructure to produce, store, and use it. However, it has potential to become a widely used fuel source, and many countries are supporting it through policy and funding.

7.4 There is a supportive policy environment at national and regional level for the green hydrogen sector, recognising its potential to support Scotland and the UK in reaching net zero targets. Key strategies include the UK Hydrogen Strategy[125] and the Scottish Government's Hydrogen Action Plan[126] which sets out an ambition for at least 5GW of installed renewable and low-carbon hydrogen production capacity by 2030 and 25GW by 2045. Other relevant policies and strategies outlined in Table A.2.2 in Appendix A.2.

Current project activity

7.5 There are a number of proposed green hydrogen hubs, and other production and innovation sites currently at varying stages of early development across the Highlands and Islands. The Net Zero Technology Centre (NZTC) recommends the development of hydrogen hubs across Scotland as a key step in realising the country's hydrogen potential.[127] Scottish Government, along with their Enterprise Agencies are working with the sector to support the creation of 14 hydrogen hubs across Scotland.[128] Should this be met, Scotland could exceed the 25GW target of installed renewable and low-carbon hydrogen production capacity by 2045, however significant investment will be required to realise this.

7.6 The four green hydrogen hubs in the Highlands and Islands – Cromarty, Moray, Stornoway and Shetland - are all at various development stages:

- Cromarty Hydrogen Hub is a production, storage and loading project proposed by Scottish Power and Storegga. They are looking to locate the facility beside the existing Beinn Tharsuinn onshore wind farm, and for this to supply the site with electricity. It is expected to produce 6,480kg of hydrogen and an estimated 29 FTE jobs when operational.[129] Construction plans are currently being considered by Highland Council.[130]
- The Speyside Hydrogen Hub in Moray is currently in the early stages of development, receiving £3.1m in funding from the Scottish Government in August 2024.[131] This is likely to help support distilleries in the region in using hydrogen to support decarbonisation.[132]
- The Outer Hebrides Energy Hub, an Islands Growth Deal project based around Stornoway Port Authority's Deep Water Terminal. The project aims, in the first instance, to supply green hydrogen for conversion of the Stornoway Town Gas Network but also for the hydrogen production to be scalable to allow export of hydrogen by sea through conversion to containerised ammonia or methanol, or by direct pipeline mainland demand centres.

[125] https://www.gov.uk/government/publications/uk-hydrogen-strategy/uk-hydrogen-strategy-accessible-html-version
[126] https://www.gov.scot/publications/hydrogen-action-plan/
[127] https://www.netzerotc.com/reports/energy-hubs-fill-the-backbone/
[128] https://www.scottish-enterprise.com/shine/shine-media/shine-news/scotland-s-ambitions-and-capabilities-in-the-hydrogen-sector
[129] https://www.cromartyhydrogenproject.co.uk/wp-content/uploads/documents-2024/Full%20Documentation/Planning%20Statement.pdf
[130] https://forecourttrader.co.uk/latest-news/cromarty-hydrogen-project-plans-being-considered/688200.article
[131] https://www.gov.scot/news/green-hydrogen-production/
[132] https://www.scottish-enterprise-mediacentre.com/news/new-research-from-scottish-enterprise-shows-potential-increase-in-demand-for-hydrogen

- Shetland Hydrogen Hub – due to the massive onshore and offshore wind potential for Shetland and its distance from consumers, to ease the burden on the grid, the islands are seeking options for the electricity produced to be used locally for the production of alternative fuels such as methanol and SAF (sustainable aviation fuel). This will deliver an exportable product to send to other parts of Scotland, the UK and overseas.

7.7 As well as the four hydrogen hub projects, there are a number of other early-stage potential hydrogen developments across the region including:

- The Longman Site in Inverness, a proposed project by Storegga to create a green hydrogen production, storage, and distribution site with a projected operational capacity of 50 MW.
- The Argyll Hydrogen Hub in Oban, being developed by GreenPower. The project received planning approval in early 2024 for the erection of a hydrogen fuelling station with on-site hydrogen generation and storage and associated infrastructure. [133] It is intended that the hub will use renewable electricity from the nearby Carraig Gheal wind farm.
- The Flotta Hydrogen Hub is a project aiming to repurpose some of the existing Flotta oil terminal, to create a new green hydrogen hub and transport green hydrogen directly to the St Fergus gas terminal in Aberdeenshire for export.[134].

7.8 In 2022, the Hydrogen Innovation Scheme, which is part of the Scottish Government Emerging Energy Technologies Fund (EETF), provided a total of £7m to 31 green hydrogen projects including the Green Hydrogen and Oxygen Supply from Tidal energy (GHOST) project on Yell sound in Shetland; Green Hydrogen for the Isle of Gigha (GHigha); Orkney sea water electrolysis project; Green Hydrogen Integration at Sullom Voe; HySKUA; HyBrine; and the Creed Hydrogen Skills and Innovation Centre in Lewis.[135]

Economic contribution and context

7.9 The Scottish hydrogen sector (including green, blue and grey hydrogen) in the 2022/23 financial year produced a total turnover of £37 million, with a business count of 100 and total FTE count of under 500. However, export and import of all hydrogen were both under £500,000.[136]

7.10 Projections based on Scotland's current transition direction and the growth rate of the hydrogen sector (not including grey hydrogen, which uses methane to power electrolysis and has significant carbon emissions attached), indicate a likely employment of around 5,191 FTE by 2030, dropping to 3,793 FTE by 2045. [137] Monetary impacts under this scenario suggest £752.7m in turnover and £286m in GVA by 2030, falling to £550m in turnover and £209m in GVA by 2045.

[133] https://greenpowerinternational.com/greenpowers-argyll-hydrogen-hub-gets-green-light/
[134] https://www.flottahydrogenhub.com/green-hydrogen
[135] Emerging Energy Technologies Fund - Hydrogen Innovation Scheme: successful projects - gov.scot
[136] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/
[137] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/

7.11 The green hydrogen RTO projects and investments identified in this study represent an overall potential investment of around £9.10bn across the region over the period 2025 to 2040. This is estimated to create around 17,580 FTE jobs in development and construction phases and up to 3,170 direct operational and maintenance jobs, assuming all projects progress as planned. As noted above, significant investment will be required to create the conditions for these projects to progress. Under the status-adjusted scenario, investment falls to around £6.84bn.

Competition

7.12 Green hydrogen is anticipated to become a significant resource for global decarbonisation, and numerous countries are developing and innovating infrastructure to produce and supply it. For example, European countries such as Norway have existing infrastructure and reputation from oil and gas export to become global leaders, whereas internationally China produce a significant number of electrolysers and may become a significant force.

7.13 Green hydrogen production costs will be slightly higher in Scotland than in other European countries such as Norway due to their legacy hydropower. Other countries, such as Morocco and Chile, which have higher efficiency from combined solar and wind energy also have transportation costs to take into account.

7.14 There is competition in terms of value chain and local content. Currently, many of the electrolysers required for green hydrogen production are manufactured overseas, and it currently costs five to eight times less to purchase an electrolyser from China than it does from any other place in the world. Some consultees were concerned that much of the existing electrolyser production may shift to China, with one noting that a similar market shift occurred with PV solar panel production. However, it is understood that Enterprise Agencies in Scotland are actively seeking to encourage developers to site their electrolyser manufacturing plants in Scotland and thus increase local value chain content.

7.15 The Highlands and Islands will also have to compete with other areas in Scotland to ensure funding and support to develop a hydrogen industry. Within Scotland, Aberdeen, Aberdeenshire and the wider north-east is the largest competitor with existing green hydrogen projects. Aberdeenshire also has the UK's largest oil and gas pipeline terminal at St Fergus, making it well placed to export green hydrogen by pipeline.

Drivers for growth

Market drivers

7.16 Under current plans, demand for green hydrogen in the UK is anticipated to reach around £25bn by the year 2045. This includes 14.9TWh per annum required for transport targets laid out by the Scottish Government.[138] Across Europe, Green Hydrogen demand is anticipated to rise to around 20 million tonnes by 2030, further tripling to 60 million tonnes by 2050.[139] There is also a significant global market identified.

[138] https://www.gov.scot/publications/hydrogen-action-plan/
[139] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/

7.17 The Scottish Government 's Hydrogen Policy Statement confirms support for the strategic growth of a hydrogen economy in Scotland and sets out an ambition of 5GW of renewable and low-carbon hydrogen production by 2030 and 25GW by 2045.[140]

7.18 Scotland, and the Highlands and Islands in particular, can be considered a prime location for green hydrogen production, due to the high availability of renewable energy generation, much of which is constrained. At times of low demand, renewable energy generators are paid to turn off, and green hydrogen offers a solution for either avoiding energy waste, or the costs incurred for turning off generation. It was suggested through consultations that battery and battery storage technology is not sufficiently mature to maximise the opportunity presented by constrained energy, and transportation of green energy from source directly to grid (e.g. sub-sea cables) is prohibitively expensive. Instead, the conversion of electricity to a different energy medium – either as green hydrogen, or as a synthetic fuel such as ammonia or methanol – for easier and more cost-effective transportation. This approach also offers opportunities to industries with high energy consumption, such as whisky distilling.

7.19 There are domestic and international projects targeting increased demand for green hydrogen. The Scottish Government and Transport Scotland aim to transition all Scottish airports to green hydrogen by 2040[141] and the Highlands and Islands is targeted to become the world's first net zero aviation region by 2040. The UK aviation sector could require an extra nine million tonnes of hydrogen to support this full decarbonisation.[142] The Highlands and Islands' aviation industry's makeup comprising of numerous small domestic airports makes it well placed to pilot a green hydrogen transition. Reflecting this, Scottish airline Loganair signing a memorandum of understanding with Cranfield Aerospace Solutions in early 2024, to operate hydrogen-fuelled flights out of Orkney by 2027.[143]

7.20 There is international appetite for a green hydrogen transition, with a project funded by the European Union's Horizon 2020 Research and Innovation Programme, investigating the potential for European RoPax ferries to transition.[144] The project found that green hydrogen may be an optimum fuel source for decarbonising European ferry fleets, the distances which these have to travel making batteries, which need to be recharged and replaced frequently, unsuitable.

7.21 Many European countries, such as Germany, have national strategies focused on investigating the possibility of large imports of green hydrogen to support with their transition to net zero.[145] With sufficient development of both production and storage of green hydrogen, and significant improvements to the pipelines to export this, Scotland could be in prime position to take advantage of global demand for green hydrogen and become a key player on the international market. Links providing opportunities for export are currently being explored, including:

[140] https://www.gov.scot/publications/scottish-government-hydrogen-policy-statement
[141] https://www.transport.gov.scot/publication/disability-and-transport-findings-from-the-scottish-household-survey-1/transition-to-low-and-zero-emission-aviation/
[142] https://www.stantec.com/uk/ideas/topic/energy-resources/the-geography-of-hydrogen-is-the-catalyst-to-economic-stimulus-and-adaptation-to-climate-change
[143] https://www.bighit.eu/news/2024/2/19/loganair-hydrogen-flights-in-orkney-by-2027
[144] https://cordis.europa.eu/project/id/769417/reporting
[145] https://www.bmwk.de/Redaktion/EN/Hydrogen/Dossiers/national-hydrogen-strategy.html

- The Scottish Government funded Hydrogen Backbone Link (HBL) aims to connect Scotland with mainland Europe to export green hydrogen, providing cost-effective transportation to market for Scottish hydrogen producers and supporting the transition to a low-carbon energy system.[146] The project positions Scotland as a leader in pan-European hydrogen infrastructure development.
- The LHyTS Hydrogen Export Route is another project aiming to boost Scottish hydrogen export potential, by creating a direct line between Sullom Voe terminal in Shetland, and Koole oil terminal in Rotterdam.[147]

7.22 Hydrogen and green hydrogen have been explored as a potential replacement for natural gas in decarbonising domestic heat generation over a number of years. For example, projects such as SGN's H100 project[148] in Fife, and SGN's partnership with RWE[149] explore the potential for using green hydrogen in place of natural gas or liquified natural gas (LNG) and liquified petroleum gas (LPG) in places such as Thurso, Wick and Stornoway. Whilst there are currently questions over the long-term viability of green hydrogen replacing natural gas throughout the gas network, stakeholders consider that in at least in the short term, deployment of green hydrogen on remote and island local gas networks may be a potential solution.

7.23 UK Government policy is further supporting the green hydrogen industry, targeting 10GW of green hydrogen production by 2030, and supporting this with £300m in funding for hydrogen projects. There are other imperatives included such as reducing the cost of electrolysers to make these more financially viable for energy companies and integrating around 20% hydrogen into the UK energy grid, widening the market for the industry. With reliable infrastructure to support the export of green hydrogen this could drive businesses to expand into the industry by providing access to the European market.

7.24 The UK Government Hydrogen Production Business Models (HPBM) provides revenue support to incentivise investment in new low carbon hydrogen production and encourage users to switch to low carbon hydrogen by making it a price competitive decarbonisation option.[150] It is intended to stimulate demand for low carbon hydrogen as the subsidy paid to producers will enable them to sell hydrogen at affordable prices. Hydrogen Allocation Rounds (HAR) are used to allocate funding, with eligible projects able to apply to receive HPBM support over a 15-year period. There have been two rounds to date, with the shortlist for the latest round (HAR2) announced in April 2025. A further round is anticipated, but timescales are yet to be announced. There are a number of large and small projects across the region that were unsuccessful in the HAR2 round. Success in future funding rounds will be critical for such projects to enable and expedite the growth of the hydrogen sector in the region.

[146] https://www.gov.scot/publications/trading-nation-realising-scotlands-hydrogen-potential-plan-exports/pages/4/
[147] https://www.offshore-energy.biz/project-for-implementing-scotland-rotterdam-hydrogen-export-route-moves-forward/#:~:text=The%20consortium%20behind%20the%20LOHC,precursor%20to%20large%2Dscale%20export.
[148] https://www.sgn.co.uk/H100Fife
[149] https://sgn.co.uk/news/rwe-and-sgn-announce-green-hydrogen-partnership-domestic-heat-scotland
[150] https://www.gov.uk/government/publications/hydrogen-production-business-model

Innovation drivers

7.25 Scotland has a world class cluster of universities which are key innovators in a number of sectors including energy.[151] For example, the Hydrogen Accelerator, based at the University of St Andrews, produces cutting edge hydrogen research and supports projects such as retrofitting a hydrogen powered train in collaboration with ScotRail. The project was a partnership between the University of Strathclyde and the University of St Andrews, funded by Transport Scotland, and also encourages knowledge sharing between stakeholders to boost hydrogen innovation in Scotland.[152] UHI in Stornoway hosts the only dedicated hydrogen Professional Development Award (PDA) in Scotland and hosts students from all over the world.

7.26 A number of Scottish green hydrogen projects are developing innovations which will drive production. For example, the HyBrine project investigated using seawater to feed electrolysers, and HySKUA is investigating the possibility for floating offshore green hydrogen production infrastructure. Both HyBrine, and HySUKA are based at EMEC in Orkney with the potential to be placed across the region. The development of projects which can take advantage of limitations in the grid capacity and be coupled with existing infrastructure such as offshore wind and marine energy production can ensure that energy productivity is maximised.

Constraints, challenges, and market failures

7.27 There is a wealth of natural resources for offshore wind production around the Highlands and Islands with funding announced for 19 ScotWind projects, providing 27.6GW in renewable electricity.[153] Whilst an abundance of constrained renewable energy generation will increase opportunity for green hydrogen development, any uncertainty in projects prior to final investment decision (FID) will increase the perceived risk for investors. In more mature industries such as Oil and Gas, investors or banks will allow procurement of long lead-in time infrastructure and equipment prior to FID, especially if there are supply constraints. Given the nascency of green hydrogen, there is more risk, and so advance procurement of infrastructure and equipment is typically not permitted by investors. This may put green hydrogen investment projects at risk of delay due to competition with other sectors for equipment and supply chain services.

7.28 Currently, capital costs for green hydrogen production infrastructure are prohibitively high for all green hydrogen projects. Small scale green hydrogen developments could potentially be developed near to industrial sites, or next to onshore wind sites with a road transport solution to service industrial users of green hydrogen, but the small scale and dispersed nature of industrial sites in the region, and the dispersed nature of onshore wind farms, mean that costs for doing so are excessively high. One consultee suggested that this approach could be employed on a 'loss leader' basis with specific energy-intensive industrial users converting existing energy supply, to generate learning which can then be exploited and applied elsewhere.

7.29 While there are multiple terminal points to export Green Hydrogen from, such as St Fergus in Aberdeen, Sullom Voe in Shetland and Flotta in Orkney, significant investment is required in pipeline infrastructure to support the export of green hydrogen into Europe. Port access in addition to terminals would also be required. Some reports indicate that current oil and gas pipelines can be repurposed to export green hydrogen, however others indicate that this will not

[151] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/
[152] https://www.universities-scotland.ac.uk/cop_st-andrews/
[153] https://www.gov.scot/publications/hydrogen-action-plan/

be sufficient to support transition and new pipeline infrastructure will be required, with costs ranging from around £4bn to around £27bn.[154] Similar investment is required in the infrastructure to transport green hydrogen and synthetic fuel derivatives internally throughout the Scottish and UK markets. Whilst there is potential to convert existing oil and gas infrastructure, this too would be costly at present.

7.30 The current energy workforce in Scotland is insufficient to meet current, or emerging Green Hydrogen developments. There are a raft of strategies from local and national bodies to develop the supply of energy relevant skills in Scotland, and specifically the Highlands and Islands[155] However, in the short term, some of the workforce required may need to be taken from elsewhere in the country to support with the development of green hydrogen projects.

7.31 As Scotland's green hydrogen production increases the next challenge will be finding sufficient storage for excess reserves. Current solutions ready for use include storage in high compression tanks, however specialised tanks, and cryogenic systems are required to support the highly pressurised gas, which have high associated costs and associated safety concerns. Salt caverns have also been used elsewhere, but Scotland has limited supply of these.

7.32 Most projects rely on government funding for the initial stages, and there is not a reliable business model showcasing the transition beyond pilot stages, creating concerns around the chances of projects to do so.[156] There is a limited catalogue of completed green hydrogen projects in Scotland, and the industry is learning and developing as it goes. Industry wide education and knowledge sharing is an area for development.

7.33 Although the Scottish Government's Hydrogen Action Plan details the potential for hydrogen to power vehicles,[157] especially heavy goods vehicles and public transport such as buses, there is only a small number of domestic hydrogen vehicles in the UK, and few places to fuel these.[158] The UK hydrogen vehicle industry is still in its infancy and will not be a reliable market for some time.

7.34 If green hydrogen is fully harnessed and the target capacity is realised, rollout of heating systems, vehicles etc. capable of transitioning must be significantly increased to ensure a viable market for green hydrogen. However, most boilers and heating systems currently still run on natural gas and will do for the entirety of their lifespan, although research points to a small uptake in hydrogen-ready boilers and heating systems in industrial settings.[159]

7.35 There are a number of challenges to overcome to develop green hydrogen in the Highlands and Islands. However, stakeholders agree that there is a real willingness and engagement from strategic partners to support green hydrogen in the region compared to other parts of Scotland in terms of consenting and permitting. As with many other RTO sectors, the planning and regulatory regime for green hydrogen is perceived as a barrier that can delay or constrain project development, so a proactive and supportive approach by public bodies is welcomed by developers. As noted in Chapter 5, Scottish Government have established the

[154] https://www.wwf.org.uk/sites/default/files/2023-02/CAG-Hydrogen-Heating-in-Scotland.pdf
[155] https://www.highland.gov.uk/news/article/15771/council_to_consider_the_impacts_of_depopulation_and_demographic_change_on_highland
[156] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/
[157] https://www.gov.scot/publications/hydrogen-action-plan/documents/
[158] https://hydrogenindustryleaders.com/hydrogen-cars-the-future-of-the-uk-car-industry/
[159] https://www.h2knowledgecentre.com/content/government4234

National Planning Hub to help address these challenges. Courses for local planning professionals are also being provided to raise awareness of the role of green hydrogen in the energy mix and the technologies involved.[160]

7.36 There are challenges in recruiting sufficiently skilled staff. Employers can look to attract staff from the oil and gas industry do to possessing a highly transferable skillset. However as one consultee noted, recruitment for skilled workers in green hydrogen is a significant challenge, and competition with established and mature sectors, as well as other nascent energy sectors, is considerable.

> *"Getting the right people, and in the required volumes, is a serious challenge. We are just not able to fill jobs. We need more incentives to get them over [to work in green hydrogen] – oil and gas remuneration is still too good."*

7.37 It was suggested by one consultee that whilst encouraging workers to transition from oil and gas was needed, incentivisation (e.g. funding for training) should instead be targeted at new entrants rather than those switching, as this would be a more effective use of resource.

Priorities for action

- Clarity at all levels of Scottish and UK Government is necessary to establish the direction of travel for green hydrogen, to ensure the best and smoothest route to market.
- Green hydrogen is a nascent sector and therefore stimulating development of the production and use/off takers of green hydrogen is required to help realise opportunities.
- There is an aligned opportunity for green hydrogen to utilise available renewable energy, and this must be exploited to help address the next big challenge of decarbonising the Scottish economy. Green hydrogen offers a strong opportunity to do this.
- There is a strong interdependency with renewable energy generation. Without renewable energy, there is no opportunity for green hydrogen; without green hydrogen there is no avenue to rapidly scale-up means to tap into constrained energy.
- Infrastructure to support green hydrogen uptake, transportation and export is critical for sector development. Additionally, there must be certainty on the availability of green hydrogen as a fuel source, and investment in supporting infrastructure in the longer term.
- It is most effective to have green hydrogen production as close to off taker sites as possible in the first instance, and green hydrogen generators and off takers should be incentivised to do so in the right places.
- Green hydrogen as a feedstock for ammonia, methanol and SAF production offers the best route to market at scale and therefore should be prioritised. Hydrogen as a building block in the green chemistry that needs to replace petrochemical products will be the long-term future and opportunity market for hydrogen production and the Highlands and Islands needs to build experience in this hydrogen as a feedstock model to achieve a first mover advantage.

[160] https://www.improvementservice.org.uk/products-and-services/planning-and-place-based-approaches/planning-skills/introduction-to-hydrogen-for-the-public-sector/

8 Marine energy

Headlines

- Scotland is the global leader in wave and tidal energy, particularly in the Highlands and Islands. However, competition from other countries is growing fast and it is vital that there is a strategic approach to commercialising the research and innovation that is taking place.
- As marine energy technologies advance and investment grows, the sector has the potential to become a cornerstone of the UK's renewable energy mix, taking a whole-system approach to energy security.
- It is estimated that there could be a Scottish market for up to 8.8GW of marine energy by 2050, with potential deployments of up to 12.6GW throughout the UK and up to 300GW globally.[161] This could deliver up to £8bn to Scotland's economy by 2050, and support more than 15,000 jobs, of which 22%-28% could be in long term operations and maintenance. [162]
- With the main concentration of Scotland's viable marine energy resources located in the North and West of the country, a significant proportion of these benefits could accrue to coastal communities across the Highlands and Islands.
- The marine energy projects and investments identified in this research represent an overall potential investment of around £2.86bn across the region between 2025 and 2040, creating up to 12,580 FTE jobs in construction and development phases.
- Innovation is being driven by the need to reduce costs and achieve efficiencies so that the technologies are commercially viable within the renewable energy mix. This will require appropriate ongoing government support.
- The European Marine Energy Centre (EMEC) in Orkney is a key asset for the sector. Its real sea test facilities have been the focus for significant advances in wave and tidal energy technologies for over 20 years. The centre can play a key role in the deployment of the next phase of demonstration array projects as the sector scales up.
- The 398MW capacity MeyGen tidal demonstration project off the North Caithness Coast is the largest such development in the world. Recent CfD awards have been granted that will see deployed capacity increased from 6MW currently, up to 65MW.
- The world's first community scale tidal array is in Bluemull Sound, Shetland, supplying electricity to the grid for the communities in Yell and Unst. This project worked with Tesla to add energy storage to their tidal technology, creating the world's first grid connected tidal power station.
- HIE subsidiary Wave Energy Scotland (WES) has spearheaded the development of wave energy technologies in the UK over the past 10 years. WES' technology development programmes have to date produced two viable wave energy concepts (Mocean and AWS) which have tested at EMEC. Ongoing government support for WES will accelerate the development of wave technologies towards full commercialisation.

[161] https://www.policyandinnovationedinburgh.org/future-economic-potential-of-tidal-stream-and-wave-energy-in-scotland.html
[162] Ibid

- As with other RTOs, there are essential enablers that are required to capture the potential value of Marine Energy. These include a skilled workforce, grid connection, port infrastructure and facilities, and digital connectivity.
- A skills system approach will be required to ensure there is an adequate workforce and that high value jobs can be retained in the region. This will sit alongside gearing the regional workforce across the RTOs.

Context

8.1 For the purpose of this study, marine energy is defined as energy generated through waves and tidal currents. Offshore wind is a separate RTO. Waves are formed by winds blowing over the surface of the sea and the resultant movement of water carries kinetic energy which can be harnessed by wave energy devices. Tidal stream technologies capture the kinetic energy of the currents flowing in and out of the tidal areas.

8.2 Marine energy has the potential to contribute significantly to the Scottish and UK economies and support substantial employment as well as contribute to a just transition to net zero emissions. It is a relatively nascent sector, much less established than wind energy and so it requires a supportive policy and investment environment to flourish.[163]

8.3 The UK, and Scotland, has significant access to wave and tidal energy given its geographical position and features. Scotland's location on the western fringes of Europe and its unique geography of seaways and firths, exposes it to a combination of intense winds, Atlantic waves, and turbulent tidal currents.[164] The Highlands and Islands has significant coastline, sounds, and firths to capitalise on. The UK has over 11GW of potential tidal stream capacity.[165] Deployment of 6GW of tidal stream and 6GW of wave energy could reduce energy system costs by £1bn per annum.[166] It is estimated that up to 21.5GW of wave and tidal energy could be generated from the waters around Scotland annually and we currently produce c.10% of the total wave energy of Europe.[167]

8.4 Consequently, Scotland is well positioned to capitalise on marine energy economic opportunities. The Highlands and Islands has a particularly outstanding marine environment and contains almost two thirds of the UK's coastline and coastal waters within which there is huge potential for harnessing wave and tidal energy.[168] There are other existing assets and strengths in the region's innovative marine energy business base and research organisations, in particular the European Marine Energy Centre (EMEC) in Orkney.

8.5 Developers and technology producers operating in both wave and tidal energy are keen to enter or continue working in global markets. Aside from Scotland and the UK, the areas with the greatest potential resource and political interest include USA, Canada, France and South-East Asia.

[163] https://cms.ore.catapult.org.uk/wp-content/uploads/2018/11/Tidal-Stream-and-Wave-Energy-Cost-Reduction-and-Industrial-Benefit.pdf
[164] https://www.waveenergyscotland.co.uk/media/1505/policy_and_innovation_group_uk_ocean_energy_review_2023.pdf
[165] https://cms.ore.catapult.org.uk/wp-content/uploads/2022/06/AI-paper-tidal-stream-benefits-to-the-wider-energy-system-v1.12.pdf
[166] https://supergen-ore.net/uploads/resources/Supergen-ORE-Power-System-Benefits-Study-2023_2023-01-30-110556_ygbg.pdf
[167] https://aberdeenrenewables.com/renewable-sectors/wave/
[168] https://www.hie.co.uk/media/13381/the-blue-economy-in-the-highlands-and-islands-report.pdf

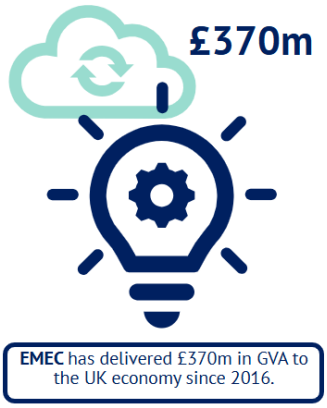
Current project activity

8.6 There is a significant amount of research, development, and testing activity in the Highlands and Islands. There are also active marine energy projects with devices deployed offshore. This section describes some of the key project activity in the marine energy sector but does not include information on all activity in the Highlands and Islands.

8.7 Of the 122MW of tidal energy projects supported by UK government through the last three Contracts for Difference (CfD) rounds (rounds 4, 5 and 6), around 84MW are located in the North of Scotland (59MW at MeyGen and 25MW by three developers at EMEC).

8.8 The European Commission remains a significant funder of marine energy R&D in Scotland. Two of the planned tidal energy array projects at EMEC (Orbital Marine Power and Nova Innovation - totalling 20 devices and 13.6MW capacity) are supported by Horizon Europe funding totalling €40m. Mocean Energy's Blue Horizon wave device has also secured €3.7m of funding via the EuropeWave programme.

8.9 EMEC, the world's leading test and demonstration facility for both wave and tidal technologies, has been at the epicentre of the development of the marine energy sector for over 20 years.[169] More wave and tidal technologies from across the world have been tested under real sea conditions at EMEC than anywhere else. The presence of EMEC within the Highlands and Islands region underlines the opportunity and value of Marine Energy to the regional economy. Since 2016, EMEC has contributed £370m GVA to the UK economy (£263m of that was accrued in Scotland and half of that, £130 million, in the Orkney Islands).[170]



8.10 The MeyGen project, which is the largest planned tidal stream project in the world (up to 398MW) is located at an offshore site between Scotland's north coast and the island of Stroma.[171] The project was awarded a leasing agreement by Crown Estate Scotland (in 2010) and it is split into several stages:

- MeyGen Phase 1: The first phase of the MeyGen project is operational and comprises four 1.5MW turbines (installed in 2018) and has produced over 74GHh to the grid (March 2025);
- MeyGen Phase 2: proposed a further 59MW of capacity for installation in 2027-2029 (awarded CfD's in rounds 4, 5 and 6);
- MeyGen Future Phases: subject to consents and grid availability, potential future build-out to full 398MW site capacity.[172]

8.11 Orkney-based Orbital Marine Power have developed the world's most powerful tidal turbine, the 2.4MW rated O2, currently under test at EMEC's fall of Warness tidal test site. The O2's floating design allows for ease of access/maintenance and capitalises on the increased tidal flows nearer the top of the water column. Orbital has been successful in securing CfD awards for the

[169] https://www.hie.co.uk/our-region/our-growth-sectors/energy/.
[170] https://committees.parliament.uk/writtenevidence/127421/pdf/
[171] https://saerenewables.com/tidal-stream/meygen/
[172] https://saerenewables.com/tidal-stream/meygen/

deployment of further devices at the EMEC site using the fully commercial O2X commercial version of its technology (6 devices/14.4MW in total). It has received a €20m award from the Horizon Europe Programme.

8.12 Nova Innovation (or Nova) is a Scottish tidal energy company that operates the world's first community-scale tidal array project in Bluemull Sound, Shetland. Installed in 2016, it had an initial capacity of 600kW, which increased to 2MW. [173] Nova has also secured CfD awards for its SeaStar and OceanStar array projects (total 6MW) both to be deployed at EMEC. The company also has a Horizon Europe grant award of €20m towards the developments.

Wave Energy Scotland

8.13 Wave Energy Scotland (WES), was established by HIE in 2014 on behalf of Scottish Government to capitalise on the knowledge and Intellectual Property from previous Scottish wave developments and take forward the development of wave technology in a controlled and systematic manner.[174]

8.14 Over the past 10 years, with funding from Scottish Government, the competitive WES Novel Wave Energy Converter programme has produced two large-scale Proof of Concept wave energy devices (Mocean and AWS) which have successfully tested at EMEC. Other complementary WES programmes have produced a suite of innovative subsystems and components with applications across the wider offshore energy sector. In all, WES has funded 132 contracts, committed £50m, and been involved with 300 organisations over 18 countries.[175]

8.15 The European Commission has replicated the WES model of technology development for its own wave energy development pathway. WES was asked to co-ordinate the Horizon 2020-funded EuropeWave programme aimed at deploying wave energy converters at full scale in both Scotland and Spain.

8.16 WES aims to assist the development of technology to provide cost effective, reliable wave energy generation and so contributes to net zero ambitions for clean energy and developing an internationally competitive wave energy industry.[176] WES's competitive programmes are open to innovators from across Europe with Scottish companies accounting for 70%, underlining the importance of Scotland in the wave sector and innovation.[177]

Economic contribution and context

By 2050, global marine energy installed capacity could reach 300GW. This could lead to 680,000 jobs, contribute $340 bn in gross value added (GVA), and prevent over 500 million tonnes of carbon emissions, underlining the sector's potential to drive socio-economic growth and combat climate change.[178]

[173] https://novainnovation.com/
[174] https://www.waveenergyscotland.co.uk/
[175] https://www.waveenergyscotland.co.uk/about/our-impact/
[176] https://www.hie.co.uk/media/13381/the-blue-economy-in-the-highlands-and-islands-report.pdf
[177] Ibid.
[178] https://www.ocean-energy-systems.org/publications/oes-annual-reports/document/oes-annual-report-2022/

8.17 Europe is a key producer of marine energy (despite total MW quantities being comparatively low in comparison to other energy industries such as offshore wind) and the position that Europe and European countries take on marine energy will influence innovation, demand, and supply chain development across the continent. A previous study[179] indicated that a decisive European approach - with the right support, investment, and intervention - to the global marine energy market could see Europe take clear steps to lead the market with an installed capacity of 100GW by 2050, creating over 500,000 jobs in Europe. The potential would be lower under an indecisive approach whereby Europe follows the market, with an estimated 60GW established by 2050, with around 200,000 jobs.

8.18 The Offshore Renewable Energy Catapult's (ORE Catapult) estimates that the tidal stream industry has the potential to support almost 4,000 jobs in the UK by 2030, while wave energy could support more than 8,000 jobs in the UK by 2040.[180] A net cumulative benefit to the UK of £1.4bn from tidal stream and a net positive contribution to the UK economy of £4bn from wave energy is possible overall.[181] These estimates will be impacted by whether or not Europe becomes a market leader in, the relatively, nascent marine energy technology.

8.19 An independent report by the Scottish Marine Energy Industry Working Group, published in 2023, highlights the scale of the opportunity from wave and tidal energy supply chains in the UK with estimated GVA totalling between £4.9 bn and £8.9 bn GVA by 2050.[182] This will be driven by a rising focus on renewable energy and a subsequent increase in investments in Marine Energy research along with growing demand for decarbonised technologies.

8.20 There were approximately 200 wave and tidal associated businesses in Scotland in 2022, however, these businesses are likely operating across several low carbon energy technology types and not solely in marine energy.[183]

8.21 Scenario-based projections indicate there could be a Scottish market for up to 8.8GW of Marine Energy by 2050, with potential deployments of up to 12.6GW throughout the UK and up to 300GW globally.[184] This could deliver up to £8bn to Scotland's economy by 2050, and support more than 15,000 jobs, including high-value employment in coastal communities in the Highlands and Islands. A significant proportion of the Scottish tidal resource is located in the Pentland Firth and Orkney waters which may induce supply chain and employment opportunities for businesses in a range of sectors (including transport, manufacturing, and logistics) located in the Highlands and Islands.[185]

8.22 The marine energy projects and investments identified in this research represent an overall potential investment of around £2.86bn between 2025 and 2040, creating up to 12,580 FTE

[179] *Source: European Technology & Innovation Platform for Ocean Energy (2022)*
[180] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/01/draft-energy-strategy-transition-plan/documents/draft-energy-strategy-transition-plan/draft-energy-strategy-transition-plan/govscot%3Adocument/draft-energy-strategy-transition-plan.pdf
[181] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/12/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/govscot%3Adocument/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero.pdf
[182] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/01/draft-energy-strategy-transition-plan/documents/draft-energy-strategy-transition-plan/draft-energy-strategy-transition-plan/govscot%3Adocument/draft-energy-strategy-transition-plan.pdf
[183] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/
[184] https://www.policyandinnovationedinburgh.org/future-economic-potential-of-tidal-stream-and-wave-energy-in-scotland.html
[185] Ibid.

jobs in construction and development phases. Data on anticipated direct operational and maintenance jobs was not available for all projects and so proxies have been used to give an indication of potential jobs. This suggests there could be at least 70 direct jobs in the region by 2040 associated with these projects.[186] However, this doesn't include wider supply chain impacts, or jobs from other marine energy developments not included within this study. As shown above, once these are considered, the growth potential for the sector overall is significantly higher. Under the status-adjusted scenario, investment from the projects identified in this study is estimate to be around £1.85bn.

Competition

Scottish Marine Energy market could deliver up to

£8bn

to Scotland's economy by 2050 and could support more than

15,000 jobs

8.23 This section examines competition in the marine energy sector overall, however, it is important to note that wave and tidal energy are at different levels of development and deployment so the markets for these technologies are at different stages.

8.24 There is global competition for Scotland and the UK in marine energy from Canada, France, China, Japan, South East Asia and the USA as many governments realise the potential importance of marine energy as a renewable source of energy. It is crucial that the Highlands and Islands develop marine energy technology at a fast pace to maintain or increase market share.[187]

8.25 Europe is a global leader in tidal stream, with a cumulative capacity almost three times as high as the rest of the world combined - 30.5MW vs 10.9MW (in 2023).[188] The USA and China are Europe's main competitors in tidal stream. The USA government has increased its yearly budget for ocean energy for the third year in a row (however there may be a change in strategy due to a new government administration in 2024), bringing the total funding over the last five years to $520M. The Chinese government recently enshrined the 'large-scale deployment of ocean energy' in its five-year plan and its total installed renewable energy capacity (which includes marine energy as a portion) increased significantly from 2022 to 2023 from c.150GW to over 300GW (overtaking the rest of the world's total capacity by over 100GW).[189] This will undoubtedly increase competitive pressure on Europe and the UK in renewable energy generation generally.[190]

8.26 For wave energy, Europe and the rest of the world are similar in terms of cumulative capacity additions – with 13.3MW and 13.1MW respectively.[191] Dedicated funding programmes to boost research, development, and innovation along with new testing infrastructures in both geographies have fast-tracked technological progress and unlocked new deployments which has led to the highest volume of wave energy deployment outside of Europe (since 2019) in 2023. Southern Europe has recently begun to increase wave energy deployment with Portugal, Italy, Spain, and the South of France receiving a cumulative deployed capacity of 690kW within the last year.

[186] See Chapter 3 for definition, methodology, and caveats for project impacts.
[187] https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2023/06/Sustainable-Growth-Opportunities-from-Tidal-Stream-Energy-in-the-UK-.pdf
[188] Ocean Energy Stats and Trends 2023: https://www.oceanenergy-europe.eu/category/publication-library/
[189] https://tethys.pnnl.gov/sites/default/files/publications/Ocean_Wave_Energy_Australia_BECRC_Report.pdf
[190] Ibid.
[191] Ibid.

Drivers of growth

Market drivers

8.27 There are several strong market drivers for marine energy globally, in Scotland, and in the Highlands and Islands and these are very closely aligned to the market drivers for offshore wind described in Chapter 6. Ambitions for net zero and a clean energy generation are arguably the primary market drivers for growth and development of marine energy. Wave and tidal energy can be an important part of the renewable energy mix and help to deliver energy security for the UK in the longer term. Other drivers that impact the market for marine energy include global competitiveness in the marine energy market and UK Marine Energy policy.

8.28 Decarbonisation of the energy generation industry is arguably the primary driver for growth and development of renewable marine energy including wave and tidal. As countries, industries, and organisations pursue net zero ambitions, securing renewable energy generation is critical.

8.29 Competitiveness in the sector will also likely drive forward the market through research, development, and ultimately growth as the sector matures. The consultations confirmed that there is proven technology in the wave energy industry, and it is important for the Highlands and Islands to commercialise this and scale up the sector. Scotland is a leader in wave energy, and it is important that we capitalise on this and stay ahead of the competition from Europe and globally, capitalising on 'first mover advantage'.

