The Blue Economy in the Highlands and Islands

Towards a regional delivery plan

February 2023

ekosgen

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

CONTENTS

INTRODUCTION

CONTEXT

1.1 The Blue Economy encompasses a range of sectors and overall makes a significant contribution to Scotland and the UK's economy. It is also important to the fabric and sustainability of communities in many areas across the country. There is worldwide recognition that we are only at the beginning of realising its potential, for example in areas such as food security, clean energy, pharmaceuticals and, with a wide range of applications, to provide new solutions to many global challenges.

1.2 Scotland has vast coastal waters and a well-deserved reputation for a pristine marine environment and quality produce such as fish, shellfish (main species are nephrops, scallops, crabs and lobster[1]) and seaweed, as well as marine pursuits and tourism. The Highlands and Islands has a particularly outstanding marine environment and contains almost two thirds of the UK's coastline and coastal waters. It is therefore no surprise that the blue economy is increasingly acknowledged as a cornerstone of the Scottish economy in the 21st Century, spanning a number of interrelated sectors and developing and harnessing new technologies and resources. It has significant and rapid growth potential in scale and also in terms of world-leading research, deployment, innovation and market leadership. Recognising its importance, there is a broadly supportive policy environment for its sustainable development and alongside this, the Scottish Government is committed to becoming a net zero country by 2045. Whilst the COVID-19 pandemic has undoubtedly impacted on some parts of the sector and its development, and Brexit has and continues to present issues, there is absolutely no doubt that the Blue Economy is and will continue to be hugely important. Within this context, the potential of the Highlands and Islands cannot be understated, given the strength and assets of the region.

1.3 In recent years, HIE, the Scottish Government, Marine Scotland and other partners have demonstrated their commitment to the development of the Blue Economy and its sub-sectors and commissioned and undertaken key pieces of research, policy, and strategy development. Underpinning this, Scotland's National Marine Plan[2] aims to enable the sustainable development and use of marine areas so benefiting the marine environment and promoting existing and emerging industry.

A COMPLEX ECONOMIC AND ENVIRONMENTAL SYSTEM: DEFINING THE BLUE ECONOMY

1.4 The Blue Economy is complex, with significant interconnectivity between its component sectors. Having a detailed, consistent and comprehensive understanding of the Blue Economy and the sectors that it is comprised of is one of the key issues related to its sustainable development. There is a degree of inconsistency in the availability and detail of data: for some sectors (e.g. aquaculture and fisheries), a wide range of economic and environmental data are available, whilst for others (e.g. seabed mining, marine biotechnology), data is limited – either a result of the nascency of the sector, or in difficulties in monitoring and recording such data.

1.5 Globally, the Blue Economy comprises a wide range of sub-sectors, industries and activities and different organisations, research studies and regions will include and exclude some of these, focusing on specific sub-sectors of interest.

[1] https://marine.gov.scot/sma/assessment/commercial-shellfish
[2] https://www.gov.scot/publications/scotlands-national-marine-plan/

1.6 Based on a review of existing Blue Economy definitions from a variety of sources, the following sectoral definition of the Blue Economy has been adopted for this study:

- Fisheries and commercial capture fishing;
- Aquaculture (including seaweed cultivation and harvesting);
- Seafood processing;
- Marine biotechnology and bioprocessing;
- Marine environmental services;
- Marine renewable energy (wave, wind, tidal and geothermal energy), incorporating distribution network operators (DNOs);
- Oil and gas;
- Marine transport (including trade, shipping, passenger transport) and shipbuilding;
- Seabed mining;
- Decommissioning; and
- Marine and coastal tourism.

1.7 Appendix 1 sets out a more detailed discussion of Blue Economy definitions.

OBJECTIVES

1.8 The Blue Economy, and sectors within it make an important contribution to the economic and social health of the Highlands and Islands. There has been a number of studies and research projects examining the Blue Economy sectors in the region and in Scotland. HIE recognises the strengths of these sectors and the opportunities for inclusive growth for the Highlands and Islands but also its strategic contribution to Scotland as a whole. Development of the blue economy, taking a cluster approach and working cross-sectorally, also aligns with the circular economy agenda.

1.9 HIE is now interested in developing a Blue Economy Regional Delivery Plan for the Highlands and Islands, taking a whole-economy approach rather than a sectoral one. This will, for example, allow common barriers to be addressed that will support the prosperity of more than one Blue Economy sector. The overall aim is to deliver transformational change and development, optimising the infrastructure, knowledge economy, skills, investment and other resources and assets in the region.

1.10 This study is the first step towards developing a Blue Economy Regional Delivery Plan for the Highlands and Islands by providing an evidence base of the current activity and strengths in the Highlands and Islands, constraints to growth, opportunities, and HIE's role in capturing the value for the region. Commissioned in two phases, its specific objectives are:

- Consider the range of definitions used to describe the blue economy and recommend the definition that best suits the regional context.
- Assess the broad policy landscape in relation to the blue economy and its specific sectors.
- Explore available data on sectors within the blue economy for the Highlands and Islands relative to Scotland overall, to provide a more balanced picture of the blue economy in the region.

- Undertake research on a sample of international examples of Blue Economy Cluster to extract the learning for the Highlands and Islands.
- Consolidate and analyse existing data relating to the blue economy in the Highlands and Islands, to make a broad assessment of the scale of activity and the current and potential economic, environmental, and wider socio-economic contribution of Blue Economy sectors.
- Articulate the longer-term growth potential of key sub-sectors and outline key constraints and support requirements to help unlock growth.
- Consider ports, harbours and onshore infrastructure as an enabler or an inhibitor
- Identify sectoral opportunities for the Blue Economy within the Highlands and Islands.
- Provide recommendations as to which sub-sectors of the blue economy should be prioritised within the region along with supporting rationale.
- Suggest key steps HIE and partners could take to support sustainable growth of the priority sub-sectors in the short and medium term.

APPROACH

1.11 The definition of the Blue Economy used within the report was considered and agreed jointly with HIE. This included the process for examining sectors within the Blue Economy, and the criteria and rationale by which sectors were determined to be within scope for the study, and for HIE. Each of the sectors in scope were then examined in turn through in-depth desk research and analysis of available quantitative economic data.

1.12 The analysis of each sector and potential opportunities, and the prioritisation for each with regard to the region was then considered through a collaborative and iterative process with HIE, before the preparation of an initial evidence base report. The findings of this report were tested through a programme of consultations and workshops with key HIE stakeholders, before refining the analysis and supplementing with additional desk research. Finally, the outcomes of this subsequent phase were incorporated into the report.

REPORT STRUCTURE

1.13 The report is structured as follows:

- Chapters 2 to 12 examine each Blue Economy sector, setting out the context, drivers, opportunities and challenges for each, as well as presenting an overview of their economic characteristics;
- Chapter 13 sets out the cross-cutting enablers for the region's Blue Economy, considering the port infrastructure assets and academic expertise within the Highlands and Islands;
- Chapter 14 draws out the findings of the research into Blue Economy clusters;
- Chapter 15 presents a discussion on the sustainable development opportunities for the Blue Economy in the Highlands and Islands; and
- Chapter 16 presents conclusions and priorities for HIE going forward.

1.14 The report is accompanied by two appendices:

- Appendix 1 provides more detail on Blue Economy definitions; and
- Appendix 2 sets out case study overviews of international Blue Economy clusters.

2 AQUACULTURE

CONTEXT

2.1 For the purpose of this report aquaculture covers the production of finfish, shellfish (main species are nephrops, scallops, crabs and lobster[3]), and seaweed. Finfish and shellfish are larger and more established industries than seaweed, but there are significant opportunities to grow the value of seaweed production and linked to that, capture the value of marine biotechnology. The majority of UK aquaculture activity is in Scotland and particularly in the Highlands and Islands where finfish is the largest industry in the sector.

2.2 Aquaculture is of particular significance to the economic and social health of rural, coastal and island areas where it can act as an anchor industry providing year-round, well-paid jobs in remote areas and contributing to the viability of many communities. It also supports a wider, and more geographically dispersed supply chain including, processing, distribution, feed supply, and exporting.

2.3 Aquaculture businesses are key investors in local skills and infrastructure in rural areas, supporting community resilience beyond its economic impact.[4] For example, Mowi Scotland has recently built affordable housing on Rum and Muck and will be supporting the development of affordable housing on Colonsay.[5]

2.4 Two key documents set the context for growth and development of aquaculture in Scotland. The *Aquaculture Growth to 2030*[6] strategy sets out the strategic priorities for the sector and the target to double its economic contribution in Scotland to £3.6 billion by 2030 and jobs to 18,000.[7] *Scottish Aquaculture: a view towards 2030*[8] is an innovation roadmap for the sector setting out the aspirations to retain a premium product, and to realise transformational growth, the journey to achieve this, and the priorities to be addressed in the short, medium and long-term future.

2.5 These strategy documents support the evidence base and research requirements for many of the industry's actions going forward, the primary recommendations for each are set out in Table

Table 2.1: Key factors for consideration in the aquaculture sector

Growth to 2030	Innovation Roadmap 2030
• Industry leadership and ambition • Enabling and proportionate regulation • Accelerating innovation • Skills development • Finance • Infrastructure	• Management of biological threats • Streamlining planning and regulation • Meeting market demand • Applied research / skills development • Managing environmental risk • Improving spat availability • Finance • Developing new production models

Source: Scotland Food & Drink (2016); HIE/SAIC (2017)

[3] https://marine.gov.scot/sma/assessment/commercial-shellfish
[4] Marine Scotland (2017) The Value of Aquaculture in Scotland (Fact sheet 40)
[5] https://mowiscotland.co.uk/2021/03/12/creating-affordable-housing-for-island-communities/
[6] Scotland Food and Drink (2017) Aquaculture Growth to 2030: A strategic plan for farming Scotland's seas
[7] Ibid.
[8] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

2.6 The Scottish Government Seaweed Policy Statement was published in 2017. The policy is fully supportive of sustainable aquaculture growth. It recognises that the west coast of Scotland has suitable sites for seaweed cultivation, supports local provenance and recognises the scale of opportunity for small-medium to large production sites.

2.7 Following an amendment to the Scottish Crown Estate Act 2019, the Scottish Government committed to a review to gather evidence on the implications of seaweed harvesting by any method, and to consider the sustainable development of the seaweed sector. A Seaweed Review statement issued in February 2022[9] acknowledged growing interest in developing commercial scale activity, including the creation of new high value products from wild seaweed, and through seaweed cultivation to supply existing and emerging markets. It highlighted the need for a more comprehensive policy and regulatory framework for the emerging seaweed sector.

2.8 Seaweed harvesting is a nascent sector in Scotland although it has been a feature of coastal communities for centuries. Many of the 16 businesses using UK-harvested seaweed are based in and harvest their seaweed in the Highlands and Islands. Marine Scotland is currently considering the need for further regulation of policy for wild seaweed harvesting following publication of its Wild Seaweed Harvesting Strategic Environmental Assessment (SEA).[10]

2.9 There is the potential to cultivate seaweed as well as or instead of harvesting it. Cultivation would help negate some of the environmental consequences of harvesting, particularly wild seaweed as a natural barrier against coastal erosion and flooding and its role as shelter/food for the marine ecosystem. Cultivation has largely been at a pre-commercial stage with a small number of pilot farms and the Scottish Association for Marine Sciences (SAMS) at the University of the Highlands and Islands is currently investigating the potential of seaweed cultivation and is operating a pilot farm.

2.10 A study on the potential scale for seaweed industries in Scotland,[11] published in February 2022 explored key areas of growth potential, and the economic and social impacts of possible growth scenarios. It highlighted a range of barriers to the development of seaweed cultivation in Scotland, including the economic feasibility of farming seaweed, lack of access to investment and funding to set up farms and the lack of defined markets for the relatively low-value species which can currently be grown. However, it also highlighted strong levels of interest in developing a circular economy for seaweed in Scotland, for example through development of novel biotechnology to produce a range of products (with a range of values) from farmed seaweeds.

2.11 Crown Estates Scotland's policy on seaweed harvesting is to licence it chiefly to ensure sustainable practice. Applications to cultivate and harvest seaweed by farming began in 2017. However, seaweed farming in Scotland saw expansion in 2020 from the mainly experimental/pilot sized farms with a number of new farms starting to harvest in 2021 and sell into a range of markets.[12] As of May 2021 there were 12 registered Crown Estates Scotland sites but only one fully commercial cultivation agreement. The remainder are pilot and experimental sites to test cultivation and its impacts. Annexe J of 'A Review of the Aquaculture Regulatory Process in Scotland' provides a list of the active licences and applications up to December 2021.[13]

[9] https://www.gov.scot/publications/statement-seaweed-review/
[10] https://www.gov.scot/publications/wild-seaweed-harvesting-strategic-environmental-assessment-environmental-report/
[11] https://www.gov.scot/publications/understanding-potential-scale-seaweed-based-industries-scotland/
[12] https://www.crownestatescotland.com/resources/documents/economic-feasibility-study-on-seaweed
[13] https://www.gov.scot/binaries/content/documents/govscot/publications/independent-report/2022/02/review-aquaculture-regulatory-process-scotland/documents/review-aquaculture-regulatory-process-scotland/review-aquaculture-regulatory-process-scotland/govscot%3Adocument/review-aquaculture-regulatory-process-scotland.pdf

2.12 The Farmed Fish Health Framework (FFHF) for 2018-2028[14] was established for the maintenance of high standards of fish health to be upheld and for Scottish aquaculture developments to be able to respond to challenges within the sector. It acts as a roadmap for improving farming salmonid survival and features a programme for developing standards for disclosure of on-farm health information. The Framework was designed by the Farmed Fish Health Working Group, whose members consists of finfish farming businesses, trade associations/networks, the Sustainable Aquaculture Innovation Centre and veterinary professionals.

2.13 The programme of work for the FFHF features seven cross-cutting areas for action, which consist of improving information flow and transparency surrounding marine survival data, improving knowledge and understanding surrounding gill health and its impact on marine mortality in Scottish finfish, improving control over sea lice in Scottish fish farms by limiting interaction with wild fish, adopting the use of "cleaner fish" (wrasse and lumpfish) to reduce the impact of sea lice on salmonid growth, investigating better on-farm management practices such as fallowing and growing larger smolts to improve health and deliver environmental benefits, ensuring the licensing regime is fit for purpose and supports innovation of new fish treatment methods, and monitoring and reviewing the impact of climate change and ocean acidification on Scottish waters. All of these activities are framed with regards to the impact on the marine aquaculture industry in Scotland.

2.14 Aquaculture is also a feature within the draft Fourth National Planning Framework (NPF4) in Scotland, published in November 2021.[15] Within it, there is an acknowledgement that "the planning and licensing system should support the prosperity of the finfish, shellfish and seaweed sectors" by guiding any future developments to the most appropriate sites. It is noted that environmental impact should be considered, however proposals for aquaculture should be supported "where they comply with the local development plan, the National Marine Plan and, where relevant, the appropriate Regional Marine Plan." It should be noted that, while development proposals should only be supported in instances where they conserve and enhance biodiversity, it is stated that "applications for farmed fish or shellfish development are excluded from this requirement."[16]

NATURE AND SCALE OF THE SECTOR

2.15 Aquaculture is a key part of the Scottish Food and Drink sector competing in a global market, particularly salmon production. The Highlands and Islands is the largest aquaculture production region in the UK, benefiting from sheltered lochs and coastline. This, coupled with best-practice production processes and high provenance and traceability, helps Scotland command a high premium for its aquaculture produce.[17] The aquaculture industry in Scotland has seen considerable growth in recent years, with Scottish salmon both Scotland and the UK's number one food export. Mussels are the main shellfish species produced (95% of shellfish production in 2018).[18]

2.16 Atlantic salmon production is dominated by international enterprises who tend to be highly vertically integrated, with production companies owning considerable proportions of the value chain besides production (e.g., processing). Whilst vertical integration is less common in indigenous fish farms, the sector overall is characterised by a small number of finfish producers (mainly salmon, with some trout production) typically located in the Highlands and Islands, and a larger base of smaller shellfish producers, also largely located in the Highlands and Islands.

[14] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2018/05/scotlands-10-year-farmed-fish-health-framework/documents/00535697-pdf/00535697-pdf/govscot%3Adocument/00535697.pdf
[15] https://www.gov.scot/binaries/content/documents/govscot/publications/consultation-paper/2021/11/scotland-2045-fourth-national-planning-framework-draft/documents/scotland-2045-fourth-national-planning-framework/scotland-2045-fourth-national-planning-framework/govscot%3Adocument/scotland-2045-fourth-national-planning-framework.pdf
[16] https://spice-spotlight.scot/2022/01/20/aquaculture-and-the-fourth-national-planning-framework/
[17] ekosgen and Imani Development, for HIE (2018) MAXiMAR: Maximising the Marine Economy in the Highlands and Islands
[18] https://marine.gov.scot/sma/assessment/aquaculture

2.17 A considerable amount of engineering takes place in Scotland to supply farm cages, gear, and some equipment. However, well boats and research and design is often undertaken outside of the country, for example in Norway, as are upstream and downstream supply chain services. Despite this, there are some strong examples of indigenous supply chain organisations and upstream and downstream supply chain services for example support vessels and feed barges, transport and logistics, fish health services, and predator deterrents.[19]

2.18 Aquaculture in Scotland directly employed over 2,400 workers in 2019, mainly in Salmon production. This is a 25% increase on 2010 employment levels. Conversely, the industry has seen a decrease in the number of businesses over this period illustrating the move towards a smaller number of larger companies.[20]

2.19 In 2018, the aquaculture sector supported 11,700 jobs in the Scottish economy and had a turnover of £1.5 billion. It generated £885 million GVA of which £468 million was direct GVA, £359 million GVA was generated in the supply chain and £57 million through staff salaries.[21] The majority of the GVA was generated by salmon production followed by aquaculture processing. Combined, these accounted for 96% of aquaculture's GVA.

2.20 Finfish production in Scotland has seen considerable growth in recent years. In 2020 salmon production was just over 192,000 tonnes, a significant increase from 2010 production levels of 154,000 tonnes. Rainbow trout production has also increased, from 5,139 tonnes in 2010 to 7,576 tonnes in 2020 (+47%).[22] In contrast, shellfish production has decreased each year over the period 2017-20.[23]

2.21 Global aquaculture production is dominated by Asia which has accounted for around 89% of global production of farmed aquatic animals in the last two decades. Asian production benefits from low labour and other costs, long coastlines, supportive government policies, and efficient technology.[24] Africa, the Americas, and Asia have all seen their market share increase.

2.22 The Norwegian aquaculture sector has grown significantly and consolidated in recent years. It accounts for over half of global production of Atlantic salmon[25] and exports approximately 95% of what it produces. [26,27] Many of Norway's large aquaculture companies such as Mowi, SalMar (who part-own Scottish Sea Farms[28]) and AKVA Group either operate in Scotland, and/or own Scottish companies. Norway's shellfish sector is similar to that of Scotland's – characterised by a number of small producers (in 2020, there were 40 companies involved in shellfish production, employing 105 workers), with limited growth in sales in the 10-year period to 2020.[29]

2.23 Production of salmon in Scotland has grown at a lower rate than competitor countries leading to a fall in global market share from 10% in 2005 to between 7% and 8% in 2017. [30,31]

[19] https://www.kamesfishfarmingequipment.co.uk/
[20] Marine Scotland Science (2020) Scottish Fish Farm Production Survey 2019; Scottish Shellfish Production Surveys 2019
[21] BiGGAR Economics (2020) Estimation of the Wider Economic Impacts of the Aquaculture Sector in Scotland
[22] Marine Scotland Science (2021) Scottish Fish Farm Production Survey 2020
[23] Marine Scotland Science (2021) Scottish Shellfish Farm Production Survey 2020
[24] https://www.fisheries.noaa.gov/national/aquaculture/global-aquaculture
[25] Ibid., p.22
[26] EY (2018) The Norwegian Aquaculture Analysis 2017
[27] Eurofish International Organisation (2019) at: https://www.eurofish.dk/norway
[28] https://www.shetlandtimes.co.uk/2021/06/29/greig-seafood-sells-shetland-operations-in-164m-deal
[29] https://www.fiskeridir.no/English/Aquaculture/Statistics
[30] Food and Drink Scotland (2017) Aquaculture Growth to 2030: A strategic plan for farming Scotland's seas
[31] EY (2019) The Norwegian Aquaculture Analysis 2018

DRIVERS AND CHALLENGES

2.24 An increased demand for protein and the need for food security are driving sustainable growth in aquaculture as well as fisheries.[32,33] The United Nations Food and Agriculture Organisation (FAO) highlights that aquaculture has expanded fish availability and affordability to regions and countries with otherwise limited or no access to these farmed species. This has led to improved nutrition and food security.[34] However, there are a number of inter-related challenges and market failures that can constrain growth and optimisation of opportunities.

2.25 Seaweed cultivation is undergoing rapid global expansion and is ideally suited to the sheltered, nutrient-rich waters of the west coast of Scotland. There are high value applications in, for example, human health and pharmaceuticals, food supply, cosmetics, carbon sequestration, animal feed, and biomass (energy). It is on the cusp of large-scale commercialisation and could contribute substantially to the economy of the Highlands and Islands and Scotland. Estimates from research undertaken by Scottish Government indicate that under a high growth scenario, Scotland's seaweed industry and supply chain could generate around £38.5 million per year in GVA by 2040, and up to £45.1 million once induced impacts are included. Overall, the socio-economic impacts at the local/regional level are likely to be more significant, compared to the national level output.[35]

2.26 As well as biotechnology applications, seaweed can contribute to achieving the Scottish Government's net-zero targets through carbon sequestration. Seaweed islands, located in strategic and unused marine areas like windfarms, could be used to sequester large quantities of carbon dioxide from the water.[36] It can also help climate change by deacidifying oceans. However, in Scotland there are concerns about the potential environmental impacts of seaweed harvesting and cultivation and these are yet to be resolved. Mitigation measures have been identified to protect areas of the Scottish coast especially sensitive to harvesting and where industrial scale harvesting may be restricted or unacceptable, such as exposed coastal areas prone to erosion and areas where beach cast seaweed is used by crofters. A long-term vision and coherent policy (industrial strategy) is essential to de-risk developments and provide clarity for investment.

2.27 Management of disease and biosecurity of fish stock remains a significant challenge for aquaculture production, and a constraint to growth. Reduced production and productivity through mortalities and lower quality/size of harvested fish[37,38] because of pathogens and specifically sea lice, are becoming a serious problem for the Scottish salmon industry.[39,40] Scotland has invested around £30 million in sea lice control in each of the last five years.[41] This investment in biological and engineering solutions will help to reduce the use of medicinal treatments, with their associated negative environmental impacts. Non-chemical approaches include the mechanical removal of sea lice using 'cleaner fish' such as wrasse.[42,43]

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[32] UN FAO (2020) The State of World Fisheries and Aquaculture: Sustainability in Action
[33] ekosgen and Imani Development, for HIE (2018) MAXiMAR: Maximising the Marine Economy in the Highlands and Islands
[34] UN FAO (2020) The State of World Fisheries and Aquaculture: Sustainability in Action
[35] https://www.gov.scot/publications/understanding-potential-scale-seaweed-based-industries-scotland/pages/10/
[36] https://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-49277556
[37] 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
[38] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*
[39] 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
[40] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*
[41] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*
[42] 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
[43] 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

2.28 Limited availability of inshore sites for aquaculture development is a key barrier to growth. It has driven the need to consider locations further offshore, semi-closed systems and potentially land-based aquaculture production through recirculating aquaculture systems (RAS). The offshore environment and conditions in more exposed sites may drive up production costs and processes and equipment will need to be significantly adapted to cope with the conditions in such high-energy, dynamic and often extreme environments. For example, cages will have to withstand stronger wave and wind movement and deeper waters. An advantage is that sites that are more exposed with strong tides can disperse biomass waste before it builds up on the seabed.

2.29 The risk of land-based RAS is that producers move away from marine based sites and closer to distribution hubs, processing centres and markets.

2.30 Access to investment finance is a challenge, most acutely for shellfish production. Finance institutions in the UK do not always understand the industry, take account of assets, accurately assess risk or understand growth potential. This puts the Scottish producers and the supply chain at a disadvantage as there is more supportive access to finance in competitor countries such as Norway. In July 2021 the Norwegian Government established Export Finance Norway (Eksfin) as a financial enterprise by merging the Norwegian Export Credit Guarantee Agency (GIEK) and Export Credit Norway. Eksfin provides loans and guarantees to support Norway's export industries and help them be financially competitive in global markets. Against this backdrop, in Scotland, lack of investment funding makes it difficult for businesses to lever in funding for expansion, research and development (R&D), and innovation. However, the UK Government has announced the availability of at least £1 million to help the UK seafood industry increase exports to existing and new markets. Manged through Defra and the Department for International Trade, the seafood exports package will: identify and connect seafood companies with overseas buyers; promote UK seafood at international events; and increase expertise on UK seafood produce in embassies and consulates overseas.[44]

2.31 Climate change is impacting on Scotland's aquaculture sector and will continue to do so. The physical and chemical characteristics of coastal waters is changing, and water quality degradation is a serious threat as a result of temperature increases. Degradation in water quality is a risk to the premium pricing of Scotland's produce[45] and may lead to the emergence of new diseases and increase the prevalence of existing parasites and pathogens. Warmer waters may also be contributing to increasing occurrence of harmful algal bloom events (HABs), which can cause mass finfish mortalities.[46]

2.32 On a more positive note, higher water temperatures could mean that new species can be farmed in Scottish waters.[47]

[44] https://www.gov.uk/guidance/uk-seafood-fund

[45] See for example: IPCC (2014) Fifth Assessment Report, at: https://www.ipcc.ch/assessment-report/ar5/; also Cheng, L. et al. (2020) Record-Setting Ocean Warmth Continued in 2019, Advances in Atmospheric Sciences, Vol. 37, pp.137-142

[46] ekosgen and Imani Development, for HIE (2018) MAXiMAR: Maximising the Marine Economy in the Highlands and Islands

[47] Callaway, R. et al. (2012) Climate change and marine aquaculture in the UK. Aquatic Conservation: Marine and Freshwater Ecosystems 22, pp.389-421

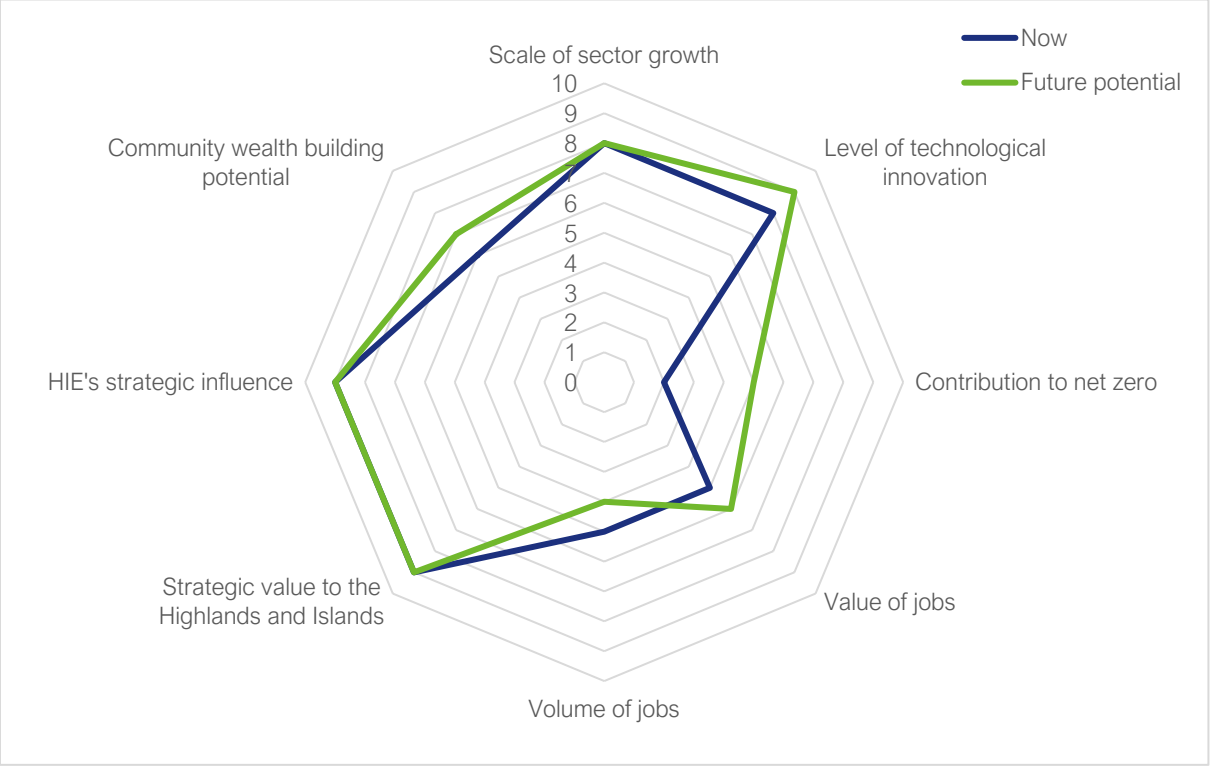
2.33 Aquaculture's social licence[48] for current and expanding production is under threat from a strong environmental and ethical lobby. In recent years, aquaculture has received a fair degree of negative media coverage, related to fish health,[49] management of farm stocks and response to predators.[50] This has influenced how the industry is perceived by the public and may make it less attractive as an employment and career option. Despite this, there are some good examples of co-investment and co-operation between the aquaculture industry and host communities in terms of housing, as well as in other infrastructure and services such as digital connectivity.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

2.34 There are opportunities to realise significant growth in the aquaculture sector in the Highlands and Islands and expand Scotland's share of the global market. Given HIE's strategic role in food and drink, its activities have a direct impact on aquaculture.

2.35 Figure 2.1 shows the current position of the sector in the Highlands and Islands and the potential. It shows that despite Aquaculture being an established sector in the region, there remain opportunities to increase its value and optimise its contribution to net zero through new systems and technologies. It also has an important role to play in the UK's food security.

Figure 2.1: Current and future potential of Aquaculture in the Highlands and Islands



2.36 Expansion will be achieved by building on the sector's already strong market position, improving fish welfare, and demonstrating improving environment stewardship. However, it will require expansion into new larger sites, supported by a different type of infrastructure as there is very limited access to new inshore sites. As well as finfish and shellfish, there are also substantial opportunities to develop seaweed production in the Highlands and Islands and capture the high value-added activities in Scotland.

[48] The level of acceptance or approval by local communities and stakeholders of businesses and their operations
[49] https://www.theguardian.com/business/2018/oct/29/campaigners-call-for-temporary-ban-on-new-scottish-fish-farms
[50] https://www.scotsman.com/news/environment/fish-farms-kill-more-seals-as-industry-tries-to-save-salmon-1-4593698

2.37 The region's aquaculture sector also has the potential to provide by-product to other markets (e.g., use of salmon heads, tails and viscera to extract purified amino acids for the production of dietary supplements).[51]

2.38 Generally, the currently regulatory environment is not considered to be enabling, working against the sustainable development of the seaweed industry and constraining growth and expansion of finfish and shellfish.

2.39 Achieving a step change in aquaculture in the Highlands and Islands will require strategic planning, investment and support to maximise the opportunities. There is scope for HIE and partners to accelerate delivery in terms of its role in aquaculture. It will require new approaches including harnessing and building on current examples and areas of innovation.

2.40 There is potential to explore innovation and new approaches within the industry, including the emerging seaweed cultivation sector. There is current opportunity for this sector to grow as single species developments or as part of Integrated Multi-Trophic Aquaculture systems (IMTA) (where species which are fed or farmed, for example Atlantic salmon, are grown alongside species whose culture results in nutrient or energy extraction for example, mussels or seaweeds).

2.41 An IMTA trial in Loch Fyne is being facilitated by the Scottish Salmon Company and the Loch Fyne Oyster Company in partnership with SAMS UHI.[52] This is in response to an estimated 60% of the nitrogen in salmon feed being lost to the wider loch ecosystem within conventional salmon farming, ultimately exerting negative ecological impacts. In the trial, seaweed and shellfish are grown close to the salmon to maximise uptake of nutrients. Early results are positive, with significantly higher growth rates in the seaweed and shellfish through absorbing the nutrients. This process enhances seaweed and shellfish value as a future source of marine proteins and oils for healthcare and pharmaceuticals.

2.42 Available space, or lack of it, is a key constraint to growth for aquaculture. There is increasingly limited availability of inshore sites for aquaculture development, and competition for marine space with other uses. This pressure on space means that there is a need to look for alternative locations and so a drive towards more exposed sites with more extreme marine conditions. Scottish Sea Farms is aiming to trial Scotland's first open ocean salmon farm with a view to expanding production capacity. However, the extent to which this is viable in Scotland depends on the regulatory environment, reaching agreement with SEPA on stock levels, and assessments of the marine environment.[53,54] The environment and conditions in these more exposed sites may drive up production costs and will certainly mean that processes and equipment will need to be significantly adapted to cope with the conditions in such high-energy, dynamic and often extreme environments. Companies in the supply chain will therefore need to develop new equipment, systems and processes to increase productivity in aquaculture and facilitate offshore aquaculture. Structures for offshore aquaculture developments require different cage designs as they must withstand harsher weather conditions, and the distance from the shore means more complex logistics chains and maintenance systems. So far, it is understood that submersible cages are considered more resistant to wave action but there is a need for maritime data across a suitable time-series period to develop and deploy the appropriate technology – this typically would require at least a year of site monitoring.

[51] Zero Waste Scotland (2015) Circular Economy: Sector study on beer, whisky and fish, Final Report June 2015
[52] Zero Waste Scotland (2016) Integrated Multi-Trophic Aquaculture
[53] https://thefishsite.com/articles/scotland-set-for-first-open-ocean-farm
[54] Callaway, R. et al. (2012) Climate change and marine aquaculture in the UK. Aquatic Conservation: Marine and Freshwater Ecosystems 22, p.389-421

2.43 Management of disease and biosecurity of fish stock remains a significant challenge for aquaculture production, and a constraint to growth. Reduced production and productivity through mortalities and lower quality/size of harvested fish[55,56] because of pathogens and specifically sea lice are becoming a serious problem for the Scottish salmon industry.[57,58] If this is not addressed, then the implications for Scottish salmon production are significant. Scotland has invested around £30 million annually over the last five years to improve sea lice control.[59] Its investments in biological and engineering solutions will help to reduce the use of medicinal treatments, with their associated negative environmental impacts. These non-chemical approaches include the mechanical removal of sea lice using 'cleaner fish' such as wrasse. Funding is available to assess the effectiveness of this method and to improve efficacy and fish welfare.[60,61]

2.44 Scotland has significant potential to expand its market share as there remain large areas of untapped resource, for example in shellfish farming and in diversifying to other finfish species. Higher sea water temperatures could offer opportunity to farm new species. There are opportunities to increase the scale of salmon farming and boost production volumes and continue to attract premium prices.

2.45 There are also opportunities to increase the volume and value of non-salmonid farmed fish including halibut and trout, as well as shellfish and seaweed. There are clear knowledge platforms and investment pathways that have been developed through the 'salmon model' which are being applied to trout farming.

2.46 Seaweed cultivation is undergoing rapid global expansion and is a commercial activity ideally suited to the sheltered, nutrient-rich waters of the west coast of Scotland. Seaweeds have been used industrially in the Highlands and Islands for hundreds of years, from burning it for potash to using collected seaweed for high quality foodstuffs, soaps and as a botanical ingredient in gin, a growth product in food and drink. There are higher value applications in, for example, human health and pharmaceuticals, food supply, cosmetics, carbon sequestration, animal feed, and biomass (energy). It has the potential to contribute billions to Gross Domestic Product (GDP) but is still on the cusp of large-scale commercialisation.

2.47 Reaching the net-zero goals that the Scottish Government has committed to can only be achieved by making radical changes to reduce the production of carbon emissions, as well as removing existing carbon dioxide from the atmosphere through the process of carbon sequestration and usage. The Highlands and Islands is in a unique position in the UK to contribute to this, using in-land resources (peatlands, forests, and re-purposed oil and gas terminals), and through seaweed. Captured carbon can also be stored at sub-sea levels, for example in old or empty oil and gas wells.[62]

[55] 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
[56] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*
[57] 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
[58] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*
[59] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*
[60] 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
[61] 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
[62] https://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-49277556

2.48 Research indicates the enormous potential of seaweed as a key tool in fighting climate change and deacidifying oceans due to its fast growth rate and ability to absorb vast amounts of carbon dioxide. Seaweed islands, located in strategic and unused marine areas like windfarms, could be used to sequester large quantities of carbon dioxide from the water.[63] Seaweed can grow in rocky underwater areas, where burial of CO_2 is not possible[64] providing an alternative to storage in oil and gas rigs.

2.49 Given some of the challenges and pressures, and the need for innovation in equipment and ways of working (e.g., use of data), there is an opportunity to explore and harness potential synergies with other marine sectors.[65] This will include innovative models for collaboration and partnership working.

2.50 Recognising the need for investment the Marine Aquaculture Programme in Argyll & Bute[66] plans to invest £15m in marine science and technology through four proposed projects: Marine Industry Training Centre (led by Argyll College UHI); Centre for Seaweed & Shellfish Innovation Development (led by SAMS UHI); Marine Industries Needs Assessment (led by HIE); Machrihanish Innovation Campus (led by University of Stirling).[67]

2.51 Attracting and retaining skills in aquaculture can be challenging and there is work to be done to communicate an up-to-date profile of the career opportunities within it, and how the application of technology is changing the skills required, ways of working and the work environment. Aquaculture can offer employment to people in some of the Highlands and Islands' more remote communities. There is also scope to develop more niche seafood processing activities in the Highlands and Islands to capture higher added value and support supply chain activities such as packaging, and distribution and transport.

[63] https://www.bbc.com/reel/video/p09bqf8t/the-miraculous-power-of-the-humble-seaweed
[64] https://marine.gov.scot/sma/assessment/case-study-blue-carbon-contribution-seaweed-detritus
[65] https://muses-project.com/
[66] Part of the Argyll Rural Growth Deal
[67] https://www.gov.scot/binaries/content/documents/govscot/publications/minutes/2021/08/convention-of-the-highlands-and-islands-meeting-papers-march-2021/documents/paper-5-workforce-and-skills/paper-5-workforce-and-skills/govscot%3Adocument/Paper%2B5%2B-%2Bworkforce%2Band%2Bskills.pdf

Table 2.2: Sector summary, observations and opportunities: Aquaculture

Current position and status in the Highlands and Islands	• Finfish and shellfish are established and substantial industries in the Highlands and Islands. • Seaweed as a commercial enterprise is currently small scale.
Opportunities and growth potential	• Opportunities to grow in value, with an industry commitment to double in value by 2030. • Strong increase in global demand for sustainable protein sources. • Potential diversification of species and growth in production sites further offshore and on land – with associated development of processes, equipment and technology. • Seaweed as a product with high value applications – including marine biotechnology.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Important economically and as an anchor industry in parts of the Highlands and Islands, in particular rural communities. • Part of seafood processing supply chain which is an area of potential development. • Seaweed in particular may have community asset and wealth building potential.
Cross sectoral opportunities and synergy	• Circular economy e.g., use of by-products and biomass. • Potential synergies with other sectors such as Floating Offshore Wind. R&D to address common challenges, co-location. • Science and R&D in the Blue Knowledge Economy are symbiotic with aquaculture. • Seaweed applications through biotech – in other sectors including health and life sciences, food and drink, agriculture. • Seaweed in transition to net zero and the carbon trading economy with its sequestration properties.
HIE's role going forward	• HIE as a strategic lead through its Blue Economy, Food and Drink and Life Sciences team. • Local responses through local teams. • Seaweed cultivation and harvesting is potentially very valuable in the Highlands and Islands but there are political constraints at this stage that must be addressed.
Comments	• There is a perception that aquaculture requires some impetus in the Highlands and Islands to increase value add activities. • Whilst it is an established and important sector, it requires attention and focus to grow its potential.

3 FISHERIES AND COMMERCIAL CAPTURE FISHING

CONTEXT

3.1 Commercial Capture Fishing is the process of fishing from mainly wild fisheries using poles and lines or trawling or dredging with nets or traps.68 The Highlands and Islands and Scotland as a whole has an abundance of marine fisheries resources, supporting commercial capture fishing and a range of supply chain businesses, as well as many coastal communities.

3.2 Fisheries is a devolved matter and Marine Scotland is responsible for controlling fishing vessels activities in the Scottish zone and manages all inshore fisheries within 12 nautical miles. The EU-UK Trade and Cooperation Agreement (TCA) sets out the terms for the EU and UK to determine their rights to catch fish in their respective waters.[69]

3.3 The sector is reasonably healthy, and it is growing sufficiently to meet a number of broad strategic targets.[70] The main focus of strategies and plans is the sustainability of stocks and fishing operations through protection and restoration of Scotland's marine assets.

3.4 For Scottish Food and Drink, there is a wider strategic ambition[71] to double the value of this to £30 billion, of which fisheries is a key part. This would assume a doubling of the value of landed catch to £1.12 billion by 2030. Previous research has indicated that, assuming the current pattern of sustainable growth persists, the target could be met four years early, by 2026.[72]

3.5 The Scottish *Environment Strategy*[73] is an overarching framework for the environment and climate change. This pinpoints sustainable fisheries management as being key to achieving outcomes, such as protecting and restoring nature, with healthy water and seas. The strategy also lines up with the *National Marine Plan*, setting out the wider approach to managing Scottish waters and interactions within sectors.

3.6 Guided by these frameworks is the *Fisheries Management Strategy 2020-2030*, which aims to deliver a Blue Economy approach to the fishing industry. It will encourage fishing, as well as securing the resilience of the industry and the benefits of fishing to local industries to promote sustainable growth.

3.7 Similarly, the Scottish Wild Salmon Strategy,[74] published in January 2022, has been informed by these frameworks. The Strategy considers the roles of improvements to the quality of rivers in building an informed evidence base through monitoring and research, and integrated policy making to ensure that the vision of "Scotland's wild Atlantic salmon populations are flourishing and an example of nature's recovery" is realised.

[68] https://sustainablefisheries-uw.org/seafood-101/commercial-fishing-methods/
[69] https://ec.europa.eu/info/strategy/relations-non-eu-countries/relations-united-kingdom/eu-uk-trade-and-cooperation-agreement_en
[70] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors
[71] https://www.foodanddrink.scot/resources/publications/ambition-2030-industry-strategy-for-growth/
[72] Ibid.
[73] https://www.gov.scot/publications/environment-strategy-scotland-vision-outcomes/
[74] https://www.gov.scot/publications/scottish-wild-salmon-strategy/documents/

NATURE AND SCALE OF THE SECTOR

3.8 In 2021 there were 5,783 UK registered fishing vessels, of which 37% are located in Scotland.[75] The 2,121 Scottish vessels have the greatest overall capacity, accounting for 60% of the total UK feet capacity.[76] Almost two thirds of the Scottish fleet (64%) is registered at a port in the Highlands and Islands, demonstrating the importance of commercial capture fishing to communities in the region.[77]

3.9 The UK's fishing fleet has contracted by almost 50% over the past three decades.[78] There has been a degree of renewal and replacement in the fleet, with fishing businesses seeking to drive efficiency gains and more selective, sustainable catching methods. Between 2019 and 2021 the number of UK vessels fell by 128 and the pattern is that there are fewer but larger vessels. However, demonstrating the strength of the sector in Scotland, the Scottish fleet increased by 12 vessels over the same period and by 90 vessels since 2016.[79]

3.10 The total value of landings into the UK in 2021, by both UK and foreign vessels, was £713m. In total 394 thousand tonnes were landed by UK vessels only, with a value of £692m - a 15% increase on 2020, but a decline of 9% on the value of landings in 2019. In 2020, the UK's departure from the EU impacted on the stocks the UK fleet had access to fish in 2021[80].

3.11 The majority of the UK's catch takes place in UK waters.[81] Of the four UK nations, Scotland landed the most fish by quantity and value in 2021, at 271 thousand tonnes (69% of total UK landings by UK vessels) with a value of £429m (62% of the UK total).[82]

3.12 In Scotland, the sector (by both number of vessels and tonnage) is predominantly located in the North-East, Shetland and the west coast. Peterhead is by far the largest UK port for landings. It accounted for 40.3% of the value of fish landings into Scotland in 2021 (at £172.9 million) and 25.0% of the UK total. Lerwick was second in the Scottish and UK rankings, accounting for 11.6% (£49.9m) of the Scottish total and 7.2% of the UK total. Scrabster, Fraserburgh, Ullapool and Kinlochbervie were also all in the top 10 UK ports in terms of quantity (tonnage) of landings 2021.[83]

The quantity of landings in Scotland was relatively stable from 2016 to 2018, but fell by 14% from 2018 to 2019, mainly driven by smaller quotas for key pelagic species. Levels remained relatively stable between 2019 and 2020 before increasing slightly in 2021 (up 4%). The value of landings in Scotland steadily increased between 2016 and 2019 but shrank by 21% in 2020, from £479m to £378m. The value of landings increased by 14% between 2020 and 2021.[84] A report by Seafish on the Economics of the UK Fishing Fleet highlighted that COVID-19 and associated lockdown measures had a noticeable impact on UK fishing fleet operations and financial performance in 2020. In 2021, fishing activity, overall fishing income and profitability of the fleet recovered but were still below 2019 figures.[85]

[75] UK Sea Fisheries Statistics 2021. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021
[76] Ibid.
[77] Ibid.
[78] Ibid.
[79] Ibid.
[80] Ibid.
[81] MMO, UK landings by rectangle and estimated EEZ 2016-2020.
[82] UK Sea Fisheries Statistics 2021. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021
[83] Ibid. Figures are based on landings by UK vessels only.
[84] UK Sea Fisheries Statistics 2021. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021
[85] Economics of the UK Fishing Fleet 2021, Seafish. Available at: https://www.seafish.org/document/?id=997d218e-0afb-4f3f-ade8-5f81db446b05

3.13 COVID-19 affected Scottish ports in different ways, depending on the species fished. Ports in the north-east of Scotland tend to focus on pelagic landings, and these had higher landings in 2020 than in 2019, as well as relatively stable prices. Ports on the west coast specialise in demersal and shellfish and the price of shellfish dropped by a quarter between 2019 and 2020.[86] Landings into Peterhead and Lerwick were affected less by Covid-19 compared with other ports because they specialise in pelagic species. Across the eighteen Scottish ports analysed by the Scottish Sea Fisheries Statistics 2020, the only other two ports who had falls in value smaller than the Scottish average (21%) were Oban (-18%) and Orkney (-18%). The other fourteen ports showed falls in value steeper than the Scottish average.[87]

3.14 At UK level, the sector's GVA fell between 2019 and 2020 (from £538m to £458m), then increased slightly to £483m in 2021.[88] Scottish registered vessels had the highest GVA in 2020 at £269m.[89]

3.15 The number of fishers in the UK remained relatively stable over the last decade following a long period of steady decline. In 2021, 40% of UK fishers worked on Scottish vessels.[90] The sector in Scotland employed 4,241 people in 2021 representing 0.2% of the Scottish labour force[91]. Employment in fishing accounts for a higher percentage of employment in island communities (4% in Shetland, 3% in Orkney and 2% in Na h-Eileanan Siar).[92]

3.16 Fisheries is heavily regulated in terms of quotas and access to fishing areas. In terms of production, the Scottish fleet faces competition for market share from countries such as Iceland with 1,647 registered fishing vessels,[93] Norway with 6,025 vessels and Denmark with 2,122 vessels.

DRIVERS AND CHALLENGES

3.17 There are a number of factors that are impacting Commercial Capture Fisheries. As well as population growth, rising incomes in developing countries have led to increased demand for high quality protein, primarily from meat and fish. As a result, fish has become one of the largest traded food commodities in the world. In 2018, UK capture fisheries produced 78% of seafood (700,242 tonnes), with the rest (197,618 tonnes) produced by aquaculture.[94]

3.18 Given the importance of fishing in many rural and remote coastal communities in the Highlands and Islands, there is a danger that a more consolidated industry means that some communities will lose the benefits of investment or financing, market development and subsequent impacts.[95] This intersects with issues of uncertainty and changing markets brought about by Brexit, as well as the impact of COVID-19 on the fishing sector. Brexit is presenting some short to medium term challenges, for example new bureaucracy for exports/imports and potential shortages of supplies. Brexit and the COVID-19 pandemic have led to the loss of European export markets and the disruption of the global supply chain, and some fishers have focused more on local markets.

[86] Economics of the UK Fishing Fleet 2020. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1020837/UK_Sea_Fisheries_Statistics_2020_-_AC_checked.pdf
[87] Scottish Sea Fisheries Statistics 2020. Available at: https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2020/
[88] Economics of the UK Fishing Fleet 2021. Available at: https://www.seafish.org/document/?id=997d218e-0afb-4f3f-ade8-5f81db446b05
[89] Economics of the UK Fishing Fleet 2020. Available at: https://www.seafish.org/document/?id=d9e7982d-e374-4de7-85a4-ca80c35f5666
[90] Economics of the UK Fishing Fleet 2021. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021
[91] Scottish Sea Fisheries Statistics 2021. Available at: https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2021/
[92] Ibid.
[93] Responsible Fisheries in Iceland. Available at: https://www.responsiblefisheries.is/seafood-industry/a-nation-with-fishing-in-its-genes
[94] Our World in Data. Seafood production: wild fish catch vs aquaculture, United Kingdom. Available at: https://ourworldindata.org/grapher/capture-fisheries-vs-aquaculture?country=~GBR
[95] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors

3.19 Access to labour and skills is a challenge for commercial capture fishing and this has been exacerbated by the combination of COVID-19 pandemic and Brexit. Across the sector there is an ageing workforce, and attracting and retaining workers, including young people, can be difficult largely due to perceptions about working conditions, the physical demands of the job and income levels.[96] In a bid to make the sector more attractive, the Scottish Government has committed to the:

- Development and delivery of training including safety and sectoral training.
- Promoting fair work and opportunities for new entrants to the seafood and marine sectors.[97]

3.20 Climate change is having an impact on fish and fisheries, through ocean deoxygenation, rising water temperature, and changes in prey distribution. The biggest declines in waters off North-east Scotland have been in cold-water Atlantic cod and Atlantic herring.[98]

3.21 Many commercial capture fishing operations are located in remote, rural and island areas, particularly inshore fisheries. Consequently, they can be a considerable distance from processing facilities and the markets in which they operate. This added travel requirements can add to costs, and extreme weather events can disrupt some transport routes.

3.22 There is growing competition for space with other marine uses, for example fixed and floating offshore wind. A shift of aquaculture operations further offshore may also have implications for access to and the ecosystem of fishing grounds.

3.23 Fuel accounts for a large proportion of operating costs[99] and recent rises in the price of oil will impact on margins and profitability if these costs are not reflected in the price of produce.[100] There is also a question about whether heavy fuel will be acceptable going forward – in terms of customer expectation and meeting net zero targets. Alternative energy solutions may have to be developed and adopted for example hydrogen powered transport, and this must be incorporated into the development of port and harbour infrastructure.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

3.24 Commercial Capture Fisheries is a long established and important industry in Scotland and the Highlands and Islands. It has growth potential as the global demand for seafood continues to increase. Figure 3.1 illustrates the current position in the Highlands and Islands and the potential future position. It shows that there is some scope to increase the value of jobs in line with the levels of technological innovation already evident in the sector. There is also some potential to increase both the scale of growth in the sector and increase its contribution to community wealth building in those communities that support fisheries operations.

[96] For example, see: Seafarers UK (2018) Fishing for a Future: An Analysis of Need, Challenges and Opportunities in UK Fishing Communities. Evidence from Marine Scotland, Seafish and MMO also indicates that the age profile of the workforce is older than many parts of the wider economy, and that it is ageing

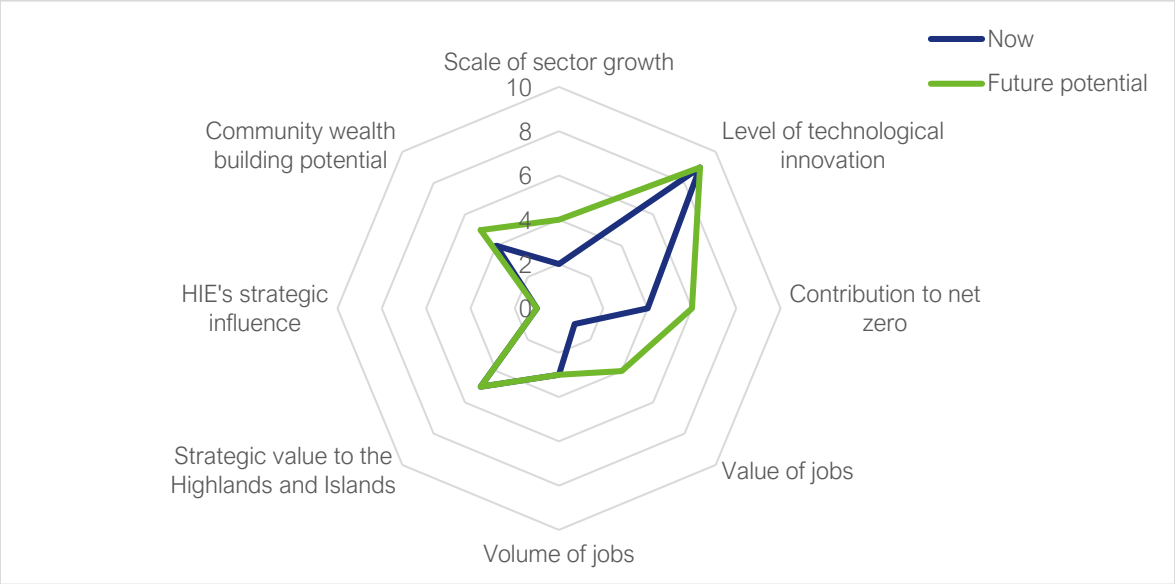
[97] https://www.gov.scot/publications/scotlands-future-fisheries-management-strategy-2020-2030/pages/3/

[98] Scotland's Marine Assessment 2020. Available at: https://marine.gov.scot/sma/

[99] Economics of the UK Fishing Fleet 2019. Available at: https://www.seafish.org/document/?id=c0640cf9-a9c8-4d03-8c35-6f7a966ad056

[100] Unless a more fuel-efficient technology is adopted.

Figure 3.1: Current and future potential of Commercial Capture Fisheries in the Highlands and Islands



3.25 Fish and seafood is Scotland's primary food export, with a value of £1.0 billion (204 thousand tonnes) in 2021, 63% of total UK fish and seafood exports (£1.6 billion).[101] Scottish seafood is exported to the European Union, the USA, and growing markets in South-East Asia, Japan, and China.

3.26 The sector is subject to very specific regulation, how much fish of different species can be taken from the sea, and where Scottish vessels can fish. Marine Scotland has strategic responsibility and so fisheries is unlikely to be a strategic priority for HIE. However, it is an important source of employment and contributes to the social and economic wellbeing of the region and communities within it. There are some areas where HIE can support the sector and its supply chain in the Highlands and Islands, working in partnership with stakeholders.

3.27 Port infrastructure and connectivity to processing facilities and markets is very important for fisheries, as it is for other sectors. The later chapter dealing with Ports and Harbours highlights where HIE has a role in helping to ensure adequate port facilities and land side infrastructure for marine sectors including fisheries.

3.28 Science, innovation and R&D will be a key aspect of sustainable commercial capture fisheries in the Highlands and Islands. Enhancing productivity will be required if the sector is to grow and increase market share in the North-East Atlantic, although of course quotas have a role to play here. As the section on Blue Knowledge (Chapter 13) highlights, the Highlands and Islands has substantial strengths in blue economy science, innovation and R&D. Collection, management, analysis and using data is key to sustainable fisheries and to a range of other blue economy sectors. Monitoring and reporting catch against quotas requires sophisticated use of data, and there may be learning from fisheries that can be applied elsewhere.

3.29 Linked to the need for innovation and new ways of working, there is a need to develop the skills in the existing workforce and ensure the workforce can continue to upskill and reskill to respond to changes. Seamanship skills are a key area. As vessel technology changes, reflecting the growing tendency towards larger vessels and impending shift to alternative energy sources, so the skills of the workforce to operate, maintain and repair vessels and equipment will need to be updated.

[101] https://www.gov.scot/publications/strategy-seafood/pages/3/

3.30 There is a need to improve staff retention and attract new entrants to the fisheries workforce. Education providers in the Highlands and Islands have a strong track record in developing and delivering skills for sectors within the blue economy, including fisheries. There is a role for HIE to contribute to this, working with partners across industry, skills and education.

3.31 These three areas of challenge have been recognised regionally, at Scottish level, and by the UK Government, and as a result the UK Seafood Fund was launched in 2021.[102] The £100m fund aims to boost innovation in industry, level up coastal communities and support job creation across the UK. It comprises schemes under four areas: science and innovation, infrastructure; skills and training; and export support.

3.32 Forming part of the UK Seafood Fund, the Seafood Innovation Fund (SIF) aims to support better science and innovation projects and develop technology, trial new gear and support world-class research to improve the productivity and long-term sustainability of the industry. Since the £24m fund was established, 94 projects have been supported, including 56 feasibility studies and 38 R&D projects. Calls for the fourth round of SIF funding opened in September 2022. Unlike previous calls, where collaborators had the opportunity to bid for up to £50k for feasibility studies or £250k for full R&D projects, this call is uncapped.

3.33 Another strand, the Infrastructure Scheme opened to applicants in March 2022 with the aim of providing around £65m to build capacity across ports processing and aquaculture infrastructure. The second funding round opens for applications in October 2022. The Skills and Training Scheme provides around £10m to attract new entrants, encourage staff retention, upskill and reskill the existing workforce, enhance employment opportunities in coastal areas, and positively impact on coastal communities. The seafood exports support package, as mentioned, provides around £1m of funding support to enhance the reach of the UK seafood industry into foreign markets.[103]

Table 3.1: Sector summary, observations and opportunities: Commercial capture fishing

Current position and status in the Highlands and Islands	• An established and substantial sector in the Highlands and Islands.
Opportunities and growth potential	• Growth potential unclear in the current political context. However, global demand for protein is increasing, so growth potential in existing and new overseas markets. • Growth potential also in (re-)establishing domestic markets.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Important economically and as an anchor industry in parts of the Highlands and Islands. • Part of seafood processing supply chain which is an area of potential development.
Cross sectoral opportunities and synergy	• Data and technology is increasingly important in fisheries. • May be potential for fishing vessels to be able to access stock in areas in which they have previously been displaced by offshore wind farms. • Potential for synergies and sharing resources for example skills development, infrastructure, science and innovation. • Decarbonising fisheries through for example, renewable energy, hydrogen powered marine vessels and waste management.
HIE's role going forward	• Not a strategic priority for HIE intervention, though there may be need for HIE to indirectly support, e.g., through community development activity.
Comments	• Politically sensitive and politically important.

[102] https://www.gov.uk/guidance/uk-seafood-fund
[103] Ibid

4 SEAFOOD PROCESSING

CONTEXT

4.1 Seafood processing is part of Scotland's food and drink industry. It comprises primary processing such as heading and gutting, filleting, washing, chilling, and packing; and secondary processing such as freezing, smoking, cooking, breading and production of ready meals. It is highly dependent on fish landed or farmed in Scotland. The sector does not include seaweed processing although it forms a small part of food and drink and, anecdotally, appears to be growing.

4.2 In terms of food and drink, The Scottish Government has stated its ambition that:

'Scotland's food and drink industry continues to grow and bring benefits to Scotland including jobs, wealth and international renown.'[104]

4.3 The Scottish Government set up the Scottish Seafood Partnership (SSP) to drive improvement in the seafood sector. It also set up the Scottish Seafood Exports Taskforce to identify and develop actions to help seafood and aquaculture businesses access EU markets. It had a core membership drawn from the catching, processing, exporting and aquaculture sections of industry and invited industry experts and specialists to join on an ad hoc basis.[105]

4.4 Seafood Scotland has launched a strategic action plan for the Scottish seafood sector, Changing Tides.[106] Within it, the opportunities (such as strong demand both domestically and internationally for seafood) and challenges (such as skills and labour shortages) that are present within the sector are identified. The strategy also names actions required within the themes of market development, innovation, people and skills, and the supply chain for Scottish seafood in order for the sector to grow in a responsible and profitable manner.

4.5 The Scottish Food and Drink Strategy[107] aims to double the value of the sector to £30bn by 2030, and seafood processing has an important contribution to make to this. Changing Tides: A strategy for Scotland's seafood industry focuses on four key themes: market development and brand; investment and innovation; people and skills; and supply chain.[108] However, the rate of recent growth in turnover in the Scottish seafood processing sector (less than 1% between 2010 and 2019)[109] indicates that doubling the turnover value of seafood processing in Scotland from 2016 will not be achieved by 2030.

4.6 A key ambition is that the seafood processing sector builds its ability to generate investment to increase its capacity in primary and secondary processing. This means we will export higher value-added seafood products. The current level of unprocessed seafood exports is a major opportunity for Scotland and is discussed later in the section.

[104] https://www.gov.scot/policies/food-and-drink/supporting-the-food-and-drink-industry/
[105] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1013600/FINAL_REPORT_SSET.pdf
[106] http://seafoodscotland.org/wp-content/uploads/2019/05/Changing-Tides-_FINAL_PAGES.pdf
[107] https://www.foodanddrink.scot/resources/publications/ambition-2030-industry-strategy-for-growth/
[108] https://drive.google.com/viewerng/viewer?url=http://seafoodscotland.org/wp-content/uploads/2019/05/Changing-Tides-_FINAL_PAGES.pdf
[109] https://www.gov.scot/collections/marine-economic-statistics/

4.7 Seafish UK[110] is the non-departmental public body set up to support the UK seafood industry and its Corporate Plan[111] sets out broad targets to 2021 to: increase seafood's contribution to the UK's GDP, improve the balance of trade of value-added seafood products, increase consumption in the UK to 1.35 portions per person per week, and an annual increase in sales attributable to marketing.[112] However, the stagnating turnover of the sector, and the ongoing trade deficit indicates that this will not be achieved.

NATURE AND SCALE OF THE SECTOR

4.8 The UK seafood processing industry is one of the largest in Europe. The Scottish sector is a sizeable part of that UK picture, although in Scotland the sector's activities are predominantly, though not exclusively, outside of the Highlands and Islands (for example, in Aberdeen and Aberdeenshire and the Central Belt). While seafood processing is a small part of the Scottish economy overall, it is a significant part of the blue economy and makes an important contribution in rural and coastal communities. Demonstrating its importance, in 2016 it was larger than the aquaculture and fishing industries in terms of turnover, employment and GVA.[113]

4.9 Overall, the UK is a net importer of fish, exporting most of what we catch and importing most of the fish that are processed or consumed within the UK, with 68% of value consumed coming from exports in 2019.[114] Scotland exports the majority of its seafood, reported as 80% in 2015 and valued at £613 million. At the same time, we import 80% of the seafood we consume according to the Scottish Seafood Association. There is therefore scope for increased domestic consumption which will have the added benefit of reducing food miles.[115] Recognising this, the Scottish Government has appointed celebrity chef, Monica Galetti as Scotland's first Seafood Ambassador, with the aim that more Scottish-sourced fish and shellfish is sold and consumed in the UK.[116]

4.10 In 2021 there were 131 seafood processing sites in Scotland, providing 7,783 full time equivalent (FTE) jobs. This accounts for approximately 38% of all UK sites and 43% of the jobs.[117] It is an illustration of the inter-relationship of blue economy sectors, notably fisheries and aquaculture, which form part of the seafood processing supply chain. The number of sites fell between 2012 and 2021 and, at the same time, the average employment per site grew indicating some consolidation in the sector, with fewer sites employing more staff.[118]

4.11 Despite having a relatively small footprint, seafood processing makes an important contribution to local economies in the Highlands and Islands. In 2021, there were 43 seafood processing sites providing 1,755 FTE jobs in the region. This equates to an average of 41 jobs per site, smaller than the Scottish average of 61 FTE jobs and the UK average of 52.[119] These sites span the Highlands and Islands and are located in some of the region's remote, rural and island communities, providing an important source of employment and contributing to community sustainability. They also help to add value to produce before it leaves the region. In the Highlands and Islands, the industry generated £275m in 2015 and added £72m GVA to the economy. This is the most recent data available at regional level.[120]

[110] https://www.seafish.org/about-us/working-locally-in-the-uk/working-with-the-seafood-industry-in-scotland/
[111] https://www.seafish.org/document/?id=314721ab-a47f-45ab-9a35-9161567072ea
[112] https://www.seafish.org/media/Publications/Corporate_Plan_18-21_V2.pdf
[113] https://digitalpublications.parliament.scot/ResearchBriefings/Report/2019/7/5/Seafood-processing-in-Scotland--an-industry-profile
[114] https://www.seafish.org/document/?id=ac08b542-3d89-4c12-812e-1c4a9a53466f
[115] https://www.seafoodsource.com/news/supply-trade/a-seafood-export-dilemma-in-scotland
[116] https://www.bbc.co.uk/news/uk-scotland-62035912
[117] Seafish - https://www.seafish.org/insight-and-research/seafood-processing-data-and-insight/
[118] Ibid
[119] Ibid
[120] Scottish Parliament (2019) Seafood processing in Scotland: an industry profile, 5th July 2019

DRIVERS AND CHALLENGES

4.12 Levels of awareness of environmental and social issues in consumer markets for seafood, particularly in Europe and North America, have risen over the past decades. As in other food sectors, convenience, health, transparency, and sustainability are the main trends shaping global consumption indicated by growth in the global sustainable seafood market. Growth in sales of certified seafood is ten times that of conventional seafood, driven almost entirely by end-buyer commitments to sustainable sourcing.[121]

4.13 UK consumer trends show that fish is increasingly recognised as a sustainable and healthy source of protein. Added to this, there is increasing demand for reliable supplies of Scottish fish products in international markets.[122] As with aquaculture, this is largely driven by an increased global demand for protein, the perception that seafood is a healthier source than some others, and the reputation of Scotland's premium seafood produce.

4.14 During 2020 the supply and demand of seafood was seriously challenged by the global COVID-19 pandemic. There were issues around exporting (e.g., lack of international flights and therefore air freight), and closure of hospitality venues. Signs point towards a return to the trend of growth in demand for seafood as a source of protein and suggest that distribution channels are more reliable again.

4.15 A challenge facing many processors is a short harvesting season of some species which results in large volumes of seafood being landed in a short period of time. Capacity issues can make it difficult for timely processing of these raw materials before they start to deteriorate. The development of live holding systems for shellfish (e.g., prawn, crab, lobster, mussels) can help to address this issue. This includes titanium chillers, water re-circulation and aeration that mimic the conditions that the products need to remain in good health until they can be delivered for processing, or while they are waiting to be processed. These technologies minimise product loss, improve product quality, and achieve processing efficiencies. To increase the shelf life of products there are innovations in processing and packaging that are enabling new product development to meet and drive changing consumer tastes and attitudes.

4.16 Waste reduction, recovery and reuse is an important area for seafood processing and new ways of working are developing around this. Technologies are being applied to extract more value from processing by-products and create valuable products such as biomedical chitosan and calcium supplements. The main goal of these technologies is to allow the seafood sector to produce high value-low-cost products and remain competitive in global markets.[123] There are also circular economy opportunities for a wide range of by products such as skins, bones and shells in, for example packaging.

4.17 The sector faces labour supply issues, and this is a significant driver for the development of automation and technology including collaborative robots (cobots), digital manufacturing, process monitoring and control, and new types of packaging reflecting consumer demand for 'green' goods. There is also innovation around energy consumption to achieve efficiencies and reduce carbon footprint.

4.18 Seafood processing in the UK has traditionally relied upon a large immigrant workforce, particularly from European Economic Area (EEA) countries. This trend is even more pronounced in Scotland – based on survey data, Seafish has estimated that in 2018, 59% of those employed in the

[121] https://seafoodsustainability.org/wp-content/uploads/2019/06/Business-Case-for-Sustainability-2019.pdf
[122] https://marine.gov.scot/sma/assessment/fish-processing
[123] https://research.library.mun.ca/2296/3/V6N4_essay_Manuel_et_al_FINAL.pdf

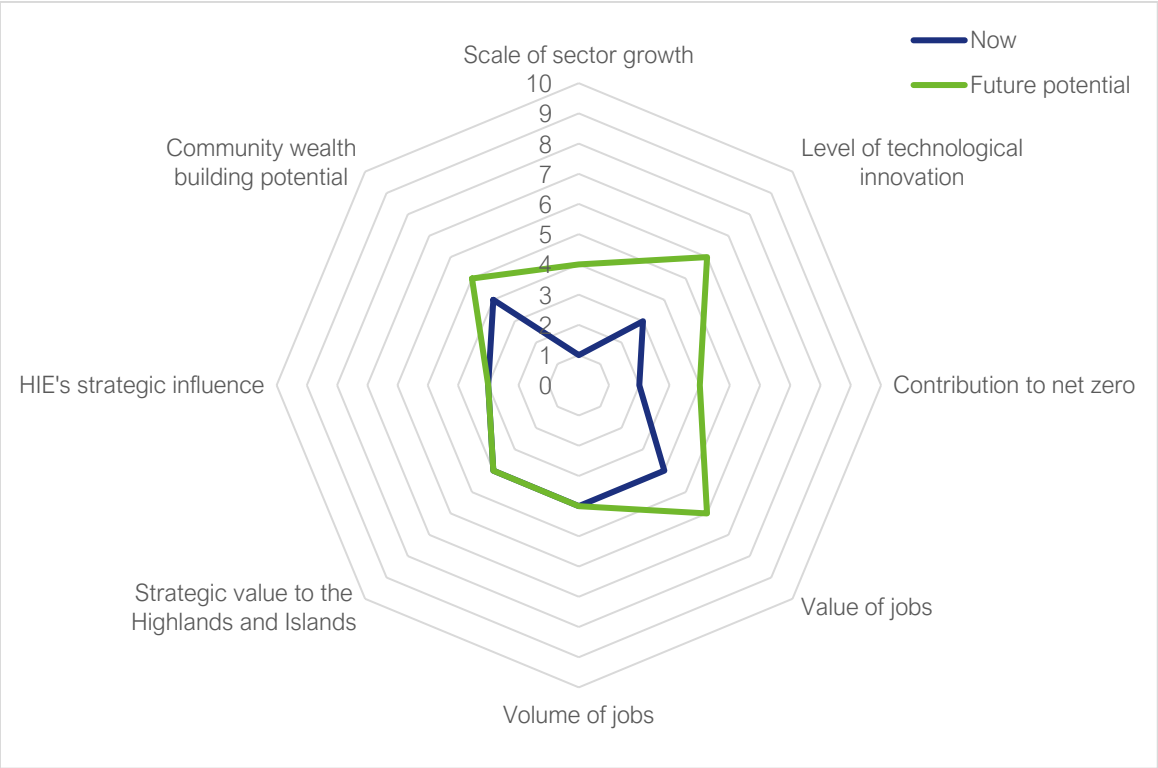
sector in Scotland were non-UK workers from EEA countries, compared with 51% in the UK seafood processing workforce as a whole. Brexit has had a severe and detrimental impact on the availability of labour and future immigration arrangements remain a risk. In addition, the current reported shortage of HGV drivers is a risk for the sector in terms of transporting goods to market.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

4.19 Now that the UK and other markets have largely emerged from lockdown restrictions, and there are more flights that can carry seafood to markets, there is an opportunity for the sector to respond to the demand from hospitality, food service and retail in the UK and internationally. There are also opportunities around new premium product development, achieving efficiencies by applying technology, and reaching into new markets where there is a growing demand for sustainable protein.

4.20 Figure 4.1 provides an assessment of the current position of the sector in the Highlands and Islands, and the potential. It shows that seafood processing is fairly limited in the Highlands and Islands and although there is growth potential it is unlikely to be transformational for the region. There is, however, scope for an increase in innovation and the application of technologies to enhance productivity. This will in turn impact on the sector's contribution to net zero by 'greening' operations and reducing carbon emissions. Increasing the adoption of technology will also drive up the value of jobs in the sector, with lower value roles being automated.

Figure 4.1: Current and future potential of Seafood Processing in the Highlands and Islands



4.21 Whilst of course exporting is critical, there is an opportunity to increase domestic consumption of domestic produce by influencing consumer buying and eating habits. For example, we do not tend to consume large quantities of commonly landed fish and shellfish such as herring, blue whiting, crab and mackerel and we source large quantities of cod, haddock and tuna from overseas. These under-consumed species may represent an opportunity for growth of seafood processing that could be optimised in the Highlands and Islands, given its reputation for premium raw product.

4.22 End markets are driving the demand for sustainable, ethical seafood and this is a very competitive marketplace. Currently well positioned, it is important that Scotland and the Highlands and Islands can continue to access suitable produce from fisheries and aquaculture to meet this demand. It also requires the industry to considers its operations at every stage in line with net zero ambitions.

4.23 Whilst there is value-adding primary and secondary processing in Scotland and in the Highlands and Islands, much of the produce is exported as raw materials, or having been primary processed. As discussed above, a challenge is to increase the capacity and capability in the Highlands and Islands and Scotland to capture more of the added value domestically.

Table 4.1: Sector summary, observations and opportunities: Seafood processing

Current position and status in the Highlands and Islands	• Established in Scotland with some activity in the Highlands and Islands.
Opportunities and growth potential	• Scope for innovation and development including retaining value-added activities in the region.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Food and Drink is an extremely important sector in the Highlands and Islands, but seafood processing is a very small part of that. • Where it exists, it offers a market for produce, local employment, and skills opportunities. However, seafood processing is unlikely to grow substantially in the next 10-15 years although there is no doubt that it should be stimulated and supported at local level.
Cross sectoral opportunities and synergy	• As part of the wider Food and Drink sector, there will be opportunities to achieve synergies in terms of process and product R&D, the circular economy, skills and workforce development, and the supply chain (e.g., packaging, storage, distribution. • Vertical integration of processing with seafood processing.
HIE's role going forward	• This should remain as one strand of HIE's support to F&D. • Local area teams can respond to requests from the sector on a case-by-case basis.
Comments	• Important pockets of local activity, but to achieve regional and transformational growth would require significant resource and input to grow from a low base.

5 MARINE ENERGY AND RENEWABLES

CONTEXT

5.1 Sustainable energy development is a priority for Scotland and key to this is reducing the consumption of fossil fuels in all sectors and areas of activity. The Scottish Government has set the ambitious target of being a net zero nation by 2045 and is supporting a range of activities to address the climate emergency. There is no doubt that renewable energy presents the best opportunity for cheaper, cleaner, and faster decarbonisation. This is reflected in the *Programme for Government 2021-22*[124] and the *Bute House Agreement*[125] which commits to strengthening the support framework for the marine renewables sector. It is also reflected in in the increasing use of offshore wind and other renewable energies to reduce Scotland's reliance on fossil fuels. It aligns with and opens opportunities for growth in the marine energy and renewables sector across Scotland and supports the development of a green economy.

5.2 The *Just Transition Commission*[126] provides a roadmap to transforming sectors and regions, including building on the success of energy efficiency initiatives, and supporting the transition of the oil and gas industry. It will also seek to build an economy with sustainability at the centre, investing in green jobs and skills for the future.

5.3 The third update on the *Climate Change Plan*[127] in 2018 and subsequent update[128] identifies that Scotland is well placed to take advantage of opportunities in emerging industries, such as marine energy and offshore wind. The most recent ambitions are to ensure that the electricity system is largely from renewable sources by 2032, as well as using smart grid technologies to improve connection to the national grid.

5.4 Scotland is driving action towards the *UN Sustainable Development Goals*[129] in the marine sector, including *Affordable and Clean Energy*. Reaching this goal will help our economy become more competitive, whilst supporting social and economic wellbeing and sustainable productivity. This is addressed in the *Scottish Energy Strategy*[130] which supports the climate change ambitions and sets out a vision for a competitive local and national energy sector that delivers secure, affordable and clean energy by 2050. It focuses on an inclusive transition to a low-carbon future with targets to increase Scotland's energy sourced from renewables, maximise the productivity of this energy use, and becoming a world leader in renewable and low carbon technologies. The Scottish Government has now published a draft Energy Strategy and Just Transition Plan (January 2023), which outlines a vision for a "flourishing, climate friendly energy system that delivers affordable, resilient and clean energy supplies for Scotland's households, communities and business".[131]

5.5 The Scottish Government published a position statement[132] that reinforces the Just Transition to net zero ambitions and how it ties into the Energy Strategy. It reflects on the success of onshore and offshore wind and hydrogen and states ambitions for increasing renewable capacity and development across Scotland. It has a particular focus on large scale deployment of floating offshore wind, islands wind projects, and wave and tidal technologies. The *National Marine Plan*[133]

[124] Scottish Government (2021) Programme for Government 2021-22, A fairer, greener Scotland.
[125] https://www.gov.scot/news/agreement-with-scottish-green-party/
[126] Just Transition Commission (2021) A national mission for a fairer, greener Scotland.
[127] Scottish Government (2018) Climate Change Plan. The Third Report on Proposals and Policies 2018-2032.
[128] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[129] SDG Network Scotland (2020) Scotland and the Sustainable Development Goals, A national review to drive action.
[130] Scottish Government (2017) Scottish Energy Strategy: The future of energy in Scotland.
[131] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/
[132] https://www.gov.scot/publications/scotlands-energy-strategy-position-statement/
[133] Scottish Government (2015) Scotland's National Marine Plan: A Single Framework for Managing our Seas

encourages the role of marine renewables in the reduction of greenhouse gas emissions and reaching the renewable energy targets, complementing the climate plans.