8.30 Scotland is well-placed to lead the development of both wave and tidal energy, having a significant marine resource, world-leading research facilities, strong innovation activity in related technologies, and transferable capabilities from our established offshore wind and oil and gas sectors. Demonstrating Scotland's leader status, the expertise developed in Scotland has the potential to support the sector's growth in the rest of the UK. However, the future of the marine energy industry will be heavily impacted by policy around leasing.

Innovation drivers

8.31 Innovation in wave and tidal energy is driven by several factors that aim to make these renewable energy sources more efficient, reliable, and commercially viable. The Highlands and Islands already has a great deal of wave and tidal activity with a particular focus in Orkney. There is an opportunity to establish this emerging cluster more formally as a high growth marine energy cluster.

8.32 Cost reduction is a key driver of innovation to make it a cost-effective energy source within the overall energy system. As the industry matures, fine tuning of technology and large-scale deployments of wave and tidal energy systems are expected to reduce costs through economies of scale. Manufacturers and developers are applying the learning from earlier installations to streamline production and deployment and drive down costs. The design of modular, scalable, and pre-fabricated components is helping to reduce both the capital and operational expenditure (OpEx) associated with wave and tidal energy technologies and these refinements are continuing.

8.33 In developing the supply chain for wave and tidal energy, there will be new opportunities for existing and new businesses in the Highlands and Islands to meet need and

demand through innovation and entrepreneurialism. There are also opportunities to achieve synergies, through innovation, across other sectors and RTOs. For example, offshore wind and wave energy co-location may allow for some shared infrastructure and economic benefits such as increased innovation, R&D collaboration, and upskilling for local populations in renewable technology practices. Evidence suggests that scenarios where assets are shared reduces the cost of energy by significant amounts for both offshore wind and wave energy.[192]

8.34 Data collection and monitoring is an important area of innovation in marine energy. Advanced sensors and monitoring systems are important in gathering real-time data from wave and tidal sites and these technologies have improved significantly. This data helps optimise the design and operational performance of energy conversion systems, as well as predict energy production more accurately.

8.35 Innovations in energy storage systems, such as batteries and pumped storage hydro, are also helping address the intermittency issues with renewable energy sources, making tidal and wave energy more reliable as a consistent power source.

Constraints, challenges, and market failures

8.36 Wave and tidal energy in the Highlands and Islands individually and combined have enormous potential but face some challenges to development and growth. This study has highlighted that there is a great deal of research and innovation in the region which is of course vital to capturing value. The next step must be to commercialise these technologies in Scottish waters. A lack of government market incentive (until recently), high installation costs, technological challenges, and environmental concerns have slowed their adoption and may continue to do so, but ongoing innovations are addressing these barriers. Other possible challenges, constraints, to growth and market failures in the sector include there being no MW generation targets, possible skills shortages, grid connection, and sequencing of activity and development.

8.37 There is a strong argument for ensuring that wave and tidal energy, along with offshore wind, are front and centre of clean energy generation. Recognising this, in the consultations, it was stated that there is an ambition for the first energy generating wave array to be in place in Scottish waters by 2030. Whilst costs are reducing and efficiencies are being realised, wave and tidal energy still requires more demonstration projects and development to work towards cost reductions and commercial viability. There is therefore a continuing need for investment and capacity to prove their feasibility and to share the risk across a wider range of stakeholders. Risk is a major challenge, as risk appetite is typically lower further down the supply chain, acting as a barrier to new sector entrants.

8.38 There has been no MW target set by the Scottish Government for marine energy and there is a lack of visibility of marine energy in the Scottish Government's Green Industrial Strategy. This will negatively impact the route to market for companies and investors.[193] There is, however, an ambition to test up to four wave energy convertors (250 kW each) at EMEC by 2027. Lack of a timebound target could be interpreted as there being less interest and policy commitment than there is for offshore wind (which has clear targets of 11GW by 2030 for example). Targets are

[192] https://www.waveenergyscotland.co.uk/media/1471/o-lo-r10-031956-r02-final-report.pdf
[193] https://www.climatexchange.org.uk/projects/economic-opportunities-in-scotlands-net-zero-and-climate-adaptation-economy/

useful for driving progress and without one, there is possibly less of an incentive for key actors in the public and private sectors to develop wave and tidal energy at pace.

8.39 There are challenges around integrating low-carbon technologies into the existing UK generation system (given decentralisation and intermittency of generation). Compounding this, transporting it to use on the national grid is not always feasible. Though existing tidal energy arrays are typically directly connected to the national grid, some new sites and technologies will be too remote or too expensive and difficult to connect directly if we move to dual scale, commercial generation. However, grid upgrades are costly, and this is compounded by lengthy and complex consenting processes, long waiting times, and the current high levelised cost of energy (LCOE)[194] for renewable energy.[195] However if Scotland is to realise the value of wave and tidal energies then the challenges presented by the grid infrastructure must be addressed. This is acknowledged and some progress has been made on this with SSEN's Pathway to 2030 projects.[196]

8.40 There is, of course, potential for off-grid applications and green hydrogen production from wave and tidal devices is a potential solution for energy capture, storage, and transportation. At the same time developments in hydrogen production is also driving the need for higher volumes of renewable generation. There are examples of green hydrogen being used as a method of marine energy capture and transport in the Highlands and Islands but these are typically small scale.[197] This is explored in more detail in Chapter 7.

8.41 As with other renewable energies, such as offshore wind, anticipated longer-term shortages in key skill areas and competition from other sectors may pose challenges for sustained growth. Skills gap challenges in STEM and data science are possible whilst the Highlands and Islands faces challenges in attracting talent and reskilling its population to pivot to marine energy.

8.42 With so much activity in marine energy, and with its complexity in terms of what needs to happen and what needs to be in place, for example mechanisms for taking energy to the grid, there is a need for clear, consistent, and shared information and knowledge to help plan and sequence activity. This is also true for offshore wind. Investors in energy projects and the supply chain will aim to mitigate risk and look for confirmed and accurate information of when, for example, consents will be in place, ports will be able to service construction and maintenance, and the skills will be available. Education providers need to know what skills will be demanded, and when, to plan provision for the right time. And at the individual level, residents of the Highlands and Islands may be reluctant to undertake skills and training for particular roles until they know the opportunity is confirmed.

Priorities for action

- Tidal energy should continue to be ring fenced in future Contracts for Difference rounds, with consideration given to a small ring-fence for wave energy. In this way, CfD will support the deployment of relatively established technologies at scale, unlock cost reductions from economies of scale and volume, allow for technological refinements, and deliver savings on the cost of capital. However, this should not be to the detriment of continuation in innovating and commercialising newer wave and tidal technologies.

[194] LCOE is a metric that measures the average cost of electricity generation over an energy asset's lifetime.
[195] Ibid.
[196] https://www.ssen-transmission.co.uk/information-centre/RIIO-T3
[197] https://www.surfnturf.org.uk/

- There is a need for a systems approach to the development, generation, and transport of energy in the UK comprising the range of renewable energy types on land and at sea. Planning for a mix of renewable energy types reduces the risk of the adverse effects of fluctuations in supply or costs.
- Decision makers should consider applying the principles of low regrets decisions, so take short term, cost effective and urgent decisions now that will have a significant and long-term impact. This will unlock pathways to enable marine energy to contribute fully to net zero ambitions. This would mean that decisions can be taken now that will have high value impacts in the future but may be costly at the time.
- Industry and partners should examine what potential synergies can be achieved at various stages of construction and operations and maintenance to achieve efficiencies, reduce cost, and de-risk investment. Synergies will include collaboration and cooperation in the development and use of AI and data across marine-based sectors.
- Co-location of activities from different sectors and industries would help to use the marine space to best effect and opportunities should be explored with industry, research organisations and other relevant partners.
- The Highlands and Islands should pursue wave and tidal energy that is underpinned by a strong local supply chain and maximises the sustainable growth opportunities. This would require rapidly building supply chain capacity and de-risking, catalysing, and then supporting supply chain development through policy and practice.
- Skills planning based on clear evidence of need will be crucial to fuel growth and for local people to benefit from the jobs that will be available.
- There will be valuable Community Wealth Building opportunities in the supply chain and there should be mechanisms to raise awareness and capture the value for the region and in local areas.
- Consideration should be given as to the viability of alternative off-take routes for tidal energy. This would facilitate small industry and community-owned tidal energy generation and so provide power to local industry and domestic users.
- Marine energy is an international marketplace with enormous opportunities to attract inward investment and export expertise, technologies, and energy. The Highlands and Islands should be positioned at the forefront of technological development to export complex and high value products, technologies, and expertise as well as attracting talent and investment.
- Government should be encouraged to state its ambitions for wave and tidal energy and consider capacity targets in gigawatt. This would help to drive progress and private sector investment into the supply chain as well as focus public sector support and investment. These targets would be tailored to each of wave and tidal stream technologies recognising that they are at different stages of development. But all policy, targets and activities should be designed to progress towards commercialisation.

9 Space

Headlines

- The global space industry is estimated to be valued at c.$1.8 trillion by 2035.
- The geography and economic conditions of the Highlands and Islands make it well suited to offer orbital, and sub-orbital launches, and associated supply chain activity.
- There are already multiple spaceports in development across the region, with plans to host the UK's first vertical orbital launch from SaxaVord in Shetland in 2025, pending regulatory approvals.
- Space RTO projects and investments identified in this study represent an overall potential investment of around £84.3m across the region over the period 2025 to 2040. This is estimated to create around 690 FTE jobs in development and construction phases and up to 150 direct operational and maintenance jobs, should all projects progress as planned.
- Scotland has a strong base for the manufacture and innovation of space technology including companies such as Orbex, based in Moray – Scotland's most prominent launch vehicle developer.
- The University of the Highlands and Islands, alongside institutions in Glasgow, Edinburgh and Strathclyde, provide a research and training base in space engineering and data analytics.
- There is strong potential for collaboration with European and international companies for Scotland to offer launch options, such as the current partnership between Rocket Factory Augsburg and the SaxaVord Spaceport.
- Accelerating the development and market readiness of launch sites in the region is a key priority to secure potential impacts and a segment of this growing market, in which the region has a competitive advantage.

Context

9.1 The Space industry covers a range of activities from satellite design and manufacturing, to launch services, data analytics and downstream applications. The global space industry is undergoing rapid transformation, driven by technological innovation, commercial demand for small satellite services, and shifting geopolitical dynamics. While much of this activity is concentrated in a small number of global hubs, the Highlands and Islands has a distinct set of geographical, infrastructural, and industrial attributes that position the region as a strategic location for orbital and sub-orbital launch capability, as well as associated supply chain activity.

9.2 Scotland's space sector is one of the fastest growing in the UK, and while satellite construction activity is concentrated in the central belt, the Highlands and Islands have emerged as a focal point for launch infrastructure. The primary focus within the region is on vertical and sub-orbital launch infrastructure, small satellite support services, and some research and development activity linked to broader UK supply chains. With several sites under development and a growing ecosystem of companies, research institutions, and facilities, the region has the potential to play a meaningful role in the UK's ambitions in space.

9.3 There is a supportive national and regional policy environment for the Space sector in Scotland, and the Highlands and Islands. The Scottish Government's Strategy for Space in Scotland[198] and the UK Government's National Space Strategy[199] set ambitious targets for economic contribution, workforce growth, and international collaboration. However, realising these ambitions in the Highlands and Islands will depend on addressing structural and capacity-related challenges, including infrastructure, investment, planning, and workforce development. A brief analysis of relevant policy documents is provided at Annex A2, Table A2.4.

Current project activity

9.4 Investment project activity in Space is typically located near coastline. Northern coastal and island locations provide clear downrange paths for vertical and sub-orbital launches, which is increasingly rare in densely populated or geopolitically constrained areas of Europe. This gives Scottish spaceports a natural advantage for low Earth orbit (LEO) missions.

9.5 The Highlands and Islands hold a number of comparative advantages in the emerging UK launch sector. These include geographic suitability for polar and sun-synchronous orbits, low population density for safety assurance, and established landholdings with prior aerospace or defence uses. There is a cluster of emerging spaceports across the region - SaxaVord, Spaceport 1, Sutherland and Machrihanish – each targeting different parts of the launch market. Together they offer a diversified base from which to serve commercial, scientific, and potentially defence-related missions.

9.6 SaxaVord Spaceport in Unst, Shetland is currently the most advanced vertical launch site in the UK. It is designed to support the launch of small payloads into low Earth orbit. It has already seen significant private investment. Rocket Factory Augsberg (RFA) have exclusive use of one launch pad, and Orbex another. Plans remain to host the UK's first vertical orbital launch in 2025, pending regulatory approvals.

9.7 Spaceport Sutherland received planning permission in November 2020. In November 2022, Orbex was announced as the lead developer and operator, with ambitions to offer low-carbon launches using its Orbex Prime micro-launcher.[200] However, in late 2024, construction was paused due to financial pressures and a strategic shift towards launching from SaxaVord. Orbex retains the site lease for Spaceport Sutherland, and the potential for future activation remains.

9.8 Spaceport 1 is a sub-orbital launch facility currently under construction in Scolpaig, North Uist. It is intended to support small- to medium-scale launch operations. Initial planning permissions was secured in 2023, with enabling works starting in late 2024. Procurement is underway to secure a delivery partner for full site operations and first lift-offs may be possible by Autumn 2025.[201] Projections from early economic modelling suggest a significant initial economic impact and there is potential to further scale over time, particularly if services diversify into testing, research and payload integration.

[198] https://spacescotland.org/wp-content/uploads/2023/11/a_strategy_for_space_in_scotland.pdf
[199] https://www.gov.uk/government/publications/national-space-strategy
[200] https://orbex.space/launch-services/launch-site
[201] Construction work begins at Spaceport 1 in North Uist | HIE

9.9 Machrihanish Spaceport in Campbelltown in Argyll, is located on a decommissioned miliary airbase. It aims to support horizontal launch technologies and aerospace testing.[202] The site includes Scotland's longest airport runway and has seen incremental development since 2021, including engine testing, cryogenics research and small rocketry.[203] It has the potential to evolve into a multi-purpose aerospace hub if investment and operator interest can be secured.

9.10 In July 2024, The UK Space Agency announced £10.9m in funding for two Scottish space projects and three Scottish kick-starter projects through the National Space Innovation Programme (NSIP).[204] This included the Sustainable Hybrid Accelerated Rocket Programme (SHARP), a partnership between HyImpulse, Cranfield University, Birmingham University and the AVICON Partnership, which received £5m to conduct a vertical launch of a sounding rocket with a view to constructing and testing an orbital rocket. The funding will allow the HyImpulse rocket to be launched from the SaxaVord Spaceport in Shetland.[205]

9.11 There are also a number of assets for the sector in the Highlands and Islands. This includes Orbex, headquartered in Forres, Moray, Scotland's most prominent launch vehicle developer. It is advancing proprietary micro-launch technology aimed at small satellite markets and maintains a strong focus on low-carbon propulsion. Aurora Avionics also contribute to upstream manufacturing and avionics design, offering scope to deepen the local supply chain.

9.12 The University of the Highlands and Islands, alongside institutions in Glasgow, Edinburgh and Strathclyde, provide a research and training base in space engineering and data analytics. While challenges remain in building a critical mass of skilled workers in the Highlands and Islands specifically, this academic infrastructure offers a platform to scale from.

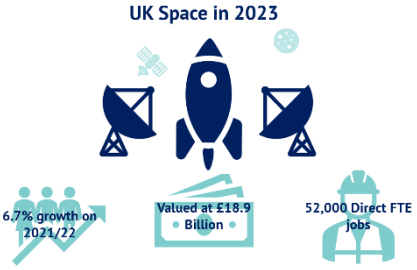
Economic contribution and context

9.13 The global space economy was estimated to be $630bn in 2023, with backbone applications, and reach applications both anticipated to grow at twice the rate of global GDP over the next decade.[206] The global space launch industry was estimated at $14.94bn in 2023, and is anticipated to grow at a rate of 14.6% until 2030.[207] This is faster than future projected growth of the space industry as a whole (11%)[208] making it one of the fastest growing areas of the industry. Key drivers of growth for the sector include commercial investments in satellite services, data analytics, and emerging sectors such as on-orbit servicing and space tourism.

9.14 The Space Foundation have highlighted the accelerating growth of the global small satellite launch segment, with a 15% increase in the number of small satellites placed into orbit in 2024.[209] These gains stem from the widespread adoption of miniaturised payload technologies, lower-cost rideshare offerings, and heightened demand for high-resolution Earth imaging and broadband services.

[203] https://assets.publishing.service.gov.uk/media/643e6a4222ef3b000c66f3d1/Spaceport_brochure_17.4.23.pdf
[204] https://www.gov.uk/government/news/109-million-boost-for-scottish-space-sector
[205] https://europeanspaceflight.com/hyimpulse-awarded-5m-in-uksa-funding-for-sr75-launch/
[206] https://www3.weforum.org/docs/WEF_Space_2024.pdf
[207] https://www.grandviewresearch.com/industry-analysis/space-launch-services-market-report
[208] https://www.strategyand.pwc.com/uk/en/reports/expanding-frontiers-down-to-earth-guide-to-investing-in-space.pdf
[209] https://www.spacefoundation.org/2025/01/21/the-space-report-2024-q4/

9.15 The UK's space sector was valued at over £18.9bn in 2023, employing over 52,000 FTEs. This represents a 6.7% increase from 2020/21.[210] The fast-growing orbital satellite launch market in the Highlands and Islands is a significant factor in this[211] with the North Coast Space Cluster anticipated to create the conditions to enable up to 740 jobs in the region by 2030.[212]



9.16 The space sector RTO projects and investments identified in this study represent an overall potential investment of around £84.3m across the region over the period 2025 to 2040. Should all projects progress as planned, this is estimated to create around 690 FTE jobs in development and construction phases and up to 150 direct operational and maintenance jobs. Even under the status-adjusted scenario, investment is anticipated to be around £72.5m.

Competition

9.17 The global space sector is rapidly evolving, with increasing commercialisation, private capital investment, and national strategic interest from established and emerging spacefaring nations. For the Highlands and Islands, global competition presents both risks and opportunities.

9.18 There are over 50 governments in the world with space budgets, with nine of them being worth over $1bn, and 20 of them worth around $20m.[213] In terms of the private sector, 77% of global space industry value in 2022 ($361bn) was contributed by the commercial market, with $47bn[214] in investment in over 600 companies[215] since 2015, growing at an average annual rate of 21%.

9.19 The US and China dominate the global space launch market in terms of both volume and technology development. The US private sector (e.g. SpaceX, Blue Origin) has pioneered reusable launch systems and high-frequency launch capability, supported by large-scale federal contracts. China specialises in space literature dataset and space-related patent applications, second only to the US in both of these, and has received support mainly from the UK and Germany across a range of space-related official development assistance projects.[216]

9.20 Historically, a significant proportion of European satellites were launched from Russia due to cost and reliability, and in recent years, over a quarter of UK and European satellites have been launched from Russia.[217] However, the geopolitical fallout from the war in Ukraine has closed off this option for many Western governments and commercial providers. This opens up a strategic market gap for alternative launch locations, including Scotland, and the Highlands and Islands, if they can become operational at pace.

[210] https://www.gov.uk/government/publications/the-size-and-health-of-the-uk-space-industry-2023/size-and-health-of-the-uk-space-industry-2023#income
[211] https://www.gov.uk/government/news/scotlands-space-sector-key-to-uk-ambitions
[212] https://sa.catapult.org.uk/cluster/north-coast-space-cluster-2/
[213] https://www.hie.co.uk/media/10475/space-launch-market-analysis-2021.pdf
[214] https://www.spacefoundation.org/2022/07/27/the-space-report-2022-q2/
[215] https://www.strategyand.pwc.com/uk/en/reports/expanding-frontiers-down-to-earth-guide-to-investing-in-space.pdf
[216] https://www.oecd-ilibrary.org/docserver/c5996201-en.pdf?expires=1725528673&id=id&accname=guest&checksum=723E51D5DFCDA0B0DDF06F7035DE6BFA
[217] https://www.thebank.scot/sites/default/files/2022-11/space_compressed.pdf

9.21 Europe currently lacks a dedicated small satellite launch site with high cadence[218], providing Scotland with an opportunity to fill this gap. Norway operates successful sub-orbital launch sites and is developing new orbital capacity.[219] Norwegian companies are also international competitors in space technology innovation, with research and development company SINTEF designing the Analysing Interferometer for Ambient Air (ANITA2) system, used in the International Space Station, which monitors the atmosphere to ensure survivable conditions.[220] Other European nations such as Germany and France have strong space manufacturing and R&D capabilities but are constrained by denser populations and less suitable launch geographies. Scotland's advantage lies not in scale, but in its ability to offer safe, flexible, and sovereign launch capability.

9.22 Emerging players such as India, South Korea, and Australia are investing in spaceports and small satellite services. While these are not direct competitors for Scotland in the short term, they underscore the global acceleration of space activity and the need for speed, agility, and clarity of purpose in Scottish developments.

Drivers of growth

9.23 There are a number of interrelated factors driving the growth of the space sector globally and in the region. These include technological, commercial, regulatory and geopolitical dynamics that create both demand and enabling conditions for the region to develop and expand its space economy.

9.24 The UK's exit from the European Union means the UK is no longer subject to the same legislation as other EU countries, and this offers an opportunity to increase the attractiveness of the UK for space launches.[221] As noted above, the ongoing conflict between Russia and Ukraine, and associated political conflict, means that many European satellites previously launching from Russian soil, now require an alternative launch site.[222] This leaves a substantial service gap that European spaceports, including those in Scotland, are seeking to fill.

9.25 The global small satellite market is growing significantly, driven by demand for earth observation, telecommunication and data services. In 2024, there was an estimated 15% increase in the number of small satellites placed into orbit.[223] The ability to launch small payloads from sovereign European soils is also of growing strategic importance for civil, commercial and defence actors. Given there is currently no European spaceport which consistently launches small satellites,[224] this is a gap in the international market which Scotland can occupy, particularly through Orbex and SaxaVord, if operational capacity is achieved soon. SaxaVord has a statutory planning limit of 30 vertical launches per year, and the region's capacity will increase as other Scottish spaceports become operational. Orbex has plans to develop its current site in Forres, to support its expanding operations with future plans to expand into medium sized satellites. This will support with its ambition of offering the Scottish and UK space markets a medium sized launch operator who will be able to compete in the European market.

[218] https://www.hie.co.uk/media/10475/space-launch-market-analysis-2021.pdf
[219] https://europeanspaceflight.com/norways-andoya-spaceport-receives-launch-site-operator-license
[220] https://www.sintef.no/en/projects/2016/anita
[221] Ibid
[222] https://www.thebank.scot/sites/default/files/2022-11/space_compressed.pdf
[223] https://www.spacefoundation.org/2025/01/21/the-space-report-2024-q4/
[224] https://www.hie.co.uk/media/10475/space-launch-market-analysis-2021.pdf

9.26 SaxaVord's relationship with Rocket Factory Augsburg and Orbex's past collaboration with a US-based spaceport in Virginia demonstrate the international interest in Scottish launch capacity. There is further potential to build bilateral partnerships with agencies and firms seeking resilient, European-based launch options.

9.27 Reusable launch vehicles, low-carbon fuel and more diverse launch types are reducing the cost of space technology and increasing access for more companies and stakeholders. For example, the European Space Agency's Small Spacecraft Mission Service dispenser allows a 'rideshare' style cubesat launch, sending in excess of 50 satellites into orbit from one launch.[225] For space launches of large rockets and satellites fully reusable equipment is currently much harder to achieve, and companies such as Space X are predominantly using partially reusable rockets.[226]

9.28 In September 2024, the European Space Agency called on companies to prioritise the development of disruptive satellite propulsion systems that are capable of deorbiting cubesats and are offering funding to facilitate it.[227] This will create further opportunities for cubesat launches from Scottish spaceports during testing, and if this technology becomes readily available, will further reduce the cost of launch and make this more accessible. As well as the implementation of de-launchers, cubesat fuel is also going through innovation. Scotland's Space Strategy sets out the ambition that Scotland can become a global leader in all areas of the cubesat industry, design, manufacture, and management of small satellites.[228]

9.29 Satellite technology is now used across multiple sectors, including climate monitoring, agriculture, insurance, maritime surveillance and logistics. For example, the ability to process satellite captured images before transmission to the ground means that companies such as insurance businesses can use it for weather mapping. Environmental organisations can also use the technology to track and predict methane leaks. The technology can also support better measurement and prediction of weather conditions, allowing the Met Office to produce more reliable and accurate reports. These applications create sustained demand for launch services, especially for constellations of small and nanosatellites requiring flexible launch options.

9.30 National and regional policy supports expansion of the space sector through strategies, skills investment and direct funding (e.g. the UKSA National Space Innovation Programme). While there is a need for greater coordination across agencies, the strategic intent is clear, and funding channels are available for credible, shovel-ready projects. The Scottish Government's 'Strategy for Space in Scotland' targets an annual contribution to the Scottish economy from the space industry of £4bn, including a fivefold increase in the Scottish space workforce by 2030[229]. It also prioritises partnerships between domestic and international organisations and space organisations to support the enhancement of international trade opportunities.

9.31 There is a strong academic base for space research and innovation in Scotland, with the University of Edinburgh, and the University of Strathclyde both having high profile space departments, and the University of the Highlands and Islands also providing a research and training base in space engineering and data analytics.

[225] https://www.esa.int/Enabling_Support/Space_Transportation/Rideshare_service_for_light_satellites_to_launch_on_Vega
[226] https://www.kdcresource.com/insights-events/the-rise-of-reusable-rockets-transforming-the-economics-of-space-travel/
[227] https://europeanspaceflight.com/esa-seeks-novel-propulsion-solutions-for-cubesat-deorbiting/
[228] https://spacescotland.org/wp-content/uploads/2023/11/a_strategy_for_space_in_scotland.pdf
[229] https://spacescotland.org/wp-content/uploads/2023/11/a_strategy_for_space_in_scotland.pdf

9.32 Being first to successfully deliver vertical orbital launch from UK soil carries reputational, political, and economic benefits. This milestone would raise the international profile of Scotland and the Highlands and Islands, strengthening the case for inward investment and talent attraction.

Challenges, constraints, and market failures

9.33 Despite the profile of the Scottish space sector, it is comprised of few companies and the failure of one or more of these could have a significant and disproportionate impact on the sector as a whole.[230] Some stakeholders have also voiced concerns surrounding the representation of Scottish voices in the UKSA, potentially resulting in a lack of Scottish presence in the governance of the space industry in Scotland.

9.34 Further, whilst some support services for the space sector are local, much of the sector's supply chain is not domestic, and so a considerable proportion of the value chain exists outside of Scotland. However, industry actors anticipate that as the space sector in the region develops, so will the local content of the supply chain.

9.35 There is a lack of diversity in funding sources for space start-ups and existing companies in Scotland. While the Scottish Government provides funding to start-ups where possible, there is not enough for all to grow and thrive.[231] This makes collaboration and investment with wider UK and international companies all the more important, to support Scottish companies to break into the market.

9.36 Geographical remoteness, planning constraints, and public opposition can cause delays and other issues with developments, impacting on smooth progression to operational phase for intended launch facilities.

9.37 Finding staff with the relevant skills to work in the space industry will likely be a significant challenge. The Scottish Government's National Strategy for Economic Transformation prioritises ensuring there is a highly skilled workforce sufficient to grow businesses and start-ups. Initiatives such as targeted skills investment and providing more upskilling and reskilling opportunities will help develop the skills required to support space organisations.

Priorities for action

9.38 The Highlands and Islands has a competitive advantage in space, and the specific segments of sub-orbital launches, and small/nano satellites. To maximise the opportunity for the region's space sector, a number of priorities are recommended.

- Ensuring that launch facilities currently under development are market ready as quickly as possible, working with National Space bodies to ensure that capital and technical assistance are made available to spaceports to move from development to operational status. Developing an operational readiness framework to align launch providers, site operators and regulators would also support this.

[230] https://londoneconomics.co.uk/wp-content/uploads/2020/05/LE-SE-Scottish-Space-Cluster-EXECUTIVE-SUMMARY-FINAL-Issue-4-S2C110520.pdf
[231] https://www.caithnesschamber.com/what-we-do/contracts-funded-projects/north-highland-and-moray-space-cluster-strategy/

- There is a need to stimulate the development of the space sector to enable it to grow sufficiently by broadening and strengthening the regional space ecosystem and supporting supply chain development. Funding innovation hubs or clusters in proximity to spaceports to attract SMEs and start-ups in the space supply and exploring collocated uses such as renewable energy, data processing and drone testing to build multi-use viability for spaceport sites are key actions.
- Expanding access to funding is also critical, particularly for early-stage space businesses, for example through blended finance models, government-backed loan guarantees, or regional investment funds. Attracting inward investors through targeted propositions that highlight Scotland's launch capability and regulator autonomy is also key.
- There is a need to develop medium-lift and scalable launch capability, supporting the progression of launch vehicle development beyond micro-launch. Alignment of UK and Scottish government polices is key here to provide clear market signals to enable growth. Alignment of site development plans with projected demand for lager payloads, including infrastructure, logistics and transport links is also required.
- Supporting workforce development and talent attraction and retention for example through expanding access to STEM training in the region and creating partnerships between space companies and local schools/colleges to build early interest in space careers. Embedding space-related modules into UHI programmes and expanding graduate-level apprenticeships in relevant fields would also help address skills challenges.
- Internal competition between spaceport developments must be managed, so that it does not negatively impact on the Space sector's development. Establishing strategic partnerships with international launch operators, governments and space agencies to promote joint missions and technology exchange and positioning the region as a trusted European location for launch an associated services would also help promote international connectivity.
- As with a number of other RTO sectors, social license to operate is critical. There is a need to proactively engage with communities and interest groups to increase understanding of Spaceport developments, their potential socio-economic benefits, and how any environmental impacts will be mitigated.
- Establishing a national or regional coordination mechanism for spaceport development to aligning scheduling, investment and marketing and promoting shared infrastructure and services to reduce costs and increase interoperability will help prevent internal market fragmentation.

10 Marine biotechnology and processing

Headlines

- The Highlands and Islands is rich in biomass from marine and terrestrial sources. Biomass is an important feedstock to scale marine biotechnology applications and include both farmed and harvested feedstocks as well as by-products or waste products of both these processes. In the marine environment biomass from fish, shellfish and algae can be used in a range of industrial biotechnology applications.
- The global market for marine biotechnology is growing at a considerable annual rate, with a range of market segments and potential applications for marine biotechnology and processing that companies in the region can seek to exploit.
- The Highlands and Islands region has a vast and under-used natural resource in seaweed and microalgae, putting it in a strong competitive position and there is longstanding recognition of the significant social, economic and environmental value which can be gleaned from the region's marine resource.
- The drive for net zero and a circular economy is producing a strong demand for low carbon, sustainable materials and products. Marine biotechnology can provide solutions such as bio-based plastics that reduce the need for fossil fuel production.
- The region has world leading science assets in the Scottish Association for Marine Science and the cluster developing around the European Marine Science Park in Oban. Inverness Campus is also home to the University of the Highlands and Islands (UHI) and Scotland's Rural College (SRUC).
- A complex policy and regulatory framework, coupled with a moratorium on the harvesting of certain kelp species for commercial purposes and lack of social license to operate have constrained the development of the marine biotechnology and processing sector.
- Marine biotechnology and processing remains a relatively nascent sector in the Highlands and Islands, albeit with strong growth potential. The RTO projects identified through this study estimate a total potential investment value of over £39m in the region over the period 2025 to 2040.

Context

10.1 'Biotechnology or industrial biotechnology uses plant-based and waste resources (biomass), and/or bio-based process to create chemicals, materials, consumer products, novel foods and feed and medicines'.[232] Bioprocessing is closely related to biotechnology and focuses on the conversion of raw materials into products using biological processes. Marine biotechnology is the application of any type of marine resource in a commercial biotechnology application, primarily marine micro-organisms (such as algae and bacteria) and macro-algae (e.g., seaweeds), and is the focus of this chapter.

[232] National Plan for Industrial Biotechnology – IBioIC

10.2 Marine biotechnology applications are in, for example, human health and pharmaceuticals, food supplements, cosmetics, alternative to plastics and biomass (energy). It has the potential to contribute significant economic impacts to the UK economy but remains on the cusp of large-scale commercialisation. The Highlands and Islands is rich in marine biomass from fish, shellfish and seaweed produced by a mixture of capture fisheries and aquaculture and marine biotechnology activities have strong heritage in the Highlands and Islands for example, in the form of seaweed harvesting.

10.3 Seaweed has been used industrially in the region for centuries, from burning it for potash, to using collected seaweed for high quality foodstuffs, soaps and as a botanical ingredient in gin, and a growth product in food and drink. The Highlands and Islands region has a vast and under-used natural resource in seaweed and microalgae. These are particularly abundant in three Marine Scotland Atlas regions: West of the Outer Hebrides, the Minch and Inner Hebrides, and the north coast of Orkney.[233] Harvesting and cultivation of seaweed is a huge opportunity for the region, not just for the inherent value of the product, but for what it can unlock for Scotland in terms of its marine biotechnology applications.

10.4 The global drive towards net zero is rapidly increasing demand for solutions to decarbonise our economy and supply chains. The application of industrial biotechnology can provide solutions both for low carbon energy production as well as materials and products that replace resource-intensive products such as packaging. The by-products from existing biomass sectors provide huge potential for valorisation through industrial biotechnology, creating a circular economy. The Highlands and Islands region could offer sustainable, large-scale production of biomass from marine and terrestrial sources. An important puzzle piece in scaling up bio-based products and materials.

10.5 The policy and regulatory framework for marine biotechnology and processing is complex with several key policies and strategies at national and regional levels of relevance including Scotland's National Marine Plan[234], and the Marine Science and Innovation Strategy.[235] In addition, a portfolio of national and regional marine plans govern activity on the seabed. More broadly, the National Plan for Industrial Biotechnology sets out the priority actions needed to accelerate growth of the prospering industrial biotechnology industry in Scotland.[236] In addition, the UK Biomass Strategy[237] sets out the potential role biomass can play in decarbonising the UK economy by providing a green energy source or alternative bio-based material. Key policy and strategy documents of relevance to the sector are outlined in table A2.5.

10.6 In accordance with the Scottish Crown Estate Act 2019, there are currently restrictions on the harvesting of certain wild kelp plants from the seabed for commercial use, or if it would inhibit the regrowth of the individual plant.[238] Harvesting cultivated seaweed is currently allowed, however this makes it more challenging for Scotland to compete on the international market.

[233] Seaweed harvesting and cultivation | Scotland's Marine Assessment 2020
[234] https://www.gov.scot/publications/scotlands-national-marine-plan/
[235] https://www.gov.scot/publications/marine-science-innovation-strategy/
[236] National Plan for Industrial Biotechnology — IBioIC
[237] Biomass Strategy 2023 - GOV.UK
[238] Wild kelp - restrictions on removal: questions and answers - gov.scot

Current project activity

10.7 There is a range of current assets and activities in relation to marine biotechnology and processing within the Highlands and Islands, as outlined below.

10.8 The European Marine Science Park (EMSP) near Oban focuses on marine science companies and is located next to the Scottish Association for Marine Science (SAMS). It is home to a cluster of marine biotechnology companies such as Oceanium and Lallemand Aquapharm, both developing new and novel compound from the active ingredients in marine feedstocks. Highlands and Islands Enterprise offers office and laboratory space to marine businesses in Malin House, located in the science park, and from late 2025 a new £8 million building, Camas House, will provide further business units.

10.9 SAMS includes expertise and facilities for algal cultivation both in macroalgae, through the Seaweed Nursery and Seaweed Academy, and microalgae via the Culture Collection for Algae and Protozoa (CCAP) - Europe's largest culture collection of living strains from marine, freshwater and terrestrial and environments. SAMS have also developed the Algal Research, Innovation and Environmental Science Centre (ARIES) which has capacity to grow and harvest hundreds of litres of cultures and carry out metabolomic and genomic analyses.

10.10 Inverness Campus offers co-working spaces and land for purpose-built facilities for those operating in technology, life sciences, renewables, space and advanced manufacturing sectors. It is home to UHI Inverness and Scotland's Rural College (SRUC). It is part of the Inverness and Cromarty Firth Green Freeport (ICFGFP) which aims to support renewable energy development and innovation in life sciences.

10.11 Outside the region, the Industrial Biotechnology Innovation Centre (IBioIC) supports businesses to innovate and apply industrial biotechnology into their supply chain. They offer Scottish businesses access to state-of-art facilities to test their bio-processing activities and scale-up projects. They also host the Scottish Bioresource Mapping Tool[239] which maps raw material and bioresource arisings across Scotland. The University of Stirling's Institute of Aquaculture is also a key asset to the sector, with their Marine Environmental Research Laboratory (MERL) located in Argyll.

10.12 There are a range of businesses across the region developing marine biotechnology and processing projects and partnerships. This includes, but is not limited to:

- N-Ocean – a spin-out from SAMS which is developing biotechnology to transform whisky by-product using marine worms. This could also be applied to fish farm waste in the future.

- Oceanium – based in Oban which is developing functional ingredients from seaweed for food, health and materials. They are also a member of the Horizon Europe funded consortium Seamark which is developing price-competitive market applications from seaweed.[240]

239 IBioIC - Scottish Bioresource Mapping Tool
240 SeaMark – Seaweed-based Market Applications

- BASF Pharma[241] - located on the Isle of Lewis, they manufacture highly concentrated omega-3 fatty acids for pharmaceutical and nutritional applications.

- Creed Integrated Waste Management – located on the Isle of Lewis, it uses an anaerobic digester (AD) to processes fish waste from salmon farms across the Hebrides and combines it with household and garden waste to produce biogas that can used for electricity production.[242]

- Bakkafrost – who are developing a pyrolosis unit to turn sludge from their Applecross salmon hatchery wastewater into biochar that can be used as fertiliser on nearby woodlands.

- Ishga – a company based in the Outer Hebrides that spun out from the seaweed harvesting company Hebridean Seaweed. They create cosmetic products with Hebridean seaweed extracts selling both to UK and international markets.

10.13 The availability of renewable energy in the Highlands and Islands region offers an opportunity for biomass production and/or biotechnology manufacturing where large amounts of green energy is needed e.g. for large scale microalgae production. Microalgae can also use biomass feedstocks for growth.

Economic contribution and context

10.14 The global market for marine biotechnology is estimated to be valued at $7.44bn in 2025 and is estimated to be worth $12.59bn by 2032, an annual growth rate of 7.8%.[243] This will be driven by a rising focus on environmental sustainability and a subsequent increase in investments in marine biotechnology research along with growing demands for marine-derived pharmaceuticals and nutraceuticals, the development of marine-derived cosmeceuticals and the need for sustainable marine ingredients in animal feed.

10.15 Despite North America and Europe accounting for the greatest market revenue share for marine biotechnology in 2025 (43% and 23% respectively), the Asia-Pacific market is substantial, with steep and continued growth forecast.[244] It is expected that Europe will also be a major regional market and in line with the picture in the Highlands and Islands, its marine resources are currently under-used and under-explored.[245]

10.16 Industrial biotechnology across Scotland has grown from an estimated turnover of £189 million in 2013 to £797 million in 2020 and is targeted to reach £1.2 billion by 2025.[246] The marine biotechnology sector is a subsector of this, but the type and diversity of activity, and the fact it is a relatively nascent sector, means it is challenging to quantify its scale and size.

[241] https://www.basf.com/gb/en/who-we-are/Locations/Callanish.html
[242] OHLEH - Community Energy Scotland
[243] Marine Biotechnology Market Size & YoY Growth Rate, 2032
[244] https://www.coherentmarketinsights.com/market-insight/marine-biotechnology-market-6222
[245] https://www.marine.ie/site-area/research-funding/marine-biotechnology/what-marine-biotechnology
[246] National Plan for Industrial Biotechnology — IBioIC

10.17 RTO investment projects in the marine biotechnology and processing sector identified through this research indicate a total potential investment of over £39 million across the region over the period 2025 to 2040, and £23 million in total potential GVA. Assuming all projects progress as planned, this is estimated to create up to 120 direct operational and maintenance jobs.

10.18 The aquaculture industry in Scotland is mainly based in the Highlands and Islands, generating around £337m in GVA to the Scottish economy in 2022.[247] While the industry mainly supplies the food and drink sector, any by-products can be used in anaerobic digestion for energy production but could be further valorised using biotech applications. The establishment of the Scottish Ocean Cluster hopes to increase opportunities for value added applications of by-products from both fishing and aquaculture, estimating that this could triple the value of the current by-products.[248]

10.19 Seaweed cultivation to produce raw material for marine biotechnology is undergoing rapid global expansion and is a commercial activity ideally suited to the sheltered, nutrient-rich waters of the west coast of Scotland. The seaweed industry in Scotland mainly produces seaweed from wild harvesting of different wrack species in Na h-Eileanan Siar, but more seaweed farms have started up and are scaling up production of kelp species.[249] In 2020 the seaweed industry was estimated to be worth £510,000[250].

10.20 Alginate is used for its combination of viscosity and solubility in foods and medicines (e.g., Gaviscon), and for delivering active medical ingredients. Production of alginates is a core part of the marine biotechnology potential and has existed for many decades in the Highlands and Islands. It is a high quality and high value product. Quality, provenance, and strong standards compliance are important in the alginate market, all of which the Highlands and Islands can deliver. Exploiting the potential of alginates requires a staged approach to compliance (hand-gathered seaweed on the beach is different to cultivating or harvesting seaweed underwater), volume production, and market segmentation. Another strand of the sector in Scotland is using marine invertebrates (shellfish) for bioremediation (i.e., cleaning waste products from water).

10.21 Biotechnology solutions may be able to be applied to a range of biomass sources by adapting the technology. In this way companies will be able to utilise a range of feedstocks from both marine and terrestrial sources. In the Highlands and Islands, in addition to marine resources there are also significant feedstocks available from forestry and whisky industries. The availability of renewable energy may also be an advantage for companies to use in their production or manufacturing processes.

Competition

10.22 While North America accounted for the greatest market revenue share for marine biotechnology in 2025, China is a global leader in marine biotechnology such as marine aquaculture production and breeding innovations. For example, China has sequenced the genomes of over 60 marine animals, providing valuable information surrounding the genetic makeup of the species to support with understanding of diseases.[251] This is stimulated by intense government

[247] Scotland's Marine Economic Statistics 2022 - gov.scot
248 Seafood sector 'can triple value of by-products'
[249] sma2020_-_seaweed_harvesting_and_cultivation_-_production.pdf
[250] Potential scale of Scottish seaweed-based industries: research paper - gov.scot
[251] https://link.springer.com/article/10.1007/s44307-024-00043-7

support in China, with the marine biotechnology industry receiving tax incentives and being supported by strong regulatory framework which stimulates economic development.[252] The marine ecosystem system is significantly different in China compared to Scotland with Scotland having much cooler waters with different species, and significant seaweed deposits. These differences may allow Scottish marine biotechnology to specialise in specific areas, compared to the large-scale industry in China.

10.23 There is also strong competition in Europe, with several significant marine biotechnology operations in the Faroe Islands and Norway, sharing significantly closer marine ecosystem characteristics with Scotland. For example, Ocean Rainforest[253] is a blue economy company operating in the waters of the Faroe Islands who specialise in harvesting and selling a range of seaweed products at wholesale for commercial purposes. In 2020, they opened a site in California, expanding further into the US market, and showcasing the international opportunities in marine biotechnology.

10.24 Alaska has significant marine biotechnology potential due to its wealth of natural resources and geography. The state has some of the largest beds of kelp in the world, alongside large deposits of various types of seaweed.[254] Seaweed farming has always been culturally important in Alaska, and with the longest coastline in the US and over 500 different species of seaweed, it has also recently started to become a commercially successful industry.

10.25 Aotearoa in New Zealand are another company who have an international partnership to develop their marine biotechnology industry.[255] The company is being supported by US company GreenWave to pilot a three-year seaweed farming programme to address the ongoing supply chain challenges which New Zealand experiences in the seaweed industry. The $5m investment will support the design and development of new hatcheries and seaweed farms to boost the supply chain and improve the health and quality of seaweed in New Zealand.[256] Similarly, Auskelp have recently secured a lease to grow Ecklonia Radiata kelp in the waters of New South Wales, which will help to boost the Australian kelp population.[257]

10.26 As well as international competition, there is a raft of innovative marine biotechnology projects developing in the rest of the United Kingdom. In Wales, for example, the Assessing Welsh Aquaculture Activities project has supported in evaluating the condition of seaweed in the Welsh marine ecosystem, using intertidal zones, and subtidal seaweed cultivation to support seaweed health and improve management of beds.[258] There are also projects based in the South-West of England, piloting the viability of seaweed farming in the region, aiming to become established as an emerging player on the international marine biotechnology market.[259]

[252] https://www.hillpublisher.com/ArticleDetails/4241?cid=4241
[253] https://www.oceanrainforest.com/about-overview
[254] http://www.climatehubs.usda.gov/hubs/northwest/topic/seaweed-farming-alaska
[255] https://www.greenwave.nz/
[256] https://envirostrat.co.nz/greenwave-aotearoa/
[257] https://www.auskelp.net/
[258] https://naturalresources.wales/media/ol2fl5u2/awaa-aquaculture-activity-assessment-intertidal-planted-seaweed-aquaculture-final.pdf
[259] https://www.jurassicseafarms.co.uk/

Drivers of growth

10.27 Innovation for marine bioprocessing is focused on how to produce the raw material sustainably, understanding the opportunities for different types of biomass, developing processes for extraction and processing, and current and new, often cutting edge, high value applications.

10.28 The transition to net zero is a key driver for growth. Businesses across Scotland, the UK and globally are looking to decarbonise their supply chains and reliance on fossil fuel-based products. To meet this demand an alternative biomass resource needs to be found that is renewable and can supply biomass at a large scale. The Highlands and Islands has over 60% of the UK's coastline and its clean, nutritious waters in sea lochs has the potential to supply marine biomass as a sustainable raw material. The existing industries that produce large amounts of biomass in aquaculture and fisheries are key drivers for scaling up biomass for marine and wider industrial biotechnology application. Infrastructure to support both production and movement of biomass is crucial to strengthen the supply chain and upscale new products.

10.29 Marine biotechnology, and seaweed in particular, can also potentially make a significant contribution to net zero ambitions in Scotland through the potential for carbon sequestration. However, it is important to recognise that the gains from seaweed sequestering CO_2 can be reversed if it is not used correctly. If seaweed is grown for the sole purpose of absorbing carbon without being harvested, it will rot and release the CO_2 it has captured. To avoid this, seaweed should either be sunk into the deep sea or used for marine biotechnology applications, like food, packaging, or biofuel. However, the first option requires access to technology to sink seaweed, with associated costs, while the second option itself emits CO_2.[260] Seaweed harvesting has to be carefully planned to mitigate such issues.

10.30 Many industries including packaging, cosmetics, nutraceuticals and pharmaceuticals are looking for sustainable materials to use in their value chain which is driving innovation and growth. A challenge will be to meet the scales of production and reliability of supply that these industries require.

10.31 As more companies are interested in using by-products from existing industries there will be competition for the bio-based feedstocks. Currently, accessing feedstocks is arguably a bigger barrier than competition, and creating opportunities to connect biotech companies with feedstock producers could enable important partnerships that can pilot and scale production and create pilot studies.

10.32 As such, a key innovation driver, certainly in Scotland, is how to ensure a sustainable, reliable supply of raw materials, including seaweed, to fuel the growth of a bioprocessing industry in the country.[261] However, the seaweed sector currently remains small-scale in Scotland and the UK. There are some well-established, hand-harvesting operations in Na h-Eileanan Siar and parts of the west coast for food products such as salt substitute. More recent commercial and industrial developments have seen companies established to commercialise the extraction of seaweed components for a range of higher value pharmaceutical, cosmetic and food uses.[262] With the current moratorium on seaweed harvesting for commercial purposes, cultivation is the key source of the raw product.

[260] https://time.com/5848994/seaweed-climate-change-solution/
[261] https://www.communitiesforseas.scot/seaweed-cultivation-in-scotland/
[262] For example, Marine Biopolymer Ltd., based in Ayrshire

10.33 SAMS has particular interest and expertise in seaweed industry development and development of biotechnology. As noted above, the launch of the seaweed academy[263] reflects the enormous growth potential for commercial cultivation and harvesting of seaweed for marine biotechnology processes.

10.34 SAMS also has the largest culture and algae and protozoa (unicellular organisms) collection in Europe which is effectively a 'nursery' for the industry. It is also leading the way in Europe in seaweed cultivation. It holds a large stock of seaweed species and has access to experimental farming facilities which focus on species including *Alaria esculenta*, *Saccharina latissima*, *Laminaria hyperborea*, *Palmaria palmata* and *Ulva*. This stock and associated research provides the opportunity to build on the knowledge base of what is available and examine the potential of these species on a small scale, before commercial scale is required. Access to this resource is enabling researchers to identify which species are the most advantageous for culture, further develop cultivation and harvesting techniques, explore how to identify and control seaweed pathogens, and to consider the policies needed to enable sustainable industry development.

10.35 There is a drive to continue to increase understanding of traditional biomass sources and isolating and characterising the compounds for bioactivity and the known and potential applications. At the same time, there is a drive to identify and research new, non-traditional sources and understanding their properties and potential applications.

10.36 There are future opportunities in terms of expanding the range of functional foods and ingredients, nutraceuticals, cosmeceuticals, fine chemicals, enzymes, and other biomaterials derived from marine organisms to develop products and applications. There is also scope to explore of how they can be used in more diverse activities, for example as sensors and biological indicators. Additionally, there are opportunities to innovate sampling and extraction processes to ensure the highest quality of extracted material, achieve efficiencies and minimise environmental impacts.

10.37 There are also potential synergies through developing innovative approaches to integrate seaweed cultivation with other marine activities such as offshore wind and finfish aquaculture. Where seaweed cultivation is co-located with salmon farms, it absorbs excess nutrient emissions which is a dual benefit.

10.38 Scottish universities are producing high numbers of spinouts compared to other UK regions.[264] The transfer of academic knowledge and development of entrepreneurship is an important driver for the development of new industrial biotechnology applications. Investment into startups and spinouts from public funding and private investment is key to commercialise and scale these new businesses. Scotland has several public support programmes such as the High Growth Spinout Programme hosted by Scottish Enterprise[265] and IBioIC's spinout support programme[266] that support fledgling entrepreneurs.

263 https://www.sams-enterprise.com/seaweed-academy/
264 Scottish businesses secure nearly a fifth of UK spin-out deals - Business Insider
265 High Growth Spinout Programme | Scottish Enterprise
266 Spin Out Support Programme — IBioIC

10.39 A key opportunity identified during consultations was capitalising on the cluster of expertise and activity that has developed around the European Marine Science Park (EMSP) in Oban. As well as economic activity, there has been significant development of high-level skills and knowledge capital for marine biotechnology. Consultees point to the tangible and intangible assets that have developed over a number of years, and that will be augmented by subsequent phases of the EMSP (for example, the EMSP might see significant investment from Community Regeneration Partnership Funding with final funding awaiting decision in 2025[267]), and other related activity. The Marine Aquaculture Programme as part of the Argyll and Bute Rural Growth Deal (RGD) is hugely significant in this regard.

Challenges, constraints, and market failures

10.40 While several drivers of growth support the development of marine biotechnology and bioprocessing, there are many challenges to overcome. The diversity of applications presents enormous opportunities but can also be challenging in terms of defining the sector by activity. For example, the cultivation and harvesting of seaweed is classed as aquaculture, while the downstream biotechnology activity is subject to landside and sectoral regulations for chemical or biomass processing.

10.41 Given the scale of the sector, there is a lack of a supporting industry ecosystem, and with this a lack of access to finance. Marine biotechnology is still relatively new to banks and commercial lenders and is deemed as an investment risk, compounded by the seasonality of algal biomass. This restricts investment in the sector for R&D or equipment purchase, and without the necessary financial outlay, businesses are not able to grow and take advantage of market opportunity. Marine biotechnology operators can access early-stage funding, but struggle to access finance for full development and commercialisation. In addition, it is the downstream value chain of activities such as seaweed harvesting that are high value, for example pharmaceuticals and other marine biotechnology applications. There is an information failure in investment terms in that the downstream industrial and commercial applications are not taken into consideration by investors.

10.42 Biomass prices and availability are hugely important to enable biotechnology companies to scale. While many companies are interested in using farmed seaweed from Scotland or Europe it is currently only available in small quantities and is more expensive than wild harvested seaweed sources. Feedstock availability will therefore be a crucial consideration for R&D and manufacturing. The by-products from existing large-scale industries such as aquaculture and fisheries therefore present a key opportunity for rapid development and progress towards circular economy.

10.43 In addition, production cost for bio-based products have been identified as a barrier.[268] Many markets are looking for sustainable and/or bio-based products or materials to potentially meet net zero targets and attract customers who value sustainability. In these markets bio-based products can attract a premium which may be able to cover higher production costs. However, new products will still be competing with existing products on the markets which may be less sustainable but more affordable.

[267] https://www.argyll-bute.gov.uk/news/2025/feb/key-infrastructure-projects-identified-potential-funding
[268] Website blocked by your organisation

10.44 Regulation of byproducts or waste materials can limit potential applications, for example, use of fish waste for bioplastics may limit uses in food applications due to biosecurity. In contrast, biomasses like whisky by-products is attractive to use due to access and less regulatory constraints. Research is needed to understand the potential risks of using raw materials or byproducts from different origin to inform policy makers and recommend potential pathways to increase development of safe and sustainable bio-based materials.

10.45 The slower pace of market development in Scotland means the marine biotechnology sector is losing ground on competitors elsewhere. The rate of growth globally forecast means that this key sector for the Highlands and Islands, is in danger of being left behind and thus losing market share in an increasingly competitive global industry.

10.46 As more companies are interested in using by-products from existing industries there will be competition for the bio-based feedstocks. Currently, accessing feedstocks is probably a bigger barrier than competition, and creating opportunities to connect biotech companies with feedstock producers could enable important partnerships that can pilot and scale production and create pilot studies.

10.47 Supporting businesses to scale up can help unlock growth of biotechnology companies. While land is available in the Highlands and Islands many companies cannot afford or wait to build. Instead, a large space that can be used flexibly and quickly by companies to pilot scale up processes at multiple scales could support companies to commercialise.[32] While IBioIC's facility Flexbio[269] and Centre for Process Innovation[270] offer facilities for testing and scale up of biorefinery, they do not offer commercial production to start scaling different processes and commercialise products.

10.48 While Scotland has a high number of spinouts from universities, the jump to setup a spinout remains challenging. Support is needed both for universities within the Highlands and Islands to increase their knowledge and capacity in knowledge transfer activities, as well as support for budding entrepreneurs to take the step to start a business. The development of entrepreneurial skills in young people, students and researchers could further enhance success of spinouts from Scotland's universities.

10.49 Information gaps and knowledge disparities are a key constraint to the development of the commercial seaweed harvesting industry. First, there is a lack of knowledge exchange and research alignment between academia and industry. Some industry actors are progressing with industrial research on the feasibility of seaweed harvesting on a commercial basis. Alongside this, Higher Education and research institutions are undertaking a considerable range of scientific research but there is a strong view that this research is not immediately accessible to industry. There is a need to overcome this information disconnect and bridge the translation 'gap' to help better engage industry in research activity and outputs, and at the same time ensure that research is aligned to the needs of industry.

10.50 Second, there is a degree of dissonance between industry players and communities, interest groups, environmental groups, etc. with regard to the potential value of marine biotechnology to the region versus the intrinsic value of marine ecosystems. Social license acts as a constraint to the sector in Scotland. However, for some consultees, it is helping to change the

269 IBioIC - Bioprocessing Scale-Up Centre
270 Let's innovate together | CPI

view of the marine environment from an extractive resource to be exploited, to a valuable resource to be managed carefully and sustainably. This also includes consideration of the intellectual property (IP) of any seaweed cultivation industry and related marine biotechnology applications as and when the sector begins to grow.

10.51 Geographical immobility is a key market failure for marine biotechnology. The prime sites for seaweed harvesting or shellfish cultivation for marine biotechnology purposes are in peripheral coastal areas of the region. Consequently, there is a lack of supporting infrastructure, and also access to the required labour for the sector. There are pockets of activity, and much work has been done to establish Oban as a nationally and globally significant cluster of marine biotechnology activity. However, there are land-side geographical constraints on growth of the sector due to the coastal and island nature of the Highlands and Islands. As an example, it has previously been reported by an industry stakeholder that transport difficulties and lack of available space for land-side facilities has led them to locate outside the region.

10.52 Infrastructure challenges are considerable for marine biotechnology. Some consultees reported that the available infrastructure on both sea- and land-side is currently constrained. In particular, there is lack of grow-on space for marine biotechnology (and also related life sciences activity) companies:

'[There is] a lack of decent sites on the coast, strategic sites are in very short supply especially on the west coast of the Highlands and Islands.'

10.53 Skills challenges were also highlighted by consultees. In particular, the uncertainty around Further and Higher Education funding, and changes to the strategic skills landscape following publication of the Withers Independent Review of the Skills Delivery Landscape was highlighted as a particular concern with regard to marine biotechnology. There was a perception that this was negatively impacting on ensuring the supply of highly skilled workers needed by the marine biotechnology industry. Though this point was raised with regard to marine biotechnology, it will of course be of relevance to skills provision for other RTO areas. This lack of clarity presents challenges for strategic partners especially in ensuring skills provision. However, developments such as the Inverness Campus, create areas where businesses can access talents from graduates from the co-located universities or other companies.

10.54 Finally, gaps in the marine biotechnology supply chain were reported as a challenge by consultees. One consultee noted that the sector overlaps with aquaculture, where the majority of operators are Norwegian- or Faroese-owned and are increasingly vertically integrated. Consequently, much of the supply chain that might otherwise be shared exists outside of Scotland. The impact of this is that the accessible supporting supply chain for marine biotechnology in the region or across Scotland is smaller than it would otherwise be.

Priorities for action

- Ensure that the regulatory framework for marine biotechnology is based on current research and enables sustainable business start-ups and growth.

- The Highlands and Islands has a clear competitive advantage through the scale and quality of its available natural resources. However, support is required to connect biomass producers with biotechnology companies and a mix of public and private investment will be needed to support encourage more startups and scaling business growth.
- Marine biotechnology is a relatively new and innovative sector, and a mix of public and private sector funding will likely be required to mitigate risk and encourage entrepreneurship and innovation.
- Research needs to identify the balance between the natural stocks required for marine biotechnology and marine sustainability to build and capitalise upon a sustainable marine biotechnology sector.
- Undertake research to understand the opportunity for novel bio-based materials and assess risks in new applications.
- Build on existing enabling and supporting infrastructure and wider investment to foster growth in the sector, supporting businesses to scale-up and move to commercialisation and attracting inward investment.
- Support greater innovation and knowledge transfer between academia and business and support spinouts on their growth journeys. This includes taking more academic ideas and enabling their translation to commercial viability – and doing so at a larger scale than is currently the case.
- Encourage greater numbers of people – academics and industry actors – to operate at the interface between science and industry. This will facilitate a greater degree of technological and knowledge transfer between academia and business.
- Develop skills and educational opportunities for young people in industrial biotechnology and entrepreneurship.
- Increase public awareness of marine biotechnology so that it is better understood by all stakeholder groups, including how it can benefit society, and how host communities can benefit from activity in these industries over the long term.

11 Life sciences, digital health and social care

Headlines

- Life sciences, digital health and social care is a large and complex sector covering a range of activities relating to humans, animals and plants, and includes industries such as pharmaceuticals, medical research and medical technologies.
- The life sciences cluster contributed almost £10.5bn in turnover to the Scottish economy in 2022, with life sciences exports worth £4.3bn. Around 46,900 people were employed in businesses and HEIs.[271]
- The Highlands and Islands has some strong and valuable assets in terms of academic knowledge, a skilled workforce and enabling infrastructure that support commercial operations, including clusters around the European Marine Science Park in Oban and at Inverness Campus. There is scope to strengthen and increase their value and influence.
- Growth drivers include an ageing population, demand for value-based healthcare, advances in big data creating a move towards personalised treatments, development of advance therapeutics and the digitalisation of healthcare delivery and the drive towards net zero. They present opportunities for innovation and entrepreneurial businesses and academia.
- Animal health, agritech, and aquaculture growth drivers include an increased global demand for responsibly and sustainably produced animal protein and natural ingredients/products.
- Being clear about the value proposition in the Highlands and Islands will be very important in attracting investment and stimulating growth.
- Pressures on public sector health and social care services is driving an increase in the private market and there is an opportunity for the Voluntary, Community and Social Enterprise (VCSE) sector to expand to address the widening gap between supply and need.

Context

11.1 The life sciences and digital health and social care sector refers to any activity that covers health technology for humans, animals, and the development of relevant biotechnology. It encompasses technology that is produced for use by land and sea-based farms, before the fish, animal or crop is transported for further processing. This highly innovative sector focuses on the delivery of technological solutions within medical technology (such as digital health), pharmaceutical innovations (such as within precision medicine and health informatics) and animal health, agritech, and aquaculture (AAA) services (ranging from animal and plant health to the adoption of new technologies to improve efficiencies in primary production sectors).

11.2 The Highlands and Islands' disparate population and rural geography, means it is well positioned to test and trial digital and remote healthcare solutions to address where geography can be a physical barrier to accessing health and social care services. The region is rich in natural capital and land and seas that are used for farming. The AAA sector is prominent in the region with a range of vertical and technology integrated supply chains.

[271] Industry statistics - gov.scot

11.3 Table A.2.6 in the Appendix details key policy and strategy documentation relevant to the life sciences and digital health and social care sector including the Life Sciences Industrial Strategy, and the Life Sciences 2030 Skills Strategy.[272]

11.4 Overall, there is a supportive policy environment for life sciences at UK level, in Scotland, and in the Highlands and Islands. However, there remain some substantial structural issues for health and social care and there is a strong sense that for this part of life sciences, there needs to be a significant policy shift with adequate financial support and restructuring, combined with a radical rethink and swift implementation of workforce planning and development. Innovation research and technology are seen as being part of the solution and so this is also a key policy focus, with investment in digital health innovation and scale up. Whilst this is positive, there are some issues around its implementation, for example access to data and clinical testing, selling into the NHS, and commercialising and scaling new technology.

11.5 The rapid response by the UK's life sciences sector during the Covid-19 pandemic demonstrated effective collaboration between research institutes, the NHS, industry, and government. The pandemic also highlighted the crucial role of healthcare data and data analysis, with real-time reporting on testing and vaccination influencing policy and strategy at unprecedented pace.[273] It brought about lasting changes although pressures in the delivery side of the sector are perceived to have diminished some of what was achieved.

11.6 Food security and the sustainability of production are also important policy areas. These types of policies and initiatives have developed rapidly in recent years. However, there needs to be more effective and direct policy support, backed up by a positive financial environment to better enable and encourage, for example, wider adoption of agritech, and more rapid and innovative responses to managing animal health and mitigating risks.

11.7 The UK Government vision for the life sciences sector remains to '*regain status as a Science Superpower by making the United Kingdom the leading global hub for life science*'.[274] Whilst there is international competition (predominantly from the US, Germany, France, and Italy), the research capacities of the UK life science sector are seen as a particular strength. At all levels of government, the life sciences sector is seen as a priority high-growth sector for further development, leaning heavily on research and development strengths for development of innovative and emerging technologies in health and social care. The heavy focus on accelerators, incubators and wider business support found across the sector through innovation hubs and catapults in the Highlands and Islands, Scotland and the UK demonstrate the emphasis placed on innovation support for the sector across all levels of government.

11.8 Another key focus for future planning in the life sciences sector in the UK is to promote exports and attract inward investment. Both Scottish Development International[275] and the Department for International Trade's export strategies for life sciences focus on maintaining strong relationships in markets where the UK has a strong track record and growing in markets where there is potential for future trade and investment.[276]

[272] https://cogentskills.com/wp-content/uploads/2022/09/sip-life-sciences-2030-skills-strategy-digital-version.pdf
[273] https://scottishscience.org.uk/sites/default/files/article-attachments/SSAC%20Report%20-%20Building%20on%20the%20Science%20Legacy%20of%20Covid-19%20in%20Scotland.pdf
[274] https://assets.publishing.service.gov.uk/media/612763b4e90e0705437230c3/life-sciences-vision-2021.pdf
[275] https//www.gov.scot/publications/export-plan-scotlands-life-sciences-sector/
[276] https://www.gov.uk/government/publications/board-of-trade-report-life-sciences/life-sciences-whats-next-for-this-top-uk-sector-a-board-of-trade-paper-web-version

11.9 Given the Inverness Campus' situation within the Inverness and Cromarty Firth Green Freeport boundary, the Highlands and Islands has a fairly unique opportunity to avail of a favourable tax environment for attracting inward investment and also for both paying lower prices on imports that could be manufactured into life science products (through tariff exemptions), while also paying less in the export of the finished product to overseas markets.

Current project activity

11.10 The following section details current assets and activities within the life sciences and digital health and social care sector across the Highlands and Islands, and more widely across Scotland. The two most significant assets in the Highlands are the European Marine Science Park (EMSP) in Dunstaffnage (near Oban), and Inverness Campus.

11.11 EMSP was opened in 2014 as a centre of excellence for new and expanding firms in the life science sector by providing office and laboratory space, with a focus on supporting businesses in AAA. At present, the park's main building, Malin House, is home to 15 companies that employ more than 70 people including Patogen AS, Tritonia Scientific and Oceanium. The next stage of development at EMSP was announced in July 2024 for the building and first floor fit-out of a new two-storey building, Camas House, with 11 laboratories and office suites of varying sizes. This expansion is expected to be completed by the end of 2025, with ground floor fit-out expected to be part of a subsequent contract.[277]

11.12 EMSP is home to the world-renowned Scottish Association for Marine Sciences (SAMS), an academic partner of UHI. SAMS is Scotland's largest and oldest marine science organisation, delivering marine science for a productive and sustainably managed marine environment through innovative research, education, and engagement with society. Home to circa 160 staff, 20 research fellows, 200 students[278] (across undergraduate and postgraduate cohorts), SAMS undertakes research into all aspects of the marine system and works in partnership with academia, government, regulatory organisations, business, and society to increase knowledge sharing and understanding in practice. SAMS is also home to the Culture Collection of Algae and Protozoa (CCAP), Europe's most diverse collection of marine and freshwater algae, protists and seaweeds and is a significant contributor to the marine biotechnology sector (see chapter ten).

11.13 Inverness Campus, which opened in 2015, is an enterprise and innovation park developed by HIE. The Campus is home to a collaborative helix of businesses, academics, and researchers with a focus on life sciences and technology, including the following buildings:

- Solasta House and Aurora House which offer workspaces for enterprises. There are a range of tenants in life sciences and technology sectors including PHARMAQ Analytic (part of global animal health company Zoetis) and Zenith Surveying. Co-location enables networking and encourages collaboration and joint projects.

- An Lòchran, which is home to HIE, as well as key research and education departments of Scotland's Rural College (SRUC), the University of the Highlands and Islands (UHI), and Wave Energy Scotland (WES). It also hosts the Science Skills Academy, which encourages young people to become more involved in science and technology-based subjects.

[277] https://www.hie.co.uk/latest-news/2024/july/17/argylls-new-81m-building-will-strengthen-marine-industries/
[278] https://www.sams.ac.uk/about/

- The Life Sciences Innovation Centre (LSIC), a collaboration between HIE and UHI, which includes laboratory space and wider purpose-built office space for lease to SMEs in the life sciences and technologies sectors. The facilities aim to encourage collaboration between businesses, with academia and the public sector on projects that will help businesses to grow through the development and commercialisation of new products and services.

- The NHS National Treatment Centre (NTC-Highland) which provides NHS Highland's eye care service, with surgical and outpatient facilities also offering elective orthopaedic procedures. The NCT and neighbouring NHS departments enable collaborative opportunities to develop, test and commercialisation new products and services.

- The Rural and Veterinary Innovation Centre (RAVIC), designed to co-locate SRUC's teaching, research and consultancy expertise with commercial businesses and entrepreneurs. It aims to catalyse and realise new innovations in agriculture, animal health, food and drink, natural capital, conservation and climate, and veterinary medicine. RAVIC is home to SRUC's Centre for Epidemiology and Planetary Health, which focuses on data science, epidemiology, animal health, infectious disease control and zoonotic disease. RAVIC is the north of Scotland base for SRUC's consulting arm and is part of SRUC's new Veterinary School of Medicine.

11.14 Work is underway to develop the second phase of Inverness Campus, with some of this undeveloped land included within the Inverness and Cromarty Firth Green Freeport zone. Uniquely this is the only Green Freeport in the UK to have land designated specifically to life sciences innovation, offering a range of tax incentives to businesses located there.

11.15 In 2024, HIE launched a Life Sciences Growth Fund to support capital investment in the sector to establish or grow activities.[279] The Fund is a non-repayable grant funding mechanism of between £25,000 and £75,000 to cover up to 50% of total project costs. This may include funding for establishing or expanding an enterprise or site, developing new products, services or processes, or delivery of new commercial products, services, or processes.

11.16 There are other important assets and partners elsewhere in Scotland that contribute significantly to the life sciences and digital health and social care sector including National Innovation Centres such as Digital Health Innovation (DHI), Industrial Biotechnology (IBioIC), the Sustainable Aquaculture Innovation Centre (SAIC) and the UK-Agritech Centre. Collaboration and partnerships, for example in how we utilise new and emerging technologies and science, will present opportunities for businesses and academics in the Highlands and Islands.

Economic contribution and context

11.17 Scotland hosts one of the largest life sciences clusters in Europe. It is estimated that there were around 750 enterprises in the life sciences cluster in Scotland in 2022 with a total turnover of around £10.5bn, and around 46,900 people employed in businesses and HEIs.[280] Almost a quarter of those worked in Edinburgh and Glasgow, where there are significant academic strengths at Edinburgh and Glasgow Universities and business support facilities including the Medical Device Manufacturing Centre.

[279] https://www.hie.co.uk/support/browse-all-support-services/lsfund/
[280] https://www.gov.scot/publications/industry-statistics/

11.18 Across Scotland, the life sciences sector's workforce is estimated to have increased by 27% between 2014 and 2024.[281] It is expected to grow by 4.3% (900 people) between 2024 and 2027, compared to a national average of 1.9% over the same period.[282] GVA growth of 5.4% is expected over the same period, slightly higher than the forecasted overall national GVA growth of 4.2%.

Life sciences cluster contributes

£10.5bn

in turnover per annum to the Scottish economy and is one of Scotland's fastest growing sectors

11.19 The sector is highly export driven. The national Export Plan for Scotland's Life Sciences Sector shows that exports increased by 82% between 2010 and 2019. [283] Its forecasts for international growth highlight pharma services, medical devices and diagnostics, digital health and AAA as the most significant global opportunities. It is widely recognised that large companies are important drivers of export growth but more than 95% of life sciences businesses are SMEs. There is an international trade opportunity to be gained if these businesses can scale up. Support will most likely be needed to understand the complexities of international markets, to access and engage with the right customers, to navigate the international regulatory and reimbursement landscape.

11.20 The life sciences sector can play a significant role in the Highlands and Islands economy. While the business base is dominated by SMEs and micro businesses, one of Scotland's largest life science businesses is based in the region and there are a range of international enterprises. Consequently, there is a depth of skills and knowledge, particularly in medical technologies, high-volume manufacturing and international logistics.

11.21 RTO projects and investments in the life sciences and digital health and social care sector identified through this research have a total potential investment value of up to £450m across the region over the period 2025 to 2040. If all projects progress as planned, this would create over 2,000 FTE jobs in development and construction phases and around 125 direct operational and maintenance jobs. Under the status-adjusted scenario, the potential investment is around £226m.

Competition

11.22 The UK's 'Golden Triangle' of London, Oxford and Cambridge was ranked 3rd in the Savills' 2024 index world's top life sciences hubs, with Boston and San Francisco ranked first and second. Edinburgh and Glasgow were highlighted as emerging hotspots with the potential to grow.[284] The Savills' evaluation is based upon factors including the depth of life sciences talent pool, level of research investment, business environment and property affordability.

11.23 Table A.3.1 in Appendix 3 summarises the key indicators of competitive advantage and leadership as defined by the UK Government[285] for the UK life sciences sector, the sector leader, and the global competition, across four areas: research, workforce, exports, and foreign direct investment (FDI).

[281] https://www.skillsdevelopmentscotland.co.uk/media/tluj4jex/sectoral-skills-assessment-life-sciences.pdf
[282] https://www.skillsdevelopmentscotland.co.uk/media/tluj4jex/sectoral-skills-assessment-life-sciences.pdf
[283] https://www.gov.scot/publications/export-plan-scotlands-life-sciences-sector/documents/
[284] https://ukcitiesinvestment.co.uk/the-uks-golden-triangle-ranked-third-in-global-index-of-life-science-hubs/
[285] https://www.gov.uk/government/publications/life-science-sector-data-2022

11.24 The USA is the global leader in human health research, with the highest government spending on health-related R&D, the highest share of participants in studies, and the highest share of academic citations. This reflects the size of the USA, the maturity of the sector there and the structure of healthcare provision.[286] The USA also leads in exports of medical technology products, exporting $35.1bn in 2020.

11.25 Asia-Pacific is now providing competition as there are several globally renowned universities, a large talent pool, comparatively lower costs and investment sources. Beijing and Singapore have strengths in new technologies and artificial intelligence which will be key elements for future life sciences innovations. China has been growing, particularly in respect to academic citation shares (second behind USA), medical technology products exports (third behind USA and Germany) and attracting inward FDI expenditure (fourth behind USA, UK and Ireland).

11.26 The UK has the fourth largest workforce in both the manufacture of pharmaceutical products and medical products (behind Germany, France, and Italy), and attracts the second highest levels of inward FDI (behind the USA).

11.27 There is limited quantitative data on global leaders and competition with the AAA sectors. This is most likely because of the breadth of activities in these cross cutting sub-sectors, for example, in the UK economic activities fall into a broad range of Standard Industry Classification (SIC) codes. However, many European counties have competitive strengths to Scotland, particularly The Netherlands in agriculture and agritech and Norway for aquaculture and agritech.

Drivers of growth

Market drivers

11.28 There are very strong and high-profile drivers of growth in life sciences and digital health. These include an ageing population, demand for value-based healthcare to address rising costs, advances in big data creating a move towards personalised treatments, the advancement of the One Health agenda, concern about climate change and the drive towards net zero. This was most clearly demonstrated by the COVID-19 pandemic, which showed that demand for certain products within the industry can be accelerated by global events. Similarly, our understanding of climate change is driving the sustainability agenda in primary sectors who are partnering with businesses and organisations outside traditional supply chains to produce sustainable foods. Global events including the war in Ukraine and turbulence in international trade are driving a need for future food resilience.

11.29 The population in Scotland (and this is a global trend) is ageing and this is particularly acute in parts of the Highlands and Islands. Life-changing and life-lengthening medicines are constantly being developed (and in demand). Alongside this, a global obesity epidemic is forecast, with associated potential comorbidities having implications for health, treatments, and management. These demographic changes are driving the need for new medicines and treatment, new delivery methods, and the application of technologies across all healthcare settings.

[286] https://www.hie.co.uk/our-region/our-growth-sectors/life-sciences/

11.30 There has been a huge uplift in the pressures on health and social care services, largely due to an increase in need, more complex cases, and workforce pressures. Many people in Scotland are finding it harder to access healthcare and waiting times, even for routine appointments, are often very long. In essence, demand is outstripping supply and health and wellbeing inequalities are becoming more marked. This has presented the private sector with an opportunity to fill the gap by offering screening, testing, wellbeing, menopause treatments and other services, often based in high street premises and online. Local companies addressing this market include recent start-ups IMULAB and TestMe Health.

11.31 In the UK, it is commonplace to privately fund treatments for musculoskeletal problems for example physiotherapy and chiropractic treatments but there is a move towards a broader range of services. A private independent clinic in Inverness, Open MRI Scans Inverness, has become the first in Scotland to purchase a state-of the art open MRI scanner, which they hope will help ease NHS pressures in the region. Another area where the private sector has expanded to fill an important gap is in neurodiversity diagnosis and management.

11.32 There is evidence of a growing place in society for organisations outside of the public sector to offer health and social care services. This is an opportunity for sector-specific Community Wealth Building in local areas, particularly in remote, rural and island communities where market failure in the capability of public health services is arguably more marked e.g. accessibility and transport considerations in healthcare services. This acts as a driver for both the private and Voluntary, Community and Social Enterprise (VCSE) sector to protect local services. For example, Voluntary Action Orkney recruited Community Wellbeing Coordinators, who develop community projects and connect people across the islands to services that improve their wellbeing.[287]

11.33 There are also other examples of the VCSE sector providing health care services such as the Oxygen Works in Inverness which is a charitable organisation providing oxygen and other complementary therapies to help manage conditions.[288] Both national and local organisations offer health checks and tests such as Bluecrest Wellness[289] and Clinic M Medical in Inverness.[290]

11.34 Healthcare is shifting from products applicable to large patient populations towards more personalised products targeted at specific patient populations. As well as advanced pharmaceutical skills, personalised medicine will generate (and requires) large volumes of data, which will require secure medical records and data recording systems, and access to data from a wide range of sources. This is increasing the need for data analytical and artificial intelligence (AI) skills to analyse these complex clinical datasets (essentially health informatics and bioinformatics skills).

11.35 In terms of animal health, key drivers are food security, the increasing global demand for protein foodstuffs and a drive to reduce the adverse environmental impacts of producing this protein; mitigating and managing disease and maximising yield. The region has a valuable, innovative, and well-established aquaculture industry as well as land-based food protein production. With 49.6% of all agricultural land across Scotland within the region[291], there is a significant opportunity to focus on innovations and collaboration across the AAA sectors.

[287] Rousay's Visiting Podiatry Service's Story | Voluntary Action Orkney
[288] The Oxygen Works | Providing Oxygen Therapy & Support
[289] Bluecrest Wellness - Take Control Of Your Health
[290] Private Medical, Physical & Dermatological Treatments | Clinic M
[291] Highland, Shetland, Orkney, Na h-Eileanan Siar and Argyll and Bute, as per June 2024 Scottish Agricultural Census data here: https://www.gov.scot/publications/results-from-the-scottish-agricultural-census-june-2024/documents/

11.36 The Highlands and Islands has an abundant supply of natural resources which has applications in life sciences. A key example is seaweed which is discussed in detail in chapter ten. There is a rise in interest and demand for naturally inspired health and wellbeing products and this is an opportunity for the region, drawing on the marine and land-based assets.

11.37 Agriculture has a considerable carbon footprint and there are opportunities for innovations to reduce this and create a more sustainable supply-chain. Finding alternatives to imported soy to boost protein in cattle feed, from sources such as seaweed, is a key area for growth and already by-products from whisky distilleries and waste from aquaculture hatcheries are being used in circular economy processes.

11.38 Aquaculture has a much smaller carbon footprint and there is a growing global demand for fish protein which organisations in the region are responding to. International sales of Scottish salmon hit a record high of £844m in 2024, up 45% in a year to remain the UK's top food export.[292] In terms of life sciences, this means a continuing need to develop technologies and treatments to enhance fish welfare and productivity and minimise environmental impact.