NATURE AND SCALE OF THE SECTOR

5.6 The offshore renewables sector is a dynamic and rapidly expanding field and is expected to play a significant role in providing energy for Scotland and globally. The sector comprises offshore wind, wave, and tidal energy, all of which have the potential to produce vast amounts of power that can be harnessed by modern technology.[134] Globally, offshore wind capacity has passed 35 GW, representing 4.8% of total global cumulative wind capacity.[135]

5.7 Scotland's capacity for renewable electricity has seen steady growth from 2009 to 2019 with an average annual capacity increase of over 800 MW. This was lower in 2020 due to the COVID-19 pandemic. As of 2020, the total installed capacity is at around 11,900 MW and offshore wind, wave and tidal energy account for approximately 8% of this[136]. Whilst marine wave and tidal energy makes a smaller contribution overall, there is massive potential for growth in the future with over 4,000 MW of capacity in planned projects.[137]

5.8 The UK has some of the best wave and tidal natural resources in the world – a significant asset that contributes to the drive for clean growth. The UK has 50% of Europe's tidal energy and 35% of its wave energy.[138] Within this, Scotland has around 10GW of tidal stream potential, and 15GW of wave resource.[139] The Simec Atlantis MeyGen project in the Pentland Firth is the largest planned tidal stream project in the world.[140] Wave Energy Scotland is driving the development of wave energy technology in the biggest research and development programme ever seen in the sector.[141] [142]

5.9 Offshore wind is one of the top three technologies within renewable energies with the greatest economic contribution to Scotland's national output. It was estimated to have a direct output of £474m in 2019. In addition to these direct impacts, the sector was estimated to have £185m stimulated in supply chains and induced a further £230m in the wider economy when direct and indirect employees spend their earnings.[143] Developments include the Beatrice Offshore Windfarm, Scotland's largest offshore windfarm. It is expected to create around 90 full-time jobs over its 25-year lifespan and power 450,000 homes with 84 turbines.[144] Added to this the Moray Offshore East and West wind farms are aiming to provide a secure and reliable source of energy at a more competitive price.[145]

5.10 There are around nine companies in Scotland specialising in marine energies, including AWS Ocean Energy and Atlantis. The latest data shows that the renewable energy sector in Scotland accounts for 22,660 FTE jobs, inclusive of direct, indirect and induced jobs. Approximately 60% of these jobs are in wind, a third of which are in offshore wind.[146]

[134] Offshore Renewable Energy Catapult, 2019

[135] GWEC (2021) Global Wind Report 2021.

[136] Scottish Energy Statistics Hub: Renewables and Low Carbon – Renewable electricity capacity

[137] https://www.scottishrenewables.com/our-industry/statistics

[138] https://cdn.ymaws.com/sites/renewableuk.site-ym.com/resource/resmgr/publications/OER_inside_track_final_-_onl.pdf

[139] https://www.oceanenergy-europe.eu/annual/ocean-energy-scotland/

[140] https://simecatlantis.com/projects/meygen/

[141] https://www.oceanenergy-europe.eu/annual/wave-energy-scotland-wes/

[142] https://www.waveenergyscotland.co.uk/

[143] https://www.scottishrenewables.com/our-industry/statistics

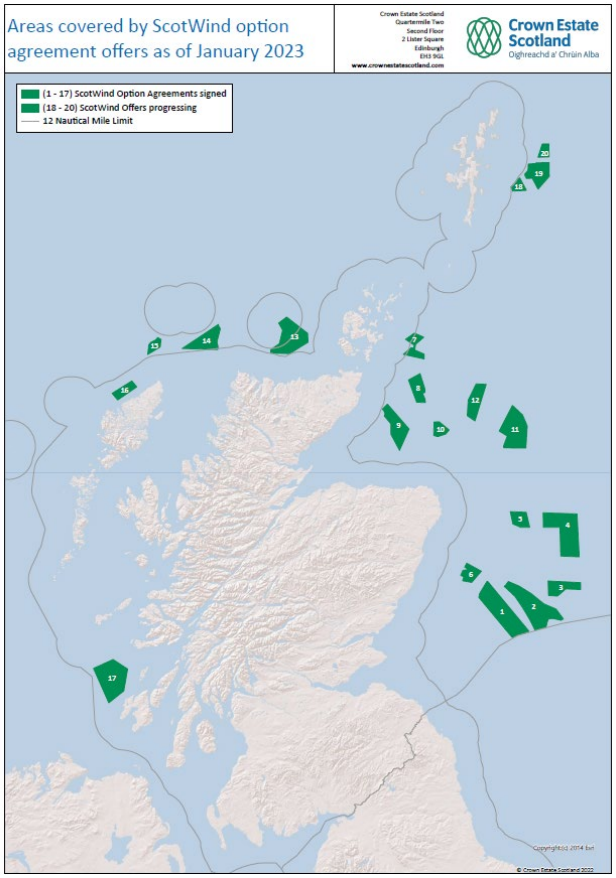
[144] Regensw; Marine Energy Pembrokeshire; HIE (June 2016), Marine Energy - Key Steps to Maintain a Great British Success Story

[145] https://www.morayoffshore.com/

[146] https://www.scottishrenewables.com/our-industry/statistics

5.11 The initial ScotWind leasing round led by Crown Estate Scotland sought to capitalise on these resources and expand Scotland's marine renewable generation capacity on a number of sites, many of which are in waters off the Highlands and Islands coastline (Figure 5.1). A total of 17 projects were selected in January 2022 to receive option agreements which reserve the rights to specific areas of seabed, covering a total seabed area of over 7,000km^2. A further three projects have since signed seabed option agreements (confirmed August 2022). The capacity of the 20 ScotWind projects totals up to 27.6 GW of clean energy. The total option fees associated with these projects will lead to the Scottish Government receiving around £755 million from successful applicants.[147]

Figure 5.1: Offshore wind plan awarded sites for ScotWind leasing round



Source: Crown Estate Scotland - ScotWind Offers Map (January 2023)[148]

5.12 Denmark is recognised as a leader in offshore renewable energy and an interesting comparator for Scotland. Denmark has more than 500 companies working in the wind industry[149] and two Danish manufacturers, Siemens Wind Power and MHI Vestas Offshore Wind, dominate the global market for offshore wind turbines. The Netherlands and Norway also have significant expertise and activity in wind energy including innovations in floating wind power. In Norway there is some focus on aligning offshore wind farms with other marine activities and the surrounding environment and the Norwegian Government recently announced a large-scale investment plan to develop offshore wind capacity, stating its ambition that almost as much new power will be produced from offshore wind by 2040 as Norway produces in total in 2022.[150],[151]

147 https://www.crownestatescotland.com/news/three-scotwind-clearing-project-agreements-confirmed

148 https://crown-estate-scotland-spatial-hub-coregis.hub.arcgis.com/documents/coregis::scotwind-offers-map/explore

149 https://www.winddenmark.dk/sites/windpower.org/files/media/document/Profile_of_the_Danish_Wind_Industry.pdf

150 https://www.regjeringen.no/en/aktuelt/norway-opens-offshore-areas-for-wind-power/id2705986/

151 https://www.offshorewind.biz/2022/05/11/norway-launches-30-gw-by-2040-offshore-wind-investment-plan/

DRIVERS AND CHALLENGES

5.13 Decarbonisation of the energy generation industry is arguably the primary driver for growth and development of renewable marine energy. As countries, industries and organisations pursue net zero ambitions, securing renewable energy generation is critical. Even for continuing carbon-based fuel operations such as oil and gas, which will still be required during energy transition, there is a push to minimise emissions for extraction by harnessing renewables in operations and across the supply chain.[152]

5.14 The Scottish Government's Climate Change Plan update[153] and the aspiration for a green recovery are also strong drivers in the development of marine energy and renewables. In particular, the new target for 50% of all of Scotland's energy consumption to be met by renewables, and a commitment to support the development of between 8GW and 11GW off offshore wind capacity by 2030 are contributing to increased demand. The ScotWind leasing round has awarded sites that have the potential total capacity to generate up to 27.6 GW.[154] Also contributing to increased demand is a specific requirement that was included for developers to include local content and supply chain commitments in applications for the latest round of ScotWind leasing, as well as in other planning activity such as Innovation and Targeted Oil and Gas Decarbonisation (INTOG).[155]

5.15 Cost reduction is an important consideration for some forms of marine renewables, such as for floating offshore wind. Floating offshore wind is not currently cost-competitive relative to piled offshore wind since the proven, mature technology used in piled offshore wind is cheaper to deploy. However, current floating offshore wind projects are helping to bring costs down. For example, Equinor has already seen a reduction in capex costs per megawatt of 70% between its initial Norway demonstrator and its Hywind Scotland array and expects a further 40% drop between Hywind Scotland and Hywind Tampen.[156] Industry ambitions for cost are around €40-60 per mWh by 2030, from around €200 in 2018.[157] An ORE Catapult report identifies a number of pathways to subsidy-free generation for the FOW industry, and sets out an expectation that cost reduction in UK FOW will happen much faster than for piled offshore wind.[158]

5.16 There are challenges around integrating low-carbon technologies into the existing UK generation system (given decentralisation and intermittency of generation) and transporting it for use on the national grid is not always feasible. Though existing wind and tidal energy arrays are typically directly connected to the national grid, some new sites and technologies such as floating offshore wind are too remote or too expensive and difficult to connect directly.

5.17 Grid upgrades would be costly but if Scotland is to realise the value of marine energies and renewables then the issues presented by grid infrastructure constraints must be addressed. There is, of course, potential for off-grid applications and green hydrogen is a potential solution for energy capture, storage, and transportation. It negates the need for expenditure on export cabling and grid upgrades. At the same time developments in hydrogen production is also driving the need for higher volumes of renewable generation.

[152] https://www.gov.scot/publications/annual-energy-statement-2020/
[153] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[154] https://www.crownestatescotland.com/news/three-scotwind-clearing-project-agreements-confirmed
[155] https://marine.gov.scot/data/sectoral-marine-plan-offshore-wind-innovation-and-targeted-oil-and-gas-decarbonisation-intog
[156] https://www.equinor.com/en/news/20210323-hywind-scotland-uk-best-performing-offshore-wind-farm.html
[157] https://www.greentechmedia.com/articles/read/floating-wind-is-cutting-costs-faster-than-regular-offshore-wind
[158] https://ore.catapult.org.uk/wp-content/uploads/2021/01/FOW-Cost-Reduction-Pathways-to-Subsidy-Free-report-.pdf

5.18 Despite having access to sizeable wind resources in the Scottish marine environment, there is a constraint on the size of available piled offshore wind sites. In UK waters overall, suitable piled offshore wind sites are constrained to a capacity of around 47 GW, though opportunities in floating offshore wind opens a much wider range of sites for marine energy generation.

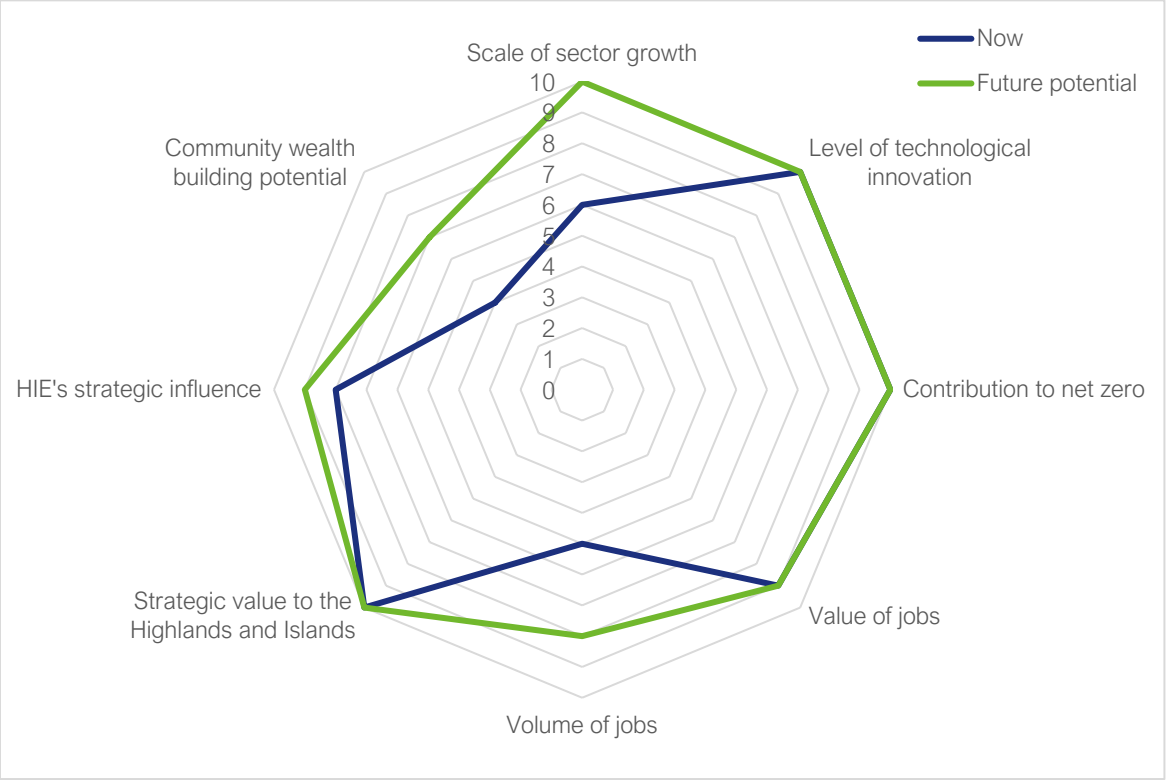
5.19 An additional constraint is the capacity and capability of ports to meet the current and future demand from the offshore wind sector. As discussed in Chapter 13, there are currently only a small number of ports in Scotland with the required depths, quay lengths and adjacent laydown sites for marshalling, assembly, fabrication, or operations and maintenance activity.

5.20 There are challenges to future developments include marine technologies competing with alternative technology options that are more cost-effective and well established, such as onshore wind. Whilst costs are reducing and efficiencies are being realised, as a less established technology, offshore wind and tidal energy will require more demonstration projects and development to help with cost reductions. More investment and capacity is needed to help prove its feasibility and to share the risk across a wider range of stakeholders. Risk is a major problem, as appetite for risk is typically lower further down the supply chain, acting as a barrier to new sector entrants.

KEY FINDINGS AND OPPORTUNITIES FOR THE HIGHLANDS AND ISLANDS

5.21 Figure 5.2 demonstrates the strength of marine renewable energy in the Highlands and Islands and also, based on the region and Scotland's natural assets and advantages, expertise and existing activities, the opportunities for growth in terms of the scale of the sector and employment. There is also a real opportunity here for community wealth building through communities having a stake in renewable energy generation.

Figure 5.2: Current and future potential of Marine Renewables in the Highlands and Islands



5.22 The need for decarbonisation of energy is driving innovation growth and research and development in marine energy and renewables. As a result of easy access to natural resources for marine renewables, Scotland is already a world-leader in marine energy and renewables and has a reputation for research and development in this sector. There is a clear opportunity to sustain and capitalise on this across the energy generation and value chain. This includes demonstrating the viability, effectiveness, and market readiness of some forms of energy generation technology. For example, wave and tidal energy have the potential to deliver transformational change in terms of energy generation, but there are some challenges, particularly for wave energy, in demonstrating and then scaling up the technology. Wave Energy Scotland's work has seen the commitment of £50 million of funding across 132 contracts, with projects focused on key systems and sub-systems of Wave Energy Converters to demonstrate reliable and economically viable technology and achieve cost-effective wave energy generation.[159]

5.23 The European Marine Energy Centre (EMEC) in Orkney has developers from all over the world testing prototype wave and tidal devices, highlighting a strong position and drive to move this forward. The capabilities and ambitions in this sector are demonstrated by the fact that there has been more deployment of wave and tidal devices at EMEC in the Highlands and Islands than in any other single location in the world. An impact assessment identified that EMEC has generated almost £285 million of GVA for the UK economy.[160] Building on this world class expertise is therefore a clear opportunity for the region, and for Scotland.

5.24 A key component of the ScotWind leasing round was the requirement for projects to be developed in a way that supports the sustainability of offshore wind development in Scotland. Specifically, bidding companies had to commit to ensuring a significant proportion of their development, manufacturing and fabrication, installation, and operations expenditure being in Scotland, through a Supply Chain Development Statement (SCDS).[161] Going forward, there is therefore an opportunity to grow the value chain in Scotland and in the Highlands and Islands. As an example of what could be different in future, much of the fabrication for the Kincardine Offshore Floating Wind Farm[162] project is being undertaken in Spain rather than in Scotland.[163]

5.25 As we progress in decarbonisation, Scotland and the UK must simultaneously maintain affordable, secure, and reliable energy supplies to ensure social resilience and wellbeing. There are already challenges in energy affordability for many people in Scotland with rising energy prices and market failures.[164] Recent events have highlighted the importance of energy security and the impact of global events on energy prices. The costs of wind and solar projects are falling, and renewables are fast becoming the cheapest source of power.[165] Streamlining the energy supply and capturing it in a manner that is sustainable and without waste is an opportunity for Scotland and the Highlands and Islands to contribute to affordable, secure, clean energy. Building on existing expertise and activities in the region, there is an opportunity to continue to grow the research and development in hydrogen capture, storage, and transportation to maximise Scotland's marine energy assets and capitalise on the global market for these technologies and for our energy. The need for energy security has been brought in to sharp focus with the war in Ukraine resulting in rapidly rising energy inflation and volatility in the market.

[159] https://www.waveenergyscotland.co.uk/
[160] http://marine.gov.scot/sites/default/files/8._emec_socio-economic_report_rep659.pdf
[161] https://www.crownestatescotland.com/resources/documents/supply-chain-development-statement-summary-1
[162] https://pilot-renewables.com/
[163] https://www.grupocobra.com/en/proyecto/kincardine-offshore-floating-wind-farm/
[164] Scottish Government (2017) Scottish Energy Strategy: The future of energy in Scotland.
[165] IRENA (2021) World Energy Transitions Outlook: 1.5°C Pathway.

5.26 An OECD report identified that digital technologies have a very important role to play in ocean sustainability, including artificial intelligence (AI), cloud commuting, the Internet of Things (IoT), automation, robotics, and high-performance sensors. Uptake of digital and novel technologies into the Blue Economy has been slower than for other sectors, but these technologies have the potential to reshape the performance and efficiency of ocean activities, as well as creating new ones whilst contributing to sustainability.[166] The Scottish Government has announced a further £16.5m from the Energy Transition Fund to the Net Zero Technology Centre to accelerate a range of energy transition projects, including transforming the North Sea energy system through digital technologies. This is expected to deliver £403bn for the economy and 21,000 jobs by 2050 through seven projects. Offshore Low Touch Energy Robotics and Autonomous Systems will be built for use offshore to support energy transition and lead Scotland in deploying robotic and automation technologies. Another project in offshore energy digital architecture will also help develop a sector-wide digital and data architecture to improve data visibility in the future offshore energy system.[167] This all presents opportunities for enterprises and organisations in the Highlands and Islands while helping find solutions to tackle some of the challenges identified.

5.27 Energy transition and ocean transport are pinpointed as key areas of economic activity with opportunities for green jobs growth and skills. Developing the future workforce for this transition and providing sustainable employment in a green economy is an opportunity to increase the number of jobs in the region. This will help to retain and attract talent and provide alternative employment for oil and gas workers to transition and use their skills in renewables. There is a clear direction for changes in the skills system and the role that industry can play in achieving this to support net zero targets, as well as achieving social and economic recovery and building resilience.[168]

Table 5.1: Sector summary, observations and opportunities: Marine energy and renewables

Current position and status in the Highlands and Islands	• Established in the region, in particular offshore wind and increasingly floating offshore wind. • Some at nascent/early stage
Opportunities and growth potential	• Decade of delivery. • Developing storage solutions for continuity of supply. • Capitalising upon and exporting Scotland's world-class expertise; maximising Scotland's marine energy assets in the global market for marine renewable technologies and renewable energy.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Strategically high importance in the Highlands and Islands and Scottish Government. • Renewables as a community-asset and wealth building opportunity.
Cross sectoral opportunities and synergy	• Significant cross-sector opportunities in terms of skills, clean energy for transport and power supply, and in sharing knowledge and R&D activity with oil and gas and other Blue Economy Sectors. Also in the application of digital technologies. • Opportunity to build a strong supply chain. • Inward investment proposition. • Decommissioning of installations, equipment and end of life. • Waste handling industries. • Knowledge and infrastructure development and sharing with oil and gas decommissioning.
HIE's role going forward	• HIE should continue to take a strategic role in the development of all types of marine energy and upstream and downstream activities.
Comments	• Future rounds of ScotWind could further increase the sector's potential.

[166] OECD (2021) A New Era of Digitalisation for Ocean Sustainability, Prospects, Benefits, Challenges.
[167] https://www.gov.scot/news/investing-in-net-zero-technology/
[168] SDS and Scottish Government (2020) Climate Emergency Skills Action Plan 2020-2025.

6 OIL AND GAS

CONTEXT

6.1 Oil and gas constitute the majority of primary energy in Scotland,[169] and continue to play a significant role in the Scottish economy. However, the policy environment in Scotland is facilitating a shift towards a low carbon economy, as part of efforts to reduce dependency on fossil and carbon-based fuels and associated carbon emissions, to increase the proportion of renewables in Scotland's energy mix, to increase energy efficiency, and respond to the climate emergency.

6.2 The Scottish Government's Energy Strategy, published in December 2017, is a wide-ranging and far-reaching strategy which acts as a strong driver of change for the Energy sector in Scotland. The Strategy's vision is for:

'A flourishing, competitive local and national energy sector, delivering secure, affordable, clean energy for Scotland's households, communities and businesses.'

6.3 One of its six priorities is to capitalise on the oil and gas industry's strengths and support *"investment, innovation* and *diversification"* across the oil and gas sector, to maximise the recovery of remaining resources, subsea engineering, decommissioning and carbon capture and storage –

"collaboratively addressing the challenges of today and preparing the sector and its workforce for a positive role in Scotland's future energy system".

6.4 The climate emergency response is an increasingly central feature of Scottish Government policy. The Scottish Government's Programme for Government (2019-20),[170] set out actions for ending Scotland's contribution to climate change, and building a successful, fair and green economy. Building on the COVID response- and climate emergency-related actions in the 2020-21 and 2021-2022 Programmes for Government [171,172] highlights the actions required to help meet the ambition for Scotland to be a Net Zero Nation. The Scottish Government has now published a draft Energy Strategy and Just Transition Plan (January 2023), which considers the future for oil and gas in Scotland.[173]

6.5 This reflects the recognition of the important role that oil and gas plays in the energy transition. Consequently, there is now effort on decarbonising extraction and production as far as possible. A good example is the new Sectoral Marine Plan round for Offshore Wind for Innovation and Targeted Oil and Gas Decarbonisation (INTOG). This initiative aims to identify areas for future offshore wind development that will help to decarbonise the oil and gas sector through the replacement of traditional energy sources with renewable energy.[174]

6.6 The offshore oil and gas industry is becoming more integrated with the wider energy sector, and a variety of projects including the Shetland Energy Hub, Aberdeen ETZ, and Acorn Project are ongoing around Scotland. They range from the production of green and blue hydrogen to platform electrification and Carbon Capture Utilisation and Storage.[175] In the future, contracts will be won based on sustainability performance, and decommissioning has a major role to play in this transition.

[169] Scottish Government (2021) Scottish Energy Statistics
[170] Scottish Government (2019) *Protecting Scotland's Future: The Government's Programme for Scotland 2019-2020*
[171] https://www.gov.scot/publications/protecting-scotland-renewing-scotland-governments-programme-scotland-2020-2021/
[172] https://www.gov.scot/publications/fairer-greener-scotland-programme-government-2021-22/
[173] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/
[174] https://marine.gov.scot/data/sectoral-marine-plan-offshore-wind-innovation-and-targeted-oil-and-gas-decarbonisation-intog
[175] https://oguk.org.uk/wp-content/uploads/2020/11/Decommissioning-Insight.pdf

6.7 At the UK level, the North Sea Transition Deal sets out how the Oil and Gas industry and the public sector will collaborate to ensure the development of skills, innovation and new infrastructure required to meet stretching greenhouse gas emissions reduction targets. This includes staged reductions in offshore production emissions with the aim of creating a net zero basin by 2050, investment of up to £14-16 billion by 2030 in new energy technologies, and a 60 million tonne reduction in greenhouse gas emissions, including 15 million tonnes through the progressive decarbonisation of UK Continental Shelf (UKCS) production over the period to 2030. The Deal also aims to provide support for the transition of industry and supply chain jobs to decarbonising roles as well as pivoting to Carbon Capture Usage and Storage (CCUS) and hydrogen production.[176]

6.8 Similarly, the Oil and Gas industry's Roadmap 2035[177] aims to pivot the industry towards low carbon activities by:

- Supporting the development of transferable skills, developing new roles and capitalising on existing sector expertise to excel, and be recognised as a global leader in carbon management;
- Establish net zero solutions and support the development of diversified economic activity in the oil and gas sector, with a focus on low carbon technologies; and
- Ensure the development of an integrated energy system, including the development of carbon capture and storage and other low-carbon technologies, whilst contributing to meeting the UK's energy needs through a diversified energy system.

NATURE AND SCALE OF THE SECTOR

6.9 In 2019, Scotland (including Scottish adjacent waters) produced an estimated 54.0 million tonnes of oil equivalent (mtoe) of crude oil and natural gas liquids (NGLs). This is approximately 40% of peak output recorded in 1999. However, it is an increase of 2.2% on 2018 production output. Scotland accounts for 95.2% of total UK crude oil and NGLs production.[178]

6.10 Scotland produced 23.2 mtoe of natural gas in 2018, although this has decreased over each of the previous three years. It represents 62.1% of total UK gas production and is the equivalent of almost six times Scotland's gas consumption.

6.11 Oil and gas is the most highly represented sector in terms of employment in the energy industry. In 2019, 152,100 were directly employed in oil and gas and its immediate supply chain in the UK. In 2020, this is estimated to have decreased to 117,400 (a decrease of -23%) and is forecast to be 118,400 in 2021 (+1%).[179]

6.12 Oil and gas employment in Scotland is estimated to be around 36% of total UK employment. This equates to around 64,200 workers across the oil and gas supply chain in 2020 and 70,500 workers in 2021, based on UK estimates and forecasts by OGUK. This represents a 30% decrease since 2018 (no data available for 2019 employment in Scotland). Previous research has indicated that the Highlands and Islands' share of overall Scottish oil and gas employment was around 5%. Assuming that the region's share of employment remains broadly the same, this would equate to around 3,700 workers (direct, indirect and induced).

[176] https://www.gov.uk/government/publications/north-sea-transition-deal
[177] https://roadmap2035.co.uk/roadmap-2035/
[178] Scottish Government (2021) Scottish Energy Statistics / Scottish Government (2021) Oil & Gas Production Statistics
[179] OGUK (2021) Workforce & Employment Insight 2021, at: https://oguk.org.uk/wp-content/uploads/woocommerce_uploads/2021/08/OGUK_Workforce-Employment-Insight-2021-z07os0.pdf

6.13 The decrease in employment is largely due to redundancies and loss of contracts because of the COVID-19 pandemic and the resulting drop in investment. However, it is also important to note that many roles (particularly in the supply chain) will now be supported by demand from other sectors as the pace of company diversification increases.

6.14 Oil and gas sales revenue was £25 billion in 2018/19, up from £19.5 billion in the previous financial year. GVA estimates indicate that oil and gas extraction is worth around £5.7 billion in GVA to the Scottish economy in 2020, though this is down from around £9 billion in 2019 (Figure 6.2). Wider oil and gas production GVA is estimated to be around £8 billion in 2020, down from £13.5 billion in 2020 (-41%). This reduction in GVA value is largely a result of the COVID-19 pandemic.

6.15 Though UKCS drilling activity was low in 2020, it was expected to recover in 2021[180] and so far, 39 wells have been drilled - 3 exploration, 2 appraisal and 34 for development.[181] The UK oil and gas Authority is also considering consent for new exploration in the Cambo oil field off the coast of Shetland.

6.16 Within the oil and gas industry there is a focus on the optimisation and efficiency of existing wellstock on the UKCS. This is to ensure that industry operators can continue to maximise production and extend the operational life of existing wells and platforms.

6.17 As noted, there is also a shift to making extraction as decarbonised as possible, through schemes such as INTOG. There is industry recognition that existing UKCS reserves cannot be developed unless it is done as cleanly as possible, with platform operations needing to be net zero. As a consequence, industry operators are switching resources to renewable energy generation activity, including floating offshore wind and green hydrogen.

DRIVERS AND CHALLENGES

6.18 A key challenge for the oil and gas industry is the need to ensure decarbonisation of extraction operations. Whilst oil and gas will continue to play an important part of Scotland's energy mix for some time to come, there is a clear commitment from the Scottish Government to ensure that production operations are decarbonised.

6.19 A similar challenge for the industry is for it to maximise the existing oil and gas reserves and resources on the UKCS, and making the necessary investments to do so, whilst contributing to energy transition. This will require careful balancing and judgement in terms of making investment, and innovating to achieve cost reduction, to ensure ongoing oil and gas supply. This is particularly important in terms of energy security, given recent volatility in energy markets.

6.20 Allied to these challenges is the impact of COVID-19 and Brexit on energy transition. These major economic disruptors have accelerated, rather than paused or reversed, the energy transition.[182] This puts additional emphasis on how oil and gas companies can demonstrate their roles, and that of the fuels that they operate in, in a changing energy economy. This includes investment in areas outside of their current core operations, including low-carbon hydrogen, biomethane and advanced biofuels, as these can deliver the energy system benefits of hydrocarbons without net carbon emissions.[183]

[180] https://www.energyvoice.com/oilandgas/north-sea/286837/ukcs-exploration-drilling-westwood-global/
[181] https://oguk.org.uk/wp-content/uploads/2021/08/OGUK-Economic-Report-2021.pdf
[182] https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/oil-and-gas-industry-outlook.html
[183] https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions

6.21 Supporting supply chain companies is a critical issue. Many upstream and downstream supply chain companies operating in oil and gas are still recovering from the economic downturn of 2008 and remained fragile as the COVID-19 pandemic and its associated economic slowdown hit.[184] This has resulted in redundancies although there are signs of an upturn in the oil and gas supply chain. As with other parts of the economy, support is needed to recover, flourish, innovate and diversify to serve both oil and gas and other sectors, such as renewables.

6.22 Managing the workforce transition is another challenge for the oil and gas industry. Though research indicates that the majority of workers are 'transition-ready' in terms of skills transferability,[185] such a transition will still need to be managed carefully. This is necessary to ensure existing and future oil and gas operations can be maintained, whilst meeting the demands from emerging clean energy sectors.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

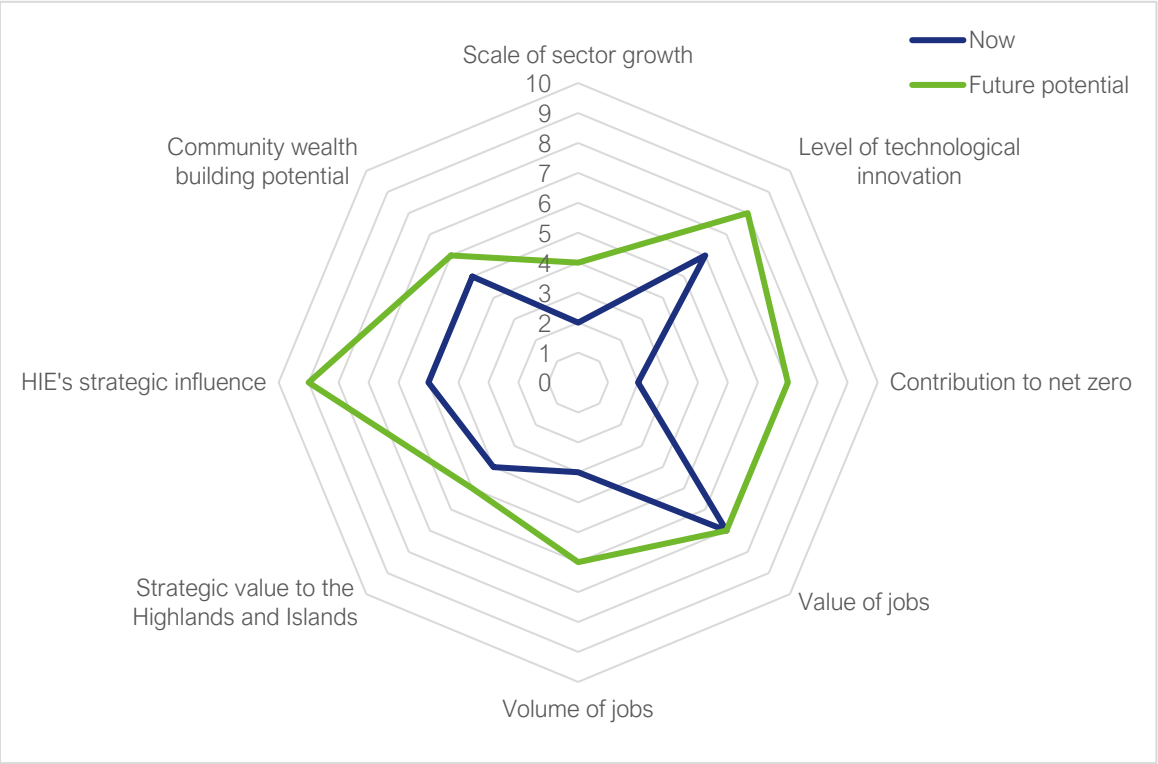
6.23 It is anticipated that delivering against the objectives of The Scottish Government's Energy Strategy will create a range of opportunities in both energy supply and consumption, through supporting work already planned or underway to achieve Scotland's long-term climate change targets, and to address shortcomings in energy provision across the country. The Strategy is underpinned by three core principles:

- A whole-system view to broaden the focus of Scottish energy policy to include heat and transport, alongside electricity and energy efficiency, creating an integrated approach to energy;
- An inclusive energy transition, recognising that the transition to a low carbon economy over the coming decades must happen in a way that tackles inequality and poverty, and promotes fairness and inclusion;
- A smarter local energy model enabling a smarter, more coordinated, approach to planning and meeting distinct local energy needs that will link with developments at the national scale.

6.24 Figure 6.1 sets out the current and future economic potential for oil and gas in the Highlands and Islands. Much of the growth potential relates to the energy transition, and ways in which this can drive higher levels of economic activity. It is in this space that HIE has most to offer and the greatest role to play – providing the strategic impetus to facilitate the energy transition, whilst supporting decarbonisation of existing operations.

[184] https://oguk.org.uk/wp-content/uploads/2021/08/OGUK-Economic-Report-2021.pdf
[185] https://www.rgueti.com/wp-content/uploads/2021/05/workforce-transferability-report.pdf

Figure 6.1: Current and future potential of oil and gas in the Highlands and Islands



6.25 The ORION Project[186] (Opportunity, Renewables, Integration, Offshore Networks) is a partnership between the Shetland Islands Council and the oil and gas Technology Centre in Aberdeen, involving HIE and UK energy industry players such as Wood Group, and advised by a steering group including BP, Shell, Total, Equinor, EnQuest, SSE and Siccar Point Energy.[187] The project's aim is to establish Shetland as a centre for green hydrogen, capitalising on its existing energy expertise and infrastructure. The project is driving collaboration amongst major oil and gas players, supporting activity intended to achieve ambitions related to new technology development and decarbonising extraction.

6.26 Workforce transition is a key opportunity. As Scotland's energy mix continues to change with the transition towards net zero, and with increasing skills demand from emerging low carbon sectors, opportunities for the incumbent oil and gas industry workforce to transfer their skills will also increase. However, it is anticipated that this will not be a linear process, but rather will happen on a project-by-project basis, on work delivered alongside oil and gas activity. By 2030, the offshore energy workforce mix is expected to change significantly, with jobs in the offshore renewables sector increasing from 20% of the sector's roles in 2021 to around 65% by 2030. At the same time, it is estimated that around half of the skills demand from the offshore energy sector will be met by people transferring their expertise to emerging low carbon energy sources, applying their skills to new areas as well as oil and gas.[188] Research by the Robert Gordon University Energy Transition Institute estimates that over 90% of the UK's oil and gas workforce have medium to high skills transferability and are well-positioned to work in adjacent energy sectors including renewables.[189]

[186] https://www.apse.org.uk/apse/assets/File/Douglas%20Irvine.pdf
[187] https://www.shetland.org/blog/green-hydrogen-potential
[188] OGUK (2021) Workforce & Employment Insight 2021, at: https://oguk.org.uk/wp-content/uploads/woocommerce_uploads/2021/08/OGUK_Workforce-Employment-Insight-2021-z07os0.pdf
[189] https://www.rgueti.com/wp-content/uploads/2021/05/workforce-transferability-report.pdf

Table 6.1: Sector summary, observations and opportunities: Oil and gas

Current position and status in the Highlands and Islands	• An established and significant, high value sector in Scotland, including parts of the Highlands and Islands.
Opportunities and growth potential	• Opportunity to migrate skills from oil and gas to renewables. • Potential to maximise the role that energy transition plays in a wider Just Transition. • Areas of growth potential include optimisation and efficiency of existing wellstock, and decarbonisation of operations.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Strategically important but recognition of a migration to clean energy. • Will continue to play ongoing strategic role in specific locations such as Shetland, and Inner Moray Firth.
Cross sectoral opportunities and synergy	• Applying skills in oil and gas workforce to other Blue Economy sectors such as renewables and aquaculture.
HIE's role going forward	• Highly political, driven by UK Government through the North Sea Transition Deal. • Strategic partners are Scottish Government and Scottish Enterprise. • HIE should be a partner and keep a watching brief to mitigate risk to the regional economy.
Comments	• Energy transition requirements are key to HIE's involvement with the sector.

7 DECOMMISSIONING

CONTEXT

7.1 Decommissioning is an emerging sector in Scotland, for oil and gas and going forward, offshore renewables. After more than forty years of production, and associated wear and tear on assets, new exploration and new production wells are now juxtaposed with more mature assets that are reaching the end of their productive life and so required to be appropriately decommissioned.

7.2 Previous estimates placed a ten-year expenditure for decommissioning at £17.6bn[190] on the UK Continental Shelf (UKCS) but this was recently updated to £15.3bn over the next decade.[191] The Decommissioning Action Plan,[192] launched by Highlands and Islands Enterprise and Scottish Enterprise in 2016, aims to support Scotland's oil and gas sector to capitalise on this forecast. It provides a framework that clarifies the range of different activities involved in decommissioning programmes, from high value offshore activity such as well plugging and abandonment, to the relatively lower value contracts for onshore disposal of jackets and superstructures. The action plan outlines the potential opportunities for established oil and gas companies in Scotland to gain access to the emerging decommissioning market.

7.3 The Decommissioning Challenge Fund (DCF),[193] announced in 2017 by the Scottish Government was developed as a means of supporting:

- infrastructure upgrades and innovation in retrieval and transportation methods at ports and harbours
- supply chain projects to strengthen Scottish decommissioning capabilities and capacities
- projects to develop high quality and comprehensive investment-grade business proposals for decommissioning
- engineering scoping work at key sites to build business cases
- feasibility studies to help to attract private investment

7.4 The DCF supports the Decommissioning Action Plan and complements past successes of the Scottish supply chain in securing contracts for certain aspects of high-value decommissioning work. Grant offers totalling £10.3 million were made to 28 projects and partnerships.[194] Successful projects in the region include a feasibility study to explore options for preparing facilities to increase the ability to retain decommissioning projects in Scotland at Port of Cromarty Firth, and an Engineering feasibility study for a decommissioning pad, plus construction of a quayside skid path at Dales Voe.[195,196]

[190] HIE/SE (2016) Oil & Gas Decommissioning Action Plan
[191] Oil & Gas UK (2018) Decommissioning Insight 2018
[192] https://www.gov.scot/binaries/content/documents/govscot/publications/corporate-report/2018/11/oil-and-gas-decommissioning-action-plan/documents/oil-and-gas-decommissioning-action-plan/oil-and-gas-decommissioning-action-plan/govscot%3Adocument/Oil%2Band%2Bgas%2Bdecommissioning%2Baction%2Bplan.pdf
[193] https://www.gov.scot/policies/oil-and-gas/oil-and-gas-decommissioning/
[194] Ibid.
[195] https://www.hie.co.uk/latest-news/2018/november/28/decommissioning-challenge-fund-for-regions-projects/
[196] https://www.energyvoice.com/oilandgas/north-sea/decom/256399/north-east-firms-scoop-up-funding-for-decommissioning-projects-and-technologies/

7.5 As an emerging sector, the decommissioning of oil and gas has its own sectoral plan, published by the Scottish Environment Protection Agency (SEPA).[197] Within it, SEPA states an ambition for "Scotland to be recognised worldwide for its responsible approach, high quality infrastructure and technical skills and experience" in the field of decommissioning. This will be achieved by firstly ensuring that all regulations at which compliance is expected and mandatory are to a high standard, then ensuring compliance by all organisations working within the sector are achieved, and then a forward look "beyond compliance" to profitability opportunities. It is hoped that as a result, Scottish organisations in the decommissioning sector will ensure that the environment is protected and improved, that communities with strong oil and gas dependencies are protected and that businesses are able to operate effectively and successfully in their markets.