11.39 The AAA subsectors have overlapping interests and established working relationships with a range of other key Scottish sectors including chemicals, food and drink and technology. The role of AAA has been acknowledged to be a significant opportunity as a subsector of life sciences in the region. In September 2024, SRUC and HIE jointly hosted an international A3 Conference in Inverness[293], coinciding with the launch of HIE's Life Sciences Growth Fund. The main aim of the A3 Conference was for delegates to gain insights and meet potential new local, national and international partners, and also was an opportunity to promoting the expertise of enterprises based in the Highlands and Islands to an international audience.

Innovation drivers

11.40 This is a very innovative sector being driven by a range of intersecting factors such as increasing and changing needs, the drive for efficiencies, improvements in health and conditions management, global health challenges, advancements in genomics and biotechnology, data and new technologies and net zero targets. Partnerships across industry, academia and public sector, national innovation centres and national innovation clusters and the need for NHS testbeds are also driving innovation.

11.41 As noted above, the ageing population, the rise of chronic diseases and the growing cost pressures on health and social care systems, are recognised as a growing concerns. Much of this is particularly acute for people living in more remote, rural and island communities. In response to these concerns, the Scottish Government recognised an opportunity and commissioned NHS Education Scotland to establish a National Centre for Remote and Rural Health and Care to support the delivery of improved primary and community healthcare for remote, rural and island communities. The Scottish Government's Primary Care Directorate has committed £3.03 million to the delivery of phase one of the Centre's programme for work, focusing on primary care as an initial proof of concept between October 2023 and September 2025.[294]

[292] https://www.salmonscotland.co.uk/news/scottish-salmon-exports-hit-record-high
[293] A3 conference shows worldwide reach of region's life sciences sector | HIE
[294] The National Centre for Remote and Rural Health and Care Programme

11.42 The Centre's first phase has involved projects focused on improving capacity and capability amongst the remote, rural and island workforce, increasing the range of experience of community healthcare settings in these areas, data and intelligence sharing around particular remote, rural and island population health needs, evaluating new ways of delivering health services in partnership with practitioners, partner agencies and residents, and developing tailored training programmes for remote and rural healthcare staff to meet the needs of their unique communities.

11.43 The region has specific clusters of life sciences activity, notably at the Inverness Campus with a strength in MedTEch, and around Oban with SAMS and the EMSP with a strength in marine. These are high profile and represent clear opportunities to focus specific life sciences research and expertise in the region. The specialist offer of these clusters needs to be well defined and clearly articulated. Scottish examples of areas known for specific expertise include precision medicine in Glasgow, and biotech (Edinburgh BioQuarter), animal sciences (Easter Bush including Roslin Institute, Moredun and SRUC), crop sciences (James Hutton Institute) and life sciences R&D (Pentlands Science Park) in Edinburgh. There are also very strong growth clusters around Cambridge in England and further afield, Boston USA (health tech), Medical Valley Sweden and Denmark (health tech).

11.44 Globally, these innovations are being supported by increased investments in research and development, government initiatives, and regulatory advancements that help bring new products and treatments to market faster so that the advantages can be realised.

11.45 Demands on health and social care services are increasing and Scotland is facing well documented shortages of skills in the health and social care workforce. There simply is not the volume of people to provide the care that is required now and going forward. It is widely acknowledged that there will not be an adequate workforce to meet need and so the solution lies in rapidly increasing productivity through technological developments including AI.

11.46 Across the economy, the use of AI has increased sharply in recent years. It is now being used to enhance drug discovery, diagnostics, and treatment planning. By analysing large datasets, AI can identify patterns and predict disease outcomes which enhances treatments and speeds up drug trials. The NHS North of Scotland Innovation Hub has a number of AI projects including the GEMINI project evaluating the potential impact of introducing AI into the national breast screening programme and GRACE AI trialling the use of AI for prioritisation and decision support tool, in radiology departments, emergency departments and acute medical assessment units. The GEMINI project shows AI has the potential for detecting cancers that may otherwise be missed. GRACE AI is showing where measurable cost savings can be made whilst still improving outcomes for patients.

11.47 There is a very valuable opportunity for the region to be a test site for technologies to deliver healthcare in remote and rural areas. Examples included using drones to deliver medical supplies, remote monitoring and wearable devices, telemedicine, e-health platforms and prescription advice, and community health hubs. The region already has a track record in developing and testing these sorts of solutions, and this can be built on as a specialism. The NHS Boards in the region are well positioned to collaborate and provide test sites and data collection opportunities to pilot and develop new delivery mechanisms.

11.48 Linked to this, there is an opportunity and a need to undertake research to better understand public health challenges in rural areas. This would then form part of the evidence base to develop and test a whole system approach to health and social care as an exemplar to build out from.

11.49 An active test bed in the region is hosted by the Rural Centre of Excellence (RCE) for digital health and care in Moray. This £5m initiative funded by the UK Government is delivered by the Digital Heath and Care Innovation Centre funded by the Moray Growth Deal. The Centre has operated several Living Lab projects.

11.50 As with humans, AI can be used to develop new medications and treatments for animals in the food supply chain. Similarly, monitoring and managing animal and fish health can now be done remotely through the use of sensors, drones and other technologies. This can be particularly useful where, for example, fish farms are located in remote areas and further offshore. Linked to this are advancement in the collection and use of data in animal health and research.

11.51 Management of disease and biosecurity of fish stock remains a significant challenge for aquaculture production, and a constraint to growth. This is driving the need for investment in biological and engineering solutions to help reduce the use of medicinal treatments, with their associated negative environmental impacts and costs.[295,296]

Constraints, challenges, and market failures

11.52 There are a number of inter-related challenges and market failures that can constrain growth and optimisation of opportunities in life sciences and digital health and social care in the Highlands and Islands.

11.53 Life sciences and digital health and social care is a very large and complex sector. It is also very competitive with a great deal of activity in Scotland, the UK, Europe and globally. The Highlands and Islands cannot compete effectively across the entire sector – no region can. The region must focus on areas of advantage and specialisms and build its reputation and profile on that, to attract investment and talent and grow from within.

11.54 Commercialising research outputs in life sciences can be a challenge, but with the right policy, funding and support environment, there is a great deal of potential in the region. It will be important that the value of the research, as it moves towards the market, is retained in the region rather than dispersed elsewhere.

11.55 There are challenges in securing clinical test sites for drug trials and new digital health technologies. Pressures on the NHS and healthcare staff often means that they are reluctant to become involved, instead focusing on immediate needs and day-to-day delivery. Using data is part of the solution, but there remains a need for live test sites. This is both a constraint to growth but an opportunity for the Highlands and Islands. One of the strengths of the life sciences cluster at Inverness Campus is the National Treatment Centre being based onsite. The Campus' proximity to Raigmore Hospital also provides associated opportunities for networking and collaboration.

[295] Steve Westbrook and Imani Development (2017), '*The value of aquaculture to Scotland*', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html
[296] SAIC News release: *Scottish Aquaculture Innovation Centre to fund industry-changing research on sea lice control,* at: http://scottishaquaculture.com/wp-content/uploads/2015/04/SAIC.project-announcement-Mar-2015.pdf

11.56 Achieving social license for health-related data to be used in life sciences and digital health and social care can also be a constraint, and this can extend to a reluctance to test new ways of remote service provision. Life science organisations in the Highlands and Islands must be alert to the increasing need to engage with the pubic and other stakeholders to build trust and demonstrate their social responsibility and ethical conduct.

11.57 Access to investment finance is a challenge in life sciences and digital health and social care, in common with many sectors including other RTOs. Long development timelines due to regulatory complexity create a higher risk investment environment.

11.58 A persistent challenge and concern since the UK exited the European Union is that it is now more difficult to participate and instigate collaborative research with EU partners. The UK's status is now that of a third party which makes it more complex and makes UK organisations less attractive as research partners. Some progress has been made on this around Horizon Europe and three projects are currently ongoing – CODECS, UNITE and ECIV.

Priorities for action

11.59 Life sciences, digital health and social care in the Highlands and Islands is relatively well established but as a valuable and dynamic sector, there is significant potential for growth and development. There are strengths to build on and opportunities to harness and this will require an agreed approach, shared objectives and a combination of research funding, collaboration, skilled talent, regulatory support, infrastructure, and access to capital. Priority actions identified by the research are as follows.

- Provide clarity on the value proposition of the Highlands and Islands both nationally and internationally. This would establish the Highlands and Islands as a focused, place-based, life sciences hub with high value and demonstrable specialisms and a critical mass of activity.
- Build on the emerging life science clusters in Inverness and Oban, providing the right policy support to enable them to become powerful growth clusters with significant strategic and international influence, greater membership bases, high growth potential and strong value creation.
- Capitalise on the vast extent of aquaculture and agricultural activity taking place across the region, and the existing anchor institutions such as SAMS and SRUC, to support the growth of the AAA subsectors. There are prospective opportunities for AAA enterprises to network, collaborate and innovate in partnership with the food and drink sector within the region.
- There is an opportunity for the region to be a test and learn destination for technologies and approaches to deliver health, wellbeing and social care services in rural areas and remote and isolated communities. Combined with this, the region could establish itself as a life sciences test hub offering trials and data collection in clinical settings.
- Undertake research that builds evidence to better understand and manage public health in rural areas and in this context, taking a public health approach to respond to pressing health challenges, such as ageing populations, chronic disease management, and emerging infectious diseases.

- Improve support for and encourage commercialisation of research and innovation generated in the Highlands and Islands through spin outs and ensuring a sector-specific supportive ecosystem. This might include incentives for innovation, targeted entrepreneurship support for researchers, and programmes to identify and fast track innovations to the marketplace. Particular areas of focus could include strengthening NHS, industry, and research collaboration to accelerate translation of research through to testing and refinement and onto developing market ready products and services.
- Create formal mechanisms to encourage collaboration between the life sciences and digital health and social care sector and healthcare providers through shared databases, electronic health records (EHR), and real-world evidence. It would help to fast-track drugs discovery, improve research outcomes and accelerate the process of taking products to market.
- Ensure that the high value activities and jobs created by the commercialisation of life sciences research and innovation are retained in the region including through the provision of the facilities and supporting infrastructure to retain and attract investment and a skilled workforce. Area and career attractiveness will be key for this.
- Building on what is already in place to support the VCSE sector and community wealth building, implement a proactive mechanism to stimulate and support the community wealth building potential of life sciences and digital health and social care and catalyse social entrepreneurship in this sector.
- Investment in education and workforce development will be vital to attract and retain skills, talent and expertise, including entrepreneurship, in the sector and the supply chain to ensure the region has the required expertise to fuel growth of the sector. Demonstrating the reliability of employment and career progression opportunities in life sciences and digital health and social care will enhance the attractiveness of the sector and encourage people to pursue education and careers in the sector.

12 Pumped storage hydro and onshore wind

Headlines

- The wealth of natural resource assets in the region puts it at the vanguard of Scotland's response to the Climate Emergency, and for measures in pursuit of Net Zero targets. The region is well-placed to exploit opportunities offered to it through use of its natural resources.
- Renewable energy generation and storage, including through onshore wind and pumped storage hydro are key activities supported by natural capital.
- Onshore wind accounted for around 59% (22,565GWh) of all renewable electricity generated in Scotland in 2024. It is estimated to have supported around 10,120 FTE employment and £1,075m in GVA across Scotland in 2020.
- A significant pipeline of onshore wind developments seeks to capitalise on the wind resource in the Highlands and Islands. The RTO projects identified in this study represent a total potential investment of around £10.89bn, which could add further capacity of around 11.7GW.
- Given the cyclical nature of onshore wind, there are ongoing opportunities in terms of life extension, repowering and decommissioning sustaining opportunities in the supply chain.
- The Highlands and Islands is home to two of the UK's four existing pumped storage hydro projects, with a total capacity of 740MW. A new surge in large-scale Pumped Storage Hydro schemes demonstrates the scale of the opportunity that the region's hydrological resource offers.
- The pumped storage hydro RTO projects identified in this study represent a total potential investment of around £13.2bn. If realised, this could create up to 18,000 FTE jobs in construction and development phases and around 220 direct operational and maintenance jobs.
- Pumped storage hydro can mitigate some of the grid constraints and costs associated with onshore and offshore wind in Scotland by storing this excess energy. Reflecting this, UK Government have introduced a Cap and Floor mechanism for Long Duration Energy Storage (LDES) which includes new pumped storage hydro projects.

Context

12.1 Scotland – and particularly the Highlands and Islands – has enormous strengths and huge potential in renewable electricity generation arising from its wind and water resources. While not originally specified as RTOs in the original scope for the research, the transformational opportunities associated with onshore wind and pumped storage hydro emerged clearly during fieldwork, given the cumulative impacts associated with the opportunities they present and their potential roles in a sustainable energy system. While the associated investments were included in the impact assessment component of the study, the more detailed review of the sectors was beyond scope. However, further detail has been included where possible, to give greater insight into the potential economic contribution of these sectors and what may need to be addressed to help maximise their potential.

12.2 Scotland has some of the highest wind speeds in Europe, creating abundant wind resources that underpin the country's onshore and offshore wind sectors. Of the 10 windiest parts of the UK, seven are in the Highlands and Islands.[297] Onshore wind forms the backbone of Scotland's renewable energy generation with the industry accounting for around 59% (22,565GWh) of all renewable electricity generated in Scotland in 2024 (38,440GWh).[298] The Scottish Government have set out an ambition to achieve a minimum installed capacity of 20GW of onshore wind by 2030, as stated in their Onshore Wind Policy Statement, 2022.[299] The total installed capacity was around 10.3GW by the end of 2024. Highland was home to the largest installed capacity of onshore wind of any local authority in the UK at over 2GW in 2023.[300]

12.3 Scotland's water resources have long been a source of renewable energy generation. The first wave of hydro-electric dam construction was driven by the Hydro-Electric Development (Scotland) Act 1943, and saw a total of 54 power stations and 78 dams constructed, resulting in more widespread accessibility to and more affordable electricity for Highland communities, transforming the way people lived and worked.[301] Of these, the bulk were conventional hydro projects with only two being pumped storage systems, Cruachan (1965) and Foyers (1974), both in the Highlands and Islands. These are two of the UK's current four pumped storage projects with the other two being situated in Wales.

12.4 Pumped storage hydro is a means of storing potential renewable energy for use in instances of low energy availability, or energy crisis, which is supported by the Scottish Government as a key vehicle for providing secure renewable energy.[302] The technology involves using two bodies of water at different altitudes, with the ability to pump water from one to the other, and a dam between these. Low cost or excess power is used to pump water from the main body of water to a smaller body of water where this is stored at a higher altitude. The water acts as a charged battery, and when energy is required, this will be released back into the main body of water through the dam, powering a motor which then generate large quantities of low carbon energy.

12.5 The geography of the Highlands and Islands lends itself to the development of pumped storage hydro projects. The abundance of lochs and mountains across the region leads to the conditions which favour this technology with many sites offering the juxtaposition of two bodies of water at different elevations which creates the gravity fed 'head' differential necessary for pumped storage hydro. Following a number of years where many hydro-electricity schemes developed across the region were small-scale and community-owned, a new programme of large-scale pumped hydro schemes are being developed in the Highlands, demonstrating the scale of the opportunity that the region's hydrological resource offers.

[297][297] https://www.metoffice.gov.uk/weather/learn-about/weather/types-of-weather/wind/windiest-place-in-uk
[298] Renewable electricity generation - Energy Statistics for Scotland – Q4 2024 - gov.scot
[299] https://www.gov.scot/publications/onshore-wind-policy-statement-2022/
[300] UK Government, 2023. Regional renewable electricity in 2023, p. 9. Available: https://assets.publishing.service.gov.uk/media/672270c287df31a87d8c49af/Regional_renewable_electricity_in_2023.pdf
[301] https://www.sserenewables.com/news-and-views/2023/08/sse-heritage-unveil-power-from-the-glens-art-exhibit-at-scottish-storytelling-centre-edinburgh/
[302] https://www.gov.scot/publications/call-for-uk-government-to-support-pumped-hydro-storage-through-a-market-mechanism-letter-to-prime-minister/

Current project activity

12.6 Onshore wind is a significant and rapidly growing industry in Scotland, with current installed capacity of around 10.3GW comprising 59% of Scotland's renewable energy capacity in 2024, an increase of 765GW since 2023.[303] There are a further 11.7GW of potential projects in the Highlands and Islands at various stages of development identified through this research.

12.7 Scotland benefits from a supportive policy environment to onshore wind, in contrast to the situation elsewhere in the UK, where there was a de facto ban on new onshore wind developments between 2015 and summer of 2024[304]. A number of prominent current projects revolve around extending and developing the capacity of current, well-established onshore wind projects. For example the extensions to Dornell, and Glen Ullinish wind farms will deliver a combined capacity of over 800MW, whereas new developments such as Strathy South, and Fiodhag wind farms, will deliver a combined capacity of around 500MW.

12.8 Onshore wind is cyclical, with wind turbines having a finite lifespan. This means that there will be ongoing opportunities in terms of life extension, repowering (replacing older turbines with new, more powerful and efficient models that use the latest technology) and decommissioning. Previous research highlighted the opportunities and enablers associated with decommissioning of offshore and land-based wind generation structures.[305]

12.9 Currently there are four operational pumped storage hydro plants in the UK with a total production capacity of 2.8GW, and a total storage capacity of 32GWh. Two of these plants are in Scotland (Foyers and Cruachan, both in the Highlands and Islands) making the total Scottish pumped storage hydro production capacity 740MW (26% of the UK total), and the total storage capacity 14GWh (44% of the UK total).[306] There is also a large number of pumped storage hydro projects in the pipeline.

12.10 Pumped storage can contribute to a more diverse energy mix in Scotland, making use of potentially curtailed energy, and providing a natural storage of energy for use in times of low energy generation.

12.11 There are nine significant pumped storage hydro projects proposed or in development in the region. Together they could deliver more than 10GW of new installed capacity:

- Coire Glas Pumped Hydro Scheme: is an SSE development on Loch Lochy looking to create a pumped storage hydro unit which, when operational, will have a storage capacity of up to 1,500MW, providing back up storage to the region in times of low energy generation.
- Cruachan Hydro Upgrade and Expansion: is an extension of the current Cruachan Hydro Power Station run by Drax. The upgrade followed by the expansion will increase the capacity of the Argyll and Bute station to over 1,000MW of storage, and become one of the largest pumped storage hydro stations in the UK.
- Sloy Pumped Hydro Conversion: aims to upgrade the existing SSE Sloy hydro power station to a pumped storage station. The existing conventional hydro scheme is over 70 years old and at 152.5MW is the largest conventional hydro power station in the UK.

[303] Renewable electricity generation - Energy Statistics for Scotland – Q4 2024 - gov.scot
[304] https://www.government/publications/policy-statement-on-onshore-wind/policy-statement-on-onshore-wind
[305] https://www.hie.co.uk/media/13381/the-blue-economy-in-the-highlands-and-islands-report.pdf
[306] https://british-hydro.org/pumped-storage-hydropower/

- Loch na Cathrach (Red John) Pumped Storage Hydro Scheme: is a project owned by Statkraft to develop a 500MW hydro scheme on Loch Ness. Located 14km south of Inverness, the project, when complete, will provide a vital source of renewable energy for the region.
- Balliemeanoch Pumped Storage is a project aimed at developing a 1,500MW capacity facility on Loch Awe, being led by Intelligent Land Investments (ILI).
- Glean Earrach Pumped Hydro Scheme is a 2,000MW project being delivered by Glen Earrach Energy Ltd on the Balmacaan estate near Drumnadrochit on Loch Ness.
- Earba Pumped Storage Hydro, a proposed 1,800MW pumped storage hydro scheme on Loch an Earba, south of Loch Laggan, between Fort William and Newtonmore.
- Fearna Pumped Storage Hydro, a proposed pumped storage hydro scheme in the Great Glen, west of Invergarry, with an installed capacity of up to 1,800MW. The project is being developed by SSE and Gilkes Energy.
- Loch Kemp Pumped Storage Hydro Scheme: a 600 MW project being developed by Statera Energy on the eastern shore of Loch Ness near Fort Augustus.

12.12 With the rapid growth of the onshore wind sector in Scotland, and particularly in the Highlands, the associated supply chain has been expanding and innovating, creating jobs and a wealth of knowledge and expertise. Continuing to support the growth and development of this supply chain and skills base is essential to maintain the growth of the industry and take advantage of the enduring opportunity. As the UK Government lifts its nearly decade long de facto ban on onshore wind developments in England to help achieve its ambitions for 30GW in the UK by 2030 (double the current capacity), Scottish supply chain companies have a significant opportunity to play a key role in the development of an awakening English onshore wind industry.

12.13 The new wave of large-scale pumped hydro schemes in the region underscores the major opportunity that the hydrological resource in the region provides. There is also potential to convert existing conventional hydropower projects into pumped storage hydro in the future, with projects such as Sloy Power Station providing a blueprint for this.[307] Converting existing power stations offers significant advantages. As much of the infrastructure is already in place (e.g. dams, tunnels, generators and pipework), costs and development timescales are greatly reduced. It can also subvert the potentially expensive impact of repowering, or decommissioning current assets, ensuring maximum value is gleaned from these with contemporary developments.

Economic contribution and context

12.14 Scotland's natural assets mean that it has a wealth of natural capital that can be used to meet economic and societal need. Through its wind, water and tidal/wave resource, the Highlands and Islands is at the vanguard of renewable energy activity in Scotland. The current renewable energy capacity of the region is significant, and there is potential to increase capacity even further. This can be seen most clearly in respect of offshore wind, but also in generation and supply/storage across nearly all renewable energy technologies. The region can also leverage natural capital to support the development of onshore wind and pumped storage hydro projects, with these combined providing almost a quarter (24%) of the total investment value of the projects identified through this research. This demonstrates the extent to which the region's natural resource can contribute to net zero and other environmental and nature-based targets.

[307] https://www.sserenewables.com/news-and-views/2023/05/sse-unveils-redevelopment-plans-for-sloy-power-station/

12.15 It is estimated that Scotland's onshore wind sector supported around 10,120 FTE employment in 2020 (around 37% of all FTE employment supported by renewable technologies), and created £1,075m in GVA in 2020. Direct FTE jobs were estimated to be around 2,600.[308]

12.16 Figures on current employment and GVA in pumped storage hydro are not currently available, however it is estimated that hydropower technology more broadly supported around 4,395 FTE employment in 2020 (with 900 direct FTE jobs) and up to £495m in GVA.[309]

12.17 The onshore wind RTO projects identified in this study represent a total potential investment of around £10.89bn, creating up to 26,320 FTE jobs in construction and development phases and 6,260 direct operational and maintenance jobs. Even under the status-adjusted scenario, investment levels are around £7.39bn.

12.18 The pumped storage hydro RTO projects identified represent a total potential investment of around £13.2bn, creating up to 18,000 FTE jobs in construction and development phases and around 220 direct operational and maintenance jobs. Under the status-adjusted scenario, investment levels are around £9.2bn.

Competition

12.19 In terms of onshore wind, Scotland's most significant competition comes from Germany and Denmark, who are two of the leading countries in the development of onshore wind innovation and capacity in Europe. For example, onshore wind produced over 19.4TWh of electricity in Denmark in 2023[310] with the country producing significant innovation in areas such as advanced turbine efficiency, supported by significant companies such as Vestas and Siemens Gamesa.[311] Germany produced 114 TWh of electricity from onshore wind in 2023, supported by significant investment into research and development.[312] Both countries benefit from sophisticated grid connection and transmission infrastructure, also aided by the geography of the two countries.[313]

12.20 Scotland's competition in terms of pumped storage comes from countries with similar natural capital related to their geography and water resources which offer similar opportunities for the development of pumped storage hydro. In Europe this includes Norway, Sweden and Austria. Iceland also has significant potential in pumped storage hydro given its abundant resource, but its remoteness from the rest of Europe limits its ability to develop its vast hydro resource. While these countries already have power systems that are largely supplied by fossil free generation, they face significant demand increases over the next decade due to decarbonisation of industry and the electrification of transport. As such, all are looking to increase their pumped storage hydro capacity. Norway and Austria are also major power exporters to other European countries and are planning increased generation to also meet their export market demand.

[308] Economic Impact of Scotland's Renewable Energy Sector 2022 | FAI
[309] Economic Impact of Scotland's Renewable Energy Sector 2022 | FAI
[310] https://www.statista.com/topics/8770/wind-power-in-denmark/
[311] https://greenpowerdenmark.dk/files/media/winddenmark.dk/document/Profile_of_the_Danish_Wind_Industry.pdf
[312] https://www.cleanenergywire.org/factsheets/german-onshore-wind-power-output-business-and-perspectives
[313] https://www.cleanenergywire.org/factsheets/german-onshore-wind-power-output-business-and-perspectives

12.21 Norway has a long history of developing hydropower. It has several significant projects currently in the pipeline including the Illvatn project which has a planned capacity of 84GW.[314] Norwegian projects allow for a high level of efficiency in filling up pumped storage hydro units, which can reproduce 85% of the power required to fill them.[315] Austria is also embarking on building a new round of pumped storage hydro projects including the new 170MW Tauernmoos Pumped Hydro Storage Power Plant, which will be the first in the world to feature variable speed reversible turbines from GE Vernova.[316] This will offer faster response times for grid applications and better control over the system when pumping water, thus increasing efficiency and lowering costs. As a first mover project, Austria would have a technological advantage.

12.22 While the scale of the additional pumped storage hydro projects planned across these countries is not at the same level as Scotland, it nevertheless constitutes competition for supply chain resources and equipment supply.

Drivers of growth

12.23 The Climate Emergency and transition to net zero is a key driver for investment in both onshore wind and pumped storage hydro. As the backbone of the energy transition and to meet our energy security needs, a huge increase in variable power generation in the form of wind power, both onshore and offshore is required. This increases the need for longer duration energy storage such as pumped hydro storage as electrification is seen as a large element of the solution. Weather dependant energy generation requires backup systems for when there are periods of little or no wind and solar cannot produce power at night. Current battery technology offers short term storage of 4-6 hours, while pumped storage hydro can provide longer term storage solutions, with the ability to delivery power continuously for up to 36 hours. Any storage system capable of generating for over 6 hours is considered to be Long Duration Energy Storage (LDES), with pumped storage hydro is currently the only technology that can provide large scale LDES.

12.24 It has been estimated that in order to support UK Government carbon emission targets, Scottish pumped storage will need to meet 15GW in production capacity and 272GWh in storage capacity by 2050, requiring investment of £19-21bn.[317] The UK Government's Net Zero Strategy has set carbon capture targets of 20-30tCO_2e by 2030, supporting their broader target of becoming a net zero emissions producing country by 2050.

12.25 Reflecting this, UK Government have introduced a Cap and Floor support mechanism for Long Duration Energy Storage (LDES) which includes new PSH projects.[318] It aims to encourage LDES investment by providing a minimum revenue floor for LDES operators to manage high capital costs and long build times. The revenue cap then lowers cost for consumers. The first round of applications was opened by Ofgem on 8 April 2025 with an aim to approve the first projects by Q2 2026.

[314] https://www.renewableenergyworld.com/energy-storage/pumped-storage/84-gwh-pumped-storage-project-planned-for-norway/?related=post_cards
[315] https://blog.sintef.com/energy/norwegian-pumped-storage-hydropower-could-help-stabilise-electricity-prices/
[316] GE Verona - https://www.gevernova.com/news/press-releases/ge-vernova-awarded-contract-for-new-build-tauernmoos-pumped-hydro-storage-power-austria
[317] https://www.scottishrenewables.com/assets/000/003/039/The_Economic_Impact_of_Pumped_Storage_Hydro_original.pdf?1683649197
[318] https://www.ofgem.gov.uk/decision/long-duration-electricity-storage-cap-and-floor-application-window-1

12.26 Onshore wind turbines have an average asset life of 25 years. As a relatively mature sector in Scotland with ageing operational assets, decommissioning of old turbines will soon become a large-scale activity with as estimated 4,800 – 5,500 turbines to be decommissioned between 2021 and 2050 corresponding to 1.2-1.4m tonnes of materials[319]. Onshore wind projects face decisions around repowering existing projects, most often involving replacing existing turbines with updated models, or decommissioning projects altogether. Both these outcomes result in the need for recycling wind turbine components like blades, towers and nacelles. Already the Scottish supply chain has begun to respond to this demand as the first projects reach this stage, but it will need to scale-up to meet the increasing demand in both onshore wind and the emerging offshore wind sector.

12.27 Alongside this, operations and maintenance of installed projects provides a further increasing demand and opportunity for the supply chain from turbine maintenance and repair, to manufacturing and supply of replacement components. Ensuring the Highlands and Islands supply chain has sufficient capacity and people to feed this growing demand is pivotal to securing the longevity of the onshore wind industry in the region and retain maximum economic benefit.

Challenges, constraints, and market failures

12.28 The onshore wind industry faces similar challenges to that of its offshore counterpart in that, current grid infrastructure is insufficient to support the rate at which onshore projects are being developed, with risks of energy being curtailed without grid upgrades. Constraint payments for onshore wind Farms are commonly used to support those with curtailment, however this comes at a significant cost to the taxpayer with UK consumers compensating for £390 million of these payments in 2024, 98% of which were for Scottish wind farms.[320]

12.29 Onshore wind developments also commonly face more regulatory and planning obstructions than offshore wind, and the Scottish Government pledges that all onshore wind projects will also enhance biodiversity and support other environmental objectives.[321] Obstructions include visual and landscape barriers, where community consultation on their development can often lead to concerns and refusals based on landscape and visual amenity, specifically where developments are close to national parks and other cultural heritage landmarks.[322]

12.30 There is a lack of a stable and consistent framework for investment into pumped storage hydropower in the UK which commonly cause challenges for projects attempting to attract private investment. As noted above, the UK Government has recently introduced a cap and floor mechanism for Long Duration Electricity Storage to help stimulate investment into pumped storage hydro. However, concerns persist surrounding the effectiveness of this with the exact details of the measures, such as eligibility, and delivery of the scheme still being ironed out.

12.31 The physical size of the onshore wind turbines has been increasing in recent years as developers seek to maximise the generating capacity of their sites. Given the sheer number of wind turbines involved in the project pipeline, there are challenges in terms of the road network as

[319] Zero Waste Scotland, 2021. *The future of onshore wind decommissioning in Scotland: Summary*. Available: https://cdn.zerowastescotland.org.uk/managed-downloads/mf-pmcv5yvc-1679501141d
[320] https://www.energyvoice.com/renewables-energy-transition/wind/uk-wind/565451/scottish-wind-farm-constraint-payments-rise-to-380m
[321] https://www.gov.scot/publications/onshore-wind-sector-deal-scotland/pages/6/
[322] https://www.pinsentmasons.com/out-law/analysis/npf4-benefiting-onshore-wind-development-in-scotland-one-year-in

access routes are unsuitable for the type of loads required to deliver equipment and material to sites. Any pinch points for road access, such as bridge loads being exceeded or nearby ports lacking large component handling capability needs to be addressed in a timely manner.

12.32 The scale of proposed pumped storage hydro schemes across the region and lengthy build times (around 4-6 years) will likely mean an overlap in project development timescales. As such, access to technology, supply chain and the necessary workforce and skills will be significant constraints. Ensuring access to appropriate accommodation for workers will also be a challenge, particularly given the rural location of many projects. The British Hydropower Association, in conjunction with a number of other stakeholders including HIE, are forming a developer forum with the aim of exploring areas of collaboration between the developers themselves and with other stakeholders. Legacy housing solutions are one of the areas to be explored through this collaborative approach.

12.33 As with onshore wind, transport is another significant challenge given the location of proposed pumped storage hydro schemes within the region. Again, the suitability of road network access routes for equipment and material is a concern, and there are already issues emerging with bridge load capacity at some sites (e.g. Glen Orch Bridge for Cruachan II). The volume of traffic coming to and from sites on a daily to weekly basis at peak construction periods will also increase congestion on the road networks. This may be acute during the tourist season.

12.34 Transporting heavy loads at night could be a solution but this is also likely to cause noise issues when transiting through communities on these trunk roads. Alternatives are already being explored in an effort to reduce this type of impact. Using the Caledonian Canal to transport abnormal loads for pumped storage hydro developments in close proximity to the canal (e.g. at Loch Ness and Loch Lochy) is one potential option currently under consideration. However, it comes with a cost related to upgrading the canal's infrastructure to be fit for commercial transport.

12.35 Current restrictions on the capacity of Police Scotland to provide the necessary escorts for abnormal loads may hinder or delay delivery of the generators and transformers needed for pumped storage hydro developments. This is due to the demand for these same police escort services coming from other sectors, including onshore wind project construction for the transport of the tower, blade and turbine components from ports to wind farm construction sites. With over 15GW of onshore wind in the Scottish project pipeline, many of these projects will have construction timelines which will coincide with those of the pumped storage hydro developments, and all will require police escorts for abnormal loads.

12.36 With the proposed construction of the first major pumped storage hydro projects in Scotland for over 50 years the issue of access to water resources will be key to delivery. Cumulative impact is not something that has had to be considered by planning and water regulators in recent times, except in relation to projects on Loch Ness. The Foyers pumped storage hydro project on Loch Ness is already operational and the Loch na Cathrach, also at Loch Ness, has been consented. There are also two other projects in the planning process that are aiming to utilise Loch Ness as their bottom reservoir. Questions around the management of the water level in Loch Ness and the Caledonian Canal have already arisen and these subsequent projects may find that current solutions to this management issue will lead to capacity restrictions or loss of efficiency for these projects.

12.37 The impact of climate change already on ecosystems will need to be mitigated as far as possible if the region's Natural Capital is to support social, economic, and environmental wellbeing over the long term. Changes to rainfall patterns across the Highlands and Islands can have significant consequences for water and flood management – and thus for hydro-electric generation, amongst other activities. However, other challenges will have to be contended with: the cost of damage arising from extreme weather events such as flooding are increasing; investment in protection, mitigation and adaptation measures will need to increase as a result; and the need for careful management of natural resources is increasing in line with the unpredictability of a highly energised atmosphere that is generating more frequent and more intense extreme weather events. As such, there is an argument for a move to resilience measures and nature-based solutions rather than protection (e.g. flood protection), so that communities can realise benefits as climate change risks and impacts increase.[323] However, this may have implications for how the region's Natural Capital is utilised for socio-economic gain.

Priorities for action

- The wealth of natural resources across the Highlands and Islands put the region at the vanguard of both renewable energy generation and decarbonisation of energy supply, and also climate change, adaptation and mitigation measures. Opportunities to secure benefits from the region's wind and water resources should be pursued in as responsible and sustainable a manner as possible.
- Ongoing support towards the onshore wind supply chain to both maintain the existing activity and to build capacity and capability for the growing market is critical. Supporting businesses to identify and take advantage of these opportunities, and the potential transferable opportunities to offshore wind, will help to capture increased economic benefit from the sector.
- Maintaining the infrastructure investment and capacity for onshore wind is critical to supporting successful delivery of the future project pipeline. This includes developing infrastructure (ports and road networks) in critical locations to support delivery of projects in rural locations such as northwest Sutherland, the Isle of Skye, and Argyll and Bute.
- Innovative solutions to onshore wind component transport and onsite construction techniques need to be explored if many of the remote rural high-capacity wind sites are to be accessed by the industry.
- Road and infrastructure access is a challenge for the transportation of onshore wind turbines given the physical size of the turbines and the volume involved in the project pipeline. Any pinch points for road access, such as bridge loads being exceeded or nearby ports lacking large component handling capability needs to be addressed in a timely manner.
- Similarly, there is a need to explore solutions to remove transport related barriers arising during the construction of pumped storage hydro projects. This should include consideration of road congestion management solutions, greater use of canals for commercial transport and provision of Police Scotland abnormal load escorts. Collaboration will likely include the PSH Developer Forum, Transport Scotland, Highland Council and Argyll and Bute Council.

[323] See for example: ekosgen, for *Scottish Government (2024) Water Management, Flooding and Coastal Erosion: Socio-economic research – Summary report for Scottish Government*, which sets out a useful synopsis of the literature around water resource management in Scotland

- Potential impacts from the current and planned future pumped storage hydro projects on water resource management should be considered and planned for to ensure this does not constrain, or provide a barrier to, project development. This is particularly relevant for the Loch Ness environment and catchment area.
- There is a need for evidence-based skills planning for the construction phase of pumped storage hydro sector, building on exiting collaboration between skills providers and industry, including the PHS Developer Forum. Barriers to investing in skills, such as confirmation of when employment opportunities will come on stream and the need for worker accommodation must be explored as part of workforce delivery models.
- There is a need to achieve social license. This will help to overcome information asymmetry and misunderstanding, and secure community support. It will also help to better root activity in a particular locale and contribute to community wealth building objectives.
- Alongside activity to derive economic, social and environmental benefit from the region's wind and water, consideration must be given to how best to manage natural resources in light of the Climate Emergency, and the need to improve resilience in the face of climate change impacts including increased extreme weather events. Pumped Storage Hydro – should be planned with a contribution to climate resilience in mind (for example, contributing to the management of water stream flows).

13 Other transformational natural assets

Headlines

- The Highlands and Islands is well-placed to exploit opportunities offered to it through use of its natural resources, helping to support the transition to Net Zero. Potential opportunities identified through this research include improved biodiversity, carbon sequestration with peatland and forestry key natural assets for the region.
- The total annual value of natural capital and ecosystem services in Scotland was estimated to be £5.9bn (excluding Oil and Gas) using Natural Capital Accounting.
- Up to £2.4bn of regional domestic expenditure, £7.2bn of economic output, and up to 53,900 jobs are reliant on natural capital, in the Highlands and Islands. Yet much of the value of ecosystem services are essentially undervalued by conventional statistical systems measuring economic activity.
- Terrestrial carbon sequestration is a major opportunity for the region. Programmes such as Peatland ACTION and Peatland Code are already supporting restoration activity through which carbon credits can be sold.
- UNESCO World Heritage designation for the Flow Country is an additional opportunity for habitat restoration, peatland carbon sequestration and selling high-prestige carbon (and potentially biodiversity/habitat) credits to fund activity.
- There is also a raft of ecosystem services opportunities that can be exploited for the social, economic and environmental benefit of the region.
- Sectors such as peatland restoration, forestation and habitat restoration need greater levels of support to develop and grow. As well as business support, public sector intervention is required to ensure that impacts and benefits are firmly rooted in local areas.
- Local capacity to deliver natural capital activity is a challenge, due to lack of population density for sufficient workforce, lack of density in the business base, lack of capacity in local communities to support natural capital schemes, and the constraining effect of structural inequalities in the region.

Context

13.1 Natural capital can be considered the stock of renewable and non-renewable resources (natural assets including geology, soil, air, water and plants, and animals) that combine to yield a flow of benefits to people[324], and is defined as such in the NSET.[325] Scotland has a wide range of these habitats and ecosystems, each of which makes a unique contribution to the wellbeing of those who live and work in Scotland.[326] These benefits that contribute to wellbeing – whether economic, social, or environmental – can be considered ecosystem services: the direct and indirect contributions to human wellbeing and quality of life.[327]

[324] See for example: https://seea.un.org/content/natural-capital-and-ecosystem-services-faq
[325] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[326] https://www.nature.scot/professional-advice/social-and-economic-benefits-nature/natural-capital
[327] https://www.nature.scot/scotlands-biodiversity/scottish-biodiversity-strategy-and-cop15/ecosystem-approach/ecosystem-services-natures-benefits

13.2 Increasing attention is being placed on Scotland's natural capital, not just because of the benefits to Scotland's population, but also to the economic value of natural capital to the Scottish Economy. Recent research suggests that an estimated £40.1bn of value and around 261,000 jobs in the Scottish economy are reliant on Scotland's natural capital.[328] It identified the Highlands and Islands as one of the regions of Scotland most reliant on natural capital due to the dominance of the agriculture, forestry, renewable energy, fishing and aquaculture industries within the economy. Up to 40% of regional domestic expenditure and 54,000 jobs are reliant on natural capital. The Highlands and Islands is also one of the regions with a high share of key habitats providing ecosystem services, putting it at the forefront of natural capital activity. [329]

13.3 Given that a significant proportion of Scotland's natural capital assets are in the Highlands and Islands, the importance of the region's natural capital in combatting climate change cannot be understated. The scale of opportunity associated with this is considerable and will create substantial economic benefits in terms of new skilled green jobs and investment, particularly in some of our more rural and island communities. Also, the environmental gains that can be realised through habitat and ecosystem restoration or creation can potentially help to significantly offset negative environmental impacts elsewhere in Scotland, and indeed the UK.

13.4 Key components of natural capital assets for the Highlands and Islands include peatland and forestry, as well as wind, water and hydrological assets across the region. This is in addition to the abundant wave and tidal resources that exist in the territorial waters around the Highlands and Islands, and also Scotland's wind resource. Previous chapters have looked at sectors related to wind and water – offshore and onshore wind, marine energy, and pumped storage hydro. This chapter explores other natural capital and assets, focusing on peatlands and forestry.

13.5 Land use, land use change and forestry are currently one of the region's largest emitters of greenhouse gases. However, there is potential to turn this around, and peatland restoration and afforestation are critical to ensuring that both regional and national climate change targets are met. More than half of the land area of the Highlands and Islands is peatland that is suitable for restoration and the region contains 71% of rough grazing land in Scotland which, at least to some extent, has the potential to be transformed into woodland to support carbon sequestration opportunities.[330] Thus the potential is both to help reduce or offset the region's – and Scotland's – carbon emissions, and to facilitate a Just Transition to Net Zero.

13.6 **Peatland** covers over a third (39%) of Scotland's land mass.[331] Around three-quarters of Scotland's peatland is located in the Highlands and Islands, with over half (56%) of the region's land covered by peat and peaty soils.[332] The huge reserves of peatlands in the Highlands and Islands, in their natural state, are a carbon store – and peatlands are by far the world's most efficient terrestrial carbon store. For example, the Flow Country in Caithness and Sutherland is Europe's largest area of blanket bog peatland, extending to 494,210 acres (200,000 hectares). These reserves are Scotland's largest terrestrial carbon store, holding around 1.6 bn tonnes of carbon. However, much of the peatland resource in the region, and across Scotland, is significantly degraded or eroded.[333]

[328] https://www.gov.scot/publications/importance-natural-capital-scottish-economy/documents/
[329] Ibid.
[330] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[331] Ibid.
[332] Baselining Inventory for Greenhouse Gas Emissions | HIE
[333] Ibid.

13.7 Degradation has, over time, largely been a result of land use practices and coupled with climate change, there is a risk that many areas in Scotland may not be able to support peatlands in the near future. The potential losses of carbon have been calculated and show that more than half of the carbon currently stored in Scottish blanket bogs will be at risk of loss as emissions arising from peatland degradation. There is an opportunity to restore the peatlands to enhance their capacity to maintain carbon stocks and the Scottish Government's Climate Change Plan has set a target to restore 250,000ha of degraded peatlands by 2030.[334]

13.8 Peatland restoration incorporates multiple means of restoring degraded or eroded areas of peatland which, when restored, offer significant carbon sequestration potential. Restoring peatland typically involves increasing the level of the water table in the land to ensure more of the land is submerged. Methods of doing this can include creating peat dams to restrict movement of the water and keep the water table level high, peat bunds which are smaller dams to restore cracks in the peat which allow water to escape, and relocating sections of peatland to restore vegetation and other materials which can improve the condition of the peatland. The type of restoration technique is usually dictated by the type and condition of the peatland, and the resources available.

13.9 Many restoration projects currently underway are either supported by the Peatland Code[335] – the certification standard for peatland restoration in the UK, which assures carbon credits available through peatland restoration and bought by voluntary carbon market buyers[336] – or through NatureScot's Peatland ACTION Programme[337], who have committed £250m towards peatland restoration by 2030.

13.10 Both programmes fund on-the-ground restoration activities, including the installation of peat dams to raise water levels or revegetating peat hag to stabilise eroding peat. Since 2012, Peatland ACTION has helped to restore over 193,000ha of peatland in Scotland, with a significant majority (70%) of this being in the Highlands and Islands.[338]

13.11 Research indicates that at current peatland restoration rates, over 2 million CO_2e units could be sequestered per annum in the Highlands and Islands, with this potentially rising to just under 3 million CO_2e units if the rate of peatland restoration is increased by 10-25%.[339]

13.12 However, there is a high degree of variance in the level of peatland restoration across local authorities in the Highlands and Islands. For example, despite its size, Na h-Eileanan Siar has the second highest level of carbon emissions in the region due to the level of peatland degradation, and has one of the lowest rates of restoration with around 0.01% of degraded peatland restored per year. Comparatively, Highland is the largest local authority in the region, and has a rate of restoration higher than that of the region as a whole.

13.13 **Forestry** is a significant natural asset in the Highlands and Islands. Scotland has the highest proportion of forest and woodland coverage in the UK.[340] Around 18% of Scotland's land area is covered by forestry and woodland (as of 31 March 2024), having increased significantly

[334] https://www.nature.scot/climate-change/nature-based-solutions/peatland-action
[335] https://www.forestcarbon.co.uk/certification/the-peatland-code
[336] https://www.iucn-uk-peatlandprogramme.org/peatland-code/introduction-peatland-code
[337] https://www.nature.scot/climate-change/nature-based-solutions/peatland-action
[338] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[339] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[340] https://www.gov.scot/publications/scotlands-forestry-strategy-20192029/

from 5% coverage 100 years ago. Scotland's forest and woodland area now covers more than 1.5 million hectares[341] with around half of this located in the Highlands and Islands.

13.14 Based on 2019 National Forest Inventory (NFI) data prepared by the Forestry Commission for Great Britain, around 17% of the region is covered by woodland, with Moray (29.9%) and Argyll and Bute (29.5%) having the greatest level of woodland coverage. This accounts for all woodland and forestry which is over 0.5 hectare with over 20% canopy cover, or potential to achieve it, and a minimum width of 20 metres.[342]

Table 12.1: Woodland cover by local authority in the Highlands and Islands, 2019

Local authority name	Local authority area (hectares)	Area of land which is woodland cover (hectares)	Percentage of land which is woodland cover
Argyll and Bute[343]	700,563	206,712	29.5%
Na h-Eileanan Siar	309,386	3,367	1.1%
Highland	2,616,881	417,096	15.9%
Moray	223,969	67,058	29.9%
Orkney Islands	101,488	209	0.2%
Shetland Islands	147,000	50	<0.1%
Highlands and Islands	4,099,289	694,493	16.9%
Scotland	7,884,072	1,438,075	18.2%

Source: Friends of the Earth (2019), based on Forestry Commission NFI data

13.15 As with peatland restoration, forestation and reforestation offers an opportunity for the region with regard to carbon sequestration activity, as well as in providing wider ecosystem services such as water and flood management, biodiversity, and community benefits (e.g. leisure, health and wellbeing). Creation and maintenance of woodlands generates the need for skilled jobs, for example specialist skills required when managing ancient and veteran trees.[344] Such projects can also encourage greater levels of community engagement and have a positive impact on environmental education and community development, e.g. through volunteering or school projects. This can also contribute to community wealth building, through creation of a number of different capitals in community-owned woodland creation schemes: new financial capital (from carbon trading or timber revenues), social capital (co-operation, new capacity, and associations), individual capital (jobs), natural capital (generating ecosystem services) and built capital (if designing trails, recreational facilities or campsites).[345] These additional social and environmental benefits can be 'stacked' on top of the carbon benefit of sequestration activity.

[341] https://www.forestresearch.gov.uk/tools-and-resources/statistics/publications/woodland-statistics/
[342] https://data-forestry.opendata.arcgis.com/
[343] Arran and Cumbrae data not available: estimate from Forestry and Land Scotland suggest around a quarter of Arran is forested. https://forestryandland.gov.scot/visit/arranhttps://forestryandland.gov.scot/visit/arranhttps://forestryandland.gov.scot/visit/arran The Cumbrae Community Climate Action Plan identifies that LULUCF was a carbon sink for Cumbrae, with the majority of removals attributed to forest land https://carbonneutralcumbrae.co.uk/wp-content/uploads/2023/06/DIGITAL-Cumbrae-CCAP-Final.pdfhttps://carbonneutralcumbrae.co.uk/wp-content/uploads/2023/06/DIGITAL-Cumbrae-CCAP-Final.pdf
[344] https://www.gov.uk/government/news/woodland-projects-across-england-to-receive-funding-for-jobs-training-and-increasing-tree-cover
[345] Lyman, M, Grimm, C & Evans, J, 2014. *Community forests as a wealth creation strategy for rural communities* in Community Development Vol. 45.

13.16 The marine environment is also a vitally important resource for the region. It has long supported key industries for the region, such as commercial capture fishing and aquaculture. Increasingly, the marine resource around the Highlands and Islands is a source of renewable energy generation, as discussed in previous chapters with regard to offshore wind, onshore wind and pumped storage hydro and marine energy. Additionally, with almost two thirds of the UK's coastline, the Highlands and Islands is well-positioned to act as a valuable innovation and test area for marine environmental services and related technologies, including carbon sequestration. This is an area that is gaining increasing interest. Oceans absorb roughly 25 percent of carbon dioxide emitted from human activities annually. However, Oceanic restoration can be an expensive method of sequestering carbon, as discussed below with regard to challenges.

13.17 Importantly, there has been a shift in how natural assets are viewed in recent years across all natural capital areas. There has been an evolution from extractive approaches that sees natural assets as unlimited economic assets to be exploited, to approaches that consider natural capital as a finite resource that must be carefully managed. A responsible use of natural assets is essential to the long-term sustainability of the region's and Scotland's natural capital.

Current project activity

13.18 The Scottish Government's Nature Restoration Fund is managed by Nature Scotland, and currently provides funding for over 140 projects, with a combined total value of over £40m.[346] The most recent round of funding in April 2024 saw £7.8m in funding provided to 14 projects, ranging from forestry protection and expansion, species reintegration, and controlling invasive species, to creation of wetlands and river restoration.[347] Multiple projects in the Highlands and Islands received funding during this round including the four detailed below.

- The Knapdale Rhododendron Control project, delivered by Argyll and the Isles Coast and Countryside Trust is running until March 2026, received £935,438 in funding to reduce the rhododendron ponticum population in Argyll's rainforest area.[348]

- Saving Morvern's Rainforests, led by RSPB Scotland is restoring rainforest in 200 square miles around Mull Sound and Loch Linnie, this includes eradicating Rhododendron. The project will span five years, receiving in surplus of £3 million.[349]

- Regenerating Craignish Rainforest Habitats is a project run by Woodland Trust to restore around 2,500ha of depleted rainforest in a five-mile-long peninsula between Loch Craignish and the Sound of Jura in West Argyll.[350] The project has received £100,000 with activities including better data collection on the impacts of deer grazing and rhododendron.

- Appin Community Development Trust received £44,500 in funding to support controlling rhododendron ponticum.[351]

[346] https://www.nature.scot/funding-and-projects/scottish-government-nature-restoration-fund-nrf
[347] https://www.nature.scot/projects-share-ps78m-restore-risk-habitats-and-species
[348] https://www.act-now.org.uk/news/argylls-rainforest-north-knapdale-rhododendron-control-secures-nrf-funding
[349] https://savingscotlandsrainforest.org.uk/in-delivery/saving-morverns-rainforest-xhznt
[350] https://savingscotlandsrainforest.org.uk/in-development/craignish
[351] https://presscentre.nature.scot/news/projects-share-gbp-7-8m-to-restore-at-risk-habitats-and-species

13.19 Scotland has significant areas of vegetation and other natural heritage which is vital to the ecosystem including areas of Celtic rainforest, and the Flow Country area of peatland in north Highland. Over a third of Scotland's land is peatland, and approximately 2m hectares of this is in an eroded or modified state.[352] Likewise, forest cover in Scotland fell to a low of 5% in the early 20th century and although concerted efforts have increased this to around 18% today, this still lags significantly behind many European competitors.[353]

13.20 However, the reforestation and carbon sequestration industries are restoring these areas and can provide significant economic benefits. It's estimated that reforestation can provide employment for up to one FTE per hectare for site preparation and planting, and up to 0.08 FTE per hectare for management. Silvopasture practices of integrating trees into livestock management to tackle methane production can support up to 0.07 FTE per hectare for preparation and 0.16 FTE per hectare for planting and management, and peatland restoration can support 1.1-1.2 FTE per hectare on typical restoration projects. Scottish Government targets aim to increase woodland cover by 3% by 2032, which accounts for over 100,000 hectares of woodland, potentially supporting as many jobs, if the target is achieved.[354]

13.21 The International Union for Conservation of Nature (IUCN) has revealed that there are 196 current peatland restoration projects for Peatland ACTION covering a registered 26,612ha of peatland with an estimated total reduction of 2,567,296 tCO2e when all projects are completed.[355] There is around 400,000ha of peatlands in North Highland alone, of which 180,000ha is estimated to be degraded, with 126,000ha being practically able to be restored. Efforts to restore this entire area will likely cost £210-215m and provide 10 years of employment for around 74 people.

13.22 Two projects based in the Flow Country within this have had their estimated carbon reduction and land restoration validated by Peatland ACTION and are now underway. The first of these is the Glutt Estate Project 1. It has a project area of 963ha in which it aims to restore upland blanket bog damaged by draining haggs, gullies and artificial drains.[356] The 100-year project has an estimated carbon reduction of 637tCO2e per year, validated by the Peatland Code methodology, resulting in a total carbon emission reduction of 63,713tCO2e.[357]

13.23 Bighouse Phase 1 is the second project to have its estimates validated by the Peatland Code and to reach the operational stage. This project will also span 100 years and will restore an area of 140.17ha in Melvich, Sutherland, by reprofiling exposed and eroded peatland using a series of dams and blockers (680 peat dams, 80 plastic piled dams and 20 timber dams). The estimated total carbon emission reduction of this project is 24,318tCO_2e.[358]

13.24 There is a relatively supportive policy environment for natural capital in Scotland and the UK. There are a range of strategies which provide a strong framework for the investment, collaboration, and management of natural capital including the Interim Principles for Responsible Investment in Natural Capital[359], and Scottish Biodiversity Strategy to 2045.[360]. These also largely

[352] https://www.gov.scot/publications/mobilising-private-investment-natural-capital/
[353] https://www.gov.scot/publications/scotlands-forestry-strategy-2019-29-strategic-environmental-assessment-environmental-report/documents/
[354] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[355] https://www.iucn-uk-peatlandprogramme.org/peatland-code/peatland-code-registry
[356] https://www.iucn-uk-peatlandprogramme.org/glutt-1
[357] The Economic Impact and Business Potential of Peatland Restoration, 4C Engineering
[358] https://web.kana.earth/p/project/0a25ef52-33dc-4ea6-9a20-10bfef6e215f/documents
[359] https://www.hie.co.uk/media/kc5b4yl1/hie-strategy-2023-28-online.pdf
[360] https://www.gov.scot/publications/scottish-biodiversity-strategy-2045/documents/

prioritises research and innovation into natural capital and provide a framework for monitoring the progress of assets against net zero targets, ensuring accountability for this. Table A.2.7 provides a brief description of key policy or strategy documents for the natural capital sector.

13.25 The major opportunity in natural capital is the strength, quality and abundance of natural assets in the Highlands and Islands. The scale of the region's natural assets presents an opportunity for the area with regard to carbon sequestration activity. Terrestrial biological approaches – such as through forestation or peatland restoration – are the most feasible sequestration approaches currently. As discussed above, the designation of Scotland's Flow Country peatland asset as a UNESCO World Heritage Site in July 2024 is an additional opportunity for habitat restoration and peatland carbon sequestration.[361]

13.26 There are also opportunities through the marine environment, over and above those highlighted with regard to marine energy, onshore and offshore wind in preceding chapters. There is increasing attention in the carbon sequestration potential of sediment deposits, in estuarine and fluvial deposits in sea lochs and firths, and also under shellfish beds (e.g. oysters), as well as seagrass, seaweed, etc. For example, SSEN Distribution have recently partnered with the Scottish Marine Environmental Enhancement Fund (SMEEF) to plant 14 hectares of seagrass over the next three years through a £2.4m million initiative, being delivered through four projects in the waters around the Highlands and Islands.[362] The region is home to extremely valuable but underused marine environmental resources that could potentially support marine-based carbon sequestration activity in future. With almost two thirds of the UK's coastline, the Highlands and Islands is well-positioned to act as a valuable innovation and test area for marine environmental services and related technologies, including carbon sequestration.

13.27 In addition to the opportunities set out above, there are also a raft of opportunities through ecosystem services, for example across water and flood management, soil management, biodiversity, etc. as well as community and health and wellbeing benefits. For example:

- Improved biodiversity and habitat creation through peatland restoration and woodland creation;
- Carefully planted patches of woodland across a river basin can reduce the river flow velocity[363], and upland and river floodplain woodland can reduce water run-off by intercepting, using and recycling more rainwater than grassland, thus reducing the risk of floods in communities[364];
- Reduced run-off from restored peatland and upland wetland and bogs improves water management and reduces the rate of run-off (and thus water flow) into rivers;
- Woodlands can have a positive effect on water quality, by acting as a water filter[365], and can also affect air quality by absorbing harmful gases and removing particulate pollution[366];

[361] https://www.iucn-uk-peatlandprogramme.org/news/scottish-peatland-recognised-globally-important-unesco-world-heritage-site-designation
[362] https://www.ssen.co.uk/news-views/2025/SSEN-SMEEF-Scotland-seagrass-planting-scheme-partnership/
[363] https://carbonstoreuk.com/publications/the-wider-benefits-of-woodland-creation/
[364] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1078625/The_Case_for_Trees_WEB_May_2022.pdf
[365] e.g. see https://acsess.onlinelibrary.wiley.com/doi/10.2134/jeq2019.01.0020
[366] https://www.woodlandtrust.org.uk/trees-woods-and-wildlife/british-trees/tackling-air-pollution-with-trees/

- Peatland restoration and woodland creation projects can help reduce soil erosion and manage soil and nutrient losses[367]; and
- Peatland restoration and woodland creation projects encourage community engagement. Also, Woodlands can be used for leisure outdoor activities, bringing benefits for individuals' physical and mental health, and their social well-being.[368] 369

13.28 A further opportunity identified through consultation is capturing the wider value associated with peatland or habitat restoration and forestation projects. One consultee suggested that for some land transactions, e.g. for forestry, if small portions of land can be given to a community, then this may enable those communities to exploit the relative difference in price per hectare of land for forestry versus housing and borrow against the value of the land to build essential affordable housing. This in turn would generate revenue for the community from the sale of the housing. It would also secure greater intangible value for the communities that are able to do this through the families that move to and settle in those communities, thus increasing community resilience and viability – and also contributing to population retention in the region.

Economic contribution and context

13.29 There are two major areas of activity in the natural capital market: restoration, planting, and rewilding, either for habitat restoration, carbon sequestration or responses to the effects of climate change (i.e. for mitigation or adaptation); or for the utilisation of natural resources for economic purposes – typically energy generation, or timber production through forestry plantations. Scotland's natural assets mean that it has a wealth of natural capital that can be used to meet economic and societal need.

13.30 Estimating the value of natural capital and ecosystem services is complex. The UK Natural Capital Accounts (NCAs) produced by the Office for National Statistics (ONS) take a range of ecosystem services and aim to value, in monetary terms, the benefits they currently bring to society.[370] They are viewed as minimum value of the services provided by the natural environment as not all services can be monetised accurately at present. Recent Scottish Government analysis of NCA data shows that in 2022, the total annual value of ecosystem services in Scotland was estimated to be £5.9bn (rising to £38.7bn when including oil and gas). As such, Scotland contributes 12% of the total UK annual value (44% including oil and gas). This value includes renewable electricity and water. The natural capital asset value for Scotland in 2022 was an estimated £142.2bn (£254.7bn including oil and gas). This is a measure of the stock of ecosystem services and takes into consideration their future expected supply.[371]

Natural capital contributes

£47.5bn

per annum to the UK economy

£5.9bn

is within the Scottish economy

[367] e.g.: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1078625/The_Case_for_Trees_WEB_May_2022.pdf

[368] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1078625/The_Case_for_Trees_WEB_May_2022.pdf

[369] e.g.: Lyman, M, Grimm, C & Evans, J, 2014. *Community forests as a wealth creation strategy for rural communities* in Community Development Vol. 45.

[370] https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2024

[371] https://www.gov.scot/publications/summary-of-scottish-data-from-uk-natural-capital-accounts-2024/

13.31 However, it is worth noting that this value is different to that discussed earlier with regard to the economic dependency on natural capital. NCA data is a narrower economic consideration of natural capital. Consequently, the Scottish Government intends to change its approach to NCA reporting, with a broader report on a range of complementary natural capital analyses for Scotland planned for 2025.[372] Meanwhile, recent research produced by WSP and Economics for the Environment Consultancy (eftec) on behalf of the Scottish Government estimates that up to £2.4bn of regional domestic expenditure, £7.2bn of economic output, and up to 53,900 jobs in the Highlands and Islands area are reliant on natural capital (equivalent to c.21% of total Scottish expenditure, output, and jobs reliant on natural capital).[373] However, the research also identified a number of key aspects regarding the valuation of natural capital. In particular:

- Provisioning ecosystem services are highly valuable for certain industries but these are not captured in conventional statistical systems measuring economic activity;
- The market value of natural capital may not accurately reflect the relative importance of natural capital to an industry. Metrics such as gross domestic product (GDP) and gross value added (GVA) do not capture the value of natural capital except where it provides revenue on the market;
- Only 27% of provisioning ecosystem services can be substituted by engineering solutions or human interventions. This shows the limited ability of our economic system to replace essential ecosystem services; and
- The link between habitats, ecosystem services and economic impacts emphasises the importance of maintaining Natural Capital.

13.32 Globally, the scale of the benefits from ecosystem services is estimated at US$125 trillion each year, an amount that is 1.5 times global GDP, and more than half of global GDP is moderately or highly dependent on nature.[374] However, nature markets are only valued at $9.8 trillion in terms of goods and services, mostly from commodity production including agriculture and timber, and the costs of loss of Natural Capital and Ecosystem Services (NCES) are not fully priced.[375]

Competition

13.33 The UK is in the top 50 most cost efficient countries in the world for carbon sequestration through afforestation (25th), and forest conservation (38th), however, this is also shared by the majority of North and South America, and Europe.[376] The UK is significantly behind neighbours Ireland who are 4th for afforestation, and 6th for forest conservation, and countries such as Uruguay, Bolivia, Gabon and Guyana, who occupy other spaces on the top 10.

13.34 China has the world's largest area of planted forest, although it is not recognised in the most cost efficient, or proactive countries, often struggling to balance the demands of other industries such as timber and agriculture.[377] China is anticipated however to become hugely

[372] Ibid.
[373] https://www.gov.scot/publications/importance-natural-capital-scottish-economy/
[374] https://www.financeministersforclimate.org/sites/cape/files/inline-files/GPS_World%20Bank_NCA%20and%20Valuation%20of%20ES%20to%20Inform%20Policies-CFM%20July%202024.pdf
[375] https://www.mckinsey.com/capabilities/sustainability/our-insights/sustainability-blog/the-state-of-nature-markets-today-and-tomorrow
[376] https://one.oecd.org/document/ENV/WKP%282021%2917/En/pdf
[377] https://www.nature.com/articles/s41559-023-02198-3

important in global carbon sequestration with capacity to absorb up to 22% of the country's fossil fuel based carbon emissions between 2020, and 2050. The Chinese Government has pledged to expand its planted forest area by 49.5 m hectares from 2021 to support this.[378] Costa Rica is a current global leader in carbon sequestration using forestry and is the first tropical country to have reversed deforestation as recognised by the World Bank.[379]

Drivers of growth

Market drivers

13.35 The twin crises of Climate Emergency and Nature Emergency are drivers for investment in natural capital. Put simply, restoration of landscapes and habitats to secure climate, environmental and biodiversity benefits is helping to stimulate private investment. Since the launch of the Nature Restoration Fund, the Scottish Biodiversity Delivery Plan 2024-2030[380] has been published to guide investment through the Nature Restoration Fund, woodland grants, philanthropic investment and private finance (e.g. Peatland Code and Woodland Carbon Code), and mechanisms such as Peatland ACTION. While emission reduction is ultimately preferential to carbon capture, the Scottish Government are also aiming to utilise natural capital to support with decarbonisation.

13.36 The Scottish Government has set a target of restoring 250,000 ha of degraded and eroded peatland by 2030, committing funding of £250m to achieve this.[381,382] This is done through the Peatland ACTION programme, which provides support for peatland restoration projects, also providing a verified methodology for evaluating restoration efforts and the impacts of these.[383]

13.37 Investment in Scotland's natural capital must adhere to six key Scottish Government principles, to ensure it provides social and economic benefits.[384] These are:

- Support diverse and productive land ownership; consideration is given to the best means of ownership i.e. it may be more suitable for the investor to support community land management;
- Deliver integrated land use; the implications of investment are considered across all four capitals (human, economic, natural, social);
- Deliver public, private and community benefit; ensure investment benefits all in society and contributes towards the principles of a just transition;
- Demonstrate engagement and collaboration; communities and other relevant stakeholders must be integral to decision making on land use and development;
- Be ethical and values-led; investment aligns with the UN Principles for Responsible Investment, as well as Just Transition, Fair Work and Land Rights and Responsibilities and Global Capital Investment policies; and

[378] https://chineseclimatepolicy.oxfordenergy.org/book-content/domestic-policies/forestry/
[379] https://www.worldbank.org/en/news/feature/2022/11/16/costa-rica-s-forest-conservation-pays-off
[380] https://www.gov.scot/publications/scottish-biodiversity-delivery-plan-20242030/
[381] https://www.gov.scot/news/record-high-peatland-restoration
[382] https://www.gov.scot/publications/mobilising-private-investment-natural-capital/
[383] https://www.nature.scot/climate-change/nature-based-solutions/peatland-action
[384] https://www.gov.scot/publications/interim-principles-for-responsible-investment-in-natural-capital/

- Be of high environmental integrity; results are measurable against a reliable metric such as the Peatland Carbon Code, set processes are adhered to, and all parties involved in the investment are informed and reliable.

13.38 Designations such as UNESCO World Heritage status for the Flow Country can act as a catalyst for stimulating growth in industries related to natural capital and restoration. For example, UNESCO World Heritage status can increase the prestige associated with restoring peatland in Flow Country, in addition to the prestige and high quality already associated with peatland restoration and carbon credits in Scotland (the 'Scottish premium').

13.39 In line with this opportunity, the Flow Country Partnership has established Flow Country Restoration Ltd., to sell high-quality and high-value carbon credits firmly rooted in place around the Flow Country and more widely in Sutherland. As one consultee noted:

'The Flow Country is the only place in the world where a buyer can buy a World Heritage carbon credit just now.'

13.40 UNESCO World Heritage designation may also drive other diversification and supply chain opportunities. Similar opportunities apply to other projects and schemes in the region being driven by public sector and partners – for example woodland expansion in Cairngorms as part of Cairngorms 2030[385] and Cairngorms Connect[386], and the Atlantic Rainforest restoration as part of Scotland's Forestry Strategy and set out in the previous 2023 Programme for Government.[387]

13.41 Such international designations can also act to drive other business diversification opportunities, spanning everything from land management to sustainable and nature-based tourism. The example of the Galloway and Southern Ayrshire Biosphere[388] was highlighted through consultations as an example of how UNESCO Biosphere designation can drive economic development and diversification opportunities.

13.42 An additional policy driver is the move towards regenerative agriculture. This is encapsulated by the change away from the Common Agricultural Policy (CAP) and farming payment regimes to outcomes-based agricultural payments. Specifically, this includes payments for the achievement of high-quality food production, climate mitigation and adaptation, and nature restoration. The Scottish Government's Agricultural Reform Route Map[389] sets out how this will be achieved, as part of the Scottish Government's vision for agriculture.[390]

13.43 Voluntary Carbon Markets (VCM) are increasingly being used by large companies to offset carbon emissions and meet national and international standards.[391] Carbon reduction projects such as using natural capital for carbon sequestration can provide carbon credits to investors, which are equivalent to one tonne of carbon produced, with this offsetting one tonne of carbon produced by the investor. Consequently, there has been an increase in projects using carbon credits to attract investment, with over 5,000ha of new woodland validated under the

[385] https://cairngorms.co.uk/working-together/cairngorms-2030/
[386] https://cairngormsconnect.org.uk/
[387] https://www.forestry.gov.scot/publications/forests-and-the-environment/biodiversity/native-woodlands/1586-the-scottish-government-s-strategic-approach-to-restoring-and-expanding-scotland-s-rainforest
[388] https://www.gsabiosphere.org.uk/
[389] https://www.ruralpayments.org/topics/agricultural-reform-programme/arp-route-map/
[390] https://www.gov.scot/publications/next-step-delivering-vision-scotland-leader-sustainable-regenerative-farming/
[391] https://eprints.gla.ac.uk/271715/

woodland code in 2023[392], with a 10% increase in registered and awaiting validation since 2022. Around 560,000 carbon credits had been sold in Scotland in 2022, with larger companies buying large quantities.[393]

13.44 There is also increasing interest in private and philanthropic investment in re-wilding. This has seen the establishment of organisations such as Rewilding Britain[394] and Highlands Rewilding[395] to promote rewilding investment opportunities, and to demonstrate the scope for scaling up rewilding activity through investment.[396]

13.45 In addition to investment activity, there is increasing demand for products and services that are carbon neutral or are offsetting. This demand is from both from consumers, and also commercial/industrial buyers that are eager to demonstrate their climate and sustainability credentials. Interestingly, there is a push for companies providing carbon neutral products or services to do so *without* offsetting – this is particularly the case for fashion, where offsetting may arguably allow companies to 'greenwash' and gloss over less sustainable processes. Instead, being carbon neutral – or even carbon negative – at source can avoid claims of greenwashing and makes a bigger difference to the environmental impact of product manufacture and service development.

Innovation drivers

13.46 Universities in Scotland commonly have a strong presence in natural capital and carbon sequestration and are a driver of innovation. The University of Edinburgh for example, funds a multi-million-pound Forest and Peatland programme, launched in 2021, which targets peatland restoration, increased biodiversity, and forestry interventions, amongst others.[397]

13.47 Similarly, the University of St Andrew's owns a Blue Carbon Laboratory, which supports innovation in carbon sequestration using coastal and marine systems.[398] This also hosts the Scottish Blue Carbon Forum which includes multiple Scottish universities including the University of Glasgow, and Heriot Watt University, and supports innovation in marine and coastal carbon sequestration by providing models and expertise for UK-wide initiatives. For example, current projects investigating the role coastal sediments play in the long-term storage of carbon, which will allow the forum to better advise policy and future projects on managing the landscape.[399]

13.48 The Environmental Research Institute (ERI) is based at UHI North, West and Hebrides, Thurso has research strengths in peatland research relating specifically to the Flow County of Caithness and Sutherland. The James Hutton Institute (JHI) also has strong expertise in peatlands restoration and monitoring. Also significant is the SRUC, and UHI's Scottish School of Forestry, both of which have significant presence in the region. The Scottish School of Forestry produces a large amount of research on forestry in the region, while SRUC has recently delivered projects such as one evaluating the use of green hydrogen in forestry operations.[400]

[392] https://www.forestry.gov.scot/news-releases/the-woodland-carbon-code-an-opportunity-for-farmers
[393] https://carboncredits.com/scottish-carbon-credits-and-carbon-capitalism/
[394] https://www.rewildingbritain.org.uk/
[395] https://www.highlandsrewilding.co.uk/investing
[396] https://www.rewildingbritain.org.uk/about-us/what-we-say/research-and-reports/rewilding-finance
[397] https://www.ed.ac.uk/sustainability/operations/forest-peatland
[398] https://www.gov.scot/publications/delivering-scotlands-blue-economy-approach/pages/4/
[399] https://www.bluecarbon.scot/project/coastal-sedimentary-carbon
[400] https://www.sruc.ac.uk/all-news/green-hydrogen-project-will-focus-on-remote-rural-locations/

Challenges, constraints, and market failures

13.49 Peatland restoration efforts must be cognisant to the needs of industries and communities which rely on them. For example, whisky is one of Scotland's most significant exports valued at around £5.6bn in 2023. Around 80% of Scottish whisky production uses peat in production, and the industry extracts around 7,000 tonnes of the material per annum.[401]

13.50 Private investment into peatland restoration can been very limited compared to what has been committed by the Scottish Government. Concerns for potential private investors are around the uncertainty of the investment; there is a high failure rate of peatland restoration projects for example, with the carbon reduction market highly changeable, providing a lack of security surrounding investment. Scottish Government research has indicated that creating a Scottish Carbon Fund of around £50m would be beneficial in encouraging private investment, as this can improve knowledge sharing, streamline projects by including all stakeholders, and provide financial support for investors.[402]

13.51 This has led to the creation of the Facility for Investment Ready Nature in Scotland (FIRNS), aiming to stimulate private investment in nature and the Natural Capital market in Scotland.[403] FIRNS provides grants of up to £240,000 to investment ready projects which supports them to produce business cases, and other measures required to encourage investment. They also encourage collaboration through a network of stakeholders across public bodies, non-government organisations, and private sector, for example.

13.52 Recent research[404] has also identified information gaps and knowledge disparities amongst landowners and communities, creating a degree of resistance to sequestration schemes, particularly with regard to woodland. Cultural factors, including long-standing practices, ties to the land and a 'moral obligation' amongst landowners to maintain current modes of farming and land management, as well as financial necessity also act as barriers to the consideration and implementation of sequestration schemes. A further issue is the limited understanding of the extent to which existing land use and management practices already sequester carbon. This may restrict woodland creation and planting to more marginal or peripheral areas of land, and constrain the extent to which such schemes, and thus carbon sequestration levels, can be realised.

13.53 Availability of accurate data regarding peatland is a constraint to monitoring progress on peatland restoration in particular. Existing datasets through Peatland ACTION, Peatland Carbon Code and PeatSCOPE[405] provide a reasonably comprehensive 'map' of peatland restoration activity in Scotland. However, there is relatively limited baseline information currently collected regarding peatland sites prior to restoration (e.g. prior land use, vegetation cover, wildlife and biodiversity indicators, etc.). Peatland maps and accurate information regarding condition are also dated - though it is understood that JHI and other organisations, including the Cairngorms National Park Authority[406], are undertaking projects to improve data collection on peatland across Scotland.

[401] https://www.gov.scot/publications/ending-sale-peat-scotland-analysis-consultation-responses/pages/7/
[402] https://www.gov.scot/publications/mobilising-private-investment-natural-capital/
[403] https://www.nature.scot/funding-and-projects/firns-facility-investment-ready-nature-scotland
[404] ekosgen, for HIE (2022) Optimising Carbon Sequestration Opportunities in Argyll & Bute: Readiness Evaluation
[405] Available at: https://www.iucn-uk-peatlandprogramme.org/peatland-code/peatland-code-registry
[406] https://cairngorms.co.uk/peat-restoration-planning-tool/

13.54 Local capacity to deliver is a challenge. Given the location of many sites suitable for afforestation or reforestation, or areas of peatland in need of restoration, the (lack of) population density in these areas necessarily means that there is not a critical mass of the skills required to deliver such schemes. The availability of skills nationwide does not necessarily mean that they can be accessed either. Further, there is often insufficient capacity within host communities to support such schemes. The capacity of the local economy, and the constraining effect of the structural inequalities and associated challenges, to support the uptake and expansion of natural capital activities is a critical factor in realising any potential economic impact.

13.55 Other challenges also exist. For example, the geography of the Highlands and Islands may either serve to constrain the extent to which sequestration may be achieved or cause existing land use and activity (e.g. agriculture) to be displaced. With particular regard to woodland sequestration, the ideal conditions are found on flatter land, and thus in direct competition with grazing. The constraining effect of the structural inequalities and associated challenges arising from the region's particular geography is also a critical factor in realising the uptake and expansion of carbon sequestration activities. The realisation of any impacts and benefits, both economic, social, and environmental, would therefore be reliant on the regional economy's ability to support increased levels of sequestration activity, and a nascent industry to develop.

13.56 Realising the carbon and wider benefits of sequestration activity in the region will require a proactive and coordinated approach by public sector actors. In order for sequestration schemes to be viable, the carbon market in the region needs to be stimulated, and a critical mass of activity nurtured, to develop the required trade in carbon credits. As once consultee noted, there is a need for a pipeline of viable projects across carbon sequestration and wider natural capital activity, but there is difficulty in developing a concrete pipeline, or in some cases even identifying which projects could be included in such a pipeline.

13.57 Alongside this, ways in which social, community, and environmental benefits can be maximised for local landowners and communities need to be explored – along with ways to achieve longer-term strategic ambitions including agricultural efficiency improvements, the creation of multi-purpose forests, or more transformational ambitions around re-wilding, or the restoration of the Atlantic rainforest, for example.

13.58 Oceanic restoration can be an expensive method of sequestering carbon. The cost of various ocean alkalinity carbon storage technologies is largely speculative, but can range from $20-$190 per tonne of CO_2 dependent on approach used.[407] As an example of coastal and oceanic restoration costs per hectare, it is estimated that the cost of restoring saltmarshes along the UK coastline as a means of sequestering carbon, is between £100,000 and £500,000 per hectare.[408] Further, the capacity of natural marine habitats to sequester and store carbon is not supported by management and ownership models equivalent to those of the terrestrial environment. This is due to the nascent nature of the marine biotechnology and marine environmental services sectors. However, this may develop as sequestration approaches mature.

13.59 Finally, the impact of climate change already on ecosystems will need to be mitigated as far as possible if the region's natural capital is to support social, economic, and environmental wellbeing over the long term. Small changes to ecosystems – e.g. increase in the temperature of coastal waters in the region – can have wide-ranging consequences for marine habitats and

[407] https://www.frontiersin.org/articles/10.3389/fclim.2020.575716/full
[408] https://researchbriefings.files.parliament.uk/documents/POST-PN-0651/POST-PN-0651.pdf

biodiversity, as well as for the viability of the aquaculture sector, for example. Also, changes to rainfall patterns across the Highlands and Islands can have significant consequences for water and flood management. However, other challenges will have to be contended with: the costs of damage arising from extreme weather events such as flooding are increasing; investment in protection, mitigation and adaptation measures will need to increase as a result; and the need for careful management of natural resources is increasing in line with the unpredictability of a highly energised atmosphere that is generating more frequent and more intense extreme weather events. As such, there is an argument for a move to resilience measures and nature-based solutions rather than protection (e.g. flood protection), so that communities can realise benefits as climate change risks and impacts increase.[409] However, this may have implications for how the region's natural capital is utilised for socio-economic gain.

Priorities for action

- Natural capital-related activity requires considerable public sector support and intervention. This is either because such activity is in its nascency, or there is a need for strategic actors to help areas and communities navigate between free market conditions or an interventionist approach to influence the degree of local benefits (economic, social and environmental) that can be secured, e.g. through establishing markets for carbon credits.
- Opportunities to secure benefits from the region's natural capital resources should be pursued in as responsible and sustainable a manner as possible.
- Across all natural capital activity, there is a need to achieve social license. This will help to overcome information gaps and knowledge disparities, and secure community support.
- Where there is opportunity to exploit the natural capital of the region, evidence indicates[410] that there is a need for strategic actors to take a proactive, interventionist approach to developing natural capital markets. This will nurture and grow a nascent sector with considerable potential for the region and help to root economic activity in local areas and secure greater community wealth building.
- There is a need to build a critical mass of activity, recognising the disparate nature of the business base currently across various aspects of natural capital, e.g. peatland restoration. For example, grouping to achieve landscape-scale projects or programmes of activity grouped according to river catchment areas may help to stimulate increased economic opportunities for land management and related enterprises, alongside an appropriate programme of business support.
- Alongside activity to derive economic, social and environmental benefit from the region's natural capital, consideration must be given to how best to manage natural resources in light of the Climate Emergency, and the need to improve resilience in the face of climate change impacts increased extreme weather events. Some approaches – such as habitat restoration, carbon sequestration activity and forestation for carbon farming – all bring benefits that help mitigate climate change effects.