NATURE AND SCALE OF THE SECTOR

7.6 Decommissioning is part of the lifecycle of oil and gas assets[198] and will in time be required by the marine renewable energy sector for activities such as the decommissioning of turbines. In Scotland, the total turnover of businesses providing support activities for petroleum and natural gas extraction, which includes those involved in oil and gas decommissioning, was estimated at £4.5 billion in 2019.[199] This is a drop of around 39% from its £7.4 billion peak in 2014, when oil prices began to fall rapidly.

7.7 Data from UK Business Counts[200] indicates that in 2022 there were around 180 businesses involved in support activities for oil and gas in the UK.[201] These are almost evenly distributed between England (around 90) and Scotland (around 85), with a small number of businesses currently registered in Northern Ireland. Overall, the number of businesses has declined since 2013, particularly in Scotland which has seen a 55% reduction.

7.8 The support activities for oil and gas employed around 15,700 people in Scotland in 2019, accounting for 0.6% of the total Scottish employment.[202] Employee numbers in Scotland have been declining since they peaked at 21,500 in 2015 – dropping by around a quarter between 2015 and 2019.

7.9 In 2019, oil and gas support services generated £1,945 million GVA: accounting for 1.31% of the overall Scottish economy GVA and 39% of the marine economy GVA. GVA has declined by 37% since 2010, and between 2018 and 2019 GVA decreased by 4% (adjusted to 2019 prices)[203].

7.10 In terms of decommissioning specifically, due to rising oil prices between 2003 and 2014, there had been a reduced impetus for the sector to operate on a low-cost model. However, the rapid fall in oil prices since late 2014 has made this model inefficient and unsustainable, with the sector now committed to operational improvements and efficiencies to cut expenditure by 35% over the coming years.[204] Thus, decommission activities have increased, and it is forecast that £16.6bn will be spent on oil and gas decommissioning projects in the UKCS over the next decade, to 2030.[205] By activity, around half of expenditure is expected to be on well plugging and abandonment activities, whilst geographically, this expenditure is forecast to be divided between these areas:

[197] https://sectors.sepa.org.uk/media/1148/oil-gas_sector-plan_final_singlepage_-360916_sct0619469992.pdf
[198] Typically, though not exclusively platforms, with other infrastructure left in situ to support habitat restoration, and to avoid unnecessary disruption to marine ecosystems.
[199] Scottish Government (2022) Scotland's Marine Economic Statistics 2019
[200] ONS (2022) UK Business Counts, 2022 data
[201] It should be noted that activities specific to decommissioning cannot be separated out from wider oil and gas support activities in BRES, UK Business Count data, etc.
[202] ONS (2021) Business Register and Employment Survey, 2019 data
[203] Scottish Government (2022) Scotland's Marine Economic Statistics 2019
[204] Note the recent rise in prices due to global events
[205] Oil & Gas UK, Decommissioning Insight, 2021

- 43% in the Central North Sea
- 29% in the Northern North Sea
- 16% in the Southern North Sea
- 7% West of Shetland
- 5% in the Irish Sea

7.11 Cumulative expenditure over the next decade has been revised downward, influenced by: the aim of maximising economic recovery (MER), intended to drive down costs and improve efficiencies in oil and gas activity; better understanding of operating late-life assets, which in turn influences the timing of decommissioning; and continuing investment in new production assets in the UKCS. However, the overall trend is one of increasing oil and gas decommissioning activity, and therefore expenditure.

7.12 Wood Mackenzie forecasts that, over the decade to 2030, the UK will have the highest decommissioning spend in the world, accounting for £17bn and more than double the forecast expenditure of any other country.[206]

7.13 Costs related to the shut-down and disposal of facilities are fairly small compared to the costs related to exploration, development and operations and the revenue from the field. Decommissioning costs are also uncertain, and vary from field to field, with the largest cost elements in disposal and decommissioning related to the permanent plugging of wells and removal of the offshore facilities.

DRIVERS AND CHALLENGES

7.14 A skills review of decommissioning opportunities for a green recovery in Scotland[207] identified that decommissioning is driven by a number of factors, summarised as follows:

- There is no longer a market need for the structure/product
- The structure/product has reached the end of its useful life and is no longer repairable or fit-for repurpose
- There is a market need to replace with products that are more efficient, e.g., speed, capacity, cost, energy consumption, etc
- There is a regulatory compliance that drives replacement, e.g., emissions, safety, etc
- There is a market opportunity to use the components or materials to service other products or manufacturing processes (i.e., the components are worth more than the whole)

7.15 As a result, there has been an abundance of oil and gas rigs coming to the end of their life cycles and possessing future value as recyclable materials. Although relatively few fields have been decommissioned to date, several are currently in the process of being decommissioned and many others are entering late life operations or in the early stages of planning for decommissioning. Table 7.1 highlights key parameters forecast for UKCS decommissioning activity over the next decade, emphasising the scale of decommissioning activity set to take place with over 1,000 wells, over 500 pipelines, and 28 platforms requiring decommissioning within the Central and Northern North Sea and West of Shetland. However, as of 2017 in the Central and Northern North Sea, 82% of platform topsides and 90% of substructures due for removal were yet to be contracted.[208]

[206] https://www.woodmac.com/news/opinion/uk-north-sea-decommissioning-the-17-billion-challenge/
[207] Optimat (2021) Skills Review for Decommissioning Opportunities for a Green Recovery in Scotland
[208] https://www.hie.co.uk/media/4942/oil-and-gas-decommissioning-action-plan.pdf?id=7147c511-cbbc-4aa9-a3f6-2cb6c634291c

Table 7.1 Activity forecast 2016 to 2025

	Central North Sea	Northern North Sea and West of Shetland
Number of projects	83	31
Number of wells for plugging and abandonment	644	430
Proportion of wells that are platform wells	37%	73%
Number of platforms for removal	16	12
Topside weight to be removed	187,238 tonnes	262,022 tonnes
Substructure weight to be removed	71,056 tonnes	96,737 tonnes
Number of mattresses to be decommissioned	5,979	1,162
Subsea infrastructure to be removed	56,714 tonnes	1,697 tonnes
Number of pipelines to be decommissioned	484	96
Length of pipelines to be decommissioned	2,666 kilometres	1,038 kilometres
Total tonnage coming onshore	369,190 tonnes	360,456 tonnes

Source: Oil & Gas UK, 2016[209]

7.16 A key challenge around oil and gas decommissioning is the degree of uncertainty that exists regarding the scale of opportunity. Part of this uncertainty is due to revisions of anticipated length of field life estimates, and extended forecasts on economic recovery. The precise nature and timing of support required for oil & gas decommissioning is therefore unclear. This causes an added challenge in that it is difficult for companies to invest in greater capacity and capability without proven demand, or indeed a clear route map for sector development.

7.17 There is growing interest in applying circular economy principles to oil and gas decommissioning. Zero Waste Scotland has identified a number of ways oil and gas infrastructure could be reused and reconditioned, allowing for potential new economic benefits.[210] In accordance with high value reuse opportunities, two main re-use approaches for decommissioned materials have been identified:

- Re-use of components and equipment reconditioning; and
- Re-use in other industries.

7.18 Component re-use might incorporate steel sections from jacket and topside, pipelines and anchor chains and cables, while equipment reconditioning and re-use could consider opportunities around vessels and tanks, accommodation blocks and winches.

7.19 An alternative to complete decommissioning and removal of oil and gas rigs is leaving components in place to provide environments for marine life. The Scottish Wildlife Trust argue in favour of this 'rigs-to-reefs' (RTR) proposal noting that over the lifetime of an oil and gas platform, the subsea structure acts as an artificial reef and supports biodiversity.[211] The platform provides a hard, vertical surface in an environment dominated by sand and silt, creating natural reefs, allow sea life to flourish, enhance biodiversity and encourage the recovery of cold water corals that had been endangered.[212] [213] Added to this, removal of platforms, well-plugging and abandonment carry a risk of pollution.[214] The case for this "rigs to reef" approach has strong support and although it may mean a loss or only partial realisation of decommissioning economic opportunities, it could

[209] Ibid.
[210] https://www.zerowastescotland.org.uk/sites/default/files/North%20Sea%20Oil%20and%20Gas%20Rig%20Decommissioning%20%26%20Re-use%20Opportunity%20Report.pdf
[211] https://publications.parliament.uk/pa/cm201719/cmselect/cmscotaf/996/99607.htm
[212] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/scottish-affairs-committee/the-future-of-the-oil-and-gas-industry/written/86729.html
[213] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/scottish-affairs-committee/the-future-of-the-oil-and-gas-industry/written/83737.html
[214] https://www.theguardian.com/business/2019/sep/04/uk-facing-eu-outrage-over-timebomb-of-north-sea-oil-rigs

strengthen the UK's marine environmental resource.[215] Nevertheless, directly addressing a potential market failure – the negative externalities of pollution that may occur with well-plugging and abandonment – is a constraint on the sector in terms of the technical complexities and financial expenditure required.

7.20 As a global leader in offshore decommissioning, Scotland has strengths in the technical and commercial aspects of decommissioning. While our competitive advantage draws on expertise in the North Sea, there is perceived to be a lack of experience and knowledge exchange (particularly in project management), which presents a challenge.[216] A number of supply chain companies, such as Bibby Offshore, Expro, Global Energy Group and Veolia Peterson have responded to opportunities in decommissioning and have developed high-level expertise.[217] However, these skills are relatively concentrated, and the lack of continuity in operations means that there have been few opportunities to share knowledge and best practice. Currently, this lack of skills and expertise is a constraint to realising the potential in Scotland and thus benefiting the UK more widely. It also impacts on the ability to export these skills to overseas markets, and secure more gains from the UK's oil and gas decommissioning expertise.

7.21 The majority of decommissioning activity in the UK is expected to take place in Scotland, with onshore recycling and disposal being a relatively mature sector with established supply chains. However, as discussed in Chapter 13 there is a lack of suitable port and supporting infrastructure for increased decommissioning activity, and larger decommissioned infrastructure. This means that Scotland is unable to take full advantage of larger decommissioning project opportunities.

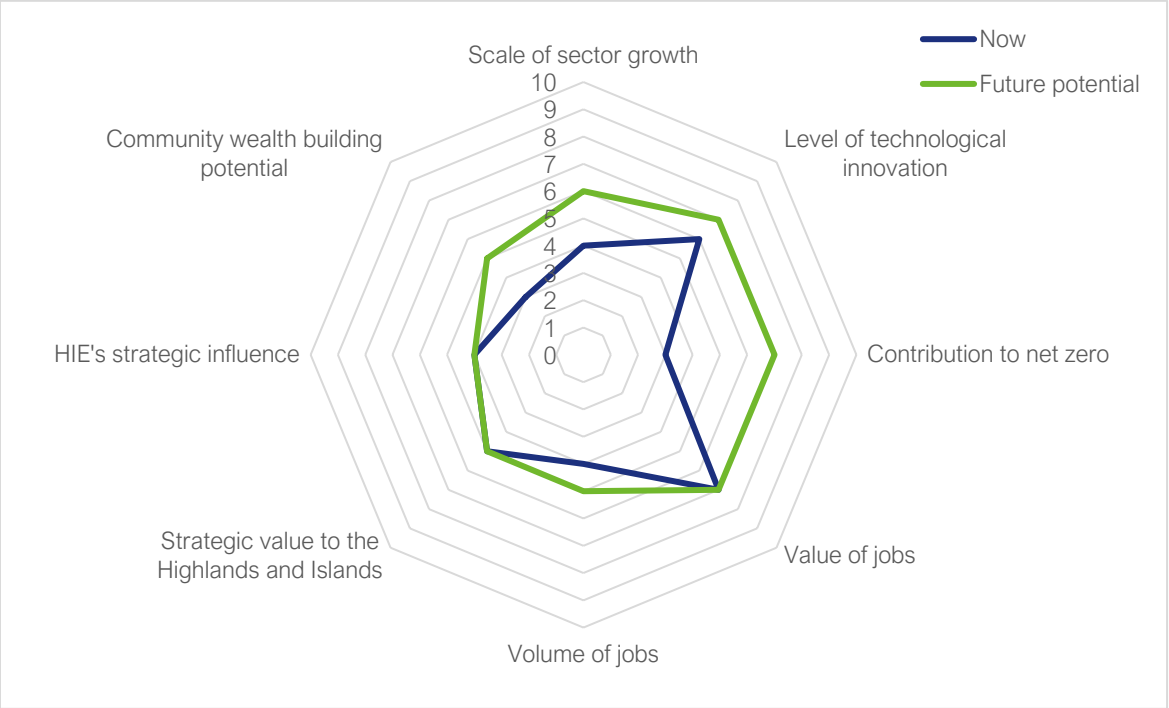
KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

7.22 It is estimated that the economic value of oil and gas decommissioning activity to Scotland over the next decade could be between £5.7 billion and £7.7 billion, supporting peak employment of 13,500 to 18,150.[218] Further and later economic value is expected from wind turbine decommissioning.

7.23 Figure 7.1 shows that the Energy decommissioning in the Highlands and Islands is established, although not currently at a significant level. Energy decommissioning has the potential to increase substantially. There is oil and gas decommissioning activity already being undertaken, as platforms reach the end of their working lives. However, there is a greater potential in wider Energy decommissioning activity related to marine renewables structures that are being put in place now, and also that are currently operational. As such, it is perhaps of more long-term and strategic importance to HIE, as marine renewable energy installations will require decommissioning. Alongside this, are the opportunities in the decommissioning supply chain. Decommissioning and managing the associated waste has a great deal to contribute to the circular economy and achieving net zero targets, and there is an opportunity in the Highlands and Islands to be at the forefront of continuing innovation and the development of sustainable decommissioning processes.[219] There is also the potential for community wealth building to be generated by decommissioning facilities and activities – for example through local procurement, employment, and community investment by companies involved in decommissioning activity.

[215] https://scottishwildlifetrust.org.uk/our-work/our-projects/living-seas/decommissioning/
[216] https://www.skillsdevelopmentscotland.co.uk/media/46022/skills-review-for-the-offshore-oil-and-gas-decommissioning-sector-in-scotland.pdf
[217] Ibid.
[218] Scottish Government (n.d.). Advising on a net-zero economy that is fair for all. Paper 4/1 – Oil and Gas sector background information
[219] https://www.zerowastescotland.org.uk/sites/default/files/North%20Sea%20Oil%20and%20Gas%20Rig%20Decommissioning%20%26%20Re-use%20Opportunity%20Report.pdf

Figure 7.1: Current and future potential of Energy Decommissioning in the Highlands and Islands



7.24 Decommissioning is a circular economy strategy with significant growth, promoting reuse and repurposing. Zero Waste Scotland has highlighted key opportunities to increase jobs relating to the circular economy by pioneering new roles and skills across a range of levels in three key priority areas of work including capital projects – such as decommissioning Scotland's oil rigs and wind farms.[220]

7.25 Within Scotland, the decommissioning of legacy energy infrastructure such as pipelines and offshore drilling platforms, and soon a first generation of wind turbines will go hand in hand with the energy transition. At least 60% of oil and gas platforms in the North Sea will be decommissioned by 2030, representing close to a million tonnes of materials.[221] Additionally, there are opportunities for decommissioning older wind farms, with analysts predicting that 80 offshore wind turbines in the North Sea will need to be refurbished or decommissioned in 2022 and 123 turbines in 2023.[222]

7.26 As mentioned previously, there are significant supply chain and employment opportunities associated with the reuse and repurposing of assets, particularly from the energy sector in Scotland, and specifically in the longer term, in marine renewables. This ranges from the removal of assets to finding markets for systems and components currently held within industries.[223]

7.27 Establishing high-value industries around the reuse of energy assets will require highly skilled industrial designers, material innovation specialists and product developers to experiment and innovate around the reapplication of assets in other industries.[224] Alongside designing new products, reuse specialists will be needed, as the emerging innovation opportunities regarding repurposing wind turbine assets are mainly underexplored as few wind turbines have been taken out of service to date.

[220] Zero Waste Scotland (2020) The Future of Work: Baseline Employment Analysis and Skills Pathways for the Circular Economy in Scotland
[221] Scottish Environment Protection Agency (n.d.). Oil and gas decommissioning sector plan
[222] Optimat (2021) Skills Review for Decommissioning Opportunities for a Green Recovery in Scotland
[223] Zero Waste Scotland (2015) The RSA and Zero Waste Scotland Programme. North Sea Oil and Gas Rig Decommissioning & Re-use Opportunity Report.
[224] Robert Gordon University: Energy Transition Institute (2021) UK Offshore Energy Workforce Transferability Review

7.28 There is a highly skilled oil and gas workforce in Scotland with the capability of undertaking separate components of decommissioning processes. Around 100,000 of the jobs in 2030 are projected to be filled by people transferring from existing oil and gas jobs to offshore renewable roles, new graduates, and new recruitment from outside the existing Scottish offshore energy sector.[225] Workforce transferability is a significant opportunity with over 90% of Scotland's oil and gas workforce having medium to high skills transferability.

7.29 However, to ensure that oil and gas workers can benefit from decommissioning opportunities, there is a requirement for strategic intervention to support the traditional workforce to diversify, upskill and pivot to decommissioning activities including material disposal.[226] The Climate Emergency Skills Action Plan (CESAP)[227] sets out a clear direction for the reorientation of our skills systems and signals the role that businesses, communities and individuals will play in supporting the *Just Transition* to net-zero. The magnitude of change required to achieve net zero demands a significant increase in 'green' skills and education – transitioning to a low-carbon, greener economy implies the creation of new jobs in environmentally friendly and sustainable production (green jobs). The CESAP gives valuable insight into the jobs required over the next five years and is a useful overview at a Scottish level. Its six defined priorities set out the direction for the changes needed in the skills system to respond to the climate emergency. Of specific relevance to the Highlands and Islands are two priorities:

- Priority 2: Building better understanding and evidence of future skills needs to support Scotland's transition to net zero; and
- Priority 6: Taking a collaborative approach to ensure a skills system responsive to changing demands.

Table 7.2: Sector summary, observations and opportunities: Decommissioning

Current position and status in the Highlands and Islands	• A growth sector in the Highlands and Islands, and with the right support it has considerable long term growth potential in decommissioning of marine renewable energy structures.
Opportunities and growth potential	• An important activity and opportunity. Oil and gas decommissioning has supply chain potential. Going forward decommissioning of marine energy installations and equipment including wind turbines. • Links to port and harbour infrastructure investment and development.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• A strategic priority for HIE – important to recognise role of decommissioning in supporting energy transition. • Opportunity to capture market share in energy decommissioning, given the assets at the region's disposal suited to decommissioning activity. • Also a priority to support oil and gas workforce diversification and business support to enable existing oil and gas support companies to pivot to decommissioning and from there, to renewable energy decommissioning.
Cross sectoral opportunities and synergy	• Repurposing of decommissioned components to other sectors. • High value activities for ports in the Highlands and Islands.
HIE's role going forward	• HIE to take a strategic role in the development of marine renewables decommissioning and the supply in the Highlands and Islands.
Comments	• Any support activity must be cognisant of the need for appropriate port investment to meet decommissioning market demand.

[225] Ibid.
[226] Oil and Gas UK (2021) Workforce and employment insight
[227] Skills Development Scotland (2020) The Climate Emergency Skills Action Plan 2020-2025

8 SEABED MINING

CONTEXT

8.1 Seabed mining is the process of extracting minerals from the deep sea, the area of the ocean below 200m metres which covers around 65% of the Earth's surface,[228] although another definition of the deep sea covers oceans more than 500m deep.[229] Valuable minerals are known to be deposited at or near the surface of the deep seabed and there are opportunities for these to provide societal and economic benefits. This includes minerals for metals, such as copper and nickel, but also novel chemicals (including drugs) found through mining of the deep-ocean floor derived from the genetic diversity of marine life.[230]

8.2 In recent years, there has been renewed interest in deep sea mining due to demand for metals, however the sector is not yet established in Scotland or the UK. This is largely due to ongoing environmental concerns about the impact of seabed mining and the implications this may have for Scotland's drive to deliver a step change in marine protection outlined in the Scottish Government's *2021-22 Programme for Government.*[231]

8.3 Exploratory research is ongoing at an international level to understand the potential environmental impacts of deep-sea mining in the central Pacific Ocean. A four-year project – the Seabed Mining and Resilience To Experimental Impact (SMARTEX) project – funded by the Natural Environmental Research Council (NERC) in partnership with UK Seabed Resources, the Joint Nature Conservation Committee and seven UK research institutions, will provide a platform for research into the baseline environment in regions selected for mineral exploration and will test the impact of small-scale mining equipment.[232] It is anticipated this project will allow for a better understanding of the environmental impact of mining the ocean floor on seabed communities, including their diversity, distribution and food webs, in order to inform strategic planning and the capacity for sector commercialisation in future.

NATURE AND SCALE OF THE SECTOR

8.4 Seabed mining is a nascent sector in Scotland and the UK more widely, with little existing activity on a commercial front. Activity that is currently ongoing is predominantly around research and gaining an understanding of the sector, opportunities, and potential environmental impacts. In 2019, the Royal Society,[233] the independent scientific academy of the UK, indicated that developments in technology and regulation could pave the way for mining activity in the next decade.[234] However, this has yet to commence.

8.5 Given the lack of seabed mining activity in Scotland and the UK, it is difficult to define the economic value or employment levels within the sector. The UK Government recently highlighted deep-sea mining as an emerging sector estimated to be worth £40 billion to the UK over the next 30 years. However, the majority of economic opportunities derived from the sector are anticipated to occur in Areas Beyond National Jurisdiction (ABNJ), where there are limits around exploitation at an international level through the International Seabed Authority (ISA).

[228] https://www.iucn.org/resources/issues-briefs/deep-sea-mining
[229] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf
[230] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf
[231] https://www.gov.scot/publications/fairer-greener-scotland-programme-government-2021-22/documents/
[232] https://www.subseauk.com/12802/scientists-to-study-environmental-impacts-of-deep-sea-mining-in-central-pacific-ocean
[233] https://royalsociety.org/
[234] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf

8.6 The first seabed mining operation at a commercial scale was launched on the continental shelf of Papua New Guinea (PNG) in 2019, however the project (Solwara 1) was met with significant resistance from communities and tourism operators, as well as legal challenges, and faced financial struggles. The Northern Territory Government of Australia subsequently banned seabed mining following the failed PNG project, citing its environmental and human impacts.[235]

8.7 Although commercial scale deep-sea mining has yet to take place on any notable scale, some shallow seabed mining has occurred. Alongside this, exploration contracts for deep-sea resources have been awarded to companies from countries including China, Belgium, Germany, France, and Japan, as well as the UK for three different mineral resources: seafloor massive sulphides (SMS), ferromanganese crusts, and polymetallic nodules.[236]

DRIVERS AND CHALLENGES

8.8 The renewed interest in deep sea mining on a global scale has been driven by the growing demand for metals, as well as increasingly inaccessible and degraded land-based deposits. It is anticipated that waters around the UK contain deposits of commercial and societal interest, although these have yet to be formally identified. Some deposits have been identified in UK Overseas Territories, with mining opportunities expected to develop over the coming decade.[237]

8.9 Seabed mining in the UK could contribute to supporting supplies in at-risk materials, such as polymetallic nodules which are increasingly at risk of global supply disruption. There are some suggestions that seabed mining could overcome this challenge by generating a secure and predictable supply for UK minerals industries, meeting demand while eliminating an element of uncertainty.[238]

8.10 Advances in areas such as marine submersible and mining technology have contributed to the growing interest and opportunities in seabed mining, meaning technological developments have increased the scope and potential of mining activities. There is also the potential for the mining of 'critical' metals (rare earth elements, cobalt, tellurium, etc.) that are used in the development of high technology and clean energy applications,[239] therefore seabed mining could act as a driver for innovation in new technologies. Minerals found in the seabed could also contribute to a "future renewable economy" in supporting the development of wind turbines and electric vehicles which require a significant amount of the critical minerals.[240]

8.11 A key challenge facing the sector, and any potential economic opportunities derived from seabed exploitation, is the impact it will have on the natural environment and seabed ecosystem. In 2019, the House of Commons Environmental Audit Committee stated any exploration activities in the UK would require an Environmental Impact Assessment to consider the potential impacts on and risks to seabed habitats, with the Committee paper stating:

> *"Deep sea mining would have catastrophic impacts on habitats and species on seafloor sites and there is little evidence that mitigation measures such as setting aside areas of the seabed will work to mitigate the damage."*[241]

[235] https://miningwatch.ca/news/2021/2/11/sinking-seabed-mining-papua-new-guinean-australian-and-new-zealand-civil-society
[236] Ibid.
[237] https://consult.gov.scot/marine-scotland/deep-sea-marine-reserve/supporting_documents/Development%20of%20deep%20sea%20reserve%20%20West%20of%20Scotland%20Reserve%20%20SEIA%20Appendix%20A%20%20Final.pdf
[238] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf
[239] https://royalsociety.org/~/media/policy/projects/future-oceans-resources/future-of-oceans-evidence-pack.pdf
[240] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf
[241] Ibid.

8.12 Deep-sea mining activities are among the main categories of human activity or influence with the potential to impact deep-sea sedimentary habitats, and although this threat is considered by some to be of low importance (among other threats to seabed habitats) until at least 2025, this is likely due to the lack of planned mining activity in the near future.[242] The International Union for Conservation of Nature (IUCN) sets out some of the impacts seabed mining could have on biodiversity and ecosystems:[243]

- Disturbance to the seafloor: Scraping by machinery can alter or destroy habitats, leading to loss of species and fragmentation or loss of ecosystem structure and function;
- Sediment plumes: Some forms of mining will create plumes of suspended sediment and silt particles, and it is unclear how this would affect surrounding ecosystems and species, i.e., by smothering animals or harming filter-feeding species that depend on clear, clean water to feed (such as krill and whale sharks); and
- Pollution: Noise pollution, vibrations and light pollution caused by mining equipment and surface vessels could impact whales, tuna and sharks. There is also a risk of fuel leakage.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

8.13 Seabed mining offers quite limited potential for growth and value-added activities in the Highlands and Islands, as illustrated in Figure 8.1.

8.14 While there remains uncertainty at a UK level around the presence of minerals in UK waters, some types of minerals have been identified in Scottish waters with potential commercial opportunities.[244] Some minerals are located near to deep-sea marine reserve areas, with metallic minerals including sediments containing titanium minerals (including rutile and ilmenite) found off the north-east coast of Scotland and the Sea of the Hebrides. Off the coast of Shetland, placer-type deposits have been discovered, and there is the possibility that high concentrations of heavy metals may also exist off the west coast of the Outer Hebrides. There is also some evidence of zircon, garnet and staurolite-rich heavy mineral suits identified in the Clair Field west of Shetland.

8.15 Despite this, and given the environmental implications, seabed mining activity within the UK's domestic waters (Exclusive Economic Zone) is not expected to be able to sufficiently support any commercial interest as it is currently not known whether UK waters and harbours contain sufficient mineral deposits. It is therefore not an area of opportunity for the Highlands and Islands at this stage and not a priority for HIE.

[242] https://data.jncc.gov.uk/data/4722c3b6-767c-4dd3-b5b4-b7a1281f4fcf/JNCC-Report-625-FINAL-WEB.pdf
[243] https://www.iucn.org/resources/issues-briefs/deep-sea-mining
[244] https://consult.gov.scot/marine-scotland/deep-sea-marine-reserve/supporting_documents/Development%20of%20deep%20sea%20reserve%20%20West%20of%20Scotland%20Reserve%20%20SEIA%20Appendix%20A%20%20Final.pdf

Figure 8.1: Current and future potential of Seabed Mining in the Highlands and Islands

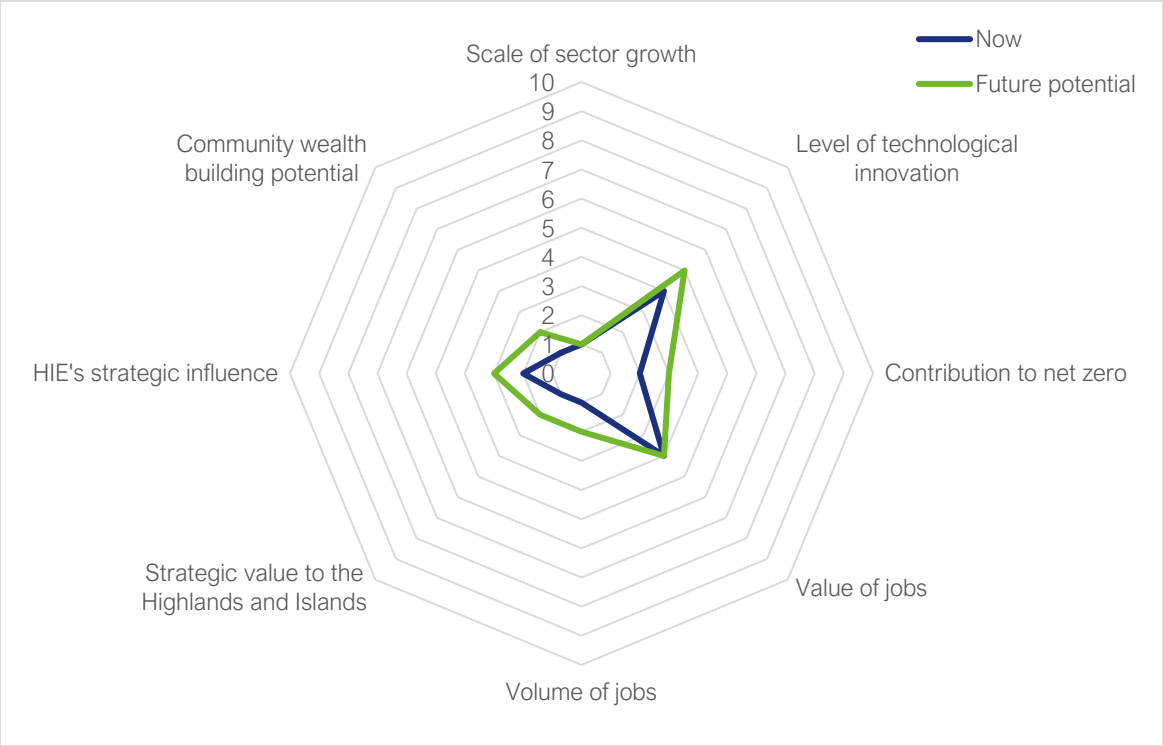


Table 8.1: Sector summary, observations and opportunities: Seabed mining

Current position and status in the Highlands and Islands	• No significant activity.
Opportunities and growth potential	• Potentially a longer-term opportunity for Scotland to consider.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• No strategic importance to the Highlands and Islands or Scotland currently.
Cross sectoral opportunities and synergy	• Limited cross-sectoral opportunity given lack of sector development in region.
HIE's role going forward	• Retain oversight.
Comments	• Potentially sensitive given environmental concerns over seabed mining elsewhere in the world.

9 MARINE BIOTECHNOLOGY AND BIOPROCESSING

CONTEXT

9.1 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). Applications are in, for example, human health and pharmaceuticals, food supplements, cosmetics, alternative to plastics and biomass (energy). It has the potential to contribute billions to the UK economy but remains on the cusp of large-scale commercialisation.

9.2 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 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. Harvesting (currently restricted in Scotland) and cultivation of seaweed in the Highlands and Islands is a huge opportunity not just for the inherent value of the product, but for what it can unlock for Scotland in terms of its marine biotechnology applications.

9.3 SAMS UHI has particular interest and expertise in seaweed industry development and development of biotechnology. It has recently launched the UK's first seaweed academy in Oban stating that:[245]

> *'The Seaweed Academy is the UK's only dedicated seaweed industry facility offering a complete package of training, education, and business development – a one-stop-shop for supporting expansion and skills development for the seaweed aquaculture industry.'*

9.4 The launch of the Seaweed Academy reflects the fact that the commercial cultivation and harvesting of seaweed for marine biotechnology processes has attracted increased attention in recent years. There is enormous growth potential, but the sector currently remains small-scale in Scotland and the UK. There are some well-established, hand-harvesting operations in the Western Isles 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.[246]

9.5 SAMS 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.

[245] https://www.sams-enterprise.com/seaweed-academy/
[246] For example, Marine Biopolymer Ltd., based in Ayrshire

NATURE AND SCALE OF THE SECTOR

9.6 Research that has mapped four kelp species in Scotland indicates a total biomass of 20m tonnes for *Laminaria hyperborean*, 2.5m tonnes for *Saccharina latissimi*, 0.19m tonnes for *Saccorhiza polyschides* and 0.16m tonnes for *Laminaria digitate*. Kelp is particularly abundant in three Marine Scotland Atlas regions: West of the Outer Hebrides, the Minch and Inner Hebrides, and the north coast of Orkney.[247] Whilst there is a moratorium on harvesting seaweed at scale in Scotland, the abundance of wild seaweed species demonstrates that the Highlands and Islands also has the natural resources and conditions required to cultivate seaweed. Scotland's summer warm water temperatures seldom exceed 16 degrees, and they are clear and rich in nutrients. These factors, combined with long daylight hours makes for excellent and high-quality kelp growth. The Seaweed Review statement issued in February 2021 acknowledged the growing interest in developing commercial scale activity in Scotland. This included the creation of new high value products from wild seaweed and through seaweed cultivation to supply existing emerging markets. The statement highlighted the need for a more comprehensive policy and regulatory framework for the sector.

9.7 As set out in the MAXiMAR Science and Innovation Audit,[248] the Highlands and Islands is home to a growing marine biotechnology sector, much of it in the science, research, and emerging innovations stages, but not all. The European Marine Sciences Park is home to a cluster of marine biotechnology companies such as Xanthella, mentioned above, and GlycoMar, who use the active ingredients in marine feedstocks for pharmaceutical and cosmetic products.[249]

9.8 Global chemicals company BASF[250] is a key asset for the region. Based in Callanish and employing around 80 people, its lipid development plant is used by researchers and pharmaceutical companies to develop active pharmaceutical ingredients. Its R&D is focused on the use of high purity lipids in cardiology, neurology and oncology, as well as novel application in diabetic neuropathy and inflammation.

9.9 The Canadian multinational Acadian Seaplants has a production facility in Uist[251] as part of its operations of using seaweed across industries such as human wellness, animal wellness, and horticulture and crop applications. Hebridean Seaweeds[252] uses seaweed for products such as nutraceuticals and fertiliser, and a provenance-focused additive to gin complementing the local food and drink sector.

9.10 In terms of marine biotechnology education, SAMS UHI attracts and hosts international students studying marine biotechnology and delivers teaching for the marine biotechnology module of the IBioIC Masters in industrial biotechnology.[253]

[247] https://scottishmarineinstitute-.my.sharepoint.com/:w:/r/personal/sa02ca_sams_ac_uk/_layouts/15/Doc.aspx?sourcedoc=%7B615141e1-7af8-4381-8284-2434264d308d%7D&action=default
[248] https://www.hie.co.uk/media/2980/maximarplussiaplus-plusreport.pdf
[249] http://www.europeanmarinesciencepark.co.uk/
[250] https://www.basf.com/gb/en/who-we-are/Locations/Callanish.html
[251] https://www.acadianseaplants.com/
[252] http://www.hebrideanseaweed.co.uk/
[253] https://static1.squarespace.com/static/5f7e28835ee59e18a639d16c/t/5f8871c94b4f4375972a1cda/1602777545983/IBioIC_MSc_A5_Leaflet-digital.pdf

DRIVERS AND CHALLENGES

9.11 Marine biotechnology has applications from diverse low volume, high value products in increasing demand in pharmaceuticals and food; to large volume, lower value processes for waste treatment and biomass. Industrially, seaweeds have been used in the Highlands and Islands for hundreds of years, including burning it for potash, using collected seaweed for high quality foodstuffs, soaps and as a botanical ingredient in gin, a growth product in food and drink.

9.12 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 has weathered some negative industry changes but there is once again the potential and conditions for full scale production. 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).

9.13 The global market for marine biotechnology is growing at 5-6% annually and is forecast to be worth $6.4bn by 2025. 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 aquaculture and hydrocolloid technologies (dressings for wounds).[254,255] Other research suggests, more ambitiously, that the sector will reach around $5.9bn by 2022, growing at a compound annual rate of 6.8% during 2016-2022.[256] The Asia-Pacific market is an enormous one with steep and continued growth forecasted.[257] 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.[258]

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

9.15 A key, perhaps *the* key innovation driver, certainly in Scotland, is how to ensure a sustainable, reliable supply of raw materials (seaweed) to fuel the growth of a bioprocessing industry in the country.[259] Currently, seaweed farmers are guided by the Scottish Government's Seaweed Cultivation Policy Statement[260] which states that '*Other marine users and activities should be considered in the siting of farms'*. There is currently a moratorium on large scale seaweed harvesting and so cultivation is the key source of the raw product.

[254] Smithers Rapra (2015) *Global market for marine biotechnology has potential to each $6.4 billion by 2025.*
[255] Ibid and Smithers Rapra (2015) *global market for marine biotechnology has potential to each $6.4 billion by 2025.* Internet: https://www.smithersrapra.com/news/2015/october/market-for-marine-biotechnology
[256] Cision PR Newswire (2016) *Market Insights & Opportunities, 2022 – Market is Anticipated to Grow Around $5.9 Billion – Research and Markets*. Internet: https://www.prnewswire.com/news-releases/global-marine-biotechnology-market-insights--opportunities-2022---market-is-anticipated-to-grow-around--59-billion---research-and-markets-300286436.html
[257] Ibid.
[258] Global Industry Analysts (2015) *Marine biotechnology Market Trends*.
[259] https://www.communitiesforseas.scot/seaweed-cultivation-in-scotland/
[260] https://www.gov.scot/publications/seaweed-cultivation-policy-statement-2017/

9.16 The diversity of applications presents enormous opportunities but can also be challenging in terms of defining the sector by activity. The cultivation and harvesting of seaweed is an aquaculture-type activity, while the downstream biotechnology activity is subject to landside and sectoral regulations for chemical or biomass processing.

9.17 There are two key financial challenges for the development of the sector. First, 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 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.

9.18 Secondly, seaweed harvesting is not necessarily high value, it is the downstream value chain that can be very 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 of seaweed are not taken into consideration by investors.