[409] See for example: ekosgen, for *Scottish Government (2024) Water Management, Flooding and Coastal Erosion: Socio-economic research – Summary report for Scottish Government*, which sets out a useful synopsis of the literature around water resource management in Scotland

[410] ekosgen, for HIE (2022) Optimising Carbon Sequestration in Argyll & Bute: Readiness Evaluation – Work package review and workshop report

14 Conclusions and priorities

Introduction

14.1 The research has confirmed the huge potential within the Highlands and Islands to capitalise on transformational opportunities with impacts that will reach well beyond the region. The Highlands and Islands is already playing a central role in the development and implementation of groundbreaking technologies but there is a great deal more that can be achieved. Harnessing the potential will bring positive impacts for people living, working, learning, and doing business in the region. It will provide significant enterprise and employment opportunities along with community wealth building potential. Investing in this potential will deliver large scale benefits for Scotland and the UK. It will also play an important role in addressing global challenges.

14.2 This final chapter draws together the findings of the extensive research programme which examined the potential value of the RTOs, the factors that could inhibit growth, the opportunities to be pursued, and the priorities that should be considered. It also highlights the importance of evidence-based planning and supporting infrastructure.

14.3 The potential is perhaps comparable and maybe even greater than oil and gas. There is consensus that we must not let it go and we must capture and retain the value. To do this, there will have to be bold, ambitious, and confident decision making coupled with trust, collaboration and co-operation.

Conclusions

14.4 There is arguably a once-in-a-generation opportunity to transform the economy of the Highlands and Islands. This cannot be allowed to pass the region by. Whilst the legacy of some transformative investments of the past are still visible and tangible – such as the original wave of hydro-electric power development – others are arguably less so.

14.5 Across each of the RTO sectors considered within this report, there are clear, significant and transformative opportunities to pursue and realise. The impact assessment demonstrates that, under optimised conditions, there is a tremendous level of investment and economic impact that can be generated.

14.6 Stakeholders must therefore be committed to not letting it go. The portfolio of projects under consideration in this analysis – and, no doubt, others that will follow – have the potential to bring transformative change for the Highlands and Islands, something that has often been elusive. The region is no longer on the periphery of economic development, but rather, at the forefront.

14.7 Investment is spread throughout the region, and across a range of different RTO sectors. There is an opportunity to distribute these benefits across the population and communities within it, and ensure that the social, economic and environmental benefits that may arise from these developments can be felt throughout the region – and not concentrated in a small number of areas, or indeed extracted outwith the Highlands and Islands, as has often been the case in the past.

14.8 Investing in the RTO sectors, the supporting infrastructure and wider enablers such as housing will positively impact across the economy and for people living in the region or looking to move to it, for example to work or study.

14.9 However, there are constraints to growth and a great deal of international competition. These pose a considerable challenge to projects coming to fruition, and to benefits being realised. Sectors and host communities will also need to be supported through a period of time that will in effect be a paradigm shift for the region. Thus, it will require a co-ordinated, collaborative and whole-systems approach across all partners, through a true quadruple helix approach.

14.10 Research has highlighted the importance of evidence-based planning and supporting infrastructure and mechanisms for major developments at the scale that is anticipated. There is a great deal of uncertainty amongst education, skills and training providers, and amongst supply chain operators: they know that there will be a substantial uplift in need and demand for skilled workers across a multitude of roles but are not clear about when. Current evidence points to a future lack of available skills, but there is a reluctance amongst many private sector businesses to invest now without knowing when the returns will be realised. Education and training providers are also not in a position to speculatively invest in new courses that are likely to be needed without clear demand from businesses. However, some companies are starting to take on the risk and invest in skills, working with training providers to stimulate the skills pipeline for the benefit of the region – in the spirit of co-opetition.

14.11 Sustainable management and use of resources will be critical. Many of the RTO sectors are highly dependent on the region's natural capital: using or benefitting from the region's natural assets to derive social, economic and environmental benefit. In line with Scottish Government policy, and the principles of the response to the Climate Emergency and Net Zero, this must be done responsibly and having secured the necessary social license. This is increasingly important, and without social license there is a risk that many projects across the RTO sectors will meet growing opposition.

14.12 There will also be a need to manage the pressures of different types of use and users in marine and terrestrial environments in the region, as projects are developed. Thought must be given to how best different users and interest groups in the same space can co-exist and grow. All actors at the local, regional and national level have a role to play through strategic oversight, identification of synergies, planning and a positive attitude to co-location and co-existence.

Considerations and priorities

14.13 The report has identified priorities for action for each RTO and whilst there are some that are specific to individual RTOs, there is a great deal of similarity and crossover. For sustainable economic growth in the Highlands and Islands driven by these RTOs, there is a need to take a place-based approach to removing the barriers and support their development.

14.14 Common barriers and constraints include the need for enabling and supporting infrastructure such as housing, transport, ports, and grid infrastructure. Other anticipated constraints relate to having the volume and types of skills needed for construction and operation and maintenance, accessing finance, and achieving social licence.

14.15 If these issues are addressed, it is not just the RTOs that will benefit, all sectors and industries stand to gain, along with communities, local areas and employers. The value that the RTOs could deliver individually and together is undoubtedly transformational and would have meaningful impacts for Scotland and the UK.

14.16 There must be a shared and agreed acceptance of the economic reality that there will be trade-offs. Decisions will need to be taken to drive growth, but some options may need to be sacrificed for another. Without accepting and managing trade-offs, the region will not achieve its potential for significant and sustainable growth. The region should not be inhibited or driven by what has gone before and how things have always been done.

14.17 The combined potential of the RTOs is arguably unprecedented in the Highlands and Islands, and it will be best achieved by taking a holistic approach, recognising the synergies between the RTOs and the intersection of constraints and enablers such as housing, ports and transport. Stakeholders should plan and work towards a multi-model economy with a basket of diverse, strong and innovative sectors that are forward looking. This will ensure a healthy, strong, resilient and sustainable regional economy that will be a very attractive and competitive destination for people, industry, and investment.

14.18 As part of this, the VCSE should be encouraged and enabled to be a key player in the RTOs and their supply chains, recognising that some RTOs may lend themselves more to this (e.g. life sciences, peatland restoration and management, and afforestation), than others.

14.19 The RTOs and enablers such as transport, housing and planning cut across a range of functions and areas. Rather than working in silos, there needs to be joined-up thinking, working and resourcing across government departments (Scottish and UK as applicable) and relevant agencies. The aim here will be to have an integrated approach to solutions, avoid single interventions, and make best use of resources. There are many examples of where an intervention by one department or organisation has interacted poorly with other interventions and so any potential gain has been diminished, or another issue has arisen elsewhere as a result. This must be avoided in developing the RTOs.

14.20 There is considerable scope to proactively seek out and support the development and adoption of synergies across RTOs and their supply chains. This will include co-location to alleviate pressures on land and in the marine space. Alongside this, a vital consideration is how to pursue growth and at the same time ensure the sustainable management of natural resources and biodiversity on land, and in seas and rivers. This is not only an environmental imperative, it is important that non-renewable assets are not exhausted and that activities are not ‘squeezed out’ or inhibited due to the pressures from other users. A major part of the solution to this will lie in technology, to assess, monitor and mitigate negative impacts. This is an area of real potential in and across the RTOs and the wider economy. Technology will also have a role to play in increasing productivity and efficient use of skills and other resources, for example alleviating pressures in health and social care.

14.21 Establishing internationally recognised growth clusters is an effective way to stimulate innovation, attract investment, and achieve growth. The Highlands and Islands has good clusters in Life Sciences and Energy which can already be seen as significant achievements. However, these clusters need to continue to be built out rapidly to become internationally recognised growth clusters with substantial and varied membership, strong value creation, and an innovative and supportive ecosystem. This will help to drive the commercialisation of research and innovation which must be a key goal in the region.

14.22 The skills system will play a central role in realising the ambitions of the RTOs. There will be an increase in employment opportunities during construction phases as well as in operations and maintenance. Stakeholders within the skills system are aware of this, but there is some trepidation around when to start delivery due to uncertainty in timelines and what skills will be needed and when. There will always be an element of imperfect information as positions can change, but this must be de-risked as much as possible, with the need for flexibility to be accepted and built into systems. The issue is exacerbated by financial pressures within education and skills.

14.23 Taking a lateral view to skills and workforce development will help better meet the needs of industry and spread the benefits to a wider population. This includes examining how economically inactive people can be supported and encouraged into the labour market, working with employability support providers, attracting older workers and career changers, reaching into under-represented groups, upskilling and reskilling people in the existing workforce and pivoting skills between and across sectors.

14.24 There is already close working between education and industry to plan skills development in terms of new entrants and to reskill and upskill staff. However, there is a sense that this has not yet translated into increased provision at the scale that will be required. This is an issue that should be addressed as a matter of urgency, which may require new and flexible funding models.

14.25 Linked to the provision of skills development, there needs to be work undertaken to increase awareness amongst the potential RTO workforce of the rapidly emerging employment opportunities in the Highlands and Islands. There needs to be a clear understanding of the value and reliability of these new career opportunities in the region and there will be value in not necessarily focusing on a particular sector. Rather the focus of the information should be on the skills that will be in demand and how these are transferable across sectors giving long term employment security and career progression opportunities.

14.26 The employment and enterprise development opportunities that will flow from the RTOs and their supply chains have the potential to retain talent in the region and attract it, both in terms of new talent and people who moved out of the region to find work but may now feel able and motivated to return.

14.27 There is significant opportunity in renewable energy in the RTOs not just economically but in terms of energy security, net zero and social value. Taking a systems approach to renewable energy will ensure clean, secure and mixed energy across technologies, These technologies will then work together to ensure a consistent, affordable and resilient green energy supply. Achieving this will require a shift in thinking and new ways of working at every stage, from research and innovation through to installation, generation and the supply chain.

14.28 Alternative offtake routes in marine energy and offshore wind can form part of the solution of inadequate grid connection. However these alternatives will not replace the need for connecting sources of power to the grid. Local offtake of tidal energy could be used to provide power in coastal communities and offshore wind can help to decarbonise oil and gas extraction.

14.29 Within and across RTOs there are considerable information gaps and knowledge disparities. There is a great deal of anticipation of what is to come, what will be needed and what the employment, commercial, and market opportunities will be. Scale and timing are the key questions. Organisations of all types are reluctant to invest until they have a good degree of certainty and an acceptable level of risk. However, there is a counter-risk that opportunities will be lost through a lack of readiness. Based on this research, there should be a cross-sectoral effort to provide an aggregated timeline of when proposed projects will come on stream taking account of the level of probability that they will progress and reach fruition. It is acknowledged that there is always going to be some adjustments in project timescales, and this should therefore be closely monitored.

14.30 Given this imperfect information, there should be a review of the attitude to risk in public, private and education sectors specifically for the RTOs. Partners then need to work together to explore how risk can be shared and alleviated so that exposure by any one organisation is minimised. By taking on part of the risk, partners must also then be able to benefit from their investment. In thinking about investment, there is an opportunity in the RTOs to consider intangible investments and develop a framework to measure and incentivise this kind of support. Examples include R&D, Intellectual Property, brand equity (value of an organisation's brand), investment in skills. These investments provide long term financial benefits and competitive advantage but can be harder to quantify and place a value on and are often excluded from establishing the true value of investment.

Appendices

A.1. RTO investment impact assessment

Introduction

This appendix sets out the methodology and approach for the impact assessment, and supporting tables for the anticipated impacts arising from identified projects detailed in Chapter 3. The assessment is based on primary and secondary information gained during the course of the research, provided by the HIE client team, other strategic stakeholders, consultees, and our own extensive desk research.

Approach

The research team included notable projects and significant investments across each of the seven Regional Transformational Opportunities identified, as well as significant supporting infrastructure developments (particularly in relation to grid connectivity and wider enablers) and developments that are adjacent to the relevant RTOs (e.g. onshore wind the planned Underground Salmon Farms in Shetland and Na h-Eileanan Siar). In total, 251 relevant projects were identified throughout this research.

Projects were identified through a combination of consultation with key stakeholders in each RTO regarding planned investment projects and propositions, desk research and analysis, and also in liaison with the HIE client team where there were any noticeable gaps in information.

Projects were categorised in multiple different ways. These included categories based on:

- Sectors broadly aligned to each of the RTOs under investigation – 12 in total;
- Local authority area;
- Project status (where the project is either unknown/early stage, scoping/pre-application, planning/consenting phase, in development and pre-operational). Where unclear, the best estimate of project status has been made based on available information and anticipated timelines for delivery, drawing on available proxies and metrics where possible.

Methodological challenges

It should be noted that the availability of information varies on a project-by-project basis. This was often determined by status of project, with early stage projects often having particularly limited data. Some of the projects' data availability was also constrained for confidentiality/commercial sensitivity reasons. In such instances, data was estimated based on info for comparable projects elsewhere, where this was available.

Where gaps existed in data provided by HIE/consultees and were unable to be filled through desk research, estimates were made based on available proxy and comparator data and other industry intelligence. This included:

- The UK Business Register and Employment Survey (BRES)[411] for Full Time Employment (FTE) ratios;
- The Scottish Annual Business Statistics (SABS)[412] for sectoral employment, Turnover: Employment and Turnover: Gross Value Added (GVA) ratios, as well as GVA per FTE and Gross Wages/Salaries per FTE estimations; and
- Relevant desk-based resources, including ClimateXchange[413], the Department for Energy Security and Net Zero[414], and relevant proxy values found in academic journals such as the Renewable and Sustainable Energy Review[415]

Investment and employment for each project has been apportioned across the projects' respective development years. In the absence of other intel and for modelling simplicity, an equal spread has been apportioned across each year of investment for the project.

It should be noted that the Inverness and Cromarty Firth Green Freeport has been included as a project, but the overall project investment values and employment have been excluded in analysis to avoid any potential double counting. The Freeport's individual seed projects have been included in the analysis.

The overall investment levels of SSEN's Pathway to 2030 programme have been included in the analysis. This has been apportioned to each Local Authority based on anticipated level of activity in each Local Authority area. The location of investment and infrastructure siting has not, however, been mapped accurately as there are current uncertainties for the precise location of some of these projects.

The location of offshore wind projects has been allocated to Local Authorities based on landfall, geographic proximity, and the known location of Operation and Maintenance bases. For some of these projects, the landfall is undetermined, therefore available intel has been used to inform judgement of these allocations. As these projects proceed, the allocation may change. It should be noted that this may mean that an offshore wind project's allocation may shift outwith the Highlands and Islands geography.

Accurate data on operational employment and associated impacts were only available for a minority of projects identified during the research. This meant that there were insufficient data available to robustly scale up from those projects where information was available. Nevertheless, we have estimated likely operational employment for projects to provide an indication of the possible long-term employment demand from the identified development projects. Estimated operational employment is presented below with regard to status-adjusted impacts for projects. Given the limited availability of robust proxy/comparator data, estimates of operational impact GVA values were omitted from analysis as this would affect reliability of calculated impacts for the operational lifespan of projects.

[411] https://www.nomisweb.co.uk/sources/bres
[412] https://www.gov.scot/publications/scottish-annual-business-statistics-2022/documents/
[413] https://www.climatexchange.org.uk/wp-content/uploads/2024/05/CXC-Skills-requirements-in-Scotlands-onshore-industry-May-2024.pdf
[414] https://www.gov.uk/government/publications/electricity-generation-costs-2023
[415] https://www.researchgate.net/publication/330936819_Co-located_deployment_of_offshore_wind_turbines_with_tidal_stream_turbine_arrays_for_improved_cost_of_electricity_generation

Once profiled by the above categories, data regarding investment value (in £), employment (FTEs both in terms of construction and operational/maintenance), timescales for construction/development (with development start and end dates) were then identified and populated for each project.

This information has been gleaned from a variety of sources, including:

- Reports and background information provided by HIE and partners;
- Information provided by consultees regarding planned investment projects and investment propositions; and
- A desk-based web search for available information for each project.

Impact assessment

The impact assessment conducted has been based on available information for each project. It has considered each individual project's investment, and construction impacts in terms of employment (direct) and GVA (direct, and indirect/induced).

There are a number of components to the impact assessment:

- An **unadjusted** impact assessment, which considered the raw data for each project;
- A **status-adjusted** impact assessment, which adjusted the investment levels for projects based on their current status and the probability of the projects reaching Final Investment Decision (FID) or consenting to then be started/completed;
- **Scenarios** were then modelled to reflect the impact of various policy, regulatory, infrastructure and other potential factors to 'switch on' certain project investment levels and timescales. These scenarios are illustrative, to demonstrate the impact of supportive/restrictive policy, regulatory and economic environments.

Across the impact assessment, monetary values for investment and GVA impacts have been rounded. It should be noted that some of the investment for projects under consideration falls out with the time period for the assessment (2025-2040; with some investment occurring either before or after the period). Therefore, the tables found within the scenario modelling section will necessarily differ from total tables throughout the immediate sections below.

Unadjusted impact assessment

Construction, development and installation impacts

This impact assessment considered the raw project data that had been sourced and assumes each project will progress as planned and to the scale stated. The impacts considered under this assessment include:

- The total investment value (£);
- Total employment in FTE job years across the development, construction and installation (DCI) phase of projects;
- Estimated number of direct, additional operational and maintenance jobs;

- Estimated direct GVA (£); and
- Estimated indirect/induced GVA (£).

The values calculated do not consider the current status of projects. It is unlikely that all projects will come to fruition, for a variety of reasons – constraints on available company finance to deliver projects, more advantageous economic opportunities elsewhere, changes in the natural environment impacting on the feasibility of delivery, macro-economic conditions negatively impacting delivery, etc. Thus it is likely that lower actual investment levels will be achieved across the portfolio of projects under consideration.

Status-adjusted impact assessment

In order to adjust the projects by status classification, projects were grouped into the following categories, set out in Table A1.1. Adjustment factors used to reflect project status and the likelihood of project progression and completion are also provided. Early-stage projects may have a relatively low likelihood of being developed at the outset, with the certainty of the investment being realised increasing as projects progress along the development life cycle.

Table A1.1: Adjustment factors for project status

Project status	Summary	Adjustment factor
Uknown	Limited information about the projects is available and the current status of the project is unknown; it is likely that the project is conceptual or at a very early stage of development	50%
Early stage	Project is at an early stage of planning and design	50%
Scoping/pre-application	Project planning and design has progressed, and project developers are scoping out planning and consenting requirements for the project.	60%
Planning/consenting phase	Projects are sufficiently advanced and are moving through the planning and consenting phase.	70%
In development	Projects have received permission/consenting, and are under development – either in terms of pre-construction activity, or are under construction.	80%
Pre-operational	Construction is complete, and projects are ready to commence their operational phase	100%

The types of impacts that were then calculated were the same as in the unadjusted impact assessment, as set out above.

Additional supporting analysis tables and figures

Unadjusted and status-adjusted impacts

Table A1.2: RTO projects by Sector

Sector	Number of projects	Percentage of total projects
Onshore wind	137	55%
Supporting infrastructure: enablers[416]	27	11%
Green hydrogen	19	8%
Offshore wind	19	8%
Marine energy	13	5%
Pumped storage hydro	9	4%
Marine biotechnology and processing	7	3%
Life sciences, digital health and social care	6	2%
Supporting infrastructure: grid	6	2%
Space	4	2%
Other[417]	3	1%
Natural capital	1	<1%
Total Highlands and Islands	**251**	**100%**

Table A1.3: RTO projects by Local Authority Area

Area	Number of projects	Percentage of total projects
Highland	110	44%
Argyll and Bute	49	20%
Orkney	28	11%
Moray	24	10%
Na h-Eileanan Siar	20	8%
Shetland	19	8%
Arran and Cumbrae	1	0%
Total Highlands and Islands	251	100%

[416] This typically includes harbour upgrade/expansion investment, research and innovation facilities, and sectoral hubs/business premises

[417] Other projects include the Clyde Engineering & Innovation Cluster development, and significant, innovative aquaculture projects.

Figure A1.1: Investments over time (2025-40) by local authority area

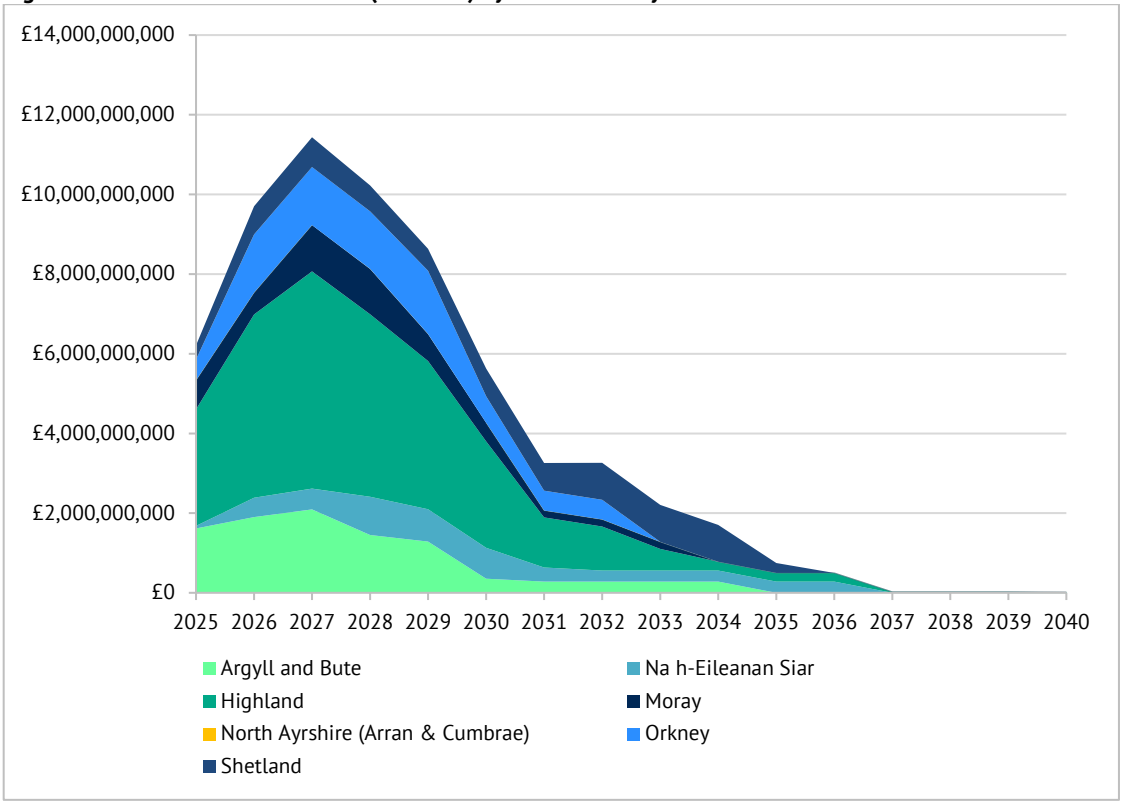


Figure A1.2: Direct GVA impacts over time (2025-40) by RTO sector

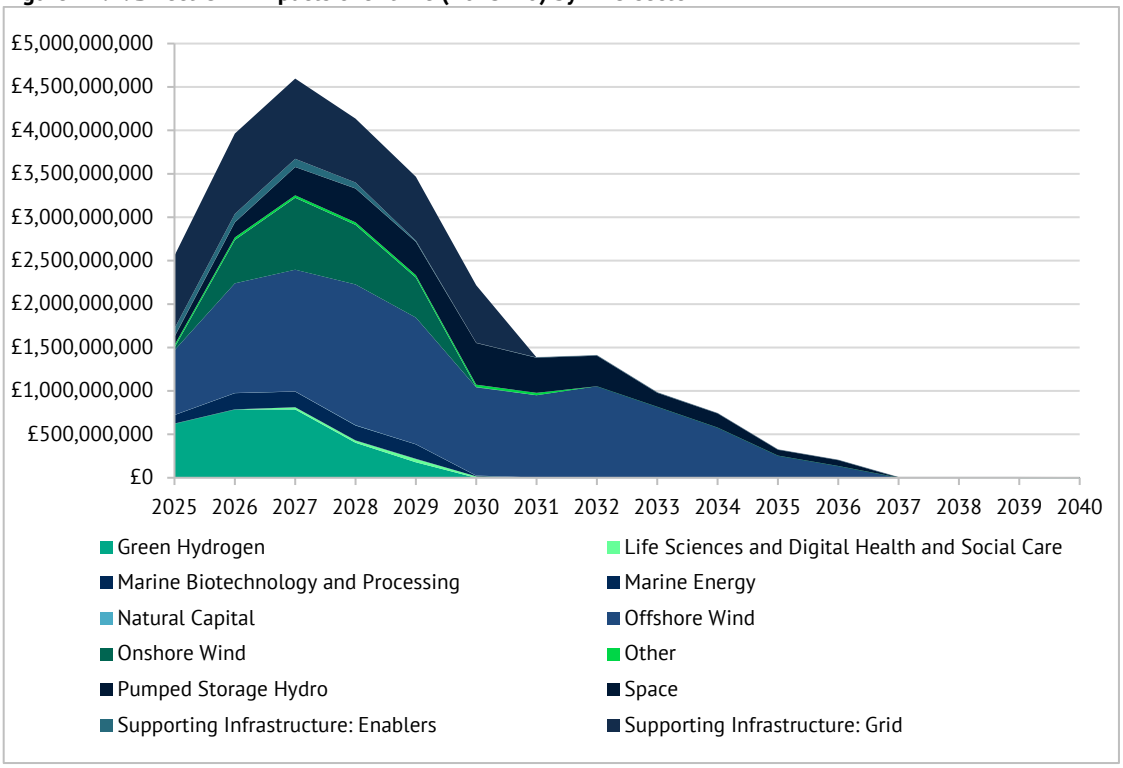


Figure A1.4 sets out the direct GVA arising from project investment, which shows a similar profile to that of project investment.

Figure A1.3: Direct GVA impacts over time (2025-40) by local authority area

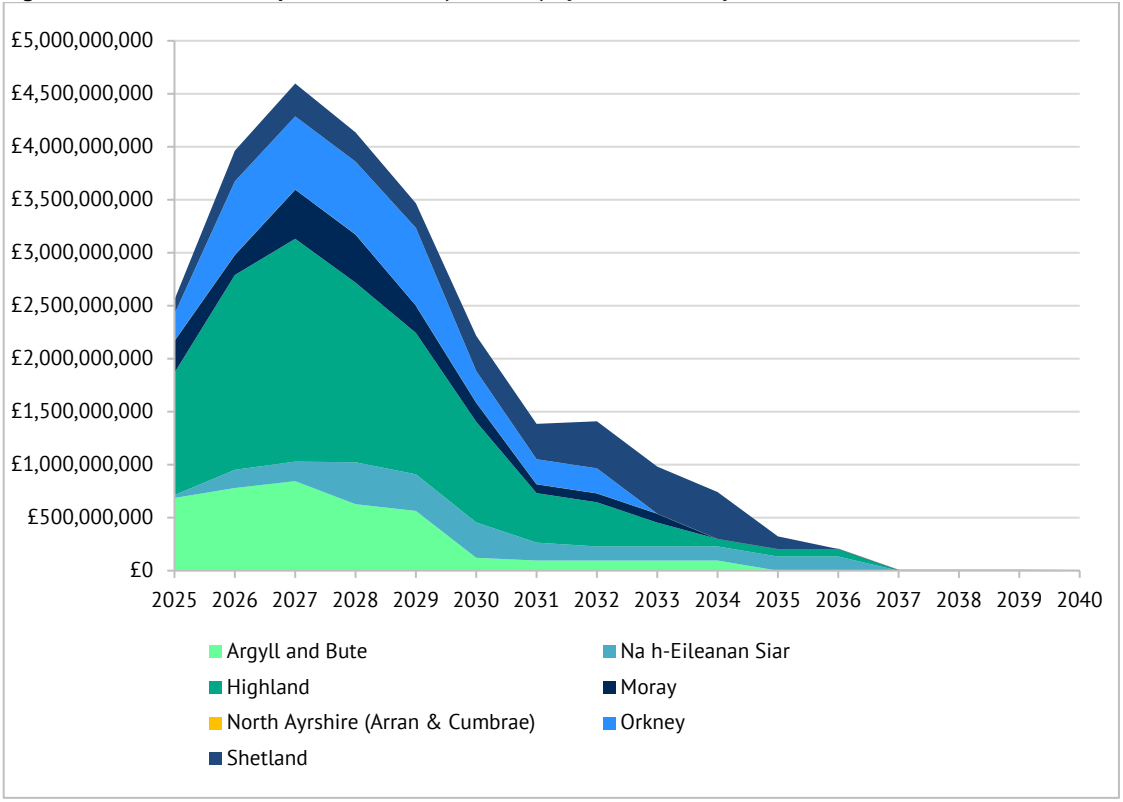


Table A1.4: Status-adjusted estimated direct O&M/operational employment impacts by RTO/sector

Sector	2030	2035	2040
Green hydrogen	2,240	2,280	2,280
Life sciences and digital health and social care	30	60	60
Marine biotechnology and processing	80	90	90
Marine energy	30	40	40
Natural capital	-	-	-
Offshore wind	460	1,010	1,250
Onshore wind	3,050	4,170	4,170
Other	150	150	150
Pumped storage hydro	10	140	160
Space	100	130	130
Supporting infrastructure: enablers	2,880	4,170	4,430
Supporting infrastructure: grid[418]	-	-	-
Total Highlands and Islands	**9,030**	**12,230**	**12,760**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

[418] It is assumed here and in subsequent tables setting out estimated operational employment under each scenario that operation and maintenance of new grid infrastructure is undertaken by the incumbent existing workforce.

Table A1.5: Status-adjusted estimated direct O&M/operational employment impacts by local authority

Area	2030	2035	2040
Argyll and Bute	850	1,150	1,150
N h-Eileanan Siar	840	1,020	1,120
Highland	5,960	8,080	8,360
Moray	600	800	800
Arran and Cumbrae	10	10	10
Orkney	320	560	560
Shetland	460	610	760
Total (Highlands and Islands)	**9,030**	**12,230**	**12,760**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

Table A1.6: Status-adjusted impacts under Scenario SC1 by RTO sector

Sector	Total investment (£)	FTE job years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Green hydrogen	£1,350,700,000	2,430	£695,500,000	£541,700,000
Life sciences and digital health and social care	£78,400,000	360	£37,100,000	£31,600,000
Marine biotechnology and processing	£9,700,000	40	£3,100,000	£2,700,000
Marine energy	£366,100,000	1,610	£172,300,000	£96,300,000
Natural capital	£111,000,000	800	£14,900,000	£21,100,000
Offshore wind	£5,437,600,000	2,430	£2,600,100,000	£2,228,600,000
Onshore wind	£1,461,100,000	3,640	£496,000,000	£425,100,000
Other	£155,600,000	730	£68,800,000	£29,000,000
Pumped storage hydro	£1,807,100,000	2,560	£613,400,000	£525,800,000
Space	£25,100,000	190	£12,000,000	£10,300,000
Supporting Infrastructure: Enablers	£499,000,000	1,970	£169,400,000	£145,200,000
Supporting infrastructure: grid	£2,597,100,000	560	£881,600,000	£755,700,000
Total Highlands and Islands	**£13,898,500,000**	**17,320**	**£5,764,200,000**	**£4,813,100,000**

Note: FTE job years and operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding.

SC1: Status quo plus grid upgrade constraints

Table A1.7: Status-adjusted impacts under Scenario SC1 by local authority area

Sector	Total investment (£)	FTE Job Years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Argyll and Bute	£2,000,300,000	1,930	£814,000,000	£696,500,000
Na h-Eileanan Siar	£1,084,000,000	1,410	£468,000,000	£381,400,000
Highland	£5,737,000,000	9,400	£2,149,900,000	£1,827,600,000
Moray	£1,700,700,000	1,180	£742,300,000	£636,200,000
Arran and Cumbrae	£1,800,000	10	£600,000	£500,000
Orkney	£1,879,800,000	1,760	£909,200,000	£699,400,000
Shetland	£1,494,900,000	1,630	£680,300,000	£571,400,000
Total (Highlands and Islands)	**£13,898,500,000**	**17,320**	**£5,764,200,000**	**£4,813,100,000**

Note: FTE job years have been rounded to the nearest 10. Totals may not sum due to rounding.

Figure A1.4: Investment over time (2025-40) under Scenario SC1 by RTO sector

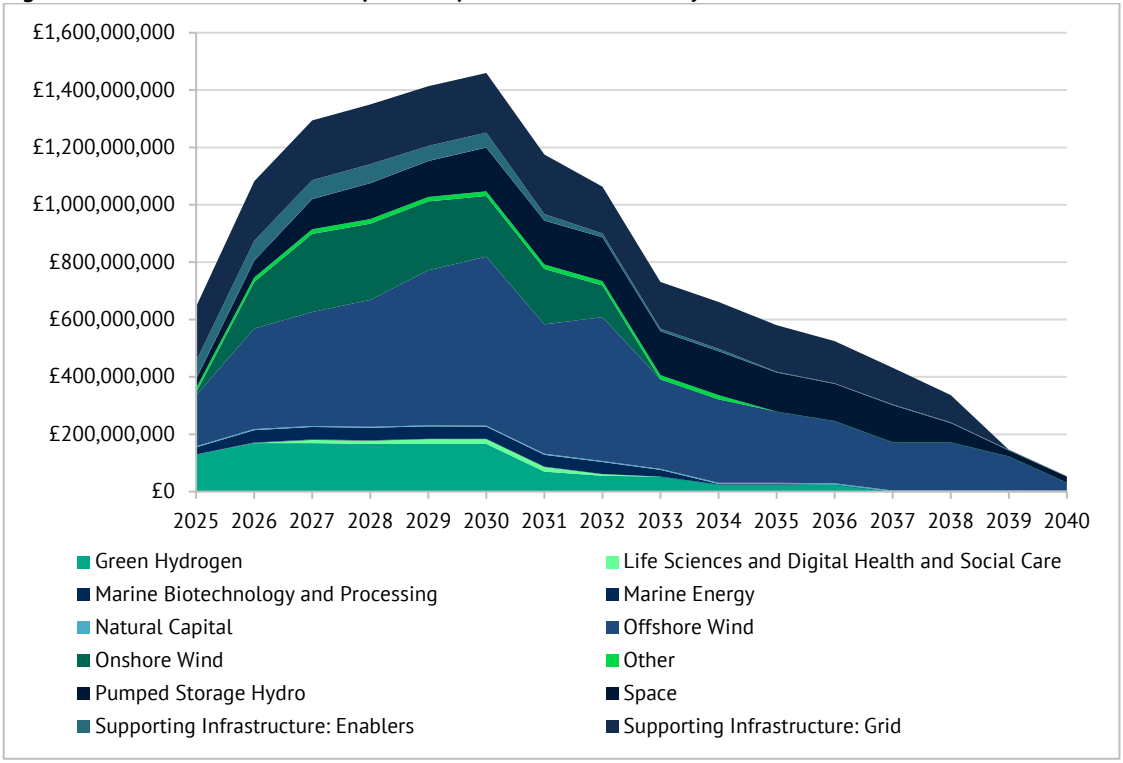


Figure A1.5: Direct GVA impacts over time (2025-40) under Scenario SC1 by RTO sector

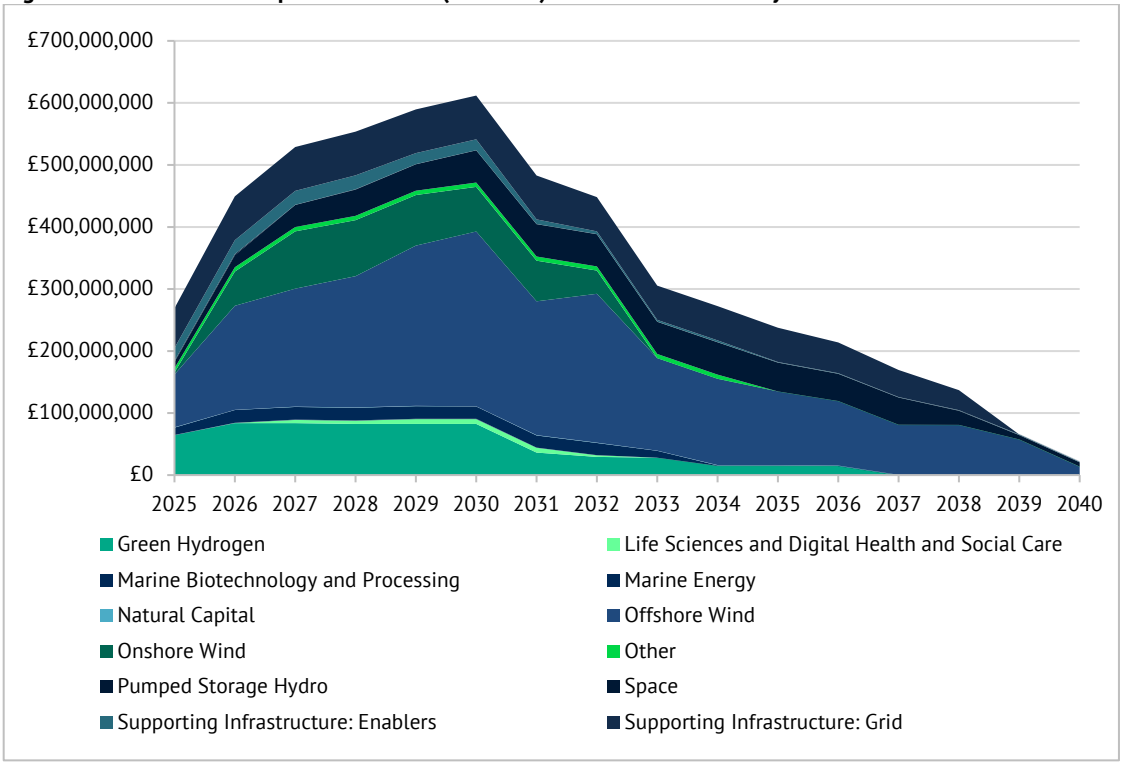


Figure A1.6: Investments over time (2025-40) under Scenario SC1 by local authority area