9.19 Social license is a constraint to the sector in Scotland. Commercial seaweed harvesting has, to date, been small-scale associated with local and 'natural' products. More recent proposals to develop large scale seaweed harvesting[261] have faced strong opposition and without addressing these sustainability concerns, seaweed harvesting will continue to be constrained by a lack of social licence to operate.[262] Currently, there is a perception that businesses are seeking to grow without full understanding of issues such as the environmental impact of scaling up operations.[263]

9.20 Another key constraint to the development of the commercial seaweed harvesting industry 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. The Seaweed Academy in Oban aims to address this gap, alongside other objectives.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

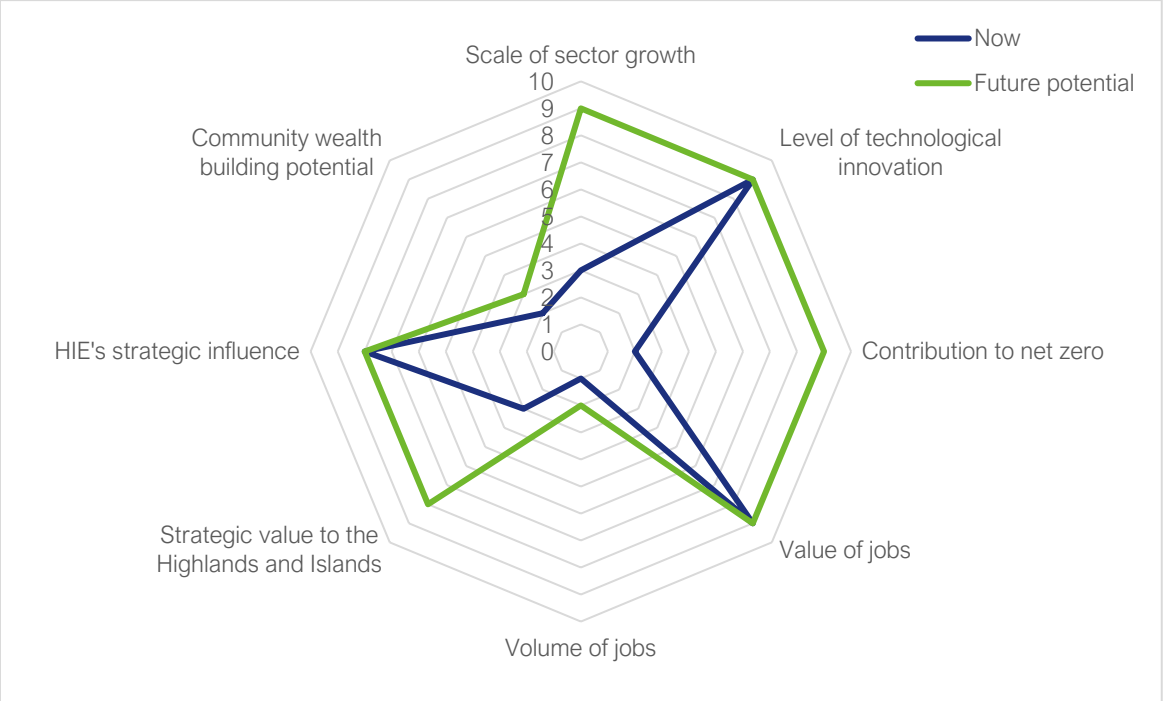
9.21 Work undertaken on behalf of the Convention of the Highlands and Islands (COHI) identified the transformative opportunity to support and develop the burgeoning marine biotechnology sector and capture the value of current and potential international markets for Scotland.[264]There is no doubt that the Highlands and Islands has very valuable natural seaweed assets, significant expertise and knowledge, and a great deal of enthusiasm and commitment to develop this very high value industry. The region, and Scotland has a growing biotechnology ecosystem coupled with well-established science and innovation assets.

[261] http://www.scotlink.org/wp/files/documents/SE_LINK_Response_Marine-Biopolymers-Scoping-Report_2018.pdf
[262] https://www.gov.scot/publications/supporting-economic-social-environmental-sustainability-uks-marine-sectors/pages/6/
[263] Ibid.
[264] https://www.gov.scot/binaries/content/documents/govscot/publications/minutes/2019/10/convention-of-the-highlands-and-islands-papers-october-2019/documents/paper-7-transformational-opportunities/paper-7-transformational-opportunities/govscot%3Adocument/Paper%2B7%2B-%2BTransformational%2Bopportunities.pdf

9.22 Figure 9.1 sets out the current and future potential for the sector in the Highlands and Islands. It illustrates the strong growth potential from a low starting point to something quite significant for the region. To give a sense of scale, estimates from research undertaken by Scottish Government indicate that Scotland's seaweed industry and supply chain could generate around £45.1 million in GVA under a high growth scenario (including induced impacts).[265]

9.23 The figure also demonstrates the contribution of seaweed and marine biotechnology to net zero – in part its 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.[266] Seaweed harvesting has to be carefully planned to mitigate such issues.

Figure 9.1: Current and future potential of Marine Biotechnology and Bioprocessing in the Highlands and Islands



9.24 As a relatively nascent industry 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.

9.25 There are 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 for exploration 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.

[265] https://www.gov.scot/publications/understanding-potential-scale-seaweed-based-industries-scotland/pages/10/
[266] https://time.com/5848994/seaweed-climate-change-solution/

9.26 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.

Table 9.1: Sector summary, observations and opportunities: Marine biotechnology and bioprocessing

Current position and status in the Highlands and Islands	• A nascent and potentially high value sector.
Opportunities and growth potential	• Significant current and future opportunities, given the scale and quality of natural resource in the region's coastal waters. • Innovations and opportunities existing in the Highlands and Islands.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Marine biotechnology currently is not of strategic importance in the Highlands and Islands given its limited business base. • Given the range of applications for marine biotechnology and bioprocessing products, it has the potential to be a high value sector, but risks losing ground to other countries.
Cross sectoral opportunities and synergy	• Clustering around seaweed cultivation. • Health and life sciences.
HIE's role going forward	• HIE could have a strategic role in stimulating marine biotechnology in the region, but this must be balanced with other priorities, potential gains, and resourcing.
Comments	• Roles and strengths of other partners (e.g., SAMS UHI) should also be considered.

10 MARINE ENVIRONMENTAL SERVICES

CONTEXT

10.1 Marine environmental services are those natural restorative activities and services – for example coastal protection, prevention of erosion, water purification, or carbon storage/sequestration – that focus on protecting the marine environment from a range of threats, from marine littering to the ocean acidification created by climate change. These services can be used across sectors to enhance the sustainability of marine practices and explore innovations.

10.2 The Highlands and Islands has extremely valuable but currently underused marine environmental resources, particularly in relation to natural resources like seaweed and microalgae. With almost two thirds of the UK's coastline, the Highland and Islands is at the forefront in relation to the health of Scotland's marine environment and the sustainability of marine planning. It is a valuable innovation and test area for developing marine environmental services and associated technologies.

10.3 Marine planning in Scotland is governed by two pieces of legislation: the Marine (Scotland) Act 2010,[267] and the Marine and Coastal Access Act 2009.[268] These were amended ahead of January 2021 when the UK left the EU[269] to ensure smooth and continuous maintenance of current standards to environmental protection and help in ensuring clean, healthy, safe, productive, and biologically diverse oceans and seas. Marine legislation includes the requirement for Environmental Impact Assessment in the development of offshore projects and marine developments.

10.4 The National Marine Plan is published every three years and is preceded by a Marine Assessment, which identifies the key areas of interest for the Plan to focus on. The Plan outlines the policies and objectives for Scottish Ministers in the use and management of marine resources, as well as guiding the Regional Marine Plans (RMPs). RMPs are developed by Regional Marine Planning Partnerships (RMPPs) and will implement national policies at a regional level. There are currently two RMPPs across Scotland – Shetland (established in 2016), Clyde (established in 2017), with a third – Orkney - still developing their plan.

10.5 The Marine Assessment in 2020[270] identified serious declines in biogenic seabed habitats and seabed habitats in general throughout Scotland's inshore seas. It also confirmed that many of Scotland's fish populations such as cod, whiting and herring remain in poor or even declining condition. Declines are recorded in "species richness" as well as "species diversity" indicators for fish, particularly in offshore areas.

10.6 The National Marine Plan Review 2021[271] focuses on enabling the sustainable use of marine areas and promoting existing and emerging industry, highlights the impact of Brexit and the Global Climate Emergency. It stresses that all policy frameworks need to be geared towards a green recovery from the COVID-19 pandemic. The Plan recognises the existence of:

"a rapid pace of change and interest in the marine sphere, combined with changes in technology, new emerging industries and a greater recognition of the benefits that can come from our marine environment".

[267] https://www.legislation.gov.uk/asp/2010/5/contents
[268] https://www.legislation.gov.uk/ukpga/2009/23/contents
[269] https://www.gov.scot/publications/eu-exit-marine-environmental-legislation-scotland-2/
[270] Scotland's Marine Assessment 2020. Available at: https://marine.gov.scot/sma/
[271] National Marine Plan Review 2021. Available at: https://marine.gov.scot/data/national-marine-plan-review-2021

NATURE AND SCALE OF THE SECTOR

10.7 Coastal protection services are currently operating in the Highlands and Islands. This includes a project at Stornoway Airport run by Highlands and Islands Airport Limited (HIAL).[272] HIAL's routine programme of inspections uses sophisticated wave modelling to predict the possible effects of extreme weather. After identifying that the rock armour protecting the eastern end of the main runway, which projects into the Bay, needed to be bolstered, and that the sand dunes were at risk of being breached during severe storm conditions, the decision was made to carry out protective work. HIAL is investing £4 million into this coastal protection project, after completing £1 million of similar protection work at Benbecula Airport in 2018.

10.8 Around 44% of all marine economy projects in the Highlands and Islands are undertaken through SAMS UHI. Enabling a sustainable blue economy is one of SAMS' areas of research,[273] with research on farming of the sea/aquaculture, marine biotechnology, fisheries, and energy from the sea. SAMS specifically has projects on using seaweed for the generation of sustainable energy,[274] producing advanced biofuels from seaweed,[275] and projects that evaluate the potential[276] as well as foster aquaculture diversification and sustainability.[277]

10.9 Scottish Blue Carbon Forum[278] also runs multiple projects relevant to the marine environment, including projects assessing the resilience of Scotland's blue carbon sediment stores, improving marine ecosystem conservation, and carbon sequestration in seaweed and seagrass.

10.10 Carbon storage and sequestration has also gained prominence in Scotland in recent years. Scotland has not only the storage capacity but also the geographical context and know-how to become a major hub for CO_2 transport and storage in Europe.[279] With its access to the largest portion of Scottish waters, it also has the opportunity of becoming a leader in marine biotechnology applications of carbon sequestration through seaweed, seagrass, or shellfish.

DRIVERS AND CHALLENGES

10.11 The current high quality of coastal waters means that UK seafood produce can command a premium price, but this competitive advantage is at risk if water quality and the marine environment deteriorates. Marine biotechnology applications are similarly threatened by ocean deoxygenation. Likewise, marine tourism relies on the expectation of coastal areas and seas looking pristine. Marine littering, climate change, and ocean acidification pose a major challenge for all marine industries. These are all driving the need and demand for marine environmental research and services to monitor conditions, identify issues and undertake mitigation and remediation measure.

10.12 There is huge potential for marine carbon storage, but these environments are threatened by three factors:

- Physical disturbances to habitats: this includes fishing activities, recreational boating, installation of infrastructure, and aquaculture.
- Climate change, as mentioned above: ocean acidification, ocean warming, deoxygenation, sea-level rise, and increased storminess all pose a threat to marine environments.

[272] https://www.hial.co.uk/news/article/30/hial-invests-more-than-4million-to-shore-up-coastal-protection-defences-at-stornoway-airport
[273] https://www.sams.ac.uk/science/blue-economy/
[274] https://www.sams.ac.uk/science/projects/seagas/
[275] https://www.sams.ac.uk/science/projects/macrofuels/
[276] https://www.sams.ac.uk/science/projects/diverseafood/
[277] https://www.sams.ac.uk/science/projects/integrate/
[278] https://www.bluecarbon.scot/scbf-funded-projects-1
[279] https://www.sccs.org.uk/images/expertise/reports/opportunities-for-co2/CO2-JointStudy-Full.pdf

- Changes in land management and use: coastal land use change and reclamation for development activities, groundwater drainage, and human developments can also have a significant negative impact on the ability of marine environments to be used for carbon storage.

10.13 This is driving the need for marine environmental services and protection to ensure that blue carbon habitats and stores do not deteriorate and become future sources of carbon emissions.[280]

10.14 The extent and rate of coastal erosion is expected to increase due to sea levels rising. Research estimates that £1.2 billion of Scotland's buildings, transport infrastructure, and cultural and natural heritage may be at risk of coastal erosion by 2050.[281] This risk highlights the need for coastal protection services to be strengthened and scaled up, and as a response the Scottish Government is encouraging local authorities to prepare coastal adaptation plans, supported by an additional £12 million of investment. The plans will be based on maps developed by the University of Glasgow as part of the Scottish Government's Dynamic Coast project, funded by the Centre of Expertise for Waters (CREW).[282] This is a prime example of how marine and coastal environmental services are being used to monitor and tackle issues in Scotland.

10.15 Commercial fishing pressure led to the depletion of fishing stock, with compound effects on the way native fish move, breed, and complete their life cycles. The presence of healthy native fish populations is seen as a key element of marine environmental sustainability. This has highlighted the need for programmes directed at fish and shellfish species recovery and in general ecosystem recovery, and for enhancing and sustaining biodiversity.

10.16 Around 60% of marine litter is made up by plastic, which does not biodegrade and results in microscopic particles known as microplastics. The plastic is ingested by marine life, from zooplankton to seabirds, fish, turtles, and whales, adversely affecting their growth and reproduction, and in some cases causing the death of the animal.[283] There is a pressing need to continue to monitor this and take mitigating and remedial action.

Multiple chemicals are polluting marine environments in Scotland, the UK and globally.[284] Endocrine disruptor bisphenol A (BPA), commonly used in paper receipts, hard plastic, and tin cans, is contaminating sea land and sea water, and disrupting the reproduction of many marine species.[285] PFSAs, used widely in industrial and consumer production have adverse health effects and increase health risks for dolphins and other marine mammals.[286] Chemical flame retardants contaminate marine animals, including Bass Rock gannets.[287] Added to this some chemical treatments used in aquaculture remain in the water for many years slowing growth, impacting egg production, and changing life cycle patterns in aquatic invertebrates.[288] Whilst marine environmental services are contributing to improving contamination of Scottish seas, serious threats remain to marine mammals, birds, fish and plankton.[289]

[280] https://www.communitiesforseas.scot/out-of-the-blue-blue-carbon-in-scotland/
[281] https://marine.gov.scot/sma/assessment/coastal-erosion-and-flood-risk-management
[282] https://www.gov.scot/news/support-to-protect-scotlands-coastlines/
[283] https://www.argyll-bute.gov.uk/marine-litter
[284] https://www.scotlink.org/avoiding-a-chemical-crisis-for-scotlands-seas/
[285] Flint, S.; Markle, T.; Thompson, S.; Wallace, E. Bisphenol A exposure, effects, and policy: A wildlife perspective. J. Environ. Manag. 2012, 104, 19–34. Available at: https://pubmed.ncbi.nlm.nih.gov/22481365/
[286] Fair, Patricia & Houde, Magali. (2018). Poly- and Perfluoroalkyl Substances in Marine Mammals. Available at: https://www.sciencedirect.com/science/article/pii/B978012812144300005X
[287] https://www.fidra.org.uk/flame-proof-gannets-tracing-toxic-chemicals-through-our-wildlife/
[288] Fidra (n.d.). The impacts of Scottish salmon farming on the benthic environment. Available at: https://www.bestfishes.org.uk/wp-content/uploads/Impacts-of-Scottish-salmon-farming-on-the-benthic-environment-.pdf
[289] Scotland's Marine Assessment 2020. Available at: https://marine.gov.scot/sma/

10.17 The most critical factor affecting Scotland's marine environment is climate change. Impacts are already being observed across our marine ecosystem. For example, Stornoway, Kinlochbervie, and Lerwick registered the largest changes in mean sea level around the coast in the last 30 years. Higher sea levels are linked to increased risk of assets being damaged from coastal flooding and coastal erosion. Furthermore, the rise in sea temperature is causing changes in species distributions.[290]

10.18 Climate change also impacts marine environments through ocean acidification which is mainly caused by carbon dioxide (CO_2) gas[291] in the atmosphere dissolving into the ocean thus making it more acidic.[292] Ocean acidification is likely to have an impact on shellfish and other marine invertebrates in Scotland's seas, with significant consequences for the sectors and communities that depends on them.[293] As with all of these issues, marine environmental services are required to understand and tackle this issue.

10.19 The lack of understanding and clarity about the marine environment could result in unnecessary environmental damage as well as lack of growth in the sector because the risk of environmental impact and mitigating actions are not fully understood.

10.20 Better data collection, analysis and application will improve the understanding of how Blue Economy sectors impact on the marine environment, and in turn how the changing marine environment and quality impacts on the sectors. A key and critical gap is data on environmental and marine resource monitoring, e.g., marine quality, stock levels, impacts/rate of climate change, or impact of marine activity on marine life. There are too few ecosystem monitoring sites and consequently understanding cumulative impacts remains a significant challenge. Some current European and Maritime Fisheries Fund (EMFF) resources have been dedicated to improving monitoring and data, but it is not considered sufficient to inform future management of marine resources and environments and so is a constraint. There are also weaknesses in data sharing and integration, and subsequent use.

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

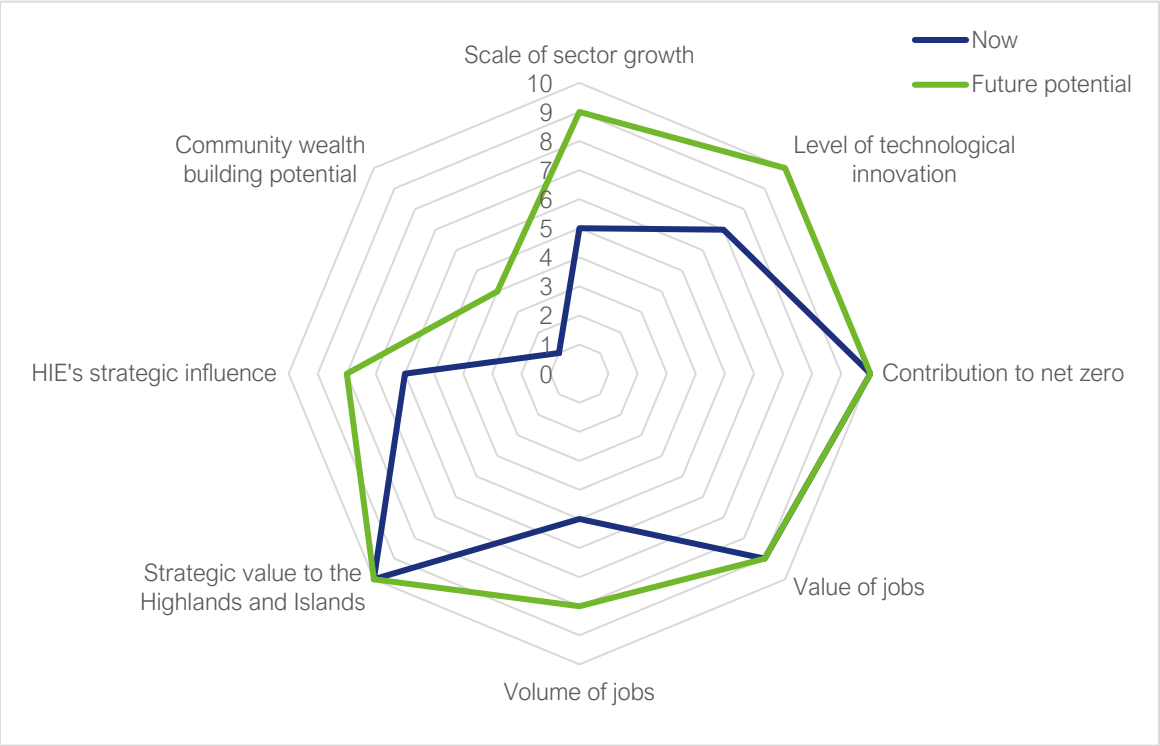
10.21 It is clear that in the Highlands and Islands, and globally, there is an opportunity to develop approaches, technologies, innovations, and expertise to understand, mitigate and address the impact of climate change and activities that degrade and threaten our seas and oceans. This will lead to better and evidence-based decision making, and enhanced management of marine environments.

10.22 There is a global need to better understand and monitor the marine environment across stock levels (e.g., fish stocks), impacts of human and economic activity, and events such as harmful algal blooms (HABs) and weather events. There is an international market opportunity to do this better and in a more open and rigorous way. Through appropriate research and development activity, the Highlands and Islands is well positioned to be a market leader in developing innovative, efficient, and industry-suited solutions to sell into this market. As technologies change, so the solutions may develop making this a long-term market opportunity.

10.23 Reflecting this, Figure 10.1 provides an assessment of the current Marine Environmental Services in the Highlands and Islands, and the potential that could be captured for the region and for Scotland. It demonstrates the potential opportunities in community wealth building, high levels of innovation, and good quality employment.

[290] Ibid.
[291] Rising carbon dioxide gas levels are largely caused by the burning of fossil fuels and by deforestation. See
[292] https://www.nhm.ac.uk/discover/what-is-ocean-acidification.html
[293] Scotland's Marine Assessment 2020. Available at: https://marine.gov.scot/sma/

Figure 10.1: Current and future potential of Marine Environmental Services in the Highlands and Islands



10.24 A thriving Marine Environmental Services sector requires facilities to deploy and test in the field, and through data analytics, predictive analytics, machine visioning, systems, and processing innovations. In the Highlands and Islands, the access to coastal areas and the marine environment creates a valuable opportunity for full system data recording and monitoring effects. The mix of conditions, environments, weather and oceanographic conditions in the region is arguably unique in the UK. It offers a geographically contained maritime area with a breadth of deployment and testing environments that can act as a living lab and centre of excellence to develop monitoring, data collection and analytical systems. This opportunity is not only about monitoring and data collection and analysis in the Highlands and Islands or Scotland. It is about establishing the Highlands and Islands as a centre of excellence and innovation on the world stage through its research and development of innovations, systems, and processes across a range of Blue Economy sectors and uses. The Highlands and Islands could operate as centre for innovation, a living laboratory, and a facility for plug-in testing for Blue Economy sectors with a scalable, worldwide application and market.

10.25 Understanding and mitigating environmental impact as part of sustainable development – a crucial area for sustainable blue economy development and capturing the value – is a key opportunity for the Highlands and Islands. There is a requirement to better understand impacts and undertake research and testing on how to build credible evidence incorporating the testing of novel monitoring approaches and technologies in situ.

10.26 An important aspect of this opportunity is the development of systems and processes to gather data, through remote monitoring, satellites and Unmanned Aerial Vehicles (UAVs) – the latter perhaps in a similar way to Cyberhawk in the Energy sector.[294] It aligns with the strengths in the Highlands and Islands in terms of aviation, including UAVs which are used to collect data, monitor conditions and identify climatic events such as Harmful Algal Blooms (HABs).

[294] https://thecyberhawk.com/

10.27 Data analysis and modelling through big data approaches, virtual reality, and the application of gaming technology, can help to better understand human and societal impact on the marine environment, and inform future approaches to sustainable development. The provision of monitoring capability across the region, and the potential of activity such as systems integration to complement data gathering, monitoring and analysis will be key opportunities. At Scottish level, this integrates with the strengths of the digital technology sector and digital economy expertise for example data, AI, software engineering and DevOps.

10.28 As well as being impacted *by* changes in the marine environment, marine economy sectors also impact *on* the environment. Developing a socially and economically sustainable Blue Economy requires understanding and monitoring of how our activities impact marine and coastal environments, which relies on robust, credible and up-to-date evidence. Monitoring and assessment, and associated systematic large-scale data capture, provides the opportunity to put into practice the ecosystem approach to managing human activities.

10.29 There is a need for Blue Economy sectors to continue to adapt to climate change and manage the impacts, for example more frequent extreme weather events. Long term environmental monitoring, production of data allows us to predict trends that can support and justify growth where proven to be sustainable. Long term monitoring can be used to estimate the past, the present and forecast future environmental parameters leading to knowledge on ecological integrity and carrying capacity of environmental assets.

10.30 There is a strong sense that whilst considerable data is collected, including monitoring catch and fish/shellfish stock, tracking cruise ship visits and marine environment quality, there is a lack of comprehensive and robust assessment of the individual and combined impacts of marine uses and activities that can inform policy and decision-making. A robust and credible scientific evidence-base is likely to enable the Highlands and Islands to maximise opportunities and provide scope to better capitalise on our marine assets whilst still ensuring environmental sustainability and protection. More, and better, monitoring and data collection across all marine sectors will improve understanding of economic performance and environmental quality. This has been a focus of past and current interventions and support mechanisms, but it has not been undertaken within an integrated, whole-seas framework which may mean we are missing opportunities for sustainable blue economy sector growth.

10.31 Greater use and availability of open data is one approach to achieving this. Similarly, greater data sharing can enable more effective planning and efficiency gains, as is the case between fishing and processing. Here, openness and sharing of data can improve the integrity of products: employing a 'blockchain from boat to plate' can meet the increasing consumer demand for traceability.

10.32 Scotland's Marine Assessments 2020 report (SMA2020)[295] identified data availability and monitoring programmes as two of the challenges for the Scottish marine science community. These are driven by the need to improve the predictions of climate change impacts on Scottish marine environments, assess cumulative pressures, and undertake sustained monitoring and investigative research to explain change in marine environments. Furthermore, scientific monitoring programmes relevant to the seas around Scotland need to be reviewed in order to maximise their benefits.

[295] https://marine.gov.scot/sma/

10.33 An example of successful delivery of ecosystem monitoring is delivered through the Baltic Marine Environment Protection Commission (Helsinki Commission – HELCOM). The HELCOM Monitoring and Assessment Strategy (2013) has a range of objectives that have synergies with what could be possible at the Highlands and Islands level.[296]

Table 10.1: Sector summary, observations and opportunities: Marine environmental services

Current position and status in the Highlands and Islands	• A strong basis to build on given the Highlands and Islands' expertise in Blue Economy research and innovation and more widely, data capture, analysis and application. • Strengths particularly in areas such as big data and analytics and support sector development in the region. • UAVs are an important tool in data collection and environmental monitoring, and this is part of sustainable aviation in the region.
Opportunities and growth potential	• Strong growth potential. • Ecological services. Need for data collation, analysis, application. • Monitoring of climate events and conditions occurrences such as hurricanes, HABS, floods and tsunamis, as well as longer-term monitoring of climate change. • Big data and analytics. • Carbon sequestration (seaweed, seagrass).
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Potentially a valuable industry in economic terms with significant positive environmental impacts. • Developing the technologies for international markets will add strategic value in the Highlands and Islands, spilling over to the Blue Knowledge sector.
Cross sectoral opportunities and synergy	• This is and will continue to be important for the majority of Blue Economy sectors. • Opportunity for these sectors to benefit from investment and development of Marine Environmental Services.
HIE's role going forward	• HIE to play a key strategic role in helping to develop the sector given the scale and nature of regional assets.
Comments	• Big data and analytics applications will have to be supported by the recruitment of workforce with the appropriate skills.

[296] https://helcom.fi/action-areas/monitoring-and-assessment/monitoring-and-assessment-strategy/

11 MARINE TRANSPORT AND SHIPBUILDING SERVICES

CONTEXT

11.1 Marine transport refers to navigation and seafaring, and the transport of people or goods via waterways across seas and oceans. Demonstrating its importance worldwide, international shipping and maritime transport represents 90% of all world trade. Recent global events such as the pandemic and the invasion of Ukraine have illustrated the impact on ensuring a smooth supply chain and managing inflation if the flow of marine freight is interrupted and the cost of marine fuel rises steeply.[297]

11.2 The *UK Maritime 2050* Strategy[298] sets out the UK Government's ambitions to maximise its strength in maritime professional services, pursue clean maritime growth through the development and adoption of new technologies and modes of transport, and continue to support investment in maritime infrastructure. One aim of this is to ensure security and resilience at ports, on vessels, and on shipping routes. In June 2022, a Maritime recovery routemap[299] was published, setting out shorter term actions to accelerate the sector's recovery from the COVID-19 pandemic, while reiterating commitment to the aspirations of Maritime 2050.

11.3 Within Scotland, *Scotland's National Marine Plan*[300] sets out key objectives for the sector. Since a considerable proportion of the population in the Highlands and Islands live in communities that rely on ferries for goods, services, and to travel, the Plan prioritises:

- Safeguarding access to ports and essential maritime transport links, harbours, and navigational safety;
- Sustainable growth and development;
- Linking ferry services to other transportation routes; and
- Using the best available technology to mitigate and adapt to climate change in fleet management and shipping.

11.4 Providing essential ferry services to Scottish islands remains a priority with targets set out in the *Scottish Ferries Plan 2013-2022,*[301] aiming to improve services for fragile communities. Maintaining existing vessels, ports and harbour infrastructure and investing in new vessels is an integral strand of this.

11.5 As set out in the *National Islands Plan,*[302] the strategic objectives relating to transport recognise the importance of maritime transport to addressing population decline and balance, improve sustainable economic development and connectivity, and its role in empowering communities and places. This includes a commitment to ensure that there is a long-term plan and investment programme for new ferries and development at ports to improve resilience, reliability, capacity and reduce emissions. The 2020 Islands Plan Annual report also detailed the commitment, by the end of 2022, to update and replace the Ferries Plan with the *Islands Connectivity Plan*.[303]

[297] https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-top-containership-operators/
[298] Department for Transport (2019) Maritime 2050: Navigating the Future.
[299] https://www.gov.uk/government/publications/maritime-recovery-route-map/maritime-recovery-route-map
[300] Scottish Government (2015) Scotland's National Marine Plan.
[301] Scottish Government (2013) Scottish Ferry Services, Ferries Plan (2013-2022).
[302] Scottish Government (2019) The National Islands Plan | Plana Nàiseanta nan Eilean
[303] Scottish Government (2020) The National Islands Plan Annual Report

11.6 Shipbuilding, refurbishment, and maintenance have long been part of Scotland's Blue Economy although of course shipbuilding has faced post-industrial decline in Scotland. It comprises the construction of ships and other floating vessels, as well as servicing, retrofitting, refurbishing, and decommissioning. It is an important industry for marine transport, with ferries for local routes, as well as larger vessels for shipping and trade. It supports the food and drink and energy sectors, for example providing maintenance for fish farming workboats or offshore wind farm vessels.

11.7 The industry is also an integral part of the UK's Ministry of Defence (MoD) shipbuilding. The *MoD National Shipbuilding Strategy*[304] was published in 2017 with the aim of growing the sector, dealing with structural challenges in terms of access to innovation, skills and training, and building a competitive approach to warship and non-warship building. The MoD has significant maritime clusters across the UK, including in Scotland on the Clyde and at Rosyth.

11.8 The National Shipbuilding Strategy was revisited in 2022 with the MoD's *Refresh to the National Shipbuilding Strategy,*[305] building on developments in transforming naval procurement and export processes for British naval ships. As part of the refresh, £4 billion of government investment was announced to galvanise and support shipyards and suppliers across the UK in delivering 150 new naval and civil vessels for the UK Government and Devolved Administrations over the next 30 years.

11.9 Outside of the MoD, there are no major strategies currently in place with direct relevance to vessel building, refurbishment or maintenance. The 2021-22 *Scottish Programme for Government,*[306] as part of its ambition for decarbonisation, sets out actions on scoping plans for using hybrid and low carbon energy sources in the public sector marine fleet. This is part of the small vessel replacement plan through Caledonian Maritime Assets Ltd (CMAL) who are working with NaValue ferry design to see ships being replaced on the Clyde and Hebrides Ferry Services network in Scotland to support net zero emissions targets.[307]

NATURE AND SCALE OF THE SECTOR

11.10 The shipping industry is critical in the UK, with around 95% of British imports and exports of goods moved by sea, including 48% of the country's food supply and 25% of the energy supply.[308] The UK maritime sector directly contributed £18.7bn GVA to the economy and supported 227,000 jobs in 2019.[309] Inclusive of value generated and jobs supported in industries that supply the sector and induced impact, the UK sector contributed £37.4bn GVA and 957,000 jobs in 2015.[310]

11.11 In 2019, freight water transport generated £229m GVA, and 67m tonnes of freight were handled by Scottish ports.[311] The maritime sector in Scotland directly supports 41,000 jobs, with marine engineering and science being the largest industry within this. The average job is estimated to contribute around £90,600 in GVA (2017), greater than UK figures, showing the large proportion of high value jobs in Scotland.[312]

[304] Ministry of Defence (2017) National Shipbuilding Strategy: The Future of Naval Shipbuilding in the UK.
[305] https://www.gov.uk/government/publications/refresh-to-the-national-shipbuilding-strategy
[306] Scottish Government (2021) A fairer, greener Scotland. Programme for Government 2021-22.
[307] https://www.cruiseandferry.net/articles/cmal-appoints-consultancy-for-small-vessel-replacement-programme-1
[308] Department for Transport (2019) Maritime 2050: Navigating the Future.
[309] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1086090/maritime-recovery-route-map.pdf
[310] Ibid.
[311] https://www.gov.scot/publications/scotlands-marine-economic-statistics-2019/
[312] https://www.britishports.org.uk/news/new-figures-show-scottish-maritime-sector-is-on-the-rise

11.12 As well as providing vital connectivity, in 2019, sea and coastal passenger water transport in Scotland generated £133 million in GVA and provided employment for 1,400 people. [313]

11.13 There are over almost 500 ports harbours and marinas in Scotland, the majority of which are local authority owned, serving a range of trades.[314] Ports and harbours are important enablers of the Blue Economy and are discussed in detail in Chapter 13.

11.14 In 2019, shipbuilding generated £408m in GVA, 0.28% of the overall Scottish economy and 8% of the marine economy GVA. Shipbuilding provided employment for 6,300 people, 0.24% of total Scottish employment and 8% of the marine economy employment. Glasgow City, Aberdeen City and Fife collectively accounted for 74% of employment, 82% of turnover, and 74% of GVA, as these local authorities host most of the commercial and MoD shipbuilding activity.[315]

11.15 Between 2010 and 2019, shipbuilding GVA decreased by 29% and employment decreased by 11%. However, between 2018 and 2019, shipbuilding GVA (adjusted to 2019 prices) increased by 45%. The industry accounted for 23% of turnover and 19% of GVA of total UK output of the industry in 2019, higher than Scotland's contribution to the whole of manufacturing. The sector comprises of larger companies, and so small changes in these can have a marked effect.[316]

11.16 The MOD is a major 'customer' for shipbuilding in Scotland. Since 2014, a total of 20 naval ships have been built (or there are plans to build) in Scottish yards, spending more than £2bn on Scottish businesses and supporting 12,400 jobs.[317] These activities are not based in the Highlands and Islands.[318]

11.17 In terms of commercial shipbuilding, Ferguson Marine[319] has been undertaking marine engineering since 1791 in Port Glasgow. Recently, the shipyard has produced over 350 vessels of various types and scales, including hybrid ferries, and ferries with innovative LNG propulsion. It also undertakes retrofit and conversions of vessels as well as servicing, repairs, and maintenance. Whilst this manufacture and maintenance work is not based in the Highlands and Islands, it has strategic importance for the region in terms of current and future sustainable transport. This shows that there is still a market for this in Scotland, but they and other companies are in competition with international firms for contracts. This was illustrated recently, with a Turkish contractor successfully securing a £91m contract to build two new ferries to service Caledonian MacBrayne's (CalMac) Islay routes in Argyll.[320]

11.18 Briggs Marine,[321] is headquartered in Fife. It provides marine and environmental services, specialising in port and marine operations, including a vessel refurbishment programme. Its work is spread throughout shipyards across the UK but not in the Highlands and Islands. Currently there are no shipbuilding or refurbishment projects in Scotland. However, the recent expansion of offices in Aberdeen[322] suggests that the company is responding to increasing local growth in demand.

11.19 Alongside more traditional boat and small vessel building activity through companies such as A&R Way, Stormcats of Islay and Flugga Boats in Shetland, the Highlands and Islands region has a well-established marine vessels engineering, maintenance, and servicing industry. Companies in the

[313] https://www.gov.scot/publications/scotlands-marine-economic-statistics-2019/
[314] https://marine.gov.scot/information/scottish-ports-and-harbours
[315] https://www.gov.scot/publications/scotlands-marine-economic-statistics-2019/
[316] Ibid.
[317] https://www.dailyrecord.co.uk/news/politics/scottish-shipbuilding-row-erupts-snp-23771578
[318] https://www.naval-technology.com/news/uk-navys-type-26-frigate-hms-glasgow-takes-shape/
[319] https://www.fergusonmarine.com/
[320] https://www.bbc.com/news/uk-scotland-glasgow-west-63135023
[321] https://www.briggsmarine.com/
[322] https://www.fifetoday.co.uk/business/fife-based-business-expands-with-new-offices-and-15-increase-in-turnover-3306657

Highlands and Islands such as Gael Force Marine,[323] Peterson[324] and Nortech Marine[325] provide fabrication, engineering, welding, painting, electrics, hydraulics, repair and integrated marine services to operators across a range of marine activity.

11.20 Macduff Group,[326], based just outside the Highlands and Islands in Aberdeenshire, provides shipbuilding, cargo handling, engineering and fabrication services, largely supplying the fishing industry. However, the nature of the sector in the region means that its focus is very much on engineering and servicing, in contrast to the shipbuilding industry that is well-established around the central belt of Scotland. As such, large-scale shipbuilding activity is unlikely to develop in the Highlands and Islands, at least in the short and medium-term.

11.21 Much of the modern shipbuilding industry is dominated by Asian countries, mainly China, South Korea, and Japan. These three countries accounted for 83% of merchant cargo and passenger vessel construction in 2019.[327]

DRIVERS AND CHALLENGES

11.22 A major driver for marine transport services, including ferries, is passenger demand. In 2019, there were over 5.74 million passengers on CalMac ferries across the various routes,[328] and almost 380,000 passengers on NorthLink Ferries.[329] For Orkney Ferries, passenger numbers were approximately 336,000, and there were approximately 777,000 passengers on ferries within the Shetland Islands.[330] Nearly all major subsidised and other ferry routes in Scotland have shown an increase in passengers over the period 2009-19.[331] 2020 data shows this fell to 2.35 million on CalMac routes and to around 122,000 on NorthLink routes as a result of the COVID-19 pandemic and associated travel restrictions which allowed travel for essential journeys only. Recovery was in process over 2021 with 3.95 million passengers on CalMac routes and around 230,000 on Northlink routes.

11.23 Allied to this, Scotland's islands are at the end of long logistics and supply chains for food and drink and other essential products. Efficient, reliable, and resilient maritime transport links are critical to meet the lifeline needs of island communities in Scotland.