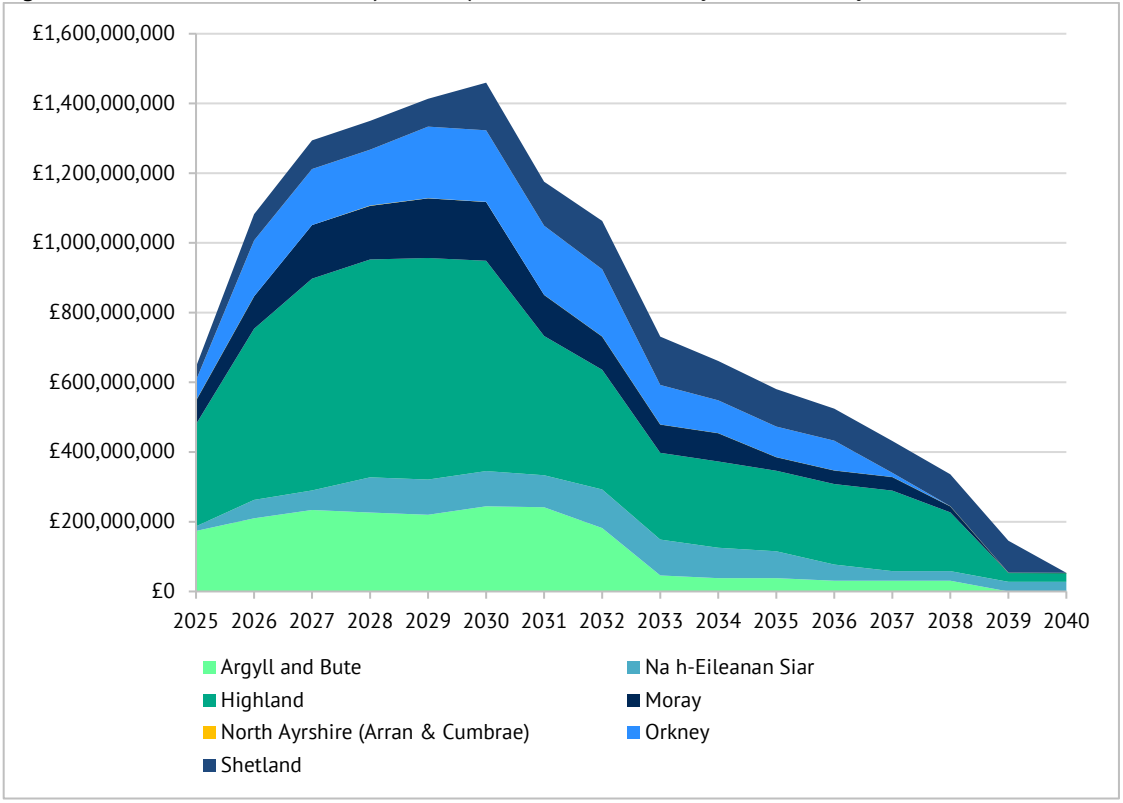


Figure A1.7: Direct GVA impacts over time (2025-40) under Scenario SC1 by local authority area

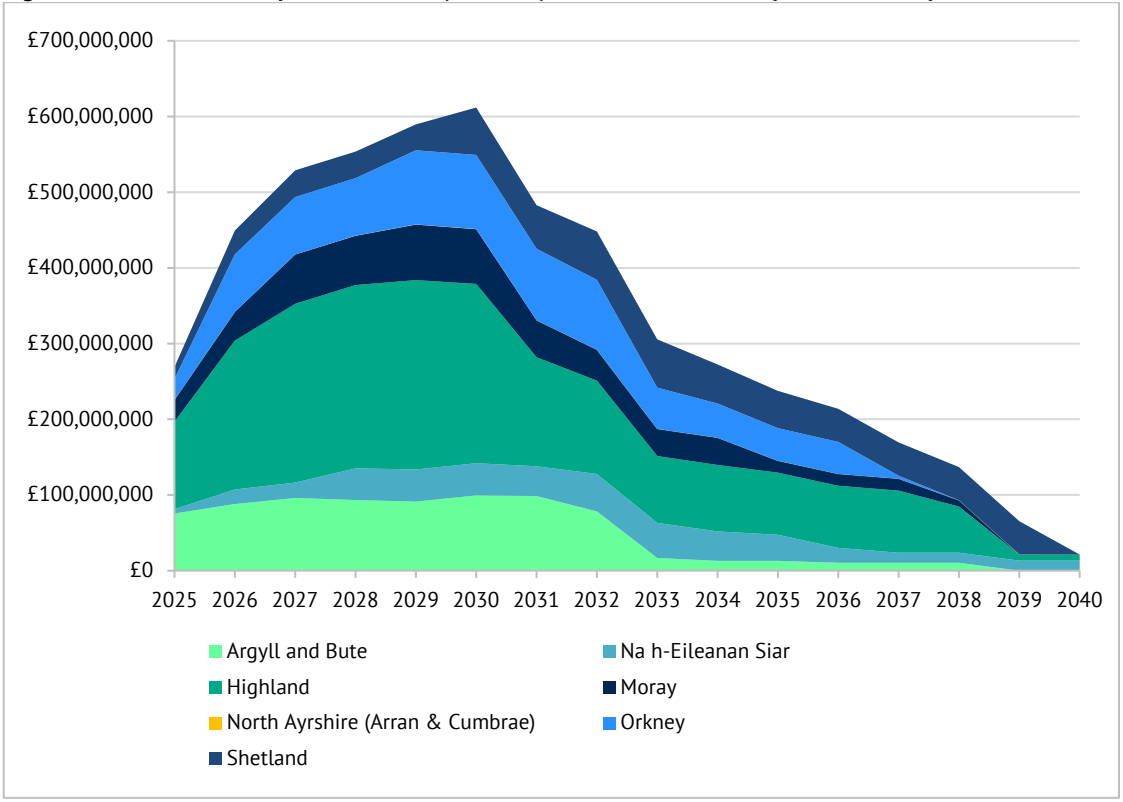


Table A1.8: Status-adjusted estimated direct O&M/operational employment impacts by RTO/sector under SC1

Sector	2030	2035	2040
Green hydrogen	140	450	450
Life sciences and digital health and social care	<10	20	20
Marine biotechnology and processing	20	30	30
Marine energy	<10	10	10
Natural capital	-	-	-
Offshore wind	40	120	230
Onshore wind	100	820	820
Other	30	50	50
Pumped storage hydro	<10	10	30
Space	40	40	50
Supporting infrastructure: enablers	560	930	1,350
Supporting infrastructure: grid	-	-	-
Total Highlands and Islands	**920**	**2,470**	**3,030**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

Table A1.9: Status-adjusted estimated direct O&M/operational employment impacts by local authority under SC1

Area	2030	2035	2040
Argyll and Bute	60	250	260
Na h-Eileanan Siar	20	200	210
Highland	730	1,640	2,090
Moray	10	150	160
Arran and Cumbrae	<10	<10	<10
Orkney	10	110	130
Shetland	80	130	180
Total Highlands and Islands	**920**	**2,470**	**3,030**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

SC2: Policy on, short time frame for switch-on

Table A1.10: Status-adjusted impacts under Scenario SC2 by RTO sector

Sector	Total investment (£)	FTE job years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Green hydrogen	£4,770,000,000	8,570	£2,456,100,000	£1,913,200,000
Life sciences and digital health and social care	£174,800,000	800	£82,700,000	£70,500,000
Marine biotechnology and processing	£21,700,000	90	£6,900,000	£6,000,000
Marine energy	£1,292,900,000	5,700	£608,600,000	£340,000,000
Natural capital	£247,400,000	1,790	£33,200,000	£47,000,000
Offshore wind	£19,202,900,000	8,600	£9,182,300,000	£7,870,300,000
Onshore wind	£5,159,900,000	12,850	£1,751,600,000	£1,501,300,000
Other	£347,000,000	1,620	£153,400,000	£64,700,000
Pumped storage hydro	£6,381,900,000	9,040	£2,166,400,000	£1,856,900,000
Space	£56,000,000	430	£26,800,000	£23,000,000
Supporting infrastructure: enablers	£1,029,800,000	4,070	£349,600,000	£299,600,000
Supporting infrastructure: grid	£12,062,600,000	2,580	£4,094,800,000	£3,509,700,000
Total (Highlands and Islands)	**£50,747,000,000**	**56,140**	**£20,912,300,000**	**£17,502,300,000**

Note: FTE job years figures have been rounded to the nearest 10. Totals may not sum due to rounding.

Table A1.11: Status-adjusted impacts under Scenario SC2 by local authority area

Sector	Total investment (£)	FTE job years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Argyll and Bute	£7,438,600,000	6,790	£3,001,100,000	£2,568,300,000
Na h-Eileanan Siar	£3,870,500,000	4,190	£1,650,300,000	£1,370,400,000
Highland	£21,153,900,000	29,870	£7,922,600,000	£6,726,500,000
Moray	£6,315,500,000	4,210	£2,726,400,000	£2,336,900,000
Arran and Cumbrae	£4,100,000	10	£1,300,000	£1,100,000
Orkney	£6,654,200,000	5,990	£3,216,300,000	£2,474,600,000
Shetland	£5,310,200,000	5,070	£2,394,400,000	£2,024,400,000
Total (Highlands and Islands)	**£50,747,000,000**	**56,140**	**£20,912,300,000**	**£17,502,300,000**

Note: FTE job years figures have been rounded to the nearest 10. Totals may not sum due to rounding.

Figure A1.8: Investment over time (2025-40) under Scenario SC2 by RTO sector

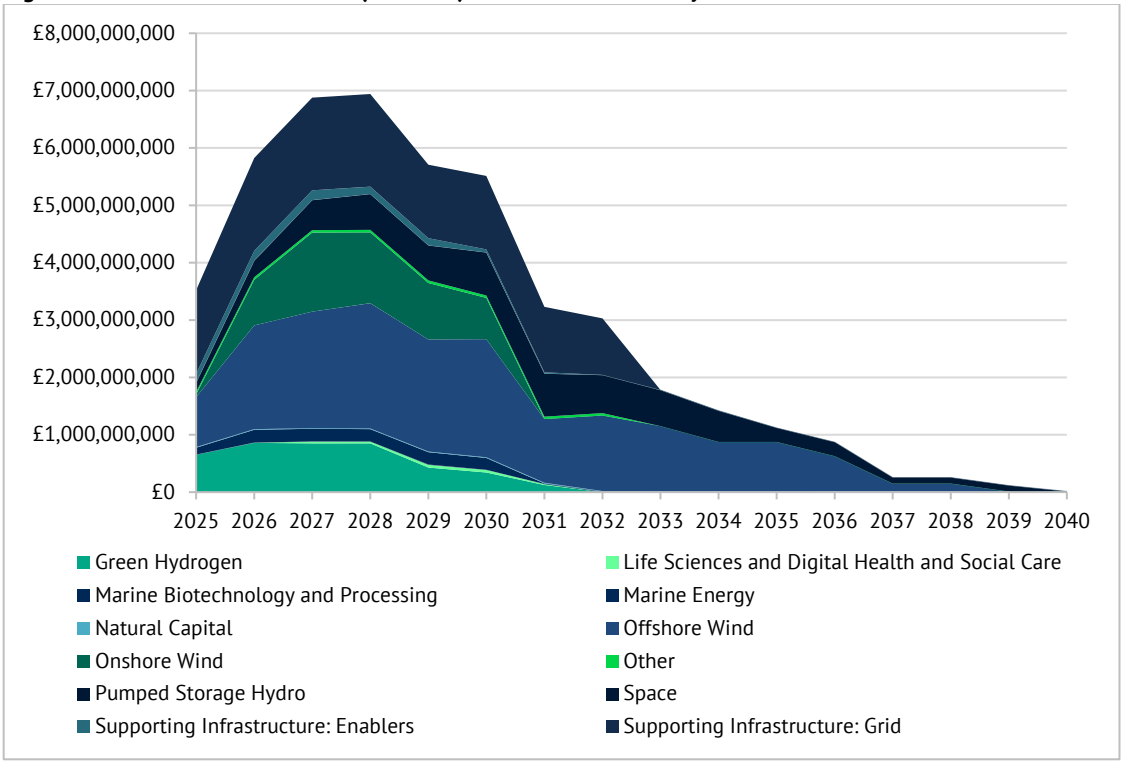


Figure A1.9: Direct GVA impacts over time (2025-40) under Scenario SC2 by RTO sector

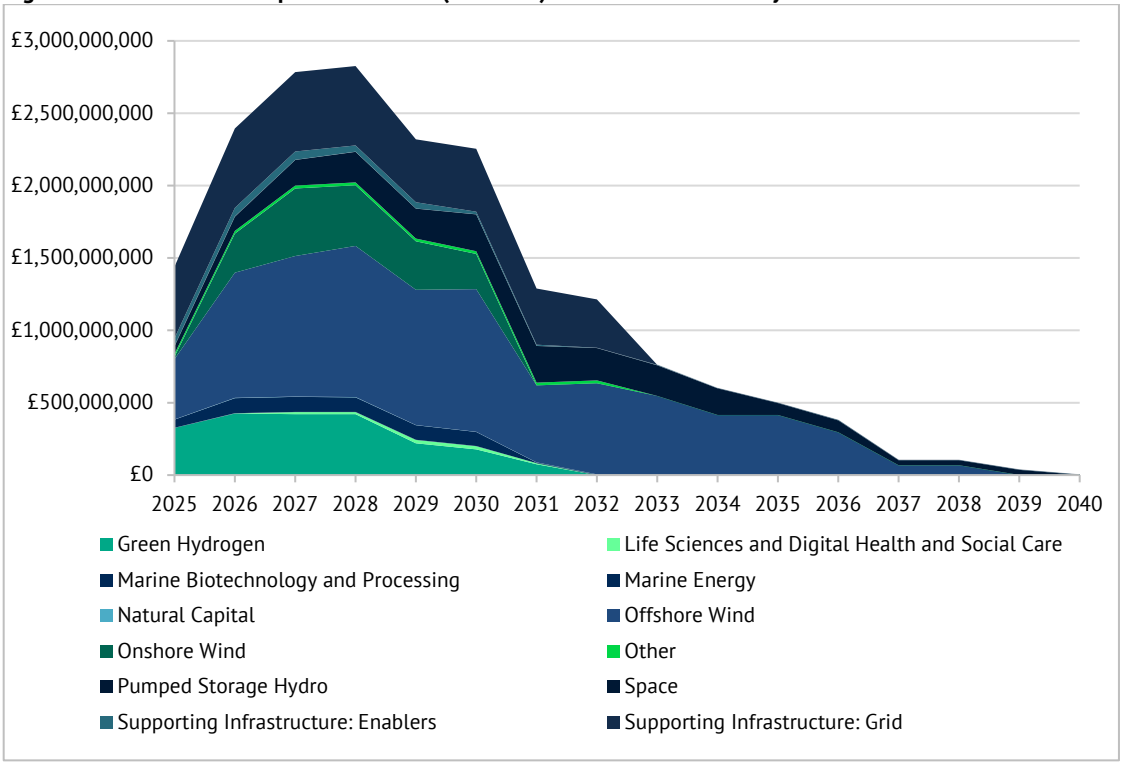


Figure A1.10: Investments over time (2025-40) under Scenario SC2 by local authority area

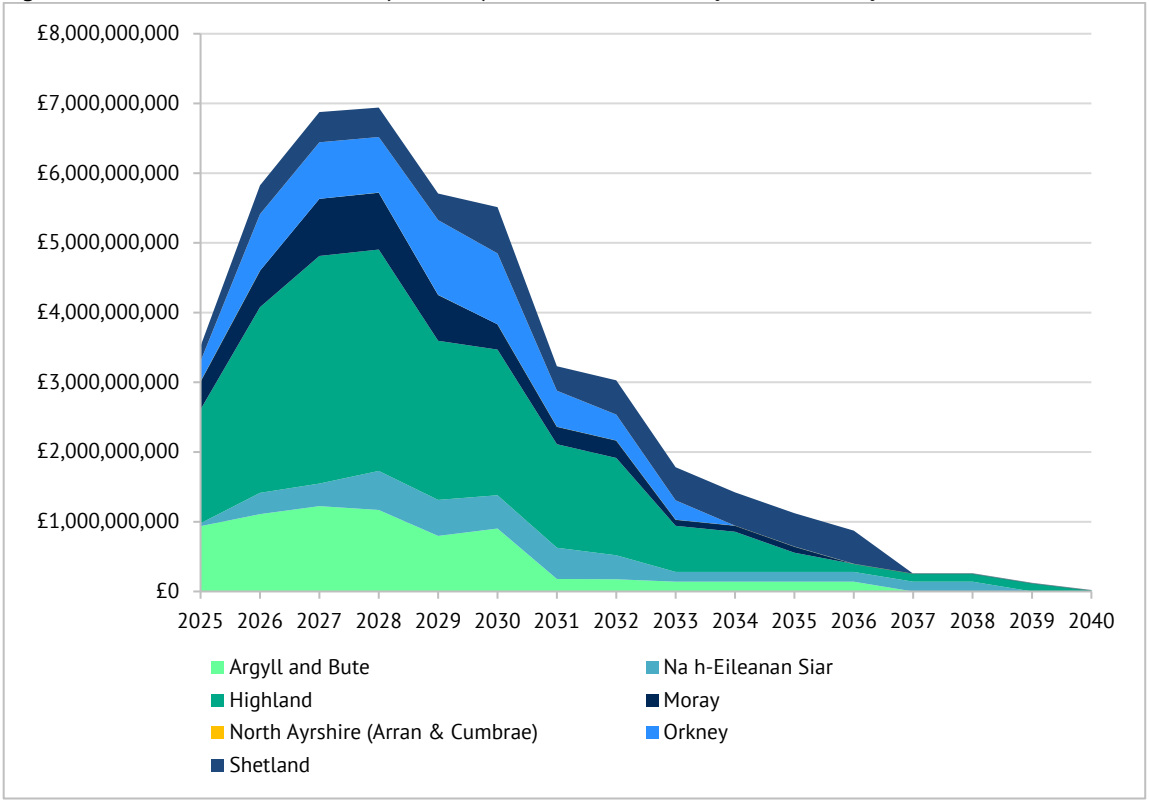


Figure A1.11: Direct GVA impacts over time (2025-40) under Scenario SC2 by local authority area

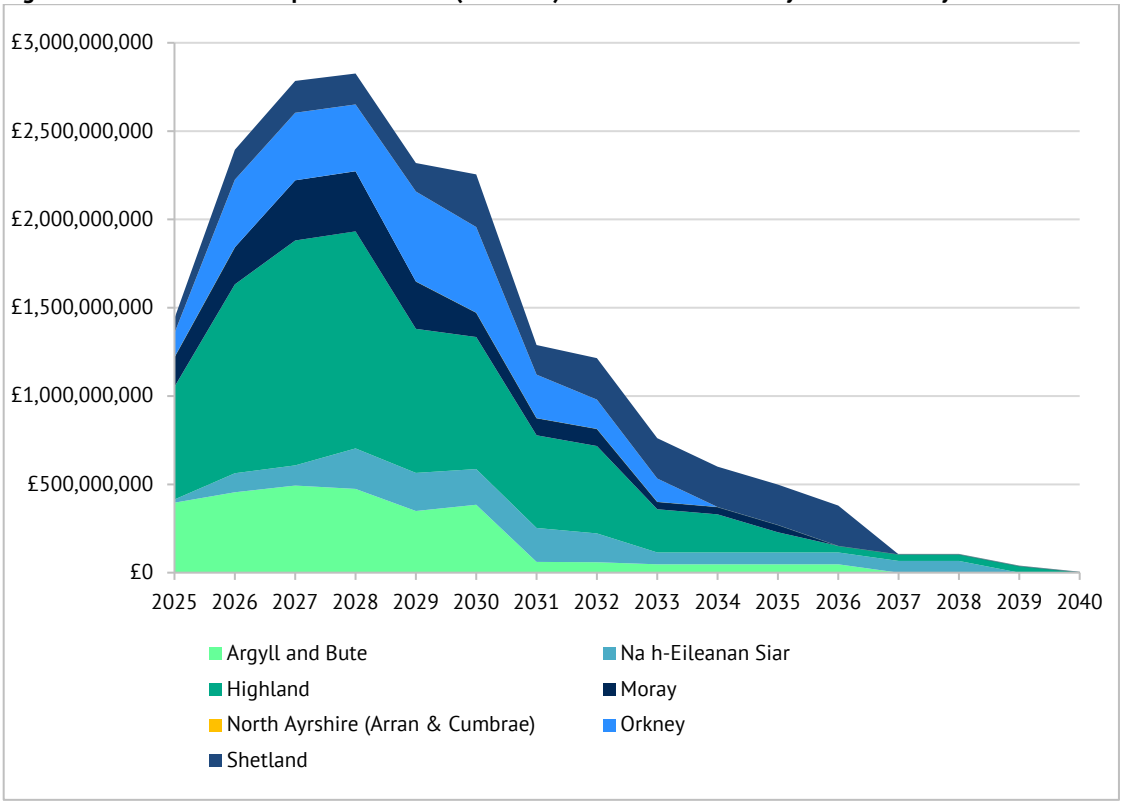


Table A1.12: Status-adjusted estimated direct O&M/operational employment impacts by RTO/sector under SC2

Sector	2030	2035	2040
Green hydrogen	1,260	1,590	1,590
Life sciences and digital health and social care	20	50	50
Marine biotechnology and processing	60	70	70
Marine energy	10	30	30
Natural capital	-	-	-
Offshore wind	310	570	880
Onshore wind	1,920	2,910	2,910
Other	120	120	120
Pumped storage hydro	<10	70	110
Space	80	100	100
Supporting infrastructure: enablers	1,680	1,920	2,980
Supporting infrastructure: grid	-	-	-
Total Highlands and Islands	**5,460**	**7,420**	**8,830**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

Table A1.13: Status-adjusted estimated direct O&M/operational employment impacts by local authority under SC2

Area	2030	2035	2040
Argyll and Bute	520	790	820
Na h-Eileanan Siar	420	710	790
Highland	3,660	4,630	5,720
Moray	370	540	560
Arran and Cumbrae	10	10	10
Orkney	170	380	390
Shetland	310	360	540
Total Highlands and Islands	**5,460**	**7,420**	**8,830**

Note: Operational employment figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

SC3: Policy on, delayed time frame for switch-on

Table A1.14: Status-adjusted impacts under Scenario SC3 by RTO sector

Sector	Total investment (£)	FTE job years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Green hydrogen	£2,527,400,000	4,540	£1,301,400,000	£1,013,700,000
Life sciences and digital health and social care	£116,800,000	530	£55,200,000	£47,100,000
Marine biotechnology and processing	£14,500,000	60	£4,600,000	£4,000,000
Marine energy	£685,000,000	3,020	£322,400,000	£180,200,000
Natural capital	£165,300,000	1,200	£22,200,000	£31,400,000
Offshore wind	£10,174,800,000	4,560	£4,865,300,000	£4,170,100,000
Onshore wind	£2,734,000,000	6,810	£928,100,000	£795,500,000
Other	£231,800,000	1,080	£102,500,000	£43,200,000
Pumped storage hydro	£3,381,500,000	4,790	£1,147,900,000	£983,900,000
Space	£37,400,000	290	£17,900,000	£15,300,000
Supporting infrastructure: enablers	£743,200,000	2,940	£252,300,000	£216,300,000
Supporting infrastructure: grid	£5,916,200,000	1,270	£2,008,300,000	£1,721,400,000
Total Highlands and Islands	**£26,728,000,000**	**31,080**	**£11,028,100,000**	**£9,222,100,000**

Note: FTE job years figures have been rounded to the nearest 10. Totals may not sum due to rounding.

Table A1.15: Status-adjusted impacts under Scenario SC3 by local authority area

Sector	Total Investment (£)	FTE job years (DCI)	Estimated direct GVA (£)	Estimated indirect/induced GVA
Argyll and Bute	£3,882,100,000	3,610	£1,570,100,000	£1,343,700,000
Na h-Eileanan Siar	£2,058,300,000	2,420	£881,000,000	£725,700,000
Highland	£11,128,700,000	16,720	£4,164,400,000	£3,538,000,000
Moray	£3,295,700,000	2,230	£1,427,400,000	£1,223,500,000
Arran and Cumbrae	£2,700,000	10	£900,000	£700,000
Orkney	£3,539,100,000	3,240	£1,708,700,000	£1,315,000,000
Shetland	£2,821,300,000	2,860	£1,275,600,000	£1,075,400,000
Total Highlands and Islands	**£26,728,000,000**	**31,080**	**£11,028,100,000**	**£9,222,100,000**

Note: FTE job years figures have been rounded to the nearest 10. Totals may not sum due to rounding.

Figure A1.12: Investment over time (2025-40) under Scenario SC3 by RTO sector

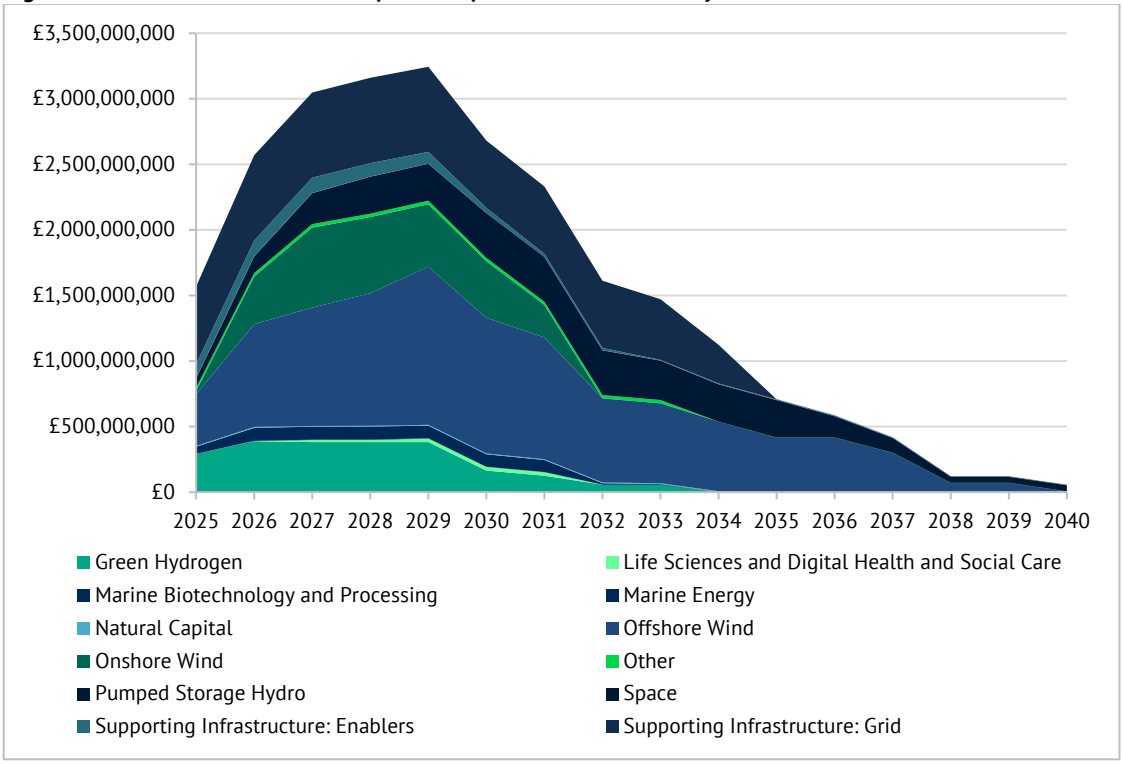


Figure A1.13: Direct GVA impacts over time (2025-40) under Scenario SC3 by RTO sector

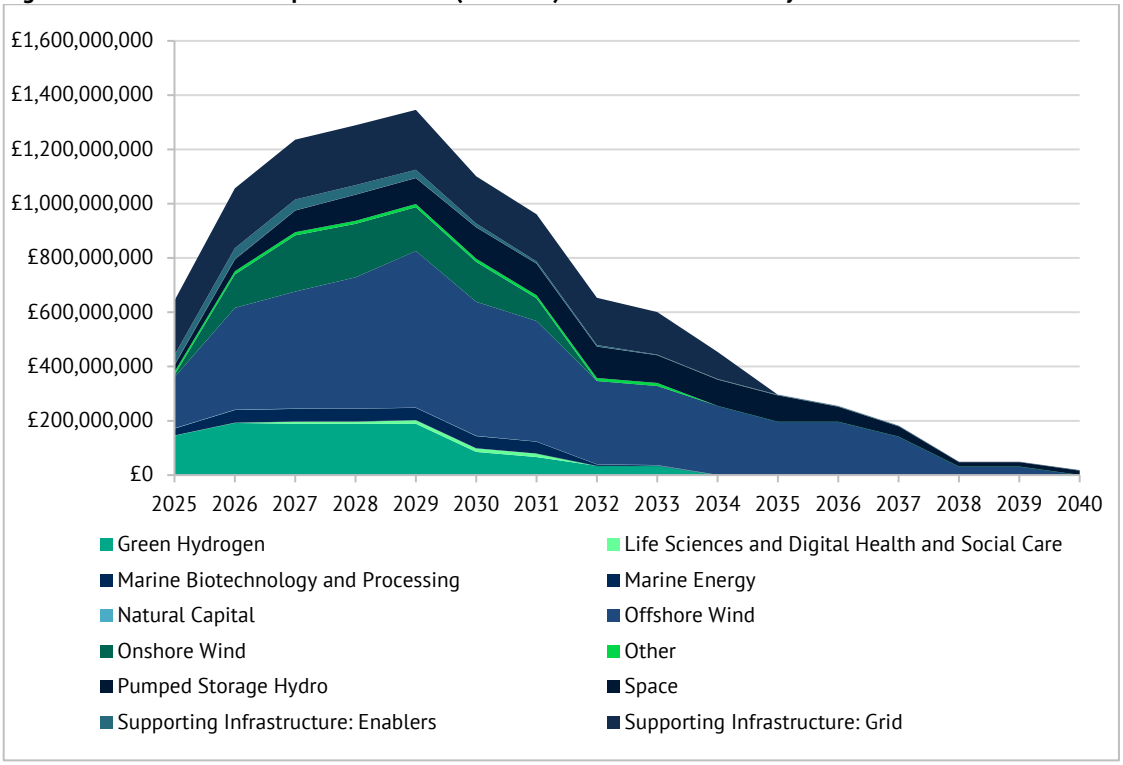


Figure A1.14: Investments over time (2025-40) under Scenario SC3 by local authority area

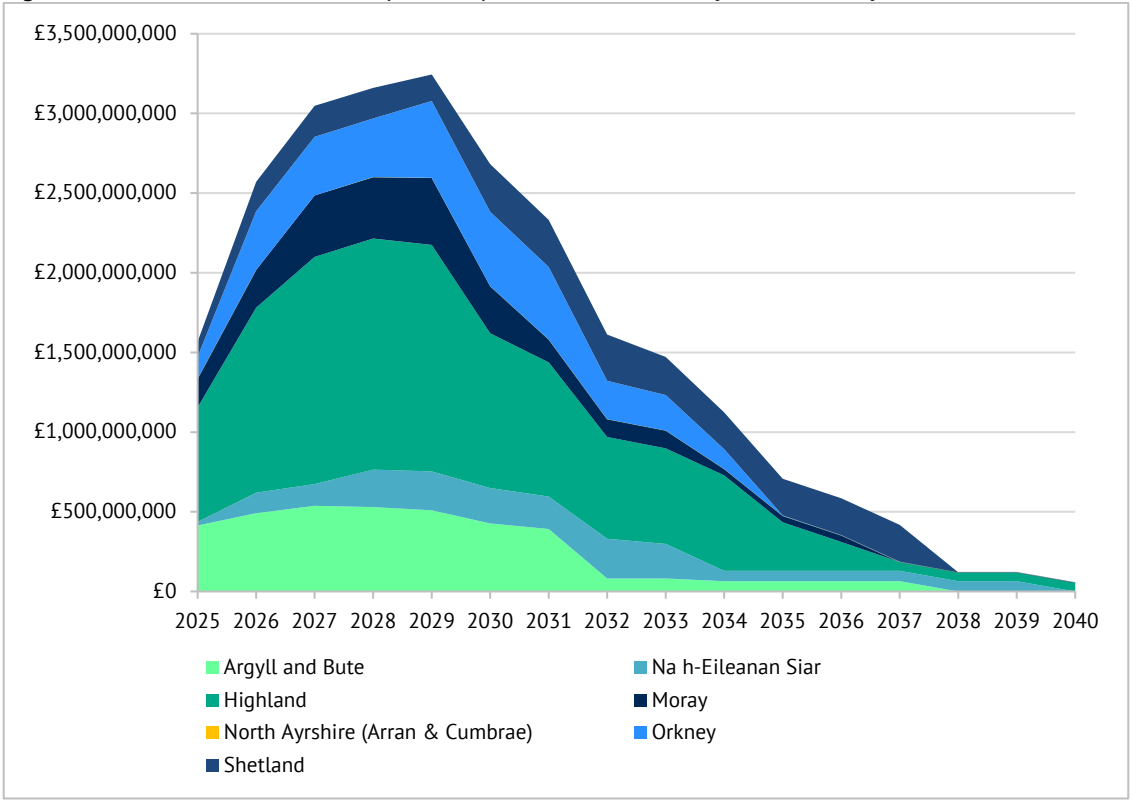


Figure A1.15: Direct GVA impacts over time (2025-40) under Scenario SC3 by local authority area

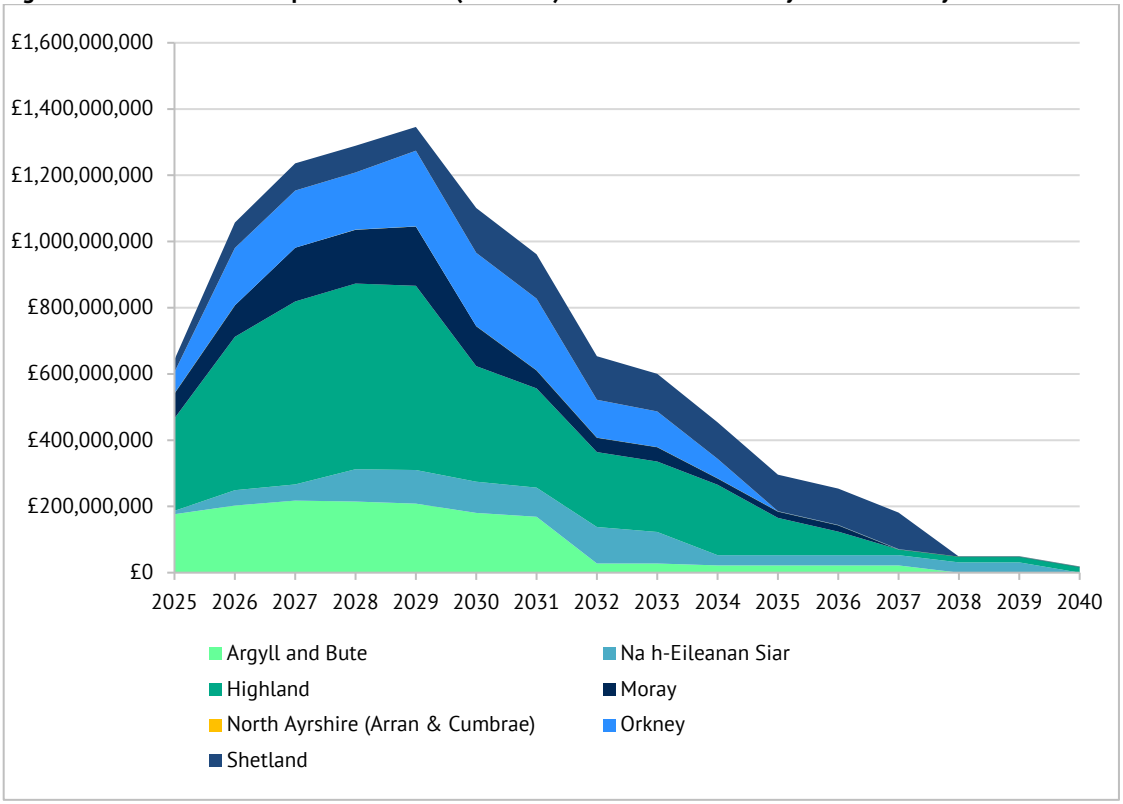


Table A1.16: Status-adjusted estimated direct O&M/operational employment impacts by RTO/sector under SC3

Sector	2030	2035	2040
Green hhydrogen	580	840	840
Life sciences and digital health and social care	<10	30	30
Marine biotechnology and processing	30	40	40
Marine energy	<10	20	20
Natural capital	-	-	-
Offshore wind	90	270	460
Onshore wind	470	1,540	1,540
Other	40	80	80
Pumped storage hydro	<10	20	50
Space	50	70	70
Supporting infrastructure: enablers	1,020	1,520	2,150
Supporting infrastructure: grid	-	-	-
Total Highlands and Islands	**2,280**	**4,440**	**5,290**

Note: Operational jobs figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

It is assumed that new grid infrastructure delivered by projects in scope for this study is maintained by the incumbent workforce. For natural capital it assumed that jobs associated with the projects/investments identified are time-bound (not permanent).

Table A1.17: Status-adjusted estimated direct O&M/operational employment impacts by local authority under SC3

Area	2030	2035	2040
Argyll and Bute	140	440	460
Na h-Eileanan Siar	100	380	420
Highland	1,730	2,900	3,570
Moray	80	280	300
Arran and Cumbrae	<10	<10	<10
Orkney	60	220	230
Shetland	170	210	310
Total Highlands and Islands	**2,280**	**4,440**	**5,290**

Note: Operational jobs figures have been rounded to the nearest 10. Totals may not sum due to rounding. Operational employment represents additional, direct employment associated with the RTO projects/investments only. It does not include supply chain impacts. Proxies and modelling have been used where data on likely operational jobs was not available for projects.

A.2. RTO policy context

This appendix outlines the key policies relating to each RTO and the points that are specific to, and a driving growth in the sector.

Table A.2.1: Offshore wind

Policy/strategy	Aims and objectives	Policy implications for offshore wind
Highlands and Islands Enterprise Strategy 2023-2028[419] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[420]	• Offshore wind is identified as an RTO in the strategy which means that the sector may benefit from: increased investment, training, education, and employment opportunities; increased finance development pathways to support enterprise development; supported conditions for growth and supply chain development; actions to ensure a net zero transition; and new technologies and data.
Offshore wind policy statement[421] *Current*	• This document outlines the Scottish Government's vision for offshore wind, emphasizing its role in achieving net-zero emissions by 2045.	• The policy supports the expansion of offshore wind capacity, with a focus on innovation, supply chain development, and environmental sustainability. • Target of 11GW of offshore wind capacity is possible in Scottish waters by 2030. • ScotWind leasing rounds will continue. • Constant review and improvements of processes, planning, regulations, innovation, and skills development. • Reduction in barriers to developing offshore wind.
Sectoral marine plan for offshore wind energy[422] *Current*	• The plan aims to identify sustainable planning options for the future development of commercial-scale offshore wind energy in Scotland. This includes deep water wind technologies and covers both Scottish inshore and offshore waters.	• Further seabed leasing for Scottish waters will increase opportunities for offshore wind development and help to attract investment. • Definition of commercial-scale offshore wind may lead to increased development scale-up and funding competitiveness. • Innovation leasing and test and demonstration projects will increase research and development. • Action plan will improve coherence, governance, and chances of successfully developing the sector and reaching 11GW capacity targets.

[419] https://www.hie.co.uk/media/vczc0zca/hie-strategy-2023-28-final-031023.pdf
[420] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[421] https://www.gov.scot/publications/offshore-wind-policy-statement/
[422] https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/

Policy/strategy	Aims and objectives	Policy implications for offshore wind
Draft energy strategy and just transition plan[423] *Proposed*	• The plan sets out a route map of actions that the Scottish Government will take to deliver a flourishing net zero energy system that supplies affordable, resilient and clean energy to Scotland's workers, households, communities and businesses.	• Ambition to have 8-11GW of installed offshore wind capacity by 2030 and consultations on setting a further offshore deployment ambition will accelerate development and increase leasing opportunities. • Scottish Government are seeking devolved powers for offshore wind which, if successful, may lead to regulatory and funding changes for offshore wind developments in Scottish waters. • Good practice principles for community benefit schemes from offshore renewable energy developments may increase community engagement and promote environmental credentials within the offshore wind sector. • Delivery of up-to-date critical research through the Scottish Marine Energy Research (ScotMER) programme to address key consenting and planning risks with increased funding for projects over the next five years.
Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update[424] *Current*	• This plan sets out Scotland's approach to reducing greenhouse gas emissions, with offshore wind playing a key role in decarbonizing the energy sector. It supports investment in renewable energy to meet Scotland's climate targets. An update was issued in 2020 which included reference to economic recovery from the COVID-19 pandemic.	• Energy transition from oil and gas to renewable energy is a significant driver of offshore wind development and investment. • Just Transition Commission has recommended that there should be increased investment into renewable energy, particularly onshore and offshore wind.