11.24 A key driver for vessel building and refurbishment is the age of vessels operating within Scottish waters. The current fisheries fleet is ageing, which limits efficiency and productivity. Despite some evidence of new investment, a considerable proportion of the fisheries fleet is old, inefficient, and polluting: one third of Scotland's fishing fleet was constructed before 1990.[332]

11.25 The ageing ferry fleet in Scotland and the ongoing refurbishment and overhaul of ferries operated by CalMac demonstrates the need for new vessels on Scotland's ferry routes, many of which are lifeline services in the Highlands and Islands, transporting essential goods and services.[333] There is well documented public concern about the reliability of services, breakdowns, reduced services, and the overhaul of timetables which causes disruption.[334]

[323] https://www.gaelforcegroup.com/sectors/boatyard-services
[324] https://energylogistics.onepeterson.com/en/our-differentiators/decommissioning
[325] https://www.nortechmarine.co.uk/
[326] https://www.macduffshipyards.co.uk/
[327] EMSA (2021) The impact of COVID-19 on the maritime sector in the EU: Detailed Report
[328] CalMac (2020) Annual Carrying Statistics
[329] https://www.northlinkferries.co.uk/news/statistics/
[330] https://www.transport.gov.scot/publication/scottish-transport-statistics-no-39-2020-edition/chapter-9-water-transport/
[331] Transport Scotland (2020) Scottish Transport. Statistics. No 39
[332] MMO (2020) UK Sea Fisheries Statistics, 2019
[333] https://www.calmac.co.uk/article/8319/CalMac-announces-annual-overhaul-timetable
[334] https://www.calmac.co.uk/FCB_Minutes

11.26 Another market driver is the rising demand for more environmentally friendly vessels. Eco-friendly vessels typically constitute vessels that have reduced greenhouse gas emissions through the development of technologies for saving fuel, alternative fuels and minimising air and marine pollutants.[335] Reflecting this, South Korea recently introduced a 'K-Ship' programme focusing on the construction of new eco-friendly ships and automated technologies.[336] The South Korean government has also announced plans to spend 254 billion won ($217 million) over the next ten years to develop technologies for ships fuelled by clean energy.[337]

11.27 Other countries are well on their way to decarbonising maritime transport. The Dutch Platform Sustainable Biofuels (PDB)[338] has accelerated the uptake of sustainable alternative fuels and power in maritime transport for both inland and shortsea shipping or seagoing vessels. They have played a key role alongside the OECD in suggesting a market for low-carbon shipping through carbon pricing or regulations such as fuel standards.[339] Northern Ireland consortium, Green Seas, has been awarded £400,000 to investigate ways to decarbonise maritime transport using zero-emission shore-side electricity and hydrogen-powered vessels.[340]

11.28 A key area of innovation that Scotland is involved in is hydrogen powered vessels, including hydrogen ferries. The HySeas series of projects, which have seen participation from CMAL, Orkney Islands Council and the University of St. Andrews, have sought to trial and demonstrate the commercial viability of hydrogen fuel cell-powered vessels.[341] More recently, the HyDIME project, funded through Innovate UK, has sought to demonstrate the viability of hydrogen as a fuel for a commercial ferry operating between Shapinsay and Kirkwall in Orkney.[342] There is growing research and development into innovative technologies affecting propulsion and the reduction of carbon emissions. Hybrid ferries are already running in the West Coast of Scotland, and there is a wider target of zero-emission ships to be introduced in 2025, relying exclusively on green propulsion such as hydrogen power, batteries, or wind.[343]

11.29 Climate change will have an impact on the resilience of maritime transport services in Scotland. Increases in extreme weather events can disrupt transport routes and potentially alter patterns of trade, disrupting the delivery of essential products and services to island communities. Building resilience in the sector will be key to mitigating this.

11.30 The drive towards a greener future may influence a change in the supply and demand within trade, alongside changes in products of shipping, for example, less oil and gas. There may also be a slight alteration due to individuals local-level purchase power, opting to support Scottish business instead of international trade. The trade is also constantly changing and there is a need to match global demand or risk losses.

[335] Lee, T. and Nam, H. (2017) A Study on Green Shipping in Major Countries: In the View of Shipyards, Shipping Companies, Ports, and Policies. Available at: https://www.sciencedirect.com/science/article/pii/S2092521217300652
[336] https://www.maritime-executive.com/article/south-korean-government-pledges-premium-ship-construction-leadership
[337] https://en.yna.co.kr/view/AEN20210909002500320
[338] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12312-CO2-emissions-from-shipping-encouraging-the-use-of-low-carbon-fuels/F513725_en
[339] https://splash247.com/netherlands-and-oecd-make-the-case-for-more-swift-adoption-of-longer-term-emissions-regulations/
[340] https://news.causewaycoastcommunity.co.uk/approx-400k-funding-award-for-zero-emission-maritime-transport-study/
[341] https://www.hyseas3.eu/the-project/
[342] https://hydime.co.uk/
[343] https://www.thetimes.co.uk/article/zero-emission-ships-ready-to-set-sail-within-four-years-jz6z93jsx

11.31 The COVID-19 pandemic has clearly demonstrated the way in which global economic shocks can disrupt logistics and supply chains. The disruption, coupled with an increase in demand for goods as economies recover, have led to supply issues and increased costs, such as that seen with construction supplies.[344]

11.32 Similarly, there are and will continue to be challenges navigating Brexit and the impact this is and will have on international trade. It has caused issues with export documents, longer delivery times and re-engineering of supply chains.[345] Post-Brexit, the first quarter of 2021 saw a decrease of 9% in total freight tonnage, a decrease of 13% in traffic, and a 17% drop in inward units.[346] However, this appears to have picked up and when comparing January to March 2022 with January to March 2021 through UK major ports.[347]:

- total freight tonnage increased by 7% to 111.8 million tonnes
- inward tonnage increased by 10% to 74.1 million tonnes
- outward tonnage increased by 2% to 37.7 million tonnes
- total volume of unitised traffic increased by 10% to 4.5 million units
- inward units increased by 11% to 2.4 million units
- outward units increased by 8% to 2.1 million units

11.33 The impacts have opened conversations about the industry and what it needs to resist more negative impacts and to grow from this.

11.34 As well as disrupting global maritime supply chains, the COVID-19 pandemic has also impacted on the shipbuilding industry. In 2020, global shipyard output decreased to its lowest level in 15 years by 11% from 2019, and by 41% from 2010 levels[348] but new orders fell by 34%. Ongoing economic uncertainty and weak investor sentiment due to COVID-19 is amplifying existing concerns over newbuild fuelling and technology choices.[349]

11.35 Within Scotland, lack of modernisation and capacity to meet demand through domestic boat production is a constraint to growth. Whilst there is recent evidence to indicate that orders for new vessels have been increasing in recent years,[350] builders such as Macduff in Aberdeenshire are struggling to meet demand. For fishing specifically, there is effectively no capacity to build vessels over 24 metres domestically, and all production is currently sourced overseas, potentially representing lost opportunity and economic value to Scotland.

11.36 Global competition and finance are significant challenges to shipbuilding in Scotland. Business is often taken outside of Scotland on the basis that it is cheaper and faster to build and dismantle ships elsewhere, and with fewer regulations to comply with in some countries. Recently, four companies were shortlisted to bid for a contract to build two vessels for CMAL, but none of these were in Scotland.[351] The contract was awarded to a Turkish shipyard.

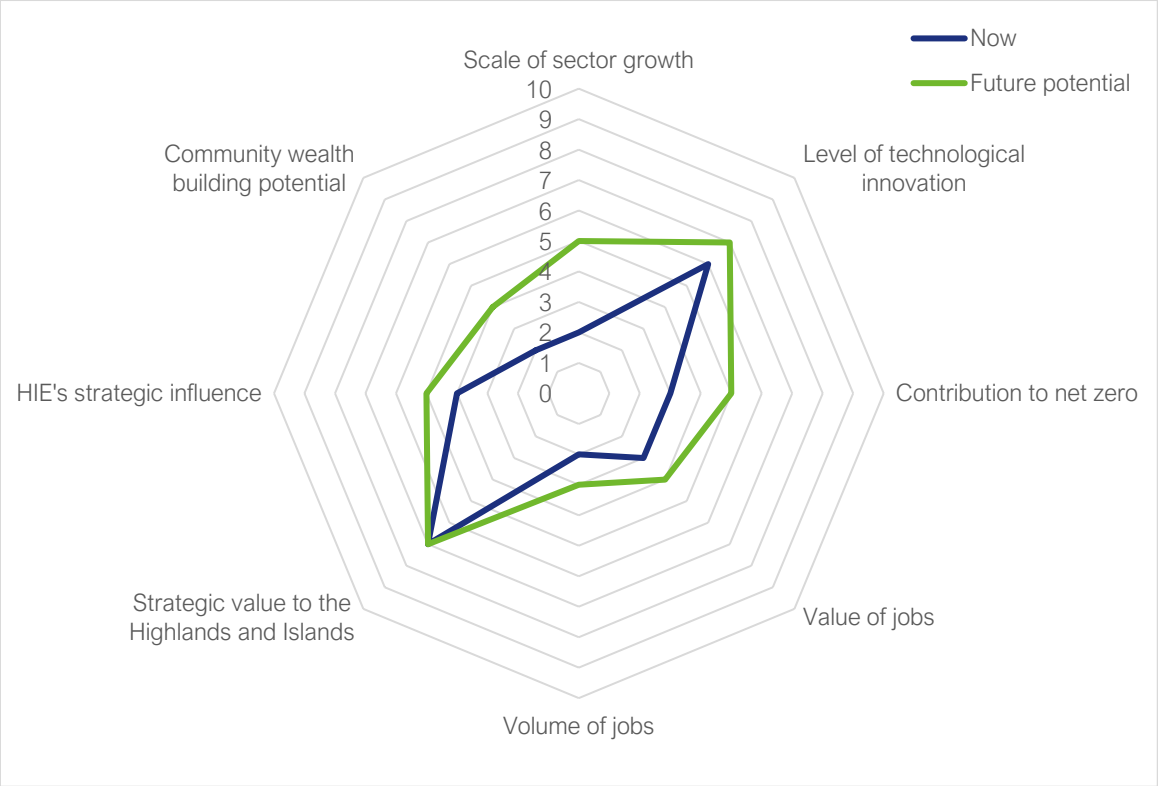
[344] https://www.cbre.co.uk/services/business-lines/building-consultancy/build-insight/articles/stretching-the-supply-chain-covid-and-brexit-add-risk-to-construction
[345] https://www.hellenicshippingnews.com/the-brexit-impact-so-far-paperwork-process-and-higher-prices/
[346] https://www.ship-technology.com/features/post-brexit-measuring-impact-on-uk-ports-half-year-later/
[347] https://www.gov.uk/government/statistics/port-freight-quarterly-statistics-january-to-march-2022/port-freight-quarterly-statistics-january-to-march-2022
[348] https://www.seaeurope.eu/images/SEA_Europe_Annual_Report_2020.pdf
[349] http://www.emsa.europa.eu/newsroom/covid19-impact/download/6786/4525/23.html
[350] e.g.: https://www.thenational.scot/news/17657381.whitelink-seafoods-invests-in-new-scallop-vessel-with-rbs-funding/
[351] https://www.heraldscotland.com/news/homenews/19580612.anger-state-owned-ferguson-marine-loses-100m-calmac-ferries-contract-overseas-firms/

KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

11.37 The sector is fundamental in the movement of people, goods, and services, particularly to and from island and remote communities, improving connectivity. It is a significant economic contributor, providing infrastructure and support for offshore industries.

11.38 Figure 11.1 shows the potential of marine transport to advance across the majority of criteria including overall growth, net zero, innovation and, with the application of technologies, and R&D opportunities, higher value jobs.

Figure 11.1: Current and future potential of Marine Transport in the Highlands and Islands



11.39 Arguably the greatest opportunity lies in the decarbonisation of maritime transport. This is a key area of focus for international shipping and maritime transport, and considerable activity in developing alternative fuels and propulsion methods are under development globally, and within Scotland. This will rely on there being the right local infrastructure in Scotland including ports and harbours.

11.40 For example, EMEC in Orkney have received funding of £2.2m to develop a Hydrogen in an Integrated Maritime Energy Transition (HIMET) initiative, centring around decarbonising ferry services and cruise terminal operations.[352] The trials showcase significant maritime innovation, building on the knowledge and experience from various other green hydrogen projects.

[352] https://www.scotsman.com/news/environment/orkneys-european-marine-energy-centre-to-test-green-solutions-for-ferries-and-cruise-ships-3384735

11.41 Oceanways Technologies[353] have received a £23m boost in green maritime funding to develop zero-emission submarines to transport cargo, specifically between Glasgow and Belfast. The vessels are intended to run on green hydrogen and collect microplastics and could secure up to 27 tonnes of CO_2 emissions in the first year.[354]

Table 11.1: Sector summary, observations and opportunities: Marine transport and shipbuilding

Current position and status in the Highlands and Islands	• Established traditional boat and small vessel building industry. • Established marine vessels engineering, maintenance, and servicing industry. • Marine transport vital to island communities.
Opportunities and growth potential	• Deployment and testing of 'clean' marine travel e.g., hydrogen ferries. • Marine renewable energy as a source of energy for electric travel – e.g., electric planes.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Strategically important in parts of the Highlands and Islands in terms of an enabling activity for communities and sectors. • Of local importance particularly in island communities in providing and maintaining essential transport routes.
Cross sectoral opportunities and synergy	• Marine transport supports Blue Economy sectors as well as sectors such as wider food and drink, provision of essential services, retail, and hospitality. • There are also important opportunities in achieving net zero by using clean energy and innovating in vessel design, material sand fabrication.
HIE's role going forward	• HIE's to support locally important shipbuilding and marine transport routes.
Comments	• Influencing of strategic direction-setting by Transport Scotland and Marine Scotland will be important.

[353] https://www.oceanways.co/
[354] https://www.thenationalnews.com/world/uk-news/2021/09/15/uk-government-funds-zero-emissio-submarine-project/

12 MARINE AND COASTAL TOURISM

CONTEXT

12.1 Marine tourism is an important part of the broader tourism industry and encompasses a diverse range of activity that takes place both in the water (such as scuba diving, sailing/ leisure marine, and jet skiing), and includes coastal tourism (usually referring to the type of tourism which takes place at the seaside), and other maritime activities. There are also a number of related sectors that are directly impacted by marine tourism, such as food and drink, transport and energy. It is likely that the diverse nature of the sector accounts for the lack of consistent data for marine tourism at the UK, Scottish and regional levels. At a global level, there are varying definitions of marine tourism, which results in a lack of comparable data.

12.2 The key strategies relevant to this sector are:

- Giant Strides 2020-2025: A Second Strategic Framework for Scotland's Marine Tourism Sector [355]
- Scotland Outlook 2030[356]
- VisitScotland Responsible Tourism Plan[357]
- Scotland National Marine Plan[358]

12.3 The Scotland National Marine Plan and Giant Strides both aim to grow the economic value of marine tourism, alongside developing the sector's capacity. Giant Strides sets out the aim to grow the value of Scotland's marine tourism industry, to over £500m by 2025.

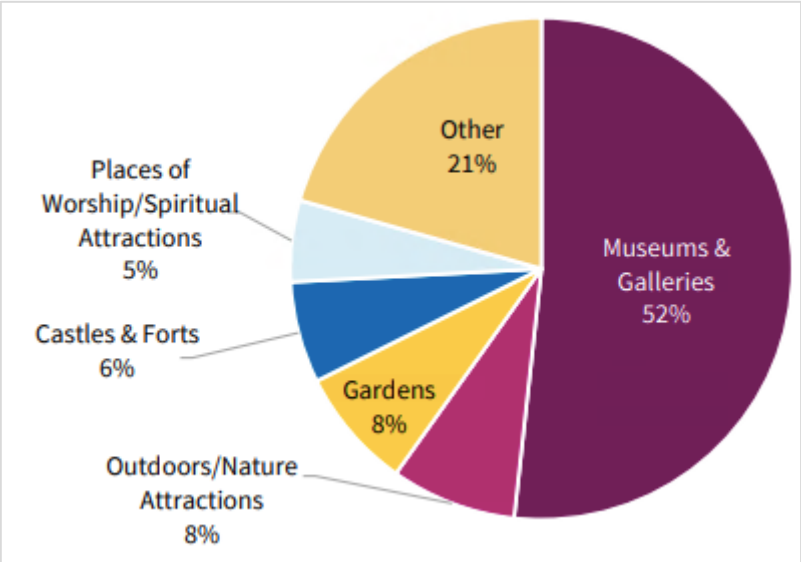
12.4 The COVID-19 pandemic had a significant negative impact on the tourism sector globally although there are signs of recovery. To tackle the challenges of the pandemic, the Scottish Tourism Recovery Taskforce (STRT) was established in June 2020 by the Scottish Government. It is 'responsible for strategic oversight of, challenging, and advising on, recovery plans in response to the COVID-19 impact on Scottish tourism and hospitality'.[359]

NATURE AND SCALE OF THE SECTOR

12.5 In 2019, 14.5m visits from domestic overnight, international inbound and day visitors were made to tourism attractions in Scotland's marine regions.[360] Figure 12.1 documents the distribution of visitors to various attractions within marine regions. Museums and galleries were most popular, with outdoors/nature attractions comprising 8% of total visitors in the same year.

[355] https://scottishtourismalliance.co.uk/marine-tourism/
[356] https://scottishtourismalliance.co.uk/wp-content/uploads/2020/03/Scotland-Outlook-2030.pdf
[357] https://www.visitscotland.org/supporting-your-business/responsible-tourism/visitscotlands-tourism-plan
[358] https://www.gov.scot/publications/scotlands-national-marine-plan/
[359] https://www.gov.scot/groups/scottish-tourism-recovery-taskforce/
[360] https://www.gov.scot/binaries/content/documents/govscot/publications/minutes/2021/02/convention-of-the-highlands-and-islands-meeting-papers-october-2020/documents/paper-3-regional-impacts-and-economic-recovery/paper-3-regional-impacts-and-economic-recovery/govscot%3Adocument/Paper%2B3%2B-%2BRegional%2BImpacts%2Band%2BEconomic%2BRecovery.pdf

Figure 12.1: Types of attractions visited in Scotland's marine regions in 2019



Source: Visit Scotland, 2021

12.6 In 2019, marine tourism generated £598 million GVA accounting for 0.4% of the overall Scottish economy and 12% of the GVA for the marine economy. The industry employed 33,100 people (headcount), contributing 1.2% of total Scottish employment. It is the biggest marine economy employer accounting for 44% of total marine economy employment. However, due to the seasonal and part time nature of tourism employment, the full-time equivalent will be significantly smaller. Scottish tourism as a whole was estimated to be worth £4.5 billion in GVA in 2019 representing around 13% of all Scottish tourism, a slightly lower percentage than in 2018 (14%).

12.7 From 2018 to 2019, the GVA of marine tourism (adjusted to 2019 prices) increased by 1%, while the longer-term trend from 2010 to 2019 showed that marine tourism GVA increased by 36%. Between 2010 to 2019, employment increased by 45% which is a significant uplift.[361]

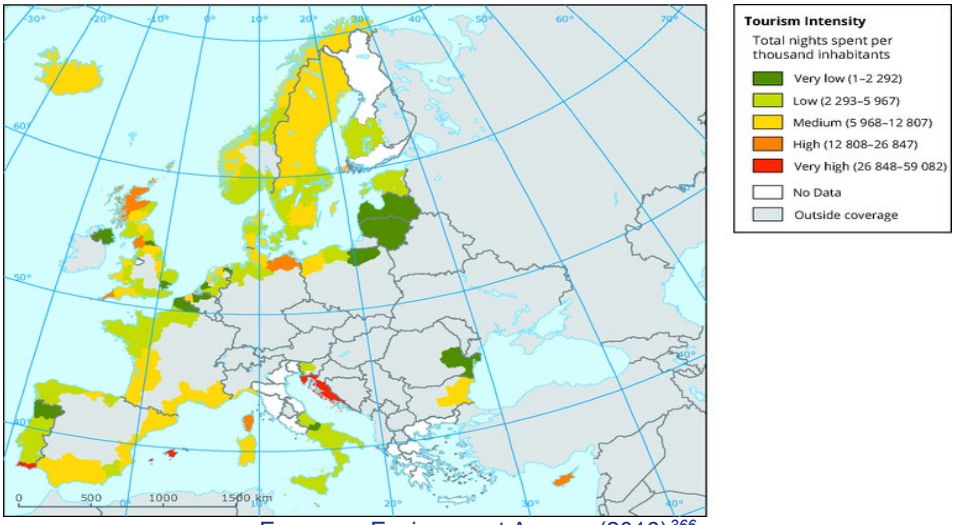
12.8 Scotland's coastal waters compete both within the UK marine tourism market, and also with marine tourism destinations globally. Scotland is within the Northern Europe cruise market which, between 2013 and 2018 grew by over 40%, from 13.5 million passenger nights to 19.4 million. This growth was greatest in North West Europe and the British Isles.[362]

12.9 Whilst Scotland, and the West coast and Firth of Clyde in particular, have traditionally been popular sailing and leisure yachting destinations, participation in sailing in UK waters has been trending downwards since 2002.[363] Port and harbour infrastructure and the lack of, or poor quality, land-based facilities is considered a barrier to participation in sailing or leisure yachting.[364]

12.10 Figure 12.2 illustrates the coastal tourism intensity throughout Europe. Whilst the Highlands and Islands has a relatively high tourism intensity (12,808-26,847 total nights spent per thousand inhabitants), this is largely due to its comparatively small population. Coastal tourist areas in Scotland, however, are largely rural and less developed in terms of tourism infrastructure than other parts of Europe.[365]

[361] https://www.gov.scot/publications/scotlands-marine-economic-statistics-2019/pages/11/
[362] G. P. Wild (2018) European Cruise Market Source and Destination Report, p.8
[363] https://www.yachtingmonthly.com/news/future-uk-sailing-68018
[364] ekosgen for North Ayrshire Council (2019) Ayrshire Growth Deal: Marine Tourism Market Analysis
[365] https://www.springerprofessional.de/en/case-study-3-overtourism-on-scotland-s-north-coast-500-issues-an/18035250

Figure 12.2: Tourism intensity in coastal areas



European Environment Agency (2016)[366]

DRIVERS AND CHALLENGES

12.11 Coastal and maritime tourism has become a major economic sector for countries and regions with accessible and attractive coastlines such as that of the Highlands and Islands. It is one of the fastest growing forms of tourism.

12.12 There is a great deal of interest and drive for green and clean tourism. Crown Estates Scotland has commissioned a £3 million Local Partnerships Capital Investment Fund[367] to help promote the sustainable development of Scotland's marine tourism sector. It also aims to support green economic recovery for coastal communities that rely heavily on boat-based tourism and support the growth of marine tourism in coastal areas, for example by providing new shore-based and harbour facilities.

12.13 The Marine and Outdoor Tourism Re-start Fund[368] is aimed at responsible tourism operators who provide sustainable outdoor related activities to visitors on land and water, from wildlife watching to charter and sailing holidays, bushcraft and survival, to canoeing and mountaineering. This presents an opportunity for tourism operators in the Highlands and Islands.

12.14 Cruise tourism has diversified into specialist areas and expanded its offering in the past decade. It offers more remote destinations, more adventurous excursions and cruises targeted at specific markets. There is a general trend for cruises of shorter durations and, while heritage and history continue to drive enthusiasm for cruising, operators expect a growing demand for a wider range of onshore activities as well as a positive passenger experience in the port and its immediate environs.[369]

12.15 Participation in sailing and yachting is anticipated to grow although it has been trending downwards since 2002.[370] In contrast, marine leisure activities such as paddle-boarding, kayaking, and surfing are growing – and growth seems to have been accelerated by the pandemic.

[366] https://www.eea.europa.eu/data-and-maps/figures/tourism-intensity-in-coastal-areas
[367] https://www.crownestatescotland.com/news/new-ps3m-fund-for-scottish-communities-green-recovery
[368] https://www.visitscotland.org/news/2020/new-fund-to-support-marine-and-outdoor-tourism
[369] ekosgen (2020) Cruise tourism in Scotland: Review & sustainable development opportunities for VisitScotland
[370] https://www.yachtingmonthly.com/news/future-uk-sailing-68018

12.16 Wildlife-based tourism is growing rapidly worldwide with travellers seeking out new and more enriching personal experiences with local cultures and wildlife. Research has estimated that around 7% of world tourism is related to wildlife tourism, growing annually at about 3%.[371] Around 4% of holiday trips in the UK include some element of wildlife activity, including whale and dolphin watching, interest in other species including seals and birds. This is typically combined with other activities such as walking, cycling, photography, history, and culture.[372]

12.17 A report by VisitScotland[373] identified the trend and renewed interest in coastal holidays and trips from domestic tourists. Over half of domestic tourists stated they were "extremely interested" or "very interested" in taking a coastal break in the UK in the next two years (Table 12.1). The challenge for tourism businesses in Scotland, however, is how to convert this interest into engagement and booking.

Table 12.1: Types of domestic holidays and their appeal to domestic markets

	Scotland	England	RoUK
1st	Coastal (53%)	Coastal (60%)	Coastal (59%)
2nd	Historic (52%)	Rural (57%)	Historic (54%)
3rd	Rural (48%)	Historic (51%)	Rural (52%)
4th	Food & Beverage (44%)	Food & Beverage (49%)	Food & Beverage (46%)
5th	Relax (41%)	Relax (49%)	Nature (44%)
6th	Nature (38%)	Nature (48%)	Relax (43%)
7th	Friends (34%)	Seaside (45%)	Seaside (37%)
8th	Arts (33%)	Friends (37%)	Shopping (34%)
9th	Shopping (32%)	Shopping (37%)	Arts (33%)
10th	Seaside (31%)	Festivals (36%)	Friends (32%)

Source: VisitScotland, 2021

12.18 Across the UK seaside attractions achieved record visitor numbers in the summer of 2021. Similarly, outdoor holiday pursuits such as paddle boarding, cycling and walking holidays have also been popular and 46% of tourism providers on the British coast are seeking to further develop their outdoor products and experiences. [374]

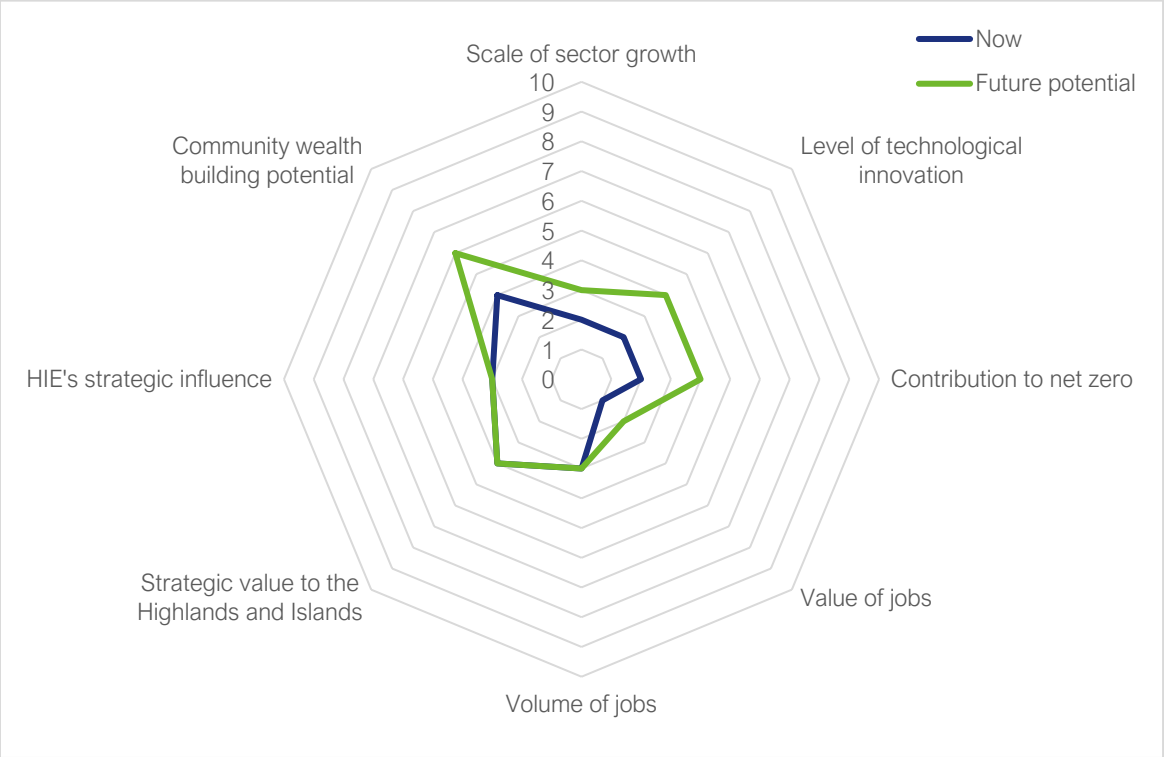
KEY FINDINGS AND OPPORTUNITIES IN THE HIGHLANDS AND ISLANDS

12.19 Marine tourism is an important part of the overall tourism offer in the Highlands and Islands, including cruise tourism but also sailing, kayaking, and other activities that are increasingly popular amongst domestic and overseas visitors. These are attractors to coastal areas providing income for local economies and supporting jobs and enterprise development.

12.20 Figure 12.3 shows that there is certainly growth potential in marine tourism in the Highlands and Islands and added value to be achieved in the region. There is also strong potential for community wealth building activities in marine and coastal tourism and it has a contribution to play in community sustainability. Tourism helps to support the viability of amenities that are important to residents such as bars, shops and culture and leisure facilities. Enhancing green and clean tourism can contribute to net zero ambitions and there is scope for harnessing the benefits of innovation and technology, for example by supporting tourism businesses, particularly small ones, to plan and implement digital transition.

[371] UN WTO (2017)
[372] https://www2.gov.scot/Resource/Doc/311951/0098489.pdf
[373] VisitScotland (2021) Exploring the appeal of Scotland's coastal destinations for visitors
[374] https://theconversation.com/how-the-pandemic-has-changed-holidaymaking-in-britain-168409

Figure 12.3: Current and future potential of Marine and Coastal Tourism in the Highlands and Islands



12.21 The Highlands and Islands is well-placed to take advantage of the considerable growth potential in marine and coastal tourism. The region has extremely valuable natural assets, including 61% of the UK coastline, making it ideal for outdoor water-based attractions.

12.22 Research to support the development of the Ayrshire Blue Economy Framework Strategy (2019)[375] suggests there are a variety of new sub-sectoral opportunities related to marine tourism backed up by emerging global trends. They represent opportunities for the Highlands and Islands and include:

- Wind/kite surfing
- Expedition and boutique cruises
- Nature and wildlife tourism
- Educational and ecotourism activity
- Sea kayaking and paddle-boarding
- 'Under the sea' activities such as snorkelling, scuba-diving and glass-bottomed boats.

[375] ekosgen (2019) Ayrshire's Blue Economy Framework Strategy for North Ayrshire Council

Table 12.2: Sector summary, observations and opportunities: Marine and coastal tourism

Current position and status in the Highlands and Islands	• An important industry in the Highlands and Islands providing supporting businesses, supply chain and employment, including in more rural and isolated communities.
Opportunities and growth potential	• On-going impact of COVID-19 is anticipated to mean steady domestic tourism. International tourism forecast to return in the medium term (2-3 years). • Supports amenities and facilities that benefit the Highlands and Islands residents and communities.
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Tourism in the Highlands and Islands is integral to the region's reputation and profile which contributes to other sectors such as Food and Drink, Culture and Heritage and Creative Industries. • Provides employment, particularly in rural coastal communities.
Cross sectoral opportunities and synergy	• Use of ports and harbours for Cruise Tourism and some water sports.
HIE's role going forward	• Visit Scotland is the strategic lead. • Local responses through HIE local area teams.
Comments	• Planning and management of volume tourism.

13 CROSS-CUTTING ENABLERS

INTRODUCTION

13.1 The preceding chapters have demonstrated the importance of blue economy sectors to the Highlands and Islands and Scotland, along with the growth opportunities and the cross-sectoral potential. However, to support this growth and capture the value of the opportunities, there must be the necessary, high-quality infrastructure and central to this is ports and harbours.

PORTS AND HARBOURS

Scotland's port and harbour assets

13.2 Scotland has a large number of diverse ports and harbours supporting a wide range of activities and functions. There are almost 250 ports and harbours around the Scottish coastline, excluding smaller harbours, jetties and slipways (Table 13.1). All contribute to their local and regional economies as employers and by providing essential facilities for users such as the fishing industry, cargo handling and ferry operators. In many cases they also contribute to the national economy and economic growth.376

Table 13.1: Types and examples of Scottish ports

Port type/ownership	Number	Examples
Local authority	122	Stranraer, Orkney, Sullom Voe
Private/commercial	63	Cairnryan, Ayr, Clyde Ports, Glensanda, Dundee, Forth Ports
Trust port	32	Lerwick, Cromarty Firth, Inverness, Stornoway, Aberdeen, Montrose
CMAL/British Waterways	25	Oban, Brodick, Port Ellen
Ministry of Defence	2	HMNB Clyde, Coulport

Source: Scotland's Marine Atlas, 2011

13.3 Whilst the majority of Scotland's ports are multi-purpose, some focus on servicing one or two sectors (e.g., Peterhead for fish, Aberdeen in supporting North Sea oil and more recently, the developing offshore renewable energy industry). A few ports specialise in specific cargos, for example, Sullom Voe for oil, and Glensanda for crushed stone.

13.4 Scotland's port infrastructure has a number of strengths. The range of available ports on both the east and west coasts offers variety to different marine and maritime operators across various Blue Economy sub-sectors, and facilities for different types of vessels. In addition, there are ports with several quays (e.g., Invergordon, Orkney, Nigg, Forth Ports) and anchorages, capable of accommodating a range of vessel sizes. A further strength is that there is clear segmentation of different users at some ports, such as at Lerwick and Inverness, which means that a range of different markets and activities can be served without competition for port and quayside space.

Port and harbour assets in the Highlands and Islands

13.5 Ports and harbours across the Highlands and Islands already serve the spectrum of Blue Economy sectors and are well-placed to support new Blue Economy developments through existing assets, current investment projects and proposed developments.

[376] https://www.gov.scot/publications/scotlands-marine-atlas-information-national-marine-plan/

Port assets as transformational opportunities

13.6 Developments at Nigg Energy Park and the ultra-deep-water harbour at Dales Voe in Shetland both represent transformational opportunities for the region, and for Scotland as a result of their unique sites and their ability to service the offshore renewables and oil and gas markets and compete in global markets.

13.7 Nigg Energy Park was identified as a priority site in the UK for the establishment of a high value manufacturing facility for the offshore wind sector – an integrated manufacturing and assembly hub for wind turbines. It is already considered an excellent location for offshore renewables works because of its unrestricted access to open water, the ground loading capacity of the quays, the amount of laydown space, the deep-water depths, and the suitability for jacking operations. It is the only port in Scotland to possess these characteristics and one of a few in the UK. Nigg Energy Park's South and East Quay developments are well-positioned to provide suitable locations for onshore services for a number of Blue Economy operations. This gives it the potential to be a strategic hub for the offshore renewables sub-sector to compete with similar facilities such as Esbjerg and Rotterdam. The Opportunity Cromarty Firth initiative aims to exploit the potential of the Port of Nigg for the benefit of the marine renewables sector.[377]

13.8 Dales Voe in Shetland has been identified as an optimal location for an ultra-deep water decommissioning facility. It has a long track record in decommissioning activity over a number of decades and is in close geographical proximity to both the existing oil and gas infrastructure, and the locations that will be used for future marine renewable energy activity. An Islands Growth Deal project will establish the new ultra-deep-water facility with a minimum depth of 24 metres.[378]

13.9 Scapa Flow in Orkney is the second largest natural harbour in the world. Its oceanographic conditions and physical characteristics mean that it is well-suited to serving the offshore renewable energy market.

Recent port investments and developments

13.10 There has been extensive investment in ports infrastructure in the region in recent years, (approximately £250m over the last decade or so), for example at Arnish, Kishorn and Stornoway. The deep-water port developments currently taking place at Kishorn and Stornoway in particular will provide ideal locations for onshore operation and maintenance for marine renewable energy and other marine sectors. Ardersier has also seen recent developments.

- Stornoway: The £49 million construction contract for the development of Stornoway's Deep Water Port Terminal was signed in April 2022.[379] The Stornoway project will provide enhanced port facilities and create a deep-water port on west coast of Scotland. As well as responding to current market opportunities in offshore wind, this will increase the competitive advantage of the Western Isles and wider west of Scotland in terms of supporting marine economy activity. This is particularly the case in terms of the current ScotWind leasing round. This has seen a number of inward investment-related enquiries, with lease bidders and consortium members exploring suitable locations for marshalling and assembly, and for fabrication in the longer term. The enhancement of port facilities will contribute to Stornoway's inward investment proposition. In addition, any subsequent ScotWind rounds could bring further offshore wind work to Stornoway port.

[377] https://opportunitycromartyfirth.co.uk/
[378] https://www.islandsdeal.co.uk/leading-way-low-carbon-future/dales-voe-ultra-deep-water-port
[379] https://www.stornowayportauthority.com/latest/49million-construction-contract-signed-for-new-deep-water-terminal-that-will-boost-the-economy-of-the-outer-hebrides/

- **Arnish**: Arnish already serves the marine energy sector. Previously operated by BiFab, the Arnish Point site is currently operated by Harland & Wolff following its purchase by InfraStrata, and recently hosted fabrication of jackets and substructures for the Beatrice Offshore Wind Farm.[380]
- **Kishorn**: Approval for expansion of the Kishorn site was granted in April 2021.[381] The re-development includes an extension of the dry dock. When completed, this will allow the port to receive vessels and structures up to 250 metres in length, thus enabling it to accommodate a wider range of marine projects for decommissioning, maintenance, and upgrading.[382]
- **Ardersier**: Following the purchase of the former Ardersier port facility, which served the oil and gas industry for the construction of platforms and steel jackets, redevelopment commenced in December 2021.[383] The port is targeting oil and gas decommissioning, circular economy, and logistics and manufacturing for offshore wind.[384] Ardersier was identified in the Scottish Offshore Wind Strategic Assessment Report[385] as having potential to form part of a floating offshore wind port cluster in the Cromarty Firth:

> *[T]he mothballed Ardersier port site…could in future be made a part of this [Cromarty Firth] Port Cluster. Ardersier would need significant development and must resolve dredging and access but does offer the potential for large scale concrete platform manufacturing if these challenges can be overcome."*

Other development opportunities

13.11 Increased activity in sectors such as offshore wind will drive an increase in demand for port services, and therefore in other parts of the supply chain. For example, Buckie port has been selected by Ocean Winds to be the operations and maintenance base for the Moray West windfarm.[386] Buckie's existing facilities and ability to serve smaller crew transfer vessels were key in this decision, demonstrating the need for and strategic importance of smaller ports.

13.12 Demand is expected for services such as anchor and chain handling, ancillary port operations, and other specific services, for example hydrogen storage and handling as this sector develops. Ports such as Inverness,[387] who already provide services to onshore wind and biomass, can respond to this demand and have access to significant development land as well as close proximity to road, rail and air connections.

Challenges facing the region's ports infrastructure

13.13 Limited availability of suitable port infrastructure in Scotland is a risk to the industry and the value chain. There are currently only a small number of ports in Scotland with the required depths and quay lengths to accommodate activity related to offshore wind or decommissioning, for example.[388,389,390] This is compounded by limited quayside areas and adjacent sites for laydown space capable of heavy load bearing, or hazardous waste capability in the case of decommissioning.[391] This market failure in infrastructure provision means that much of Scotland is

[380] https://energy.scottishports.org.uk/ports/stornoway-arnish
[381] https://www.highland.gov.uk/download/meetings/id/78042/63_applicant_kishorn_port_limited_2003541ful_pln02821
[382] https://www.maritimeprofessional.com/news/kishorn-port-eyes-offshore-wind-366999
[383] https://www.insider.co.uk/news/work-starts-ardersier-port-transformation-25590634
[384] https://ap.uk/
[385] Scottish Offshore Wind Energy Council (2021) Scottish Offshore Wind Strategic Assessment Report
[386] https://www.moraywest.com/news/moray-west-selects-buckie-as-operations-maintenance-harbour
[387] https://portofinverness.co.uk/
[388] Arup, for Crown Estate Scotland (2020) Ports for offshore wind: A review of the net-zero opportunity for ports in Scotland
[389] Ironside Farrar, for HIE, SE and CES (2021) Port Enhancements for Offshore Wind: Assessment of Current and Future Marshalling & Assembly Capacity in Scottish Ports
[390] Scottish Offshore Wind Energy Council (2021) Scottish Offshore Wind Strategic Assessment Report
[391] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors

unable to fully take advantage of emerging opportunities. Some Scottish ports are currently expanding and developing their deep-water facilities in response or have expansion plans.[392,393] Current and future needs from the range of potential users and uses will therefore not be adequately met by existing port infrastructure.

13.14 Recent research has identified that many harbours, ports and marinas, and other coastal infrastructure – particularly in smaller ports and harbours in Scotland – are either outdated or in disrepair and require modernisation and refurbishment. It is a particular issue for smaller harbours and marinas. Marine investment activity has appeared to have consolidated around strategically important ports (e.g., for fishing), or on major transport routes (e.g., new fisheries facilities in Peterhead). There is a market failure in terms of ensuring adequate port infrastructure to support the sustainable growth of marine sectors that rely on these ports and harbours. This is a result of limited access to finance in some cases, and co-ordination failures between different interest or user groups in others – i.e., significant costs or barriers to co-ordination or collaboration on port development, but no single group able to make a financially viable port without the contribution of other users. The development plans for Stornoway port are a good example of where such a co-ordination failure is being addressed to position the port to serve and target multiple sectors through its redevelopment.[394]

13.15 Modernisation, and the necessary diversification of activity required for viable operations, is difficult for many ports due to geography, configuration, geological and marine considerations, available space and so forth. To meet the needs of a range of marine sectors and activity, ports need to be multifunctional, whereas private or ring-fenced sectoral funding may be focused on singular functions or sectors. Spatial distribution of different activities across different ports and harbours may also impact on required refurbishment activity at ports, as may concerns around displacement arising from the regeneration of port infrastructure.

13.16 The supporting infrastructure of a port's hinterland, and connectivity on land can also serve to constrain ports. Transport links to and from the ports and the extent to which they can accommodate the size and shape of loads for offshore wind and other sectors is important to a port's capability and competitive advantage. For example, the transport connectivity of Inverness, which has good road and rail links, as well as close proximity to Inverness Airport, can arguably be considered better than those such as Kishorn and Ardersier, or even relatively nearby ports such as Nigg and Cromarty, giving it a competitive advantage in this regard.

13.17 As a result, the port infrastructure in Scotland has historically worked against development of supply chain and supporting activity for a number of Blue Economy sectors. Consequently, much of the activity is done elsewhere. For offshore wind, for example, equipment is manufactured in other countries such as Spain, because of the availability of deep-water ports, and shipped directly to the site – though there are other factors such as industry structure also at play here. In the case of seafood processing, much of the produce is transported by land to the central belt for secondary value-added processing and so transport links from relatively remote production and landing sites to key markets and distribution hubs is vital.

13.18 As discussed above and elsewhere in the report, many of Scotland's ports serve a number of different sectors across the Blue Economy. This will require adequate space and, in some cases, shared facilities for different activities and operations. For example, operation and maintenance activity for offshore wind and marine renewables requires considerable quayside lay-down areas. Some ports already provide for this (e.g., Nigg Energy Park). However, the needs of other sectors

[392] HIE/SE (2016) Oil & Gas Decommissioning Action Plan
[393] http://news.hie.co.uk/all-news/scottish-energy-ports-capability-directory-is-launched/
[394] https://www.hie.co.uk/latest-news/2019/february/14/funding-boost-for-stornoway-port-developments/

also require to be met. Aquaculture produce, and particularly seaweed with its high water content, is best processed close to where it is landed. It is not cost-effective to transport seaweed 'wet'. Previous studies have identified the lack of adequate processing facilities as a constraint on growth for aquaculture (and fisheries) produce.[395]

Opportunities

13.19 There are several opportunities and areas where investment should be considered regarding port and harbour development in the Highlands and Islands.

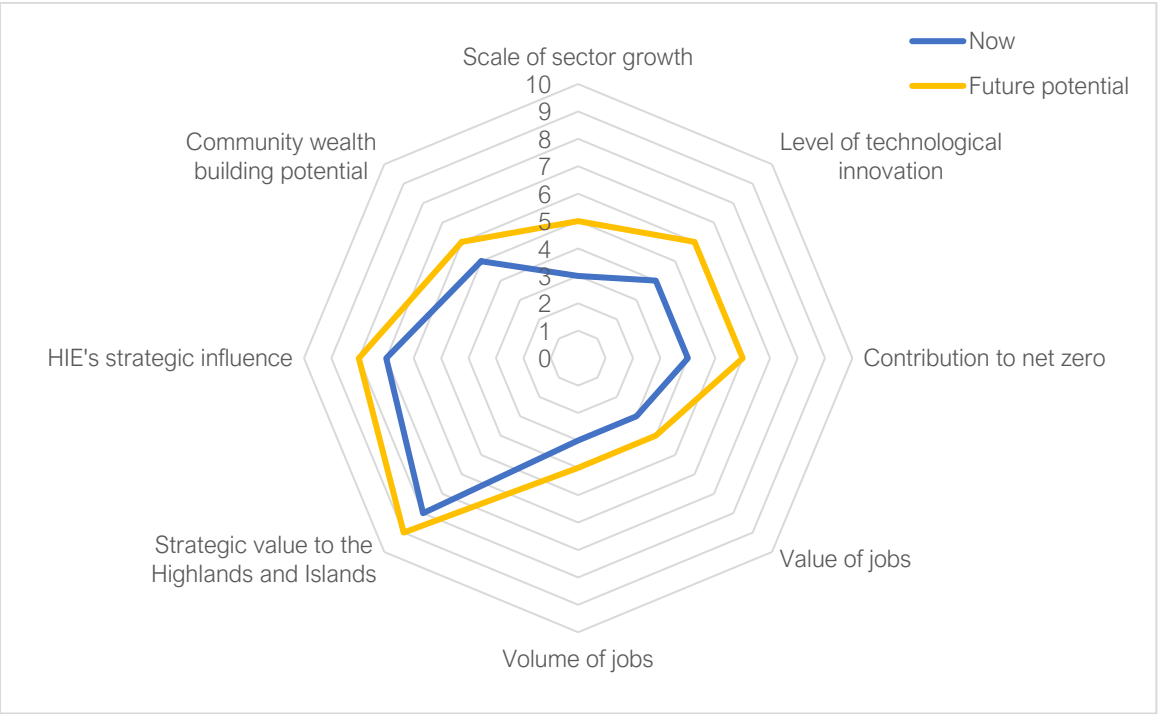
13.20 First, there will be an ongoing requirement for further investment across the region's port infrastructure if the opportunities and emerging markets associated with renewable energy in particular, are to be exploited. As sectors such as marine energy and renewables or oil and gas decommissioning develop, there is need for onshore facilities to support operation and maintenance or to provide lay-down areas.

13.21 ScotWind Offshore Wind Leasing in Scottish waters represents a significant opportunity as discussed earlier in the report. The value and opportunity is in option fees and increases in renewable energy generating capacity.[396] Potential investors are already actively developing local supply chains and sub-contractor relationships, with local content a key requirement. Overall, ScotWind submissions have typically been in deeper water, and this presents specific technological and engineering requirements, but also opportunities for new investment.

13.22 Similarly, there is an opportunity to respond to tourism-related developments. For example, prior to the COVID-19 pandemic the cruise industry in Scotland was growing, and a number of ports had targeted investment seeking to attract a larger market share. However, there were previously concerns around the pattern of growth of pressure on cruise ports and destinations arising from high volumes of cruise passengers. As this sector recovers, there is potential to better co-ordinate investment across ports and drive the adoption of port infrastructure that will reduce the environmental impact of cruise and other vessels and support the decarbonisation of water borne transport including service vessels.[397]

[395] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors
[396] https://www.crownestatescotland.com/news/scotwind-offshore-wind-leasing-delivers-major-boost-to-scotlands-net-zero-aspirations
[397] ekosgen, Reference Economic Consultants and Context Economics for VisitScotland/Scottish Enterprise/Highlands and Islands Enterprise/Scottish Government (2020) Cruise Tourism in Scotland: Review & Sustainable Development Opportunities

Figure 13.1: Current and future potential of ports and harbours in the Highlands and Islands



13.23 There is also an opportunity for port and harbour authorities and partners to address market failure through positive externalities. The wider benefits to communities and local economies around ports and harbours have not always been factored into the decision-making of investors and port operators regarding investment and facilities upgrading. Previous research[398] has identified that that there is a public good argument, as well as public safety considerations for driving investment in smaller ports, though in some cases this is now starting to be addressed. For example, through regional growth funds such as the Islands Deal,[399] and Ardrossan as part of the Ayrshire Growth Deal,[400] a number of ports and marinas are undergoing redevelopment and regeneration.

13.24 However, in considering these opportunities, there should be cognisance of the significant capital investment required in each instance, and the scale of investment required for new and upgraded infrastructure at a regional level. Investment in port upgrades will be substantial and should be de-risked as much as possible – through a visible project pipeline, public sector support, and by meeting the needs of multi-sectors, for example, other marine activities. The development of ports and harbours should encourage and enable the greening of water borne transport and services which will contribute to achieving social licence.

Requirements for responding to strategic opportunities

13.25 Stakeholders and studies related to port infrastructure in Scotland agree that the principal economic opportunities for Scotland's ports is responding to increasing demand amongst the offshore renewable energy sector (and specifically offshore wind – fixed bottom and floating), as well as for decommissioning in oil and gas (and over the longer term, in existing offshore wind installations). In recent studies reviewing and assessing Scotland's existing port assets and capacity to respond to market opportunities, there is a consensus regarding the requirements and capability of ports to achieve this. The overarching assessment is that there is a lack of capacity in terms of handling volume and laydown space.

[398] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors
[399] https://cne-siar.gov.uk/your-council/our-islands-our-future/islands-growth-deal/
[400] https://www.deliveringforscotland.gov.uk/ayrshire-growth-deal/

13.26 Arup's 2020 review of Scotland's ports in light of the opportunities related to offshore wind and net zero[401] identified that Scotland has good technical capability to support offshore wind port functions in some, but not all locations. However, the review noted a significant risk that existing port capacity is not sufficient to support the offshore wind build-out rates required in Scottish waters to meet net-zero targets. For operation and maintenance, adequate capability was identified across Scotland, but this is constrained by existing port uses and the scale of future offshore wind development. For marshalling and assembly there is adequate technical capability, but limited capacity – additional capacity is required in the form of sites with adequate laydown areas.

13.27 Following on from this report, Ironside Farrar's 2021 report on the port enhancement requirements for offshore wind[402] identified the need for lay-down areas and land-side capacity to support developments. This totalled 100-200 Ha of lay-down area by the late 2020s, and 200-300 Ha during the 2030s. In contrast, only around 50 Ha of current capacity exists. However, the report also identifies 68 Ha of latent capacity, and an additional 64 Ha through planned or consented projects. Nevertheless, the confidence or feasibility of these projects varies, and it is likely that at present, the supply is short of lower thresholds of potential future capacity demand. In terms of addressing barriers to realising port enhancements and capacity, the following observations were made regarding the Highlands and Islands ports:

- Cromarty Firth and Stornoway have limited engineering challenges, whilst Nigg, Orkney and Shetland present a degree of technical challenge but offer potentially significant scale;
- Orkney, Nigg, and Shetland could deliver capacity expansion of scale (>20 Ha) at relatively low orders of cost, whilst Lerwick, Cromarty and Stornoway could deliver mid-sized expansion of circa 5-10 Ha at similar orders of cost; and
- Nigg, Shetland and Orkney have high levels of consenting feasibility, utilising significant port footprints and hinterland to create additional laydown area. Lerwick, Stornoway, Cromarty, Campbelltown and Scrabster have small- to mid-sized expansion potential with moderate consenting feasibility.

13.28 Other opportunities also exist for the Highlands and Islands ports in responding to other sectoral opportunities, such as cruise tourism. The range of ports available in the Highlands and Islands and across Scotland, and the clear segmentation of cruise sub-sectors, is a strength of Scottish port infrastructure. Yet for many ports in Scotland, cruise is not a significant part of their business and operation. As a result, there is little conflict with other port uses. Recent and planned investments at Scottish ports demonstrates the ambition for developing the cruise sector in Scotland – not least the ambition for increased cruise activity at Stornoway. However, a similar challenge exists for cruise – that of limited capacity, or the inability of existing port infrastructure to accommodate increased activity. A recent report prepared by ekosgen for VisitScotland, recommended adopting a co-ordinated approach to public sector planning and investment in cruise-related infrastructure, balancing market demand, maximising the opportunity of cruise over other sectoral opportunities, and capacity and appetite to do so.[403]

[401] Arup, for Crown Estate Scotland (2020) Ports for offshore wind: A review of the net-zero opportunity for ports in Scotland
[402] Ironside Farrar, for HIE, SE and CES (2021) Port Enhancements for Offshore Wind: Assessment of Current and Future Marshalling & Assembly Capacity in Scottish Ports
[403] ekosgen, Reference Economic Consultants and Context Economics for VisitScotland/Scottish Enterprise/Highlands and Islands Enterprise/Scottish Government (2020) Cruise Tourism in Scotland: Review & Sustainable Development Opportunities

13.29 Local content is a key requirement for ScotWind tenders. However, without access to sufficient high-quality port capacity, the ability of the Highlands and Islands and Scotland to attract significant levels of activities such as fabrication, manufacturing, assembly, and O&M for offshore wind will be negatively impacted. Lack of capacity will also be a major barrier for decommissioning sectoral ambitions, as well as for exploiting other market opportunities in cruise, for example. The recommendations of the Scottish Offshore Wind Energy Council (SOWEC) Strategic Investment Assessment Report[404] recognise the impact that this may have, and in particular Recommendation One:

The offshore wind sector's priority must be the establishment of a collaboration framework focused on building confidence amongst Scottish ports, so that required investment is brought forward in time. The immediate priority of such a collaborative framework is supporting the creation of a Scottish Floating Offshore Wind Port Cluster.

13.30 Responding to opportunities in a piecemeal fashion, whether in offshore wind or in other sectors, is unlikely to result in a successful outcome. Any approach to port development, to ensure capacity and capability to respond to market opportunity, must be done in a joined-up and strategic manner.

13.31 The SOWEC Strategic Investment Assessment Report suggests the implementation of a collaborative framework to identify port needs.[405] Consultees agree that there is a need for co-ordination and collective working between strategic partners to identify and develop preferred options for port investment in response to market opportunity, rather than pursue a pattern of investment that could be considered either piecemeal or blanket, or one with limited co-ordination. It is critical to have capacity in the right place, especially in the case of offshore wind, which is considered to be a generational opportunity for the region, and for Scotland.

13.32 A port cluster approach would help to ensure that appropriate port capacity and capability is on offer to industry across multiple locations. This could help to ensure that the required capacity is where it is needed most. This could be achieved on a sectoral basis as per the SOWEC report, or done on a geographical basis as per the Ironside Farrar report, which identifies four clusters[406]:

- North-East Scotland Cluster, including Nigg, Cromarty and Orkney, as well as Aberdeen;
- Forth & Tay Cluster;
- West of Scotland Cluster encompassing Stornoway, Kishorn and Hunterston in Ayrshire, along with other west coast port such as Campbeltown; and
- Shetland Cluster.

13.33 Ultimately, the purpose would be to form strategic alliances, and work together to maximise the impact of targeted investment – an approach to 'pick the winners' on the basis of the market opportunity that presents itself, rather than spreading investment too thinly, either across all ports, or through open competition for investment, to realise any transformational impacts. For example, for offshore wind this should be in locations best placed to meet need; for decommissioning, there is a natural monopoly here in that it is not cost effective for all ports to have recycling facilities; therefore it is more advantageous to have strategic hubs and ensure they are not charging monopoly

[404] Scottish Offshore Wind Energy Council (2021) Scottish Offshore Wind Strategic Assessment Report
[405] Ibid.
[406] Ironside Farrar, for HIE, SE and CES (2021) Port Enhancements for Offshore Wind: Assessment of Current and Future Marshalling & Assembly Capacity in Scottish Ports

prices.[407] A lack of appropriate and co-ordinated investment in ports also runs the significant risk of failing to create a lasting legacy of the growth in offshore wind and other Blue Economy opportunities and seeing economic benefits in Scotland lost to other ports and countries.

Table 13.2: Sector summary, observations and opportunities: Ports and Harbours

Current position and status in the Highlands and Islands	• The Highlands and Islands has a large number of ports and harbours that fulfil a range of functions. They support activities such as aquaculture, fisheries, energy, tourism and marine transport.
Opportunities and growth potential	• There is substantial scope for ports and harbours in the Highlands and Islands to develop in response to market opportunities for example Cruise Tourism, decommissioning, marine renewables, and sustainable marine transport
Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• Ports and harbours are very important as strategic infrastructure to support activities and as a facilitator of economic and social development and growth.
Cross sectoral opportunities and synergy	• Ports and harbours are a cross-sector enabler. • Sustainable marine transport may require specific facilities to be available in ports and harbours to ensure reliable power supply.
HIE's role going forward	• Scottish Government is the strategic lead on this nationally important infrastructure. • HIE has established a Ports and Harbours Infrastructure Group. It will maintain a focus on ports and harbours infrastructure and help leverage additional funding for ports and harbour development.
Comments	• Investment in ports and harbours is extremely expensive. • Funding responsibility cannot lie with HIE. • To maximise impact at and enabling potential, resource and investment should be targeted at the ports and landside infrastructure. • A co-ordinated approach, potentially making use of clusters, should be taken to target investment at the most appropriate ports.

BLUE KNOWLEDGE

13.34 The Highlands and Islands has a rich base of marine science innovation and capabilities across a number of institutions and industry, as demonstrated in the MAXiMAR Science and Innovation Audit (SIA).[408] There is strong research and innovation infrastructure which, combined with the region's natural assets, and the high degree of 'blue' specialism makes it an unparalleled destination and resource for research and the development of new ideas in the marine economy.

13.35 As a result, it has a global reputation for research excellence which attracts significant funding, world-class talent, and collaborations. It provides a broad range of 'blue' learning, education and skills development through HE, FE, and work-based learning opportunities. As a key research destination, it attracts students studying at Masters and PhD levels, offering them opportunities to study and undertake research in specialist subject areas. It also makes it a leading destination for industry and others to test and develop new technologies, for example in marine renewable energy, unmanned vehicles, aquaculture (including seaweed), hydrogen and sustainable transport.

13.36 These knowledge-based activities make important contributions to the economic and social health of the region. In addition, they provide strategic added value for the Highlands and Islands and Scotland by raising its profile and establishing its reputation on the world stage. The wider

[407] ekosgen, for Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors
[408] https://www.hie.co.uk/research-and-reports/our-reports/2019/march/06/maximar-science-and-innovation-audit/

impact of this on the region should not be under-estimated, for example in attracting inward investment.

Blue Knowledge activities and infrastructure

13.37 This section provides an overview of the blue knowledge economy infrastructure in the Highlands and Islands and the key institutions. However, it is also important to recognise the importance of industry in research and innovation and the fact that blue growth businesses in the Highlands and Islands have secured substantial R&D grants to invest in technology and developments across biotechnology, energy, aquaculture, and seafood processing. In addition, the Islands Growth Deal includes a number of blue economy projects that will form part of the blue knowledge economy. These include:

- The Islands Centre for Net Zero;
- The Shetland Ocean Energy Project;
- Scapa Flow Future Fuels Hub (cleaner fuels for shipping);
- The Outer Hebrides Energy Hub; and
- Shell-volution;

13.38 The campus redevelopment projects will also boost the wider knowledge economy of the three islands groups, and it is likely that this will include blue economy-related education and learning.

University of the Highlands and Islands (UHI)

13.39 UHI has expertise in aquaculture and biology, covering the areas of health and welfare; sustainable aquafeeds; the interface between the environment and aquaculture; stock improvement and management; socioeconomic linkages and analysis; and diversification of aquaculture practices.[409] There is a range of 'instrumentation, laboratories and vessels for its staff to deliver world-class research, commercial projects and consultancy services to both academic and commercial organisations'. Facilities include a cell culture laboratory; biochemistry and functional assay laboratory; molecular biology and genetics laboratory; proteome laboratory; mass spectrometry suite; and bioinformatics and data mining tools.[410]

13.40 UHI hosts a range of research centres related to the Blue Economy. For example, UHI is home to the Scottish Association for Marine Science (SAMS UHI), 'an internationally recognised centre of expertise in marine environmental science'.[411] SAMS UHI has particular expertise in 'aquaculture, marine biotechnology, marine renewable energy, oil and gas and industrial impacts,' adopting 'a multidisciplinary and multi-sectional approach to work with industry and regulators to drive forward marine economic developments within the limits of resilience of the socio-ecological system'.[412] SAMS UHI has over 70 researchers and research scientists working under the Blue Economy theme and 30 PhD students.[413]

13.41 UHI is also home to a wave and tidal renewable energy cluster, hosting a Marine Energy Research Innovation and Knowledge Exchange Accelerator (MERIKA). MERIKA is funded by the EU and provides investment for academics, infrastructure, knowledge exchange and support for collaboration and partnerships; there are also efforts to develop links with businesses and promote

[409] https://www.uhi.ac.uk/en/research-enterprise/res-themes/mese/aquaculture/
[410] https://www.uhi.ac.uk/en/research-enterprise/res-themes/mese/aquaculture/facilities-and-equipment/
[411] https://www.uhi.ac.uk/en/campuses/scottish-association-for-marine-science-uhi/
[412] https://pure.uhi.ac.uk/portal/en/organisations/sams-theme-blue-economy(f99521d0-918d-4864-b72a-6d1c0e684c30).html
[413] https://www.sams.ac.uk/people/

innovation.[414] Its work covers resource and risk; the social, economic and policy dimensions of marine renewable energy; the effects of marine renewable devices on the environment and ecology; and marine terrestrial geographical survey.[415]

13.42 In addition, the Environmental Research Institute (ERI) in Thurso, Caithness, has the mission 'to address contemporary environmental issues and advance understanding of the sustainable use of the Earth's natural resources.[416] It focuses on three key themes: environmental contamination and ecological health; carbon water and climate; and renewable energy and the environment. It provides a range of services in renewable energy, marine renewables, organics analysis, element analysis, water quality analysis and microscopy.[417] It has a number of facilities, including marine survey and instrumentation and analytical instrumentation[418] and the Centre for Energy and the Environment (CFEE), which offers a laboratory, meeting and office facilities.[419]

13.43 The North Atlantic Fisheries College (NAFC) merged with Shetland College to form Shetland UHI in August 2021. Shetland UHI has a very strong reputation for the delivery of training and education, research and development as well as the provision of consultancy, advisory and other services for the maritime industries. It hosts a range of facilities, operates a number of vessels for research, survey, training and other purposes, a ship bridge simulator, research/ teaching laboratories and marine hatchery. Many of these can be hired for use by industry or used in collaborative projects.[420]

13.44 As part of the knowledge economy, UHI provides a range of support services for businesses, such as research, innovation, and consultancy through its knowledge exchange team.[421] Support includes collaborative research; consultancy services; providing specialist university facilities, equipment and testing services to companies; secondment and placement positions; and research commercialisation.[422] Shetland UHI has an ambition to establish a Centre of Sustainable Seafood as part of its activities.

13.45 UHI has an Aquaculture Industry Engagement Fund (AIEF) which aims to facilitate engagement between the knowledge, science and innovation resources at UHI and the aquaculture industry (in its broadest sense so includes commercial and regulatory sectors, etc.). It does this by funding 'Knowledge Exchange activities between the UHI Aquaculture Hub and Scotland's aquaculture industry'.[423]

European Marine Energy Centre

13.46 Established in 2003, the European Marine Energy Centre (EMEC) was created to help position the UK as a leader in marine renewables technologies. It is the UK's national offshore wave and tidal test centre and is the world's only centre to provide purpose-built testing facilities to developers. It offers purpose-built open sea testing facilities, operating two grid-connected accredited test sites and two scale test sites for smaller scale devices to be tested. EMEC leads and participates in a wide range of UK-funded projects and has also helped to lever in significant EU funds across more than 20 projects through ERDF Interreg, Ocean ERA-NET and Horizon 2020.

[414] https://www.uhi.ac.uk/en/research-enterprise/res-themes/mese/energy/marine-renewables/
[415] https://www.uhi.ac.uk/en/research-enterprise/res-themes/mese/energy/marine-renewables/
[416] https://eri.ac.uk/
[417] https://eri.ac.uk/services/
[418] https://eri.ac.uk/services/facilities/
[419] https://eri.ac.uk/about-us/
[420] https://www.nafc.uhi.ac.uk/
[421] https://www.uhi.ac.uk/en/business/ric/
[422] https://www.uhi.ac.uk/en/business/ric/
[423] https://www.uhi.ac.uk/en/research-enterprise/res-themes/mese/aquaculture/aief/

13.47 In recent years, there has been an increasing recognition and focus on hydrogen technologies as part of the transition to net zero and EMEC is at the forefront of this with a number of hydrogen projects. The Eday Flow Cell Battery project is an onshore hydrogen production plant in Eday (Orkney) to generate hydrogen from tidal and wind energy.[424]

13.48 It is also working on projects on the development of floating offshore wind and clean energy systems. For example. EMEC is leading the seven other AFLOWT (Accelerating market uptake of Floating Offshore Wind Technology) partners on this EU funded project which has a total budget of 31.13m Euros. Running to 2023, AFLOWT aims to demonstrate the survivability and cost-competitiveness of a floating offshore wind technology and support the development of a supply chain.

13.49 EMEC is leading the £28.5m ReFLEX (Responsive Flexibility) project which is aimed at creating an integrated energy system (IES) in Orkney. ReFLEX is funded by UKRI through the Industrial Strategy Challenge Fund and is a cross-sector partnership including Aquatera, SMS (smart energy services), Community Energy Scotland, Heriot-Watt University and Orkney Islands Council. The project will interlink local electricity, transport, and heat networks into one controllable, overarching system, coupling renewable energy with flexible demand assets like batteries and electric vehicles to maximise the use of generated energy.[425]

Heriot-Watt University

13.50 Heriot-Watt University's International Centre for Island Technology (ICIT) is part of the School of Energy, Geoscience, Infrastructure and Society at Heriot-Watt University, based in Stromness. It is described as 'a living laboratory' which focuses on research in the following areas: marine science and biodiversity; the oil and gas sector; fisheries; surveying; data modelling; marine planning and policy; and marine renewable energy.[426] The Centre's research has focussed on developing marine renewable energy, particularly in the Pentland Firth and Orkney Waters area. The ICIT links with industry, through its teaching, research, and consultancy work. Researchers provide consultancy services, working with government, statutory bodies, and industry, in areas including marine energy resource assessment, socioeconomic impacts and fisheries science and fisheries.[427]

Wave Energy Scotland

13.51 Wave Energy Scotland was established in response to challenging conditions within the wave market and a lack of private investors. It runs the world's largest wave technology development programme, driving the search for innovative solutions to the technical challenges facing the wave energy sector, through its challenge-led innovation funding programmes. The aim is to support the development of technology to provide cost effective, reliable wave energy generation and so contribute to net zero ambitions for clean energy and developing an internationally competitive wave energy industry. Examples include wave energy convertor technologies, programmes to develop power take-off technology, advanced control systems and structural materials. The competitive programmes are open to innovators from across Europe with Scottish companies representing 70%. This underlines the dominance of Scotland in the wave sector and innovation. Wave Energy Scotland acquired the IP for two wave device developers, Pelamis and Aquamarine. Whilst these two relatively high-profile company failures demonstrated the lack of

[424] http://www.emec.org.uk/projects/
[425] http://www.emec.org.uk/projects/
[426] https://www.hw.ac.uk/schools/energy-geoscience-infrastructure-society/research/iles/icit.htm
[427] https://www.hw.ac.uk/schools/energy-geoscience-infrastructure-society/research/iles/working-with-industry-at-icit.htm

market readiness for investment in nascent wave energy technology, the retention of the IP within the region ensures that the significant learning from these investments has been retained in Scotland and can be used to support the development of new technology.

13.52 Since its inception in 2014, Wave Energy Scotland has funded 132 contracts, committed £50m, and been involved with 230 organisations over 13 countries. This firmly places the Highlands and Islands at the centre of wave energy innovation and development and adds strategic value to the knowledge sector of the region.

Wider Scottish context

13.53 The expertise and activities in the Highlands and Islands sit within the context of significant blue economy research and innovation in Scotland and alignment, collaborations and synergies benefit the Highlands and Islands and Scotland as a whole. As an example, the FloWave Ocean Research Facility at the Institute of Energy Systems at the University of Edinburgh provides facilities to run model scale testing of wave and tidal energy devices. This de-risks and helps to refine the performance of first protype devices as well those that are already in the water at EMEC by allowing designs to be revised and refined in smaller scale.

13.54 The University of Stirling has expertise in aquaculture and fisheries and a worldwide reputation. Its Institute of Aquaculture, part of the Sustainable Aquaculture Innovation Centre (SAIC) network aims to tackle global problems of food security and sustainability through aquaculture.[428] It is a research and business hub providing consultancy, scientific collaboration and expertise to develop new technology and practice in aquaculture. Its work spans breeding and stock improvement; health; nutrition; aquaculture systems; and welfare and behaviour. The Institute has four research facilities providing a range of environmental conditions: marine, freshwater, temperate and tropical. It works with the aquaculture sector, including in the Highlands and Islands, providing consultancy services across a range of issues such as water quality analysis, veterinary diagnostics, and vaccine and therapeutant testing.

13.55 The Institute hosts the Marine Environmental Research Laboratory (MERL) at Machrihanish, Campbeltown, which offers contract research and facilities to industry and academic institutions including pharmaceutical development for salmonid aquaculture.

13.56 The Institute for Aquaculture was awarded £17m funding through the Stirling and Clackmannanshire City Region Deal to develop a new aquaculture facility. The facility will provide the full range of marine environmental conditions and so enhance research and development opportunities in Scotland.

13.57 Also at Stirling, SAIC works to 'connect industry with academics to encourage collaboration on priority issues; share insights and knowledge and attract funding into Scottish aquaculture. It hosts an Innovation Network, including incubators and accelerators; investors and funders; innovation centres; international collaboration; and advisory organisations.

13.58 The Offshore Renewable Energy Catapult (ORE Catapult) is a UK-wide technology innovation and research centre for offshore renewable energy. It aims to help the sector to deliver applied research, accelerate technology development, reduce risk and cost, and enhance UK-wide economic growth through the creation and growth of companies in the offshore renewable energy sector. Based primarily in the North East of England, it also operates in Glasgow and Levenmouth.[429]

[428] https://www.stir.ac.uk/about/faculties/natural-sciences/aquaculture/
[429] https://ore.catapult.org.uk/

Table 13.3: Sector summary, observations and opportunities: Blue knowledge

Current position and status in the Highlands and Islands	• Scotland and the Highlands and Islands have strengths, and a strong enabling infrastructure and institutions have international profile, partnerships and reputation.

Opportunities and growth potential	• Strengths to build on including EMEC, SAMS UHI, European Marine Science Park, and NAFC.
	• Opportunities to develop:
	  ○ Provision of short, industry focused learning.
	  ○ More collaboration with industry on research, deployment and testing.

Strategic importance to the Highlands and Islands and Scotland *Economic, Social, Environmental, Enabling infrastructure*	• The international reputation is strategically important for the Highlands and Islands. • It keeps the Highlands and Islands on the Blue Economy 'map' through international research projects and collaborations. • Attracts high level skills and academic expertise, as well as students.
Cross sectoral opportunities and synergy	• Blue knowledge in the Highlands and Islands supports the range of sectors through research, development and education. • Continue to identify skills needs and respond with provision to address gaps, including career changers and upskilling existing workforces.
HIE's role going forward	• HIE works in close partnership with UHI and other universities with a presence in the region. This should continue. • HIE is well placed to broker more industry/education/knowledge collaboration to identify issues and develop solutions.
Comments	• A need for coordination across areas, to facilitate know-how exchange, as well as scaling up.

14 BLUE ECONOMY CLUSTERS

INTRODUCTION

14.1 This chapter presents an overview of a sample of Blue Economy clusters around the world, to provide a comparison of Blue Economy-focused activity, as well as learning points for HIE to draw on in developing its own approach to the Blue Economy in the Highlands and Islands. After setting out the rationale for selecting the clusters under consideration, it provides a summary analysis of their key features, including geographical distribution and spatial focus, the types of clusters, their common themes, sectoral focus, and ways of working. The chapter also provides a discussion of approaches to superclusters and government support to clusters, for a more complete picture of how clusters function and factors contributing to successes. Finally, it draws out a number of key learning points for the Highlands and Islands in relation to development of the Blue Economy in the region.

CLUSTERS UNDER CONSIDERATION

14.2 The sample of twelve cluster listed in Table 14.1 have been selected to provide an overview of different types and approaches taken by Blue Economy clusters globally. These are not intended to serve as a definitive or exhaustive list of Blue Economy clusters; instead, they are illustrative of the types of clusters that exist, and activities undertaken within them. The examples include a range of different cluster types:

- Clusters structured as virtual networks or platforms (e.g., OceansAdvance in Newfoundland and Labrador Canada[430]);
- Clusters operating as start-up/SME incubators (e.g., Alaska Ocean Cluster[431] in Alaska, USA and Scottish Blue Economy Cluster Builder[432], or the Iceland Ocean Cluster[433]) or quasi-incubators (e.g., International Blue Co-operative headquartered in Québec Canada[434]);
- Clusters actively driving innovative research projects (e.g., Washington Maritime Blue[435] in Washington State, USA, or Blauwe Cluster[436] in Flanders, Belgium) or training opportunities (e.g., Pole Mer Bretagne Atlantique[437] in France); and
- Clusters providing common user facilities (e.g., Australian Marine Complex (AMC)[438] in Perth, Australia, in particular with its Common User Facility (CUF)[439], or New England Ocean Cluster[440] in New England USA with their collaborative space Hús[441]).

14.3 These clusters cover the wide breadth of activities and purposes that a Blue Economy cluster can have and give an overview of the approaches that could be deployed in the Highlands and Islands. Table 14.1 summarises each cluster, and the rationale for its consideration.

[430] http://www.oceansadvance.net/
[431] https://www.alaskaoceancluster.com/
[432] https://www.scottishblueeconomy.co.uk/
[433] https://www.sjavarklasinn.is/en/
[434] https://blue-coop.org/
[435] http://maritimeblue.org/
[436] https://www.blauwecluster.be/about
[437] https://www.pole-mer-bretagne-atlantique.com/en/
[438] https://developmentwa.com.au/projects/industrial-and-commercial/australian-marine-complex/about-the-amc
[439] https://www.australianmarinecomplex.com.au/common-user-facility
[440] https://www.newenglandoceancluster.com/
[441] https://www.newenglandoceancluster.com/the-hus

Table 14.1: Shortlisted comparators reviewed in detail

Cluster	Rationale
Australian Marine Complex (AMC), Perth WA Australia	A physical centre founded in 2003, hosting over 150 businesses. The AMC is organised into five precincts (shipbuilding, technology, support industry, fabrication, and recreational boating), each with a particular service focus. The AMC as a whole, services the defence, marine, oil and gas, and resource industries. Within the fabrication precinct and owned by the WA Government is the Common User Facility (CUF): this is a 400 Ha facility which specialises in integrated heavy engineering, and fabrication and assembly.
Washington Maritime Blue, Washington State USA	Founded in 2018 as a partnership between industry, public sector, research and training institutions, and community organisations, to promote sustainable industry development in Washington State through accelerating innovation for a Blue Economy. The vision of the Washington Maritime Blue focuses on sustainability for the Blue Economy: their strategy revolves around giving their members networking and knowledge sharing opportunities, facilitating joint innovation projects (including access to funding), and supporting workforce development and entrepreneurship.
Scottish Blue Economy Cluster Builder, UK	A 3-year programme to communicate and raise awareness of the benefits of the Blue Economy in Scottish SMEs and enable them to take advantage of new opportunities. Launched in 2020, with the aim of supporting the growth of the Blue Economy in Scotland.
Blauwe Cluster, Flanders Belgium	Founded in 2018 to bring together private and public sector blue economy stakeholders to streamline projects related to innovative Blue Economy. It has nearly 200 members and partners, 85% of which are enterprises. The Blauwe Cluster's covers a number of sectors, most notably (offshore) renewable energy. The Cluster also has two cross-sectional areas of focus: ecosystem approach, and smart sea.
International Blue Co-operative, Québec Canada	Global network of blue producers of marine ingredients used in a variety of industries (feed, food, cosmetics, pharmaceuticals, biomaterials etc.), initiated in 2018. The Co-operative works by helping rural communities invest in new equipment and facilities. The Co-operative is also in the process of establishing a trading platform.
Iceland Ocean Cluster	Reykjavik-based marine cluster in Iceland, established in 2011. The Iceland Ocean Cluster's mission is to create value by connecting together entrepreneurs, businesses and knowledge in the marine industries. It has over 70 cluster members. Its internationalisation strategy targets co-operation in Norway, Denmark, China and USA (including an advisory partnership with the New England Ocean Cluster. The Iceland Ocean Cluster offers incubation space in its Ocean Cluster House (Hús Sjávarklasans) and education/training through the Ocean Academy (Sjávarakademían). The Iceland Ocean Cluster also provides research and consultancy services.
Alaska Ocean Cluster, Alaska USA	Start-up accelerator founded in 2017 and focusing on innovations that bolster the Alaskan Blue Economy, and healthy, thriving oceans around the world. The cluster concept involves a coalition of private, public, and academic stakeholders forming around a base industry and, in the process, supporting both the industry and each other through economic transactions and circulated assets.
Killybegs Marine Cluster, Ireland[442]	Established in February 2021 and launched in April 2022. The Cluster is part of Enterprise Ireland's National Clustering programme and is the only one of the twelve clusters in the programme dedicated to the Blue Economy, specifically to improving the competitiveness of its member companies. The Killybegs Marine Cluster uses a quadruple helix approach, which comprises a blend of industry, academia, government, and community support.

[442] https://kmc.blue/

Cluster	Rationale
Pole Mer Bretagne Atlantique, France	The cluster, created in 2005, has a network of more than 300 members, half of them SMEs and a management board of 26 members with representation for all its stakeholder groups, as well as a cross-sector experts' team. Pole Mer has identified a number of strategic areas with related objectives and key issues, which it focuses on when supporting innovative projects. Furthermore, the Pole Mer collaborates with education and training institutions to accredit their marine-related courses.
OceansAdvance, Newfoundland and Labrador Canada	Started in 2005 to unite Blue Economy leaders across research, academia, industry, and government, OceansAdvance now has a cross-sector membership, including more than 90 export-driven companies. Its aim is to connect industry, academia, and government to promote growth, innovation, and talent in the ocean sector in Canada.
New England Ocean Cluster, New England USA	Created in 2014, the New England Ocean Cluster aims to connect Blue Economy companies through a collaborative workspace (the Hús), network facilitation, workgroups, and regular events. It is currently involved in two projects, the first on transforming the Blue Economy through education and community involvement, and the second on inclusion of entrepreneurs from under-represented demographics.
GCE Blue Maritime Cluster, Norway[443]	Established in Ålesund in 2004, the GCE Blue Maritime Cluster is a global pioneer in design, construction, equipment and operation of advanced offshore vessels for the global oil and gas industry. The Cluster has about 140 members: 114 SMEs, including 3 start-ups, 16 large companies, and 7 research organisations, universities, and technology centres.