[423] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/
[424] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/

Policy/strategy	Aims and objectives	Policy implications for offshore wind
Scotland's National Strategy for Economic Transformation (NSET)[425] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• In anticipation of rapid scaling of offshore wind activity in response to ScotWind and Innovation and Targeted Oil and Gas (INTOG) leasing rounds, the University of the Highlands and Islands (UHI), the Energy Skills Partnership, Skills Development Scotland, and Highland and Islands Enterprise (HIE) are actively expanding global offshore wind training and certification, and advanced manufacturing training capability within UHI colleges (including industry-led provision), to meet demand for a skilled offshore wind workforce. • Partners are engaged in cluster development to stimulate innovation and supply chain development in key areas such as offshore wind, hydrogen, heat decarbonisation and energy systems. Infrastructure to support these sectors is being considered for support through the Islands Growth Deal, including the development of the UK's first ultra-deep-water port in Shetland.
Green Industrial Strategy[426] ***Current***	• Outlines a plan to harness the global shift towards a net-zero economy, aiming to stimulate economic growth, create well-paid jobs, and position Scotland as a leader in clean energy and environmental sustainability.	• Building on our first-mover advantage in floating offshore wind to generate clean electricity; • Participating in global supply chains as well as expanding our domestic supply chain capacity; • Seizing opportunities across the offshore wind supply chain, from infrastructure to manufacturing opportunities; • Positioning Scotland as a leader in material circularity of wind turbines and components

[425] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[426] https://www.gov.scot/publications/green-industrial-strategy/

Policy/strategy	Aims and objectives	Policy implications for offshore wind
British energy security strategy[427] *Current*	• UK Government is delivering on a 10-point plan, having already generated 68,000 green jobs and £22 billion in private investment, to further raise ambitions.	• UK target to reach 50GW of offshore wind by 2030, including 5GW of floating offshore wind. • Over £1.6 billion invested in offshore wind securing 3,600 jobs. • Over 10GW already generated, and another 12GW in the offshore wind pipeline. • Up to £320 m in government support for fixed bottom and floating wind ports and infrastructure. • Additional government support for other low-cost renewables technologies which could strengthen offshore wind supply chains and accelerate skills development in renewables.
Great British Energy *Proposed*	• Publicly-owned clean power investment organisation to be headquartered in Aberdeen.[428] • Provide up to £8.3bn to begin making investments and securing private-sector partnerships. • Leverage the capabilities of the public sector together with electricity market reforms, to increase the speed, and reduce the cost, of deploying renewable generation capacity. • Boost the UK's energy independence, create new jobs, save money for households and tackle climate change, aligned with the Labour Party's manifesto pledge to create a 'clean energy superpower'.	• The organisation will work with Crown Estate to support the development of offshore wind and other clean technology projects, which ministers claim will help leverage up to £60bn of private investment.[429] • Crown Estate Scotland have said that the partnership will help to achieve its plans to lease out, by 2030, enough seabed for about 20-30GW of new offshore wind capacity, which could power nearly 20m homes.[430] • Lower risk for developers which may enable projects to build out faster after leasing and investment rounds. • Boost new technologies and innovation within offshore wind.

[427] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy
[428] https://www.bbc.co.uk/news/articles/c7v5y6gnjeyo
[429] https://www.ft.com/content/eb889a61-0160-4e94-b98b-d44cc250d739?shareType=nongift
[430] Ibid.

Policy/strategy	Aims and objectives	Policy implications for offshore wind
Offshore Wind Sector Deal[431] *Current*	• Approved in March 2019, the UK Government deal commits to deploying 30GW of Offshore Wind by 2030 and 50GW by 2050 which helps to secure offshore wind's position within the future energy mix and provides clarity on the route to market for the technology.	• UK Government will continue to fund collaborative research and development to increase UK competitiveness and further reduce costs within the offshore wind sector: innovation activity to include a focus on increasing the UK competitiveness of goods and services, including digital and robotic technologies for surveying and operations and maintenance, and next generation technologies contributing to cost reduction. • UK Government and research institutions will work with the System Management and Optimisation Task Group (SMOTG) on offshore wind system integration: led by the sector champion, the SMOTG will identify opportunities to strengthen offshore wind's role in delivering innovative solutions to system integration via existing government programmes.
Contracts for Difference[432] *Current*	• Contracts for Difference (CfDs) is a UK private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company.	• Increase support and investment in the offshore wind sector as it generates low carbon electricity.

Source: Various

[431] https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal
[432] https://www.gov.uk/government/collections/contracts-for-difference

Table A.2.2: Green hydrogen

Policy/strategy	Aims and objectives	Policy implications for green hydrogen
Highlands and Islands Enterprise Strategy 2023-2028[433] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[434]	• Green hydrogen is one of the Regional Transformational Opportunities outlined in HIEs strategy, and runs through most of the objectives, with HIE indicating it is a key supporting pillar of net zero producing high value opportunities and supporting up to 600 FTE roles. To support this, HIE will target a supporting regulatory framework to improve conditions for green hydrogen production, work with the Scottish Government to create green hydrogen hubs for production, storage and innovation, and encourage, and increase inward investment into the industry.
Hydrogen Action Plan[435]	• The Hydrogen Action Plan aims to set the conditions over five years to allow Scotland to reduce its carbon output to reach net zero, while achieving a just transition, and also becoming a significant exporter of green hydrogen.	• The strategy sets key hydrogen objectives of 5GW in green hydrogen production by 2030, increasing to 25GW by 2045, equating to in excess of 450,000 tonnes of green hydrogen produced per annum when at full capacity. This level of production will have a potential GVA contribution of £5 bn to £25 bn a year, also creating between 70,000 to 300,000 protected or created jobs by 2045. • To support this, the Scottish Government commit £100 m in rounds of funding for green hydrogen projects, as well as the creation of a Hydrogen Innovation Scheme which will improve understanding, and experience of hydrogen production and support innovation.

[433] https://www.hie.co.uk/media/vczc0zca/hie-strategy-2023-28-final-031023.pdf
[434] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[435] https://www.gov.scot/publications/hydrogen-action-plan/

Policy/strategy	Aims and objectives	Policy implications for green hydrogen
Draft Energy Strategy and Just Transition Plan[436] *Proposed*	• The plan sets out a route map of actions that the Scottish Government will take to deliver a flourishing net zero energy system that supplies affordable, resilient and clean energy to Scotland's workers, households, communities and businesses.	• The strategy supports recurrent Scottish Government objectives of 25GW of low carbon hydrogen production by 2045, and aims to establish a strong hydrogen economy in Scotland, promoting national and regional growth, and increasing export potential. In light of European targets of 10 million tonnes of hydrogen production capacity, and a further 10 million tonnes of hydrogen imported by 2030, the Draft Energy Strategy and Just Transition Plan aims to take advantage of this demand.
Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update[437] *Current*	• This plan sets out Scotland's approach to reducing greenhouse gas emissions, with offshore wind playing a key role in decarbonizing the energy sector. It supports investment in renewable energy to meet Scotland's climate targets. An update was issued in 2020 which included reference to economic recovery from the COVID-19 pandemic.	• The strategy commits to a £180m Emerging Energy Technologies Fund to provide support to hydrogen projects, and also sets the foundations for future hydrogen development strategies. • The strategy also commits £120m for Zero Emission Buses, and emphasises the potential for hydrogen to provide a useful alternative to fossil fuels in areas such as public transport, recognising the innovative work which has already taken place in Aberdeen to create hydrogen buses.

[436] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/
[437] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/

Policy/strategy	Aims and objectives	Policy implications for green hydrogen
Scotland's National Strategy for Economic Transformation (NSET)[438] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• Hydrogen production and export is one of the areas identified in the strategy as a key sector in which Scotland already occupies a position of global leadership in the design, development and operationalisation, and one which can be taken advantage of. This recognises the significant potential of green hydrogen facilitated by Scotland's natural resources and existing renewable energy production capacity, and supports objectives laid out in the Hydrogen Action Plan of reaching a 25GW hydrogen production capacity by 2045. • The Scottish Government further commit to financial investment to support the renewable hydrogen sector in Scotland, focussing on driving technological progress, advancing innovation and reducing cost within the hydrogen sector.
British energy security strategy[439]	• UK Government is delivering on a 10 point plan, having already generated 68,000 green jobs and £22 bn in private investment the strategy has raised ambitions.	• The UK Government recognise the significant lack of hydrogen contributing to the current UK energy mix and sets the target of a 10GW hydrogen production capacity by 2030, with at least half of this coming from green hydrogen. • Other targets are to run allocation rounds for electrolyser produced hydrogen, aiming to move to price competitive allocations by 2025, setting up a hydrogen certification scheme by 2025, and beginning to blend up to 20% hydrogen into the UK gas network.

[438] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[439] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

Policy/strategy	Aims and objectives	Policy implications for green hydrogen
Great British Energy	• Publicly-owned clean power company to be headquartered in Scotland. • The bill will provide up to £8.3 bn to begin investments and secure private-sector partnerships. • Leverage the capabilities of the public sector together with electricity market reforms, to increase the speed and reduce the cost of deploying renewable generation capacity. • Boost the UK's energy independence, create new jobs, save money for households and tackle climate change, and is aligned with the Labour Party's manifesto pledge to create a 'clean energy superpower'.	• One of the means of increasing homegrown energy production proposed by the policy is through increased hydrogen production.
UK Hydrogen Strategy[440]	• The UK Governments plan to develop the low carbon hydrogen industry, increasing capacity an export potential.	• The UK Hydrogen strategy pledges £300 m funding for hydrogen projects in early 2020s, aiming to increase the UKs capacity to both produce and export green hydrogen. • This will have the potential to boost UK's production and export capacity of green hydrogen. The strategy recognises the potential significant increase in demand for hydrogen over the next two decades, in sectors including transport, industry, power, and heat in buildings. • This will support the country in reaching the target of 5GW of low carbon hydrogen production capacity by 2030.

Source: Various

[440] https://www.gov.uk/government/publications/uk-hydrogen-strategy/uk-hydrogen-strategy-accessible-html-version

Table A.2.3: Marine energy

Policy/strategy	Aims and objectives	Policy implications for marine energy
Highlands and Islands Enterprise Strategy 2023-2028[441] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[442]	• Marine energy is identified as an RTO in the strategy which means that the sector may benefit from: strategic prioritisation; supply chain support; and employment opportunities in manufacturing, installation, and maintenance of marine energy devices.
Draft energy strategy and just transition plan[443] *Proposed*	• Draft route map of actions that the Scottish Government will take to deliver a flourishing net zero energy system that supplies affordable, resilient, and clean energy to Scotland's workers, households, communities, and businesses.	• Demand for an investment and employment pivot from traditional energy sources into renewable energy sectors such as marine energy. • Support for the delivery of the 2021–2025 business plan for Wave Energy Scotland with £18.25 m of investment, and work with stakeholders to explore the longer-term needs of the marine energy sector. • Deliver up-to-date critical research through the Scottish Marine Energy Research (ScotMER) programme to address key consenting and planning risks with increased funding for projects over the next five years. • Marine energy vision statement will be published as part of the final Energy Strategy and Just Transition Plan. • Continued Scottish Government engagement with industry and other stakeholders to understand the barriers to, and opportunities from, the further development of marine energy and the commercialisation of tidal stream energy.

[441] https://www.hie.co.uk/media/vczc0zca/hie-strategy-2023-28-final-031023.pdf
[442] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[443] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/

Policy/strategy	Aims and objectives	Policy implications for marine energy
Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update[444] *Current*	• This plan sets out Scotland's approach to reducing greenhouse gas emissions, with Marine Energy playing a contributory role in decarbonizing the energy sector. It supports investment in renewable energy to meet Scotland's climate targets. An update was issued in 2020 which included reference to economic recovery from the COVID-19 pandemic.	• Support for innovative low carbon technologies, such as Marine Energy, may help the sector to maintain Scotland's world leading position in the development of technologies in marine energy. • Continued investment in Wave Energy Scotland programme. • Emerging Energy Technologies Fund of £180 m compliments energy transition programme including innovative marine energy solutions.
Scotland's National Strategy for Economic Transformation (NSET)[445] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• HIE, local authorities and the Scottish Government are working with industry to secure affordable and timely grid capacity and address other barriers to deployment. Wave Energy Scotland and EMEC continue to further the region's lead on marine energy through technology deployment.

Source: Various

Table A2.4: Space

Policy/strategy	Aims and objectives	Policy implications for Space
Highlands and Islands Enterprise Strategy 2023-2028[446] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[447]	• Space is one of the Regional Transformational Opportunities in the strategy, recognising the significant potential for the region to boost its employment in the space industry and become a hub for orbital and sub-orbital launches. The Highlands and Islands provides a leading role for the Scottish space industry, possessing the best conditions for a range of space businesses and activities, and HIE will support this industry, encouraging growth and investment.

[444] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[445] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[446] https://www.hie.co.uk/media/vczc0zca/hie-strategy-2023-28-final-031023.pdf
[447] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/

Policy/strategy	Aims and objectives	Policy implications for Space
A Strategy for Space in Scotland[448] *Current*	• A Strategy for Space in Scotland details Space Scotland, and the Scottish Government's vision to develop the Scottish space sector, making Scotland the best country to have, and invest in space businesses.	• Recognising the strategic advantages which Scotland already possesses in the space industry, having a large number of space businesses and over a fifth of the UK's space industry workforce, the strategy targets an annual contribution to the Scottish economy from the space industry of £4 bn, including a fivefold increase in the Scottish space workforce by 2030 reflecting an annual growth of 26%. • Specific objectives which the strategy will use to deliver this include developing a strategic partnership between stakeholder organisations such as the UK Space Agency, UK Government Departments of International Trade and Business, Energy and Industrial Strategy, and the European Space Agency. This also fits within regional and national decarbonisation targets, as the strategy will support low carbon, and zero carbon innovation, such as using alternative fuel sources for space travel. • Recent data shows an increase of 25% in space-related companies based in Scotland, with total income for the sector increasing 65%.[449] These impacts were experienced over a one-year period, highlighting the rapidly growing nature of the Scottish space sector, and impacts of Scottish Government support.
Scotland's National Strategy for Economic Transformation (NSET)[450] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• NSET is aligned to A Strategy for Space in Scotland, and will support its objectives of increasing annual economic contribution of the Scottish space industry to £4 bn by 2030. This recognises new key market opportunities for Scotland in areas such as small satellite design, manufacture and launch, including earth observation data solutions that can also provide important support in realising net zero ambitions. The strategy will direct the best entrepreneurial

[448] https://spacescotland.org/wp-content/uploads/2023/11/a_strategy_for_space_in_scotland.pdf
[449] https://www.gov.scot/news/growing-scotlands-space-sector/
[450] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/

Policy/strategy	Aims and objectives	Policy implications for Space
		people into industries such as aerospace which can boost the space industry, and support these people to build new start-ups.
National Space Strategy[451] *Current*	• The UK Government's premier space strategy published in 2021, outlines the government's five goals for the space sector in order to develop this, as well as a string of activities which government, academia and industry can take to achieve these objectives	• The five goals the strategy hopes to achieve are: growing and levelling up the UK space economy; promoting the values of global Britain; leading on pioneering scientific discovery, and inspiring the nation; protecting and defending national interests in and through space; and using space to deliver for UK citizens and the world. The strategy details a ten point plan to deliver this, with specific objectives including the investment of £5 bn into the UKs military's satellite communications and £1.4 bn in new technologies and capabilities over five years, and becoming the first country to launch a rocket into orbit from Europe in 2022, further capitalising on this innovation to become a leading producer of small satellites on the global stage.
Defence Space Strategy[452] *Current*	• The Defence Space Strategy, published in 2022, is the Ministry of Defence's joint military and civil plan to boost the security of UK space infrastructure underlined by the MOD's Protect and Defend goals.	• The strategy recognises the myriad potential threats to the space industry, such as cyber attacks and other warfare posed by Russia and China, and supports the objectives outlined in the National Space Strategy. The main mission of the strategy is to generate, integrate and operate space capabilities to protect and defend the UK's interests in support of global operations. Cross cutting themes to support this mission are to broaden and deepen multinational cooperation Improving cross-government collaboration; and drive innovation and making use of technological opportunities. • This requires significant upskilling of the UK space workforce and an enhancement of space-based military operations and will therefore likely provide market opportunities for space businesses in the Highlands and Islands to provide skills and products to realise this mission.

[451] https://www.gov.uk/government/publications/national-space-strategy
[452] https://www.gov.uk/government/publications/defence-space-strategy-operationalising-the-space-domain

Policy/strategy	Aims and objectives	Policy implications for Space
Space Industrial Plan[453] *Current*	• The UK Government's Space Industrial Plan, published in 2024, is a joint civil defence plan which aims to boost growth and innovation in the UK space industry. This carries over the principles of the National Space Strategy and Defence Space Strategy of integration across a range of stakeholders to upskill the workforce and increase growth in the UK space industry.	• This provides some updated planned actions for 2024 which will support delivery of the preexisting 2030 targets outlined in the original strategies. • The first of these is the development of cross-government initiatives in a range of key areas and technologies (Space Domain Awareness; In-Orbit Servicing, Assembly and Manufacturing; Space data for Earth applications; Position, Navigation and Timing; Satellite Communication Technology). These will involve key stakeholders and support development of these areas and technologies. • The second is to finalise the National Space Capability Development Plan which will set the roadmap to developing the space industry, supporting this with 22 delivery objectives to inform development. • Finally, the UK Government will produce an updated Defence Highly Assured Technical Areas report, providing an up-to-date review of space security needs.

Source: Various

Table A.2.5: Marine biotechnology and processing

Policy/strategy	Aims and objectives	Policy implications for marine biotechnology and processing
Scotland's National Strategy for Economic Transformation (NSET)[454] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• This targets promoting economic development which ensuring positive management of Scottish wildlife and other natural capital. This involves Scotland transitioning to a 'nature positive economy' which promotes biodiversity of our habitats and encourages economic development which we continue to decarbonise.

[453] https://www.gov.uk/government/publications/space-industrial-plan
[454] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/

Policy/strategy	Aims and objectives	Policy implications for marine biotechnology and processing
Marine (Scotland) Act 2010[455]	• Aims to protect Scottish marine environments, while simultaneously promoting investment in and economic transformation of them.	• The act gives increased powers to protect and manage marine wildlife environments. For example, allowing increased powers to create dedicated marine protection areas. • This also streamlines the licensing process of activities developing marine environments such as through harvesting and managing seaweed, including clarifying the requirements for a license and ensuring that applications are processed efficiently.
Scotland's National Marine Plan[456]	• Creates a framework for the management of all activities in Scotland's marine areas and habitats, including marine biotechnology. This has the overall objective of promoting a clean and healthy marine ecosystem in Scotland, which meets the needs of people and nature.	• This provides a framework of information for stakeholders in managing marine biotechnology, including developing plans which maintain diversity and health of marine habitats.
Regional Marine Management Plans	• The marine areas in Scotland have independent regional marine plans to inform development and management of their marine areas.	• Scotland's regional marine management plans promote good and sustainable management of marine wildlife, and ecosystems across Scottish coastlines. This often includes regulatory framework to ensure supportive policy, and community engagement to promote community engagement in the planning process.
Marine Science & Innovation Strategy (Jan 2024)[457]	• Aims to ensure that all Scottish marine policy and strategy is informed by robust and reliable data and research, to ensure the best management and development of Scottish marine habitats.	• Providing high-quality, open access data sources for the Scottish Government to allow them to make informed decisions surrounding Scotland's. Other actions include collaborating with key stakeholders, especially those who have seagoing research vessels.

[455] https://www.legislation.gov.uk/asp/2010/5/contents
[456] https://www.gov.scot/publications/scotlands-national-marine-plan/
[457] https://www.gov.scot/publications/marine-science-innovation-strategy/

Table A.2.6: Life sciences and digital health and social care

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Life Sciences Industrial Strategy Update[458] *Current*	• An update on progress from the 2017 Industrial Strategy in January 2020. • Organised into five key themes of NHS Collaboration; Business Environment; Reinforcing the UK Science offer; skills; and advanced therapies.	• Commitment to boost UK spending on R&D within the sector to 2.4% of GDP by 2027. • Development of the digital innovation ecosystem (Alan Turing Institute).
Life Sciences 2030 Skills Strategy[459] *Current*	• An overview of the state of the Life Sciences sector by way of policy, drivers, demand and supply of skills and future. workforce projections • Recommendations for delivery of the ambitions around integrated skills, apprenticeships, the global environment, and attracting/retaining talent.	*Key recommendations:* • Identification of potential skills requirements linked to research priorities and the R&D pipeline to align investment in training. • Providing training and support to promote entrepreneurial activity, (e.g. placements as part of PhDs). • Collaboration between key stakeholders to promote take-up of apprenticeships in the sector • Developing career pathways to enable movement/cross-sectoral learning. • Building on STEM careers outreach initiatives to inform and enthuse young people to enter the sector.

[458] https://www.gov.uk/government/publications/life-sciences-industrial-strategy-update
[459] https://cogentskills.com/wp-content/uploads/2022/09/sip-life-sciences-2030-skills-strategy-digital-version.pdf

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Life Sciences Vision 2021[460] *Current*	• Sets out the vision for what should be done by actors to 'create the environment in which industry can grow and succeed in the UK, and patients and the NHS can receive a real benefit'. • Identifies seven key technology or disease-specific 'missions'.	*Preconditions for success:* • Highlights the NHS as a crucial innovation partner, building on its ability to trial, embrace and deliver innovation to patients at 'unprecedented speed and scale' during the Covid-19 pandemic. • Investment in science and research in must be maintained and grown over the next decade, reinforcing the above commitment to UK R&D spending of 2.4% of GDP by 2027. • Simplification of the governance and oversight of NHS health data, to drive R&D, and to promote public engagement, transparency and high data protection standards. • Access to finance for innovative life science companies to be able to access capital for growth and innovation.

[460] https://www.gov.uk/government/publications/life-sciences-vision

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Prescription for Growth: Labour's Plan for the Life Sciences Sector[461] *Proposed*	• Recognition that the above Life Sciences Vision (developed under the Conservative Government) is a 'useful starting point,' endorsing its key messages. • Establishes key actions to take forward in order to ensure that the momentum from the Vision is retained.	*Headline actions:* • Bolstering the Life Sciences Council and strengthening the Office for Life Sciences, making it a key priority for the Health Secretary. • Setting 10-year budgets for R&D institutions (e.g. UKRI), to create a more certain and streamlined funding environment. • Ensuring proper federation of data sets, with a single access point for researchers to use data from all genomic resources. • Driving inter-operability between NHS digital systems. • Maintaining the current structure and at least the current rates of R&D tax credits over the current parliament, evaluating the impact of the scheme within the sector. • Creating a Regulatory Innovation Office (RIO) to hold regulators accountable for driving innovation where appropriate. • Committing to long-term workforce planning across the NHS and social care. • Giving more people the chance to participate 'wherever they live in Britain' rather than focusing on population centres for research opportunities. • Using bilateral and multilateral negotiations as an opportunity to remove redundant or duplicative requirements UK medicines face when accessing markets overseas.

[461] https://www.abhi.org.uk/media/o2bnqk3i/labours-plan-for-the-life-science-sector.pdf

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Scotland's National Strategy for Economic Transformation[462] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• Recognises Scotland's potential to build a world-leading industry in life sciences, with 'world-leading expertise' in precision medicine, medtech and pharmaceutical services, advanced therapies, digital health and care, animal health and agritech. • One of the key actions to be implemented in developing a skilled workforce includes a focused **talent attraction** programme to attract key skills and talent from the rest of the UK, with life sciences being a key sector of interest. • Cites industrial biotechnology as one of the key industries for current and future global leadership on account of the innovative technology developments that can transform traditional industries.
Life Sciences Strategy for Scotland 2025[463] *Current*	• A vision to make Scotland the location of choice for life sciences businesses, researchers, healthcare professionals and investors through: anchoring Scotland's life science company base; building on Scotland's core capabilities; and attracting life science investment to Scotland by highlighting its strengths and assets.	• Commitment to increase the sector's economic contribution to £8bn by 2025 by prioritising innovation and commercialisation, sustainable production and internationalisation. • Recognising the significant contribution of Scotland's Innovation Centres directly aligned to life sciences.
Independent Review of Adult Care in Scotland (Feeley Review)[464] *Current*	• A review of ways to improve the adult social care sector in Scotland, primarily in terms of outcomes achieved by and with people who use services. • Identifies three key areas to securing better outcomes: shifting the paradigm; strengthening the foundations; and redesigning the system.	• Within design and structure of services, a call to shift attitudes towards technology and data sharing to improve experience of social care. • Improving performance through greater transparency, innovation and use of digital technology. • A call to explore the introduction of technology in people's own homes (technology-enabled care), focusing on the individual's needs, rights and preferences.

[462] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[463] https://www.lifesciencesscotland.com/wp-content/uploads/2017/08/Life-Sciences-Strategy-for-Scotland-2025-VisionFINALlow-res.pdf
[464] https://www.gov.scot/groups/independent-review-of-adult-social-care/

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
The Campbell Report: A roadmap to investment for health innovation Life Sciences and HealthTech in Scotland[465] *Current*	• A report from the Scottish Government's Investment in Life Sciences Working Group focusing on 'investment for scaling companies, recognising the potential for start-ups and scale-ups as engines of innovation and anchors of future industry'.	*Recommendations:* • To build a national health innovation life science cluster to facilitate connections between different parts of the ecosystem and promote internationally. • Review and enhance public sector support for life science scaling companies, providing support to SMEs to attract and retain talent, and developing local/international networks of life science investors. • To support innovation/ commercialisation, approaches to developed for advice on standards and regulation, a review of the innovation and commercialisation landscape across Scotland, and an exploration of risk-sharing mechanisms with investors such as innovation vouchers.
Greater access, better insight, improved outcomes: a strategy for data-driven care in the digital age[466] *Current*	• The national digital health and social care (HSC) strategy, focusing on: empowering individuals by giving access and the ability to manage/contribute to their own HSC data; empowering those delivering HSC services to be confident and able to gather, use and share data; and ensuring fit for purpose data is readily accessible for planning, research and innovation.	*Of the seven 'priority action areas':* • Talent and Culture: six commitments for life sciences sector professional training needs to ensure digital skills and digital leadership, including through a digitally-enabled workforce programme. • Technology and Infrastructure: adopting a continuous improvement approach for data quality and committing to working with HSC-relevant Innovation Centres on Internet of Things and AI. • Creating Insights from Data: commitments to taking a more joined-up approach to funding and commissioning to encourage communities of practice, and sharing data across public, private and third sectors collaboratively. • Supporting Research and Innovation: supporting access to HSC data through trusted research and innovation environments, such as Scotland's 'Safe Havens'.

[465] https://www.gov.scot/publications/campbell-report-roadmap-investment-health-innovation-life-sciences-healthtech-scotland/
[466] https://www.gov.scot/publications/data-strategy-health-social-care-2/

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Mental Health and Wellbeing Strategy[467] *Current*	• A vision for a 'Scotland, free from stigma and inequality, where everyone fulfils their right to achieve the best mental health and wellbeing possible'.	• Commitment to making better use of (evidenced and appropriate) digital and new technology services to enhance mental health and wellbeing services.
Highlands and Islands Enterprise Strategy 2023-2028[468] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[469]	• Recognition of the life sciences sector as a core growing market in the region, particularly in Inner Moray Firth. • Emphasises potential for collaborative working in the sector, to increase adoption/diffusion of innovation to boost health, wellbeing and economic growth. • Remoteness of the region presented as an opportunity to explore digital health. • Acknowledgement of the need to plan and increase access to relevant skills, and build STEM engagement. • Collaboration with SRUC to capitalise on new opportunities arising form the Rural and Veterinary Innovation Centre.

[467] https://www.gov.scot/publications/mental-health-wellbeing-strategy/
[468] https://www.hie.co.uk/media/vczc0zca/hie-strategy-2023-28-final-031023.pdf
[469] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/

Policy/strategy	Aims and objectives	Policy implications for life sciences and digital health and social care
Inverness and Highland City-Region Deal[470] *Current*	• The City-Region Deal for the Inverness and Highland region. • The Deal recognises nine key thematic areas to 'make the region a place where individuals, communities and businesses are able to realise their full potential and fulfil ambitions'.	*Of these thematic areas, those particularly relevant to life sciences include:* • The Northern Innovation Hub – inclusion of a Life Sciences 'soft landing' physical maker's space, teaching zone and open access lab, acting as a test-bed for codesigned end-user innovations. • UHI School of Health and Life Science – bringing commercial partners into a new dedicated centre of excellence at Inverness Campus to support delivery of new digital health/applied life science products and spinouts. • Assisted Living Initiative - clusters of innovative assisted living schemes at key locations in the region, designed with full IT health and movement sensors linked to remote health and care providers. • Science Skills Academy – raising the engagement of young people, closely linking employers with their potential workforce and fostering long term relationships with young people with an interest and aptitude for STEM subjects.
Highland Health and Social Care Partnership Adult Services Strategic Plan 2024-2027[471] *Current*	• A plan for improving the delivery of the Highland HSCP's services for adults • Overarching vision of 'working together to support communities in Highland to live healthy lives, achieve their potential and choice to live independently where possible'.	• Aiming to improve the quality and experience of care through utilising advanced technology. • A 'home first and last' policy to ensure support received (e.g. through digital health and social care) minimises time spent in other settings.

Source: Various

[470] https://www.highland.gov.uk/cityregiondeal
[471] https://www.nhshighland.scot.nhs.uk/media/qjkd4bvr/highland-hscp-strategic-plan-adult-services-2024-27.pdf

Table A.2.7: Natural capital

Policy/strategy	Aims and objectives	Policy implications for natural capital
Interim Principles for Responsible Investment in Natural Capital[472]	• Ensure natural capital investment provides social and economic benefits.	• The guidelines aim to prevent irresponsible investment, ownership and land management and instead aim to promote inclusive investment which provides the greatest benefits for all parties and adheres to the Paris Agreement and Scottish Government's decarbonisation strategies.
Highlands and Islands Enterprise Strategy 2023-2028[473] *Current*	• Sets out a vision and direction on the ways in which HIE will contribute to the delivery of the National Strategy for Economic Transformation (NSET).[474]	• Land ownership and land use is a key driver of the strategy, with management of natural assets involved in this. These are valuable, and their value must be the vehicle for social and financial investment, and the creation of green jobs and infrastructure to support a just transition. These also must be managed sustainably and maximise the carbon sequestration capacity of the Highlands and Islands. Some targets for example include carbon sequestration through peatlands and forests.
Scotland's National Strategy for Economic Transformation (NSET)[475] *Current*	• Sets out the priorities for Scotland's economy as well as the actions needed to maximise the opportunities of the next decade to achieve a wellbeing economy.	• The strategy aims to establish Scotland as a global leader and exemplar in using natural capital assets as a vehicle to deliver carbon reduction targets while supporting just transition by creating new green jobs and industries. This will create a 'Nature-Positive Economy', ensuring that communities experience the economic benefits of investment in and development of the natural assets where they live.

[472] https://www.gov.scot/publications/interim-principles-for-responsible-investment-in-natural-capital/
[473] https://www.hie.co.uk/media/kc5b4yl1/hie-strategy-2023-28-online.pdf
[474] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/
[475] https://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/

Policy/strategy	Aims and objectives	Policy implications for natural capital
Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update[476] *Current*	• This plan sets out Scotland's approach to reducing greenhouse gas emissions, with Offshore Wind playing a key role in decarbonizing the energy sector. It supports investment in renewable energy to meet Scotland's climate targets. An update was issued in 2020 which included reference to economic recovery from the COVID-19 pandemic.	• The strategy will deploy innovative methods of targeting and securing investment into Scottish natural capital such as peatlands, biodiversity, water, and forestry, with example interventions given such as restoration of peatland, tree planting, and 're-wetting' of bog land. The strategy promises to develop a Blue Economy Action Plan, and pledges £570,000 to a Blue Carbon Research Programme aiming to improve understanding of carbon sequestration methods using Scotland's water resources. The strategy also supports Scottish Forestry with funding of £100 m to increase planting, £30 m to expand the area of Scotland's forest area, and £20m to support tree nursery creation.
NatureScot Corporate Plan 2022-2026[477] *Current*	• This outlines NatureScot's vision for a nature-rich future in Scotland, supporting wider Scottish Government priorities of net zero.	• The plan promises increased financial support for natural capital industry in order to stimulate business, create jobs and increase community engagement in the natural capital industry. • This also improves the regulatory framework surrounding natural capital in Scotland, aiming to reduce the decline in biodiversity and support net zero goals, for example by ensuring that companies adopt more sustainable practices to comply with the framework. • The plan also promotes increased collaboration between a broad range of key stakeholders with interests in natural capital, such as investors, communities, and conservationists. This will incentivise partnerships that aim to conserve and promote sustainable management of Scotland's natural capital. • Promoting investment and stakeholder collaboration will also stimulate economic development stemming from Scotland's natural capital, for example eco-tourism, sustainable agriculture, and renewable energy projects.

[476] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[477] https://www.nature.scot/doc/corporate-plan-2022-2026-nature-rich-future-all

Policy/strategy	Aims and objectives	Policy implications for natural capital
Scottish Biodiversity Strategy to 2045[478] *Current*	• This is the Scottish Government's plan to tackle the issues of climate change, and biodiversity loss, in line with the timeline for achieving net zero carbon emissions by 2045.	• Within the strategy is the Scottish Government's nature positive by 2030 target which is aiming to achieve a state where nature is regenerating, and biodiversity is increasing by 2030. • Through this strategy, the Scottish Government have promised to develop an investment plan for natural capital, which will identify the practical actions that the government needs to take to tackle challenges and support the industry, and outline what investment needs to happen in order to support these. • The strategy also develops a robust monitoring framework for progression against the main objectives and ensures accountability against these.
A Framework for 30 by 30 on Land in Scotland[479] *Current*	• Proposes a range of strategies and actions to protect and conserve at least 30% of Scotland's land, including terrestrial, inland water, and coastal habitats, by 2030.	• Sites have been earmarked as designated 30 by 30 sites which will be prioritised for conservation efforts, including those crossing over terrestrial, inland water, and of coastal and marine areas. • This plans to better integrate biodiversity and natural capital policy into mainstream decarbonisation policy in Scotland through for example, through development of the Trans-European Nature Network. • Investment will be leveraged into natural capital through prioritising designated 30 by 30 sites for investment.
Hydro Nation Strategy[480] *Current*	• The Scottish Government's Hydro Nation Strategy aims to ensure the best possible development of Scotland's water resources in order to return the maximum benefit for the Scottish economy	• The policy has a strong focus on water management research and innovation, hoping to promote the development of new technologies and practices that can improve water management and conservation. • The strategy emphasises the need for increased investment to be leveraged into projects related to water conservation, wastewater treatment, and sustainable water management

Source: Various

[478] https://www.gov.scot/publications/scottish-biodiversity-strategy-2045/documents/
[479] https://www.nature.scot/sites/default/files/2024-12/1-30x30-framework-november-2024-accessible-corrections.pdf
[480] https://www.gov.scot/policies/water/hydro-nation/

A.3. Competition in life sciences

Table A.3.1: Competition in life sciences

Area	Key indicator	UK	Sector leader	Global competition
Research	R&D expenditure	£2.6bn in 2020	USA: $48bn in 2020	Large R&D expenditure in USA, Japan, Germany, France, Italy, Canada, and Spain
	Global clinical trials recruitment	3% of participants in 2020 (6th globally)	USA: 25.5% in 2020	2nd: Germany 3rd: Spain 4th: France 5th: Canada
	Academic citations share	13.2% in 2021 (3rd globally)	USA: 34.4% in 2021 (1st globally)	2nd: China, rising from 6.2% in 2011 to 18% in 2021
Workforce	In manufacture of basic pharmaceuticals and pharmaceutical products	4th in Europe	Germany (in Europe)	France (2nd) and Italy (3rd); Spain and Switzerland similar to UK.
	In manufacture of medical technology products	4th in Europe	Germany (in Europe)	France (2nd) and Italy (3rd).
Exports	Pharmaceuticals	$25.9bn in 2020 (9th globally)	Germany: $99.2bn in 2020	Other large exporters: Switzerland, Ireland, USA, Netherlands, and Belgium.
	Medical technology products	$4.7bn in 2020 (9th globally)	USA: $35.1bn in 2020	Other large exporters: Germany, China, Netherlands. China had the largest growth 2019-2020, +34.8% from $15.8bn in 2019 to $21.3bn in 2020.
FDI	Inward Foreign Direct Investment	£1.9bn in 2021 (2nd globally)	USA: £6.5bn in 2021	Other countries attracting large FDI: Ireland, China, Netherlands, Canada, Germany, Singapore, Belgium and France.

Source: Life science competitiveness indicators 2022[481]

[481] https://www.gov.uk/government/publications/life-science-sector-data-2022

A.4. RTO supporting infrastructure

Table A.4.1 sets out the supporting infrastructure for RTOs included in Figure 2.2.

Table A4.1: RTO supporting Infrastructure

Supporting infrastructure element	Local authority
Ardersier Port	Highland
Arnish Fabrication Yard	Highland
Barra Airport	Na h-Eileanan Siar
Benbecula Airport	Na h-Eileanan Siar
Buckie Harbour	Moray
Campbeltown Airport	Argyll and Bute
Campbeltown Harbour	Argyll and Bute
Castlebay Harbour	Na h-Eileanan Siar
Craignure Ferry Terminal	Argyll and Bute
Dunoon Ferry Terminal	Argyll and Bute
Enterprise Park Forres	Moray
European Marine Science Park	Argyll and Bute
Faslane Port	Argyll and Bute
Flotta Port	Orkney
Glensanda Port	Argyll and Bute
Hatston Pier	Orkney
Invergordon Harbour	Highland
Inverness Airport	Highland
Inverness Airport Business Park	Highland
Inverness and Cromarty Firth Green Freeport	Highland
Inverness Campus	Highland
Islay Airport	Argyll and Bute
Kinlochbervie Harbour	Highland
Kirkwall Airport	Orkney
Kirkwall Harbour	Orkney
Kishorn Port	Highland
Lerwick Port	Shetland
Lochboisdale Harbour	Na h-Eileanan Siar
Lochinver Harbour	Highland
Lochmaddy Harbour	Na h-Eileanan Siar
Mallaig Harbour	Highland
Nigg Skills Academy	Highland
Oban Harbour	Argyll and Bute
Port Askaig	Argyll and Bute
Port of Cromarty Firth	Highland
Port of Inverness	Highland
Port of Nigg	Highland

Portree Harbour	Highland
Rothesay Harbour	Argyll and Bute
Saint Margaret's Hope Harbour	Orkney
Scalloway Harbour	Shetland
Scapa Harbour	Orkney
Scrabster Harbour	Highland
Stornoway Airport	Na h-Eileanan Siar
Stornoway Port	Na h-Eileanan Siar
Stromness Harbour	Orkney
Sullom Voe Port	Shetland
Sumburgh Airport	Shetland
Tarbert (Harris) Marina	Na h-Eileanan Siar
Tiree Airport	Argyll and Bute
Tobermory Harbour	Argyll and Bute
UHI Argyll	Argyll and Bute
UHI Inverness	Highland
UHI Moray	Moray
UHI North, West and Hebrides	Multiple LAs
UHI Orkney	Orkney
UHI Perth	Outside Region
UHI Shetland	Shetland
Uig Harbour	Highland
Ullapool Harbour	Highland
Wick Airport	Highland
Wick Harbour	Highland

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