GEOGRAPHICAL AND SPATIAL FOCUS

14.4 The majority of clusters have a regional focus: this is the case for the AMC, Washington Maritime Blue, Scottish Blue Economy Cluster Builder, Iceland Ocean Cluster, Blauwe Cluster, Alaska Ocean Cluster, Pole Mer Bretagne Atlantique, OceansAdvance, and New England Ocean Cluster. It should, however, be noted that regional focus areas can vary a lot in size – this is certainly the case for the AMC, which as a Western Australia state facility covers over 10,000km of coastline, and is situated on the Indian Ocean – but also works nationally with the Federal Australian Government.[444] In contrast, the Blauwe Cluster in Flanders covers a portion of the Flemish coastline from Ostend to Knokke-Heist (approximately 30km).

14.5 The Blue Maritime Cluster in Norway and Killybegs Marine Cluster in Ireland have a national focus. Both have a remit to drive innovation and competitiveness: Killybegs Marine Cluster is part of the National Clustering programme driven by Enterprise Ireland, whilst the Blue Maritime Cluster was designated a Global Centre of Excellence (GCE) by the Norwegian Government in 2014, along with GCE Node in Kristiansand and GCE Ocean Technology in Bergen.[445] In the Norwegian case, the three GCEs cover nearly all of Norway's maritime industries and its extensive coastline. Meanwhile, the International Blue Co-operative based in Canada has an international remit.

14.6 Thus, the focus of these clusters is arguably driven by the functional area of the marine space that they serve, and in turn the extent of the economic activity that it supports.

[443] https://www.bluemaritimecluster.no/gce
[444] https://developmentwa.com.au/projects/industrial-and-commercial/australian-marine-complex/common-user-facility
[445] https://www.theexplorer.no/stories/ocean/norway-has-a-unique-culture-for-blue-growth/

ACTIVITY AND FUNCTIONALITY OF CLUSTERS

14.7 As discussed above, the example clusters include many types: virtual networks or platforms, start-up/SME incubators or quasi-incubators, clusters actively driving innovative research projects or training opportunities, and clusters providing open-access common user facilities. These functions do not exist in isolation, and clusters combine two or more of these elements, e.g., by providing their members with a network as well as common user facilities, like the New England Ocean Cluster does with the combination of the Hús with network groups and events.

14.8 To better understand how clusters function, it is useful to first discuss their approach to focus sectors, and the common themes across cluster's missions and visions.

Cluster activity

14.9 Blue Economy clusters typically have four main ways to pursue their goals, which are set out below:

Forums for networking and discussion

14.10 Most Blue Economy clusters, and certainly the network ones, act as virtual or physical meeting spaces for stakeholders from private, public, and third sector, as well as education and training institutions. These forums for discussion increase connectivity between cluster members, allowing for knowledge exchange.

14.11 This is sometimes done by ensuring that the management board of the cluster itself is a platform for collaboration. For example, the management board of the Pole Mer Bretagne Atlantique[446] includes one representative each for the four stakeholder groups, i.e.

- Large companies;
- SMEs;
- Universities, HE institutes, training centres and research and innovation organisations; and
- Innovation-led professional bodies and economic development agencies.

14.12 In other cases, it is the activities coordinated by or through the cluster that promote partner engagement. This is the case for the New England Ocean Cluster, which runs a collaborative workplace, the Hús (Icelandic for House), which is home to the cluster's start-up incubator as well as its rentable desks, offices, and meeting spaces. The Hús functions as a gathering place for the New England Ocean Cluster's network members and collaborators.[447] The Iceland Ocean Cluster also provides similar networking and collaborative facilities and services through its Ocean Cluster House (Hús Sjávarklasans).[448]

Projects

14.13 As discussed in greater detail below, clusters can push their strategies by promoting or facilitating projects aligned with their missions and objectives. The Blauwe Cluster in Flanders supports a range of projects to advance innovation in the Blue Economy, for its sustainable development.[449] Pole Mer Bretagne Atlantique[450] and Washington Maritime Blue[451] are also good examples of how clusters support projects to further their strategic objectives.

[446] https://www.pole-mer-bretagne-atlantique.com/en/
[447] https://www.newenglandoceancluster.com/the-hus
[448] https://www.sjavarklasinn.is/en/the-ocean-cluster-house/
[449] https://www.blauwecluster.be/projecten
[450] https://www.pole-mer-bretagne-atlantique.com/en/
[451] https://maritimeblue.org/joint-innovation-projects/

Incubators

14.14 Incubator clusters can help the healthy development of start-ups and SMEs by providing a supportive ecosystem that facilitates growth. The Alaska Ocean Cluster does this through a focus on sustainability: its staff and network of mentors support start-ups to draft a scope of work tailored to their individual needs, including helping start-ups connect with grant programs, investors, and other potential sources of funding.

14.15 The New England Ocean Cluster, on the other hand, helps start-ups develop by providing them with a collaborative workplace, which functions as a gathering place for members and collaborators, as well as workshops and events. Workgroups in particular can lead to large-format events, the creation of a new company, or the launch of a new product.

14.16 Even clusters that are not positioned as incubators can help SMEs develop by providing them with market intelligence, and up to date news and opportunities. The Scottish Blue Economy Cluster Builder offers biweekly newsletter/bulletin and periodic targeted market intelligence reports.

Partnerships

14.17 Recognising the international dimension to the marine environment, many clusters have built cross-(maritime) border partnerships through external collaborations:

- The Blauwe Cluster has facilitated collaboration on projects with partners from Flanders, the Netherlands, the UK, France, and Germany. It has partnered with other European partners including blue clusters on the ELBE+ marine energy project.[452] Blauwe Cluster is also a partner of Flanders Investment & Trade, the Flemish Agency that facilitates investment projects in Flanders and supports Flemish export companies;
- OceansAdvance collaborates with the BlueTech Cluster Alliance,[453] a global network of industry led BlueTech clusters, along with a range governmental agencies, education and training institutions, industry associations, and research organisations;
- The GCE Blue Maritime Cluster is a partner in Ocean Energy Scale-up Alliance (OESA), the international partnership to accelerate the scale up of five ocean energy pilots;
- The New England Ocean Cluster has a number of network collaborations with partners in Iceland (including the Iceland Ocean Cluster), Norway, Greenland, New Bedford (MA), Seattle (WA), and Alaska.

Other types of cluster activity

14.18 The Common User Facility (CUF) at AMC is a physical space dedicated to integrated heavy engineering and fabrication and assembly. Through the CUF the AMC offers its members substantial infrastructure capacity for multiple users concurrently, on an open access basis, across 400 Ha. It also provides immediate access to support and technology services. This facilitates efficiency and innovation for single members, and potentially valuable knowledge exchange across members.

[452] https://www.blauwecluster.be/project/elbe-plus-european-leaders-blue-energy
[453] https://www.bluetechclusters.org/

14.19 In addition, the International Blue Cooperative is in the process of establishing a trading platform, which will facilitate interactions between the producers and the industry players by automating all transactions between members and allowing them to collect relevant data on the blue economy and on upcoming trends. This aims to help small producers, often from rural communities, scale up their value chain by providing them with a more level playing field.

Focus sectors

14.20 Based on the evidence from these examples, clusters often operate across Blue Economy sectors. Network clusters, for example, promote growth in the Blue Economy by bringing different players together, and draw on their sector-specific expertise and knowledge to help find synergies across different Blue Economies sectors. This helps to stimulate innovation and cross-sector collaboration. OceansAdvance's target sectors, for example, are varied: this network cluster covers aquaculture, defence and security, fisheries, ocean observation and science, marine transportation, and offshore energy. OceansAdvance's members from all these sectors cross their paths and share their knowledge on the cluster's international forum for discussions in ocean technology.

14.21 Similarly, innovation and incubator clusters also operate across Blue Economy subsectors: their added value is in their ability to evaluate the validity of projects and their application to different Blue Economy sectors, to stimulate and support the development and delivery of research and innovation projects, and to help entrepreneurs access funding. This is something that the clusters (or cluster co-ordinators) can do across a range of Blue Economy activities without the need for specialisation. For example, the Alaska Ocean Cluster works with start-ups connecting them with industry partners, community leaders, scientific advisors, and investors with an interest in sustainable development of the Blue Economy, with the aim of protecting or enhancing the quality of the marine environment.[454] This is done without an explicit focus on specific Blue Economy sectors. The Washington Maritime Blue cluster takes a similar approach. The Blauwe Cluster in Flanders supports (or has supported) projects across renewable energy, marine biotechnology, coastal protection and environmental monitoring.[455]

14.22 Some clusters are somewhat more specialised. They focus their projects and actions on a smaller number of Blue Economy sectors. An example is the AMC, whose services focus on shipbuilding, marine infrastructure and technology to support the operation of other Blue Economy sectors. This includes its 400 Ha open-access CUF in the AMC's fabrication precinct.[456]

[454] https://www.alaskaoceancluster.com/portfolio
[455] https://www.blauwecluster.be/projecten
[456] https://developmentwa.com.au/projects/industrial-and-commercial/australian-marine-complex/about-the-amc

Figure 14.1: Australian Marine Complex, Western Australia

Source: DevelopmentWA, 2022

14.23 The GCE Blue Maritime Cluster in Norway specialises in the design, construction, equipment and operation of advanced offshore vessels, infrastructure and supporting technology for marine operations, originally for the global oil and gas industry, but now for a broader range of sectors including cruise. The cluster has established itself as a pioneer in technology development and operations at sea.

Themes

14.24 Despite the differences in cluster configuration and sector specialisation, the clusters considered show a commonality of themes across their visions and strategic objectives. There are four common themes for Blue Economy Clusters: innovation, sustainability, inclusion, and security.

14.25 Clusters often promote and co-ordinate projects related to **innovation** in the Blue Economy. These could relate to the development and adoption of new technologies and to the modernisation of infrastructure, often through applications of digitalisation and other smart technologies at sea. Innovation could also be in the digitalisation of the workforce, a theme that expands beyond the Blue Economy and resonates with the economy as a whole. Generally, clusters can provide members access to research, development and innovation they would not otherwise have access to. Thus, clusters play an important role in accelerating innovation and growth, helping enterprises overcome barriers to project feasibility and market readiness.

14.26 Clusters also give an important focus on **sustainability**. Sustainability concerns extend from sustainable fishing and aquaculture to the decarbonisation of all Blue Economy activities, including within the oil and gas sector and in waterborne transportation. Sustainability is a core motive for the development of renewable energy and marine biotechnologies. This includes better environmental monitoring and capturing of data – a particular challenge with regard to the Blue Economy and understanding the impact of economic activity on the natural resources on which this activity depends.[457] The Blauwe Cluster[458], Alaska Ocean Cluster[459] and OceansAdvance all support projects aimed at improving data capture in the marine environment.[460]

14.27 Another theme of Blue Economy clusters is **inclusion**, by building local economic diversification and by increasing numbers of under-represented groups. Building inclusion through local economic diversification can be done by raising awareness for the members, especially start-up and SME members or companies from under-developed or rural areas, and by helping these smaller members access funding and grow. This is a strong feature of the Washington Maritime Blue and the New England Ocean Cluster for example, as both have explicit underpinning values of inclusion and community engagement and resilience. Clusters can also target entrepreneurs from demographics traditionally under-represented in the marine space. A good example of this is the New England Ocean Cluster's work to address gender imbalance in Blue Economy sectors through its *Inclusion in the Blue Economy* programme.[461] Also, OceansAdvance undertakes outreach activity to engage young people[462] and Inuit communities[463] in its activity and work.

14.28 Finally, Blue Economy clusters can also be concerned with increased **security**, in its broadest sense. Marine defence, in particular, can include both maritime territorial defence and enhancing environmental protection. When considered in conjunction with increased data capture and environmental monitoring as discussed above, Cybersecurity can contribute to more awareness and increased competence being applied to Blue Economy activities.

SUPERCLUSTERS AND GOVERNMENT SUPPORT TO CLUSTERS

14.29 Clusters often operate within wider support structures. This could be in superclusters that tie together already existing collaboration networks for example, or within structures of support set up by governments and intergovernmental organisations. A feature of many of the clusters under consideration is the provision of funding, in-kind or strategic support – or the cluster itself being an initiative of a government agency, as in the case of the Killybegs Marine Cluster. Providing the clusters with a wider support framework can enable them to be more successful in achieving strategic objectives, and ultimately achieve better outcomes for their own members.

14.30 Norway has a supportive system for clusters, with funding and recognition such as the 'Global Centre of Expertise' status for its most successful clusters. In 2018, the Norwegian government announced that it would invest $700 million in ocean research labs in a plan called **Ocean Space Laboratories**.[464] These assets will be used for educating students, for research and for companies that need to test products or equipment.

[457] Marine Scotland (2020) Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors
[458] https://www.blauwecluster.be/domein/smart-sea
[459] https://www.alaskaoceancluster.com/portfolio
[460] https://oceansadvance.net/ocean-observation-science/
[461] https://www.newenglandoceancluster.com/inclusion-in-the-blue-economy
[462] https://oceansadvance.net/youth-outreach/
[463] https://oceansadvance.net/ot-news/inuk-job-offer-student-position-ocean-asset-map-oam-client-outreach-coordinator/
[464] https://www.sintef.no/en/all-laboratories/ocean-space-laboratories/

14.31 The European Commission (EC) has been focused on clusters for developing industrial sectors for a number of years, including across ocean, coastal and freshwater sectors. The EC has developed substantial regulatory infrastructure to support clusters. For example, the mission of the European Cluster Collaboration Platform[465] "is to be the European online hub for clusters and the reference one-stop-shop for stakeholders in third countries aiming to set up partnerships with European counterparts." The European Secretariat for Cluster Analysis[466] was established in November 2010, with support from the EC, to create more world-class clusters across Europe by strengthening cluster management excellence.[467]

14.32 Baltic-Sea countries have the Baltic Marine Environment Protection Commission, also known as the Helsinki Commission (HELCOM).[468] This is an intergovernmental organisation (IGO) and a regional sea convention in the Baltic Sea area. HELCOM has ten Contracting Parties: Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. HELCOM was established in signing the Helsinki Convention in 1974, with the aim of protecting the Baltic Sea from all sources of pollution from land, air and sea, as well as to preserve biological diversity and to promote the sustainable use of marine resources. HELCOM functions as a regional platform for environmental policy making. The HELCOM Monitoring and Assessment Strategy (2013)[469] has a range of objectives that have synergies with what could be possible at the Highlands and Islands level, including:

- To lay out a system which enables showing how visions, goals and objectives set for the marine environment are being met;
- To plan a system that enables linking the quality of the environment to its management;
- To facilitate the implementation of the ecosystem approach, including coastal and open waters;
- To enable the provision of data and information that links pressures on land, from the atmosphere, in coastal areas and at sea to their impacts on the marine environment;
- To describe the system for coordination of monitoring activities for any specific issues of concern;
- To set out the structure and time frame for the production of region-specific assessments such as comprehensive thematic and holistic assessments and more concise and timelier indicator reports and other assessment products;
- To create a system which enables raising awareness among the general public of the marine environment.

14.33 As of 2021, the USA had less developed clusters, and no supercluster structure in place. It is arguable that many American cluster organisations are small in scale, and/or are less mature than clusters elsewhere, such as in Europe. Despite the scale of the Blue Economy, American Blue Economy businesses are, overwhelmingly, not organising into clusters.[470] However, a proposal for an Apollo-style "Blue Wave Mission"[471] to promote blue innovation as well as synergies across blue tech clusters has been put forward by the Ocean Foundation[472] and TMA BlueTech.[473]

[465] https://clustercollaboration.eu/
[466] https://www.cluster-analysis.org/
[467] https://storymaps.arcgis.com/stories/3c3e46acf92f4f39bc42ca2b8307ae99
[468] https://helcom.fi/
[469] https://helcom.fi/action-areas/monitoring-and-assessment/monitoring-and-assessment-strategy
[470] https://storymaps.arcgis.com/stories/da20701b27734791a5a3809ade24adc2
[471] https://oceanfdn.org/wp-content/uploads/2021/04/The-Blue-Wave.pdf
[472] https://oceanfdn.org/
[473] https://www.tmabluetech.org/

14.34 Canada has established a large **Ocean Supercluster**[474] funding programme to promote collaboration between companies and existing BlueTech clusters: it brings together start-ups, scale-ups, as well as mature organisations from coast-to-coast-to-coast across the fishery, aquaculture, bioresources, offshore resources, marine renewables, defence, shipping and ocean technology to grow the ocean economy in a digital, sustainable, and inclusive way. The cluster is fostering new partnerships and innovative projects built on collaboration between industry, research, not-for-profits, investors, and government. Together with members and partners, the Ocean Supercluster is accelerating the development and commercialisation of globally relevant ocean solutions and advancing Canada's position as a global leader in the blue economy.

14.35 China is actively developing its ocean testing facilities and BlueTech sector, including the Shandong Peninsula Blue Economic Zone and the Qingdao Blue Silicon Valley.[475] The project plans to build five new towns that deeply integrate scientific research, education and living, with the aim of incubating scientific achievements and driving forward innovation. The project ultimately plans to become an innovation platform that enables China to scientifically develop and utilise marine resources cross-sectorally, and link global marine scientific research resources.

CLUSTER OUTCOMES

14.36 There is only limited publicly available information on the outcomes and delivery strengths of these clusters, with little information evaluating cluster impact. However, we are able to provide an overview of some of the key outcomes achieved through the activity of the Blue Economy clusters considered in this analysis:

- Securing government funding, e.g., Washington Maritime Blue being declared one of the 60 finalists for the US Economic Development Administration's Build Back Better regional challenge, for which it won $500,000;[476]
- Successful delivery of innovation projects, e.g., Washington Maritime Blue's Tacoma Tideflats 5G Network Study,[477] the Blauwe Cluster's many current and past projects;[478]
- Funding invested, e.g., the International Blue Cooperative helping rural communities invest in new equipment and facilities in order to scale up in the Blue Economy value chain;
- A considerable number of Blue Economy companies helped, e.g., the Alaska Ocean Cluster has worked with a dozen companies since 2020;[479]
- Successful collaboration with education and training institutions, e.g., the Pole Mer Bretagne Atlantique giving recognition and accreditation to various courses through its education and academic partners;[480] and
- Recognition of sectoral and technical excellence, e.g., the Blue Maritime Cluster being granted the status of a Global Centre of Expertise (the highest such status in Norway).

[474] https://oceansupercluster.ca/
[475] https://www.frontiersin.org/articles/10.3389/fmars.2019.00261/full
[476] https://www.commerce.wa.gov/news/washington-maritime-blue-declared-finalist-for-1-billion-build-back-better-regional-challenge/
[477] https://maritimeblue.org/joint-innovation-projects/5g-feasibility-study/
[478] https://www.blauwecluster.be/node/636
[479] https://www.alaskaoceancluster.com/portfolio
[480] https://www.pole-mer-bretagne-atlantique.com/en/services/education-and-training

Developing the Highlands and Islands Blue Economy: Learning from international practice

14.37 Based on the analysis presented above, the following key learning points can be drawn to inform the development of the Blue Economy in the Highlands and Islands.

14.38 First, any Blue Economy cluster activity should take an integrated sectoral approach. This recognises the interdependencies and interconnectedness of Blue Economy sectors and allows for a greater ability to respond to environmental challenges and economic opportunities in a joined-up, holistic way. As the Blue Economy of the Highlands and Islands is varied and spans across sectors, the area would be better served by a multidisciplinary cluster. It would help identify and harness synergies between sectors and industry partners, facilitate knowledge sharing, and extend the reach (and so markets for) technological advances across sectors.

14.39 Second, the spatial focus of clusters should be a product of functional areas of the Blue Economy space in question. This is typically defined (or constrained) by the extent of territorial waters, but also the extent to which international partnerships may be required to tackle common challenges – or to negotiate shared use of resources. In the Highlands and Islands, this holds true for both the Irish Sea, North Sea and North East Atlantic.

14.40 The third learning point is that collaboration and partnership working is critical for driving innovation. Many Blue Economy opportunities and challenges are cross-cutting (given the point on interdependencies and interconnectivity above), and therefore require a co-ordinated approach to tackling or realising them. This includes collaboration within the cluster itself, and internationally with other clusters (as per the second learning point).

14.41 Fourth, clusters of Blue Economy activity need to be proactively cultivated. Whilst some organic growth may be possible, a degree of intervention is required to ensure that projects and enterprises can flourish in a nurturing environment, with public sector support to address structural or market barriers and de-risk investment. Consequently, the fifth learning point is that there is a need for a degree of funding and other public support (e.g., in-kind support, strategy development, lobbying). This can help the delivery of cluster co-ordination, or it can be targeted at supporting projects, to drive innovation and help to demonstrate value of clusters – particularly in their early stages.

14.42 Finally, clusters are an important tool through which to contribute to sustainability and inclusive growth, and these factors should be underlying principles in the future development of Blue Economy activity, in line with the objectives of Fair Work and Just Transition. This is particularly important for the many fragile and remote communities of the Highlands and Islands that rely on sectors in the Blue Economy for economic prosperity.

15 SUSTAINABLE DEVELOPMENT OF THE BLUE ECONOMY IN THE HIGHLANDS AND ISLANDS

INTRODUCTION

15.1 This section draws together the findings of the evidence gathered through desk research, targeted consultations and group working. It gives a short overview of each sector and the growth opportunities and likely priorities.

AQUACULTURE

15.2 This is an established sector in the Highlands and Islands with ambitions to grow significantly in value. Industry and research organisations are committing substantial resources to address issues such as fish welfare, climate change and to demonstrate good environment stewardship. Aquaculture plays a key role in Scotland's internationalisation activity and would be an enabler to develop more high value seafood processing in the region.

15.3 Aquaculture in Scotland is arguably at a pivotal moment and what happens in the next 5-10 years will determine how the sector develops and its value regionally and nationally. Expansion in terms of operations and volume is likely to be further offshore and also in land-based facilities for some or all of the product lifecycle. Uplift in value will depend on maintaining and enhancing premium produce and pricing, and profitability will be determined by using technology to increase productivity and tackle production challenges.

15.4 As well as finfish and shellfish, there are substantial opportunities to develop seaweed production in Scotland and capture the high value-added biotechnology activities in the country.

15.5 Aquaculture is a key part of HIE's support of the Food and Drink sector and on-going leadership from HIE will be critical during this period of change. HIE must consider where its intervention should be focused and how it works with partners and industry to ensure a sustainable sector with high quality environmental stewardship. Linked to this is HIE's role in the development of seaweed, marine biotechnology and opportunities for seaweed cultivation for carbon sequestration.

FISHERIES AND COMMERCIAL CAPTURE FISHING

15.6 This is a very established sector in the Highlands and Islands, but it is facing a range of challenges driven by factors such as Brexit, climate change and skills shortages. Whilst the commercial capture fishing sector has grown, it needs to increase its productivity and so enhance its competitiveness in the North East Atlantic whilst safeguarding fish stocks.

15.7 This sector is important for the social and economic fabric of many communities in Scotland and along with aquaculture, supplies Scotland's seafood processing sector. It also helps to support ports and harbours, and relies on them for landing catch locally, although of course Scottish vessels also land fish elsewhere.

15.8 The sector is currently in a phase of transition as we move beyond Brexit and pandemic recovery. There are political sensitivities, and the industry is facing pressures and uncertainty around issues such as future arrangements for quotas and access to fishing grounds.

15.9 In the longer term, climate change is impacting the availability and range of species in UK waters. This is a challenge, but longer term may provide opportunities for diversification. Linked to this, there is recognition of the need to promote and encourage increased domestic consumption of some types of produce.

15.10 This sector is a key market for marine environmental services to monitor conditions, identify location of fish stocks and assess and mitigate environmental impacts. Environmental services and the development and application of technology has the potential to enable access to fishing grounds that have been and will be displaced by offshore wind installations. There are opportunities to explore and develop solutions that focus on planning and managing access, reducing risk and over time, demonstrate the impacts on fishing, and the Blue Economy benefits of mixed use of marine areas.

SEAFOOD PROCESSING

15.11 The development of seafood processing in the Highlands and Islands has the potential to anchor quality jobs and value-adding activity in coastal communities for the long term. However, this will require recruitment of more local people into the sector and addressing perceptions of it as an unattractive employment and career option. There is a need to demonstrate that there are good career opportunities and a range of functions and occupations within it. Increased automation, application of technology and cobotics is changing the sector, the processes and the working environment.

15.12 However, the sector is currently under-developed in the Highlands and Islands and there is a pattern of seafood being transported out of the region to processing clusters for high value processing. These clusters are closer to markets and distribution hubs. Scottish seafood, and seafood from the Highlands and Islands is a premium product and there may be competitive advantage for some premium seafood-processing to be located close to production, in the region itself. Transforming the sector and capturing the value for the Highlands and Islands will require strategic planning and investment, investment in business growth, and a skilled workforce.

15.13 There is an existing cluster of businesses in the Highlands and Islands that, with support, could be developed to drive sector growth in the region and in specific areas. This would build on the premium 'brand' of the region's produce and focus on building value-adding processing capacity. The region is not currently positioned to compete in terms of volume, and should focus on high value market development, product and process innovation, and using technology to achieve active supply chain management and integration to ensure that it is agile, frictionless and resilient. There must also be high quality supporting connectivity and infrastructure.

MARINE ENERGY AND RENEWABLES

15.14 The offshore renewable energy sector in the Highlands and Islands is a dynamic and rapidly expanding field and will play an increasing role in providing energy for Scotland, the UK and globally. There is already extensive activity and expertise operationally and in research and development, along with a supportive environment. This is the foundation for future development and growth – e.g., EMEC which, along with its work on wave and tidal energy, is leading and partnering on a range of research projects on hydrogen capture. The next ten years have been described as 'the decade of delivery' in renewable energy and marine energy is a substantial part of that.

15.15 Marine renewable energy is central to achieving net zero emissions by 2025, offering cheaper, cleaner and faster decarbonisation. It is also an enabler for industries such as transport, including sustainable aviation, ferries, trains, buses, lorries and private transport. An important area for development across renewable energy is the development of storage solutions to ensure

continuity of supply, move energy from one place to another without grid connection, and as independent power sources e.g., hydrogen fuel cells.

15.16 Although at an early stage, there are indications of the potential to integrate or co-locate other marine activities with marine energy installations to make better use of marine space and achieve certain synergies. As an example, seaweed cultivation with offshore wind farms, and enabling and managing access for commercial fisheries.

15.17 There are also interesting activities and opportunities to expand local energy systems and community ownership of marine renewable energy to power communities and sell constrained energy to raise income to reinvest in the community. The Highlands and Islands is very well placed as a location to develop and innovate approaches to the expansion of renewable energy generation as a community asset as part of place-based economic and social development.

15.18 The sector offers highly skilled roles, transferable skills and for workforces at risk, such as oil and gas, the opportunity to pivot to the renewables sector and repurpose their skills. The scope of marine renewables in the Highlands and Islands makes a strong inward investment proposition and a vibrant sector will attract and retain talent and contribute to the sustainability of communities. Added to this, the marine renewables innovation and R&D in the region adds strategic value to its Blue Knowledge Economy and international[481] status.

15.19 Realising the opportunity presented by marine energy and renewables requires the right supporting infrastructure, and critical enablers such as port and shoreside facilities, and handling capacity. The evidence clearly shows that additional port upgrades and supporting infrastructure will be required to support scaling up of bottom-fixed and floating offshore wind in Scotland and retain key value add activities such as manufacture and component assembly.

15.20 HIE currently has a very important, strategic role in supporting the development of marine renewables within the Scottish-wide policy context.

OIL AND GAS

15.21 The North Sea Transition Deal (NSTD) was announced in March 2021 by the UK Government's Department of Business, Energy and Industrial Strategy (BEIS). It supports the industry's transition to clean, green energy and a secure future for high-skilled oil and gas workers and the supply chain. The Deal recognises that the oil and gas industry will have a critical role in maintaining the UK's energy security through the transition to net zero carbon.

15.22 The North Sea Transition Deal is between the UK Government and oil and gas industry. It will support workers, businesses, and the supply chain as it transitions to a net zero future by harnessing the industry's existing capabilities, infrastructure, and private investment potential to exploit new and emerging technologies such as hydrogen production, carbon capture usage and storage, offshore wind and decommissioning.

15.23 The aim is that the Oil and Gas sector and government will work together to deliver the skills, innovation and new infrastructure required to decarbonise North Sea production. It will strive to bring and sustain upstream and downstream supply chain activity.

[481] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972520/north-sea-transition-deal_A_FINAL.pdf

15.24 The Deal will be the main mechanism for managing the transition of the Oil and Gas sector and the process will be vital for Scotland and the Highlands and Islands. There must be a planned, smooth transition with public sector intervention to mitigate the risk for businesses, the supply chain, workforces and communities. HIE will keep close to this within the region and work with relevant agencies such as SDS, SE and the Scottish Government to be able to support the transition process and limit any negative consequences on economic and social development.

DECOMMISSIONING

15.25 Decommissioning of oil and gas and, going forward, offshore wind turbines is an opportunity for Scotland and for the Highlands and Islands. It is reliant on adequate port infrastructure and shoreside facilities such as landing areas, decommissioning facilities and skills, transport connectivity, reconditioning and reusing of components and waste handling.

15.26 There is increasing interest in the application of circular economy principles to oil and gas decommissioning in the UK. Zero Waste Scotland has identified ways in which oil and gas assets could be reused and reconditioned for economic gain.[482] Two approaches in particular include the re-use of components (e.g., steel, pipelines, and cables) and the reconditioning of equipment (e.g., vessels, tank, and accommodation blocks) in other industries.

15.27 There will be opportunities for oil and gas employees whose jobs are at risk to redeploy their skills in decommissioning and the availability of a skilled workforce will help to attract inward investment in decommissioning.

15.28 In the longer term, end-of-life marine renewable energy installations will ensure a reliable supply of decommissioning contracts in the Highlands and Islands. To be strategically and potentially transformative, the Highlands and Islands should aim to capture market share in manufacture, assembly and installation, energy generation (including maintenance), energy storage, and decommissioning.

15.29 Within decommissioning, there is an ongoing need to review and develop processes through innovation, R&D and applying circular economy principles.

SEABED MINING

15.30 Although more exploratory work around mineral presence is required and would require significant investment, there is evidence of minerals, specifically metals in sediments in the waters off the coasts of Shetland and the Outer Hebrides. With current exploration and extraction processes, the environmental impacts of recovering these minerals are likely to be significant and controversial.

15.31 More research into the opportunities and implications of seabed mining will be required and if seabed mining in Scotland progresses, then marine environmental services will have a big role to play in modelling and assessing potential impact, planning activity, managing risk and monitoring. Exploration will also be a key activity, drawing on the expertise and knowledge from Oil and Gas.

15.32 Seabed mining operations in Scotland are not likely in the short to medium term but should remain on the long-term Blue Economy agenda.

[482] https://www.zerowastescotland.org.uk/sites/default/files/North%20Sea%20Oil%20and%20Gas%20Rig%20Decommissioning%20%26%20Re-use%20Opportunity%20Report.pdf

MARINE BIOTECHNOLOGY AND BIOPROCESSING

15.33 Stakeholders across the UK recognise that seaweed is a very valuable resource that is not currently being exploited and requires to be supported to grow sustainably. It could provide much-needed diversification of coastal employment, end the threat of excessive wild seaweed harvesting, grow crops which mitigate climate change, and if co-located with salmon farms help to mitigate environmental impacts. There is also scope to explore the potential to co-locate seaweed cultivation with bottom-fixed and floating offshore wind turbines.

15.34 Whilst seaweed harvesting and cultivation is part of aquaculture it is inextricably linked to marine biotechnology which is where the real added-value market opportunities lie. There is an opportunity to use the natural resources of seaweed and algae to lever the marine biotechnology sector in the Highlands and Islands and more widely in Scotland. This would help to ensure that we retain and benefit from the high value-added activities. The risk to be addressed is that of exporting rather retaining the product locally to maximise its value, and ensure ground is not lost in terms of research and innovation, product development, processing and manufacture.

15.35 The scale of the opportunity, the reach of the impacts and the opportunity to be at the forefront of this global sector is potentially transformative for the Highlands and Islands. Achieving it will be complex, requiring the public, private and education sectors to work together to fast track the development of the sector, invest in research and remove inhibitors and constraints to sustainable sector growth. It will require strong strategic leadership and supportive national policy. There is a clear, strategic role for HIE here, and a huge opportunity for the region, but the policy decisions rest with the Scottish Government.

15.36 A long-term vision and coherent policy (industrial strategy) is essential to de-risk developments and provide clarity for investment.

MARINE ENVIRONMENTAL SERVICES

15.37 Monitoring and assessment, and associated systematic large-scale data capture, provides the opportunity to put into practice the ecosystem to manage human activities in the marine environment and understand climatic events and conditions. There is a global need across the Blue Economy for data on environmental conditions to better understand how, where and when anthropogenic influences have affected the baseline of natural processes. Long term monitoring is required to estimate the past, the present and forecast future environmental parameters leading to knowledge on ecological integrity and carrying capacity of environmental assets. Credible evidence-based predictions can support and justify growth where proven to be sustainable.

15.38 Fully understanding the marine environment and the impacts of different activities is crucial for its sustainable management balanced with maximising the economic and social potential. This requires robust, credible, objective, and up-to-date evidence. However, data and data collection about the marine economy and our interactions with the marine environment are limited and do not currently provide all of the data required to fully inform decision making.

15.39 These are global challenges, and there is a global market for better data, monitoring and data integration.[483] Better data collection, analysis and application will improve the understanding of how Blue Economy sectors impact on the marine environment, and in turn how the changing marine environment and quality impacts on the sectors.

[483] https://www.frontiersin.org/articles/10.3389/fmars.2016.00161/full

15.40 Research undertaken for the sustainable development of the UK's Blue Economy highlighted that there is a gap in data collected and used by small operators, for example small fishing vessels and shellfish producers. A mechanism is required to facilitate small operators to gather data and report it centrally to monitor collective activity and impact.

MARITIME TRANSPORT AND SHIPBUILDING SERVICES

15.41 Marine transport is vital for the Highlands and Islands, connecting islands to each other and to mainland Scotland. It supports remote and island communities, helps to provide essential services, facilitates tourism, and is critical for transporting goods - bringing supplies in, and taking local produce to market. It is also a lifeline for residents, connecting communities and families.

15.42 Marine transport is also a critical part of the Blue Economy supply chain for example operation, maintenance and support vessels for aquaculture, oil and gas and renewables.

15.43 Cargo, support vessels and ferries have a large carbon footprint and the drive for faster transport could make this worse. As a result, the global need for 'clean' maritime transport is driving research and development, for example hydrogen powered ferries. The Highlands and Islands is an ideal location to deploy and test clean maritime transport, offering a mix of environments, weather and wave conditions, and mainland and island destinations. It interfaces with the development of hydrogen capture in Orkney.

15.44 Given the importance of marine transport in the region, clean solutions will be vital if Scotland is to achieve net zero by 2045. These solutions will have a worldwide application across all forms of marine transport.

15.45 The region has well-established marine vessels engineering, maintenance and servicing industry. There are small boat building and repair businesses across the region providing employment and services, sustaining an important and valuable skills base, and generating income in communities. It also supports the sail tourism market as well as the local market for boats and maintenance.

15.46 There are examples of innovation and development in eco-friendly boat building that can be developed going forward. Linked to this, testing and developing hydrogen powered ferries has international potential. However, boatbuilding is an important and traditional industry in the region. The UHI offers a Modern Apprenticeship in Boat Building and Repair.

15.47 Large scale commercial shipbuilding does not appear realistic in the Highlands and Islands – there are other Blue Economy sectors that have greater potential, and which should be the focus of intervention and resource.

MARINE AND COASTAL TOURISM

15.48 Visit Scotland provides strategic leadership to Scotland's tourism sector covering the Highlands and Islands and including marine and coastal tourism. Tourism and hospitality have been severely impacted by COVID-19 and Brexit, with travel restrictions, skills shortages and rising prices e.g., energy and supplies. Cruise tourism ceased entirely for a period of time. HIE Business Panel evidence[484] indicates that tourism and hospitality businesses in the region are still lagging in terms of recovery, and this was the case even prior to the latest economic shocks associated with rising costs. Many are having to scale back which is conflating capacity issues.[485]

[484] https://www.hie.co.uk/research-and-reports/businesspanel/
[485] See for example: https://www.bbc.co.uk/news/uk-scotland-62049326

15.49 However, domestic tourism is recovering with some Scottish destinations reporting that they are at, or perhaps beyond capacity. Coupled with social distancing and its impact on capacity restrictions, it has put pressure on infrastructure, notably ferries.

15.50 Assuming steady recovery, the future is very positive for marine and coastal tourism, and it will continue to make a vital contribution to the economy, providing jobs, and supporting businesses and supply chains. However, the region, and local areas must continue to work to attract and service high value tourism to maximise visitor spend. There is substantial scope to diversify and grow marine tourism activities, for example in and on-water activities such as scuba diving, sailing, and water sports; marine environmental and heritage tourism. There is potential to establish the Highlands and Islands as a green tourism destination (including marine and coastal). There is also scope to consider how marine tourism interacts with other Blue Economy sectors, for example tourism and fishing ports and harbours.

15.51 HIE is likely to continue to support marine tourism as appropriate through local area teams and work in partnership with Visit Scotland at regional level, recognising the lead role of VisitScotland.

PORTS AND HARBOURS

15.52 The Highlands and Islands must ensure that it is in a position to secure the opportunities presented by the Blue Economy and remove shoreside constraints to growth. A central strand is the ports and harbours that, as an infrastructure asset, are vital for sectors such as tourism, aquaculture, renewable energy, decommissioning, and wild capture fisheries.

15.53 To date, HIE has taken a direct interventionist role in making financial contributions to port developments. This has primarily focused on Trust ports rather Local Authority ports as LAs have greater borrowing powers for capital investments. HIE's funding has been aimed at helping Trust ports respond to market opportunities, for example offshore wind and decommissioning. This recognises that a constraint to growth and development of non-LA owned ports is the ability to raise funding in response to opportunities. There can be a significant time lag between successfully raising finance and being able to do so again in response to an emerging market opportunity. Not being able to make regular investments means that ports lose out on potential market growth, market diversity and revenue.

15.54 The research indicates that investment in ports and harbours in the Highlands and Islands will increase in terms of value and the number of 'asks'. This will not be feasible for HIE to fund at required levels. Recognising these financial constraints, the regional, cross-sectoral importance of ports and harbours and their critical role as an enabler of the development of the Blue Economy, HIE has established a Ports and Harbours Infrastructure Group. Membership is drawn from existing HIE teams including tourism, food and drink, energy, strategy and regional development, along with area managers. Specialist external organisations and individuals will be co-opted to input on an as-needs basis. The aim of this group is described in its terms of reference as:

"to support the specific and significant challenges to meeting the region's infrastructure, decarbonisation, and environmental commitments, the importance of ports and harbours to the Highlands and Islands region, and to support Scottish Government in meeting net zero targets by 2045."

15.55 The Group will position HIE as a strategic enabler of the development of Ports and Harbours. It will undertake foresighting to anticipate and plan for the 'asks'. It will work to help leverage additional funding for example public sectors funding (Scottish Government), private investment and lending.

15.56 This Group is well-placed to pursue a co-ordinated and targeted approach to identifying preferred options for port investment in response to market opportunity in marine sectors in the region. Ensuring that appropriate port capacity and capability is on offer to industry where it is needed most is critical to realising any transformational impacts through sectors such as offshore wind or decommissioning, for example.

BLUE KNOWLEDGE

15.57 It is clear that the Highlands and Islands has a very strong base in Blue Economy science, research and knowledge. It has world class facilities and expertise, with exceptional access to natural assets for research, testing and development. As well as the sheer scale of its coastline and marine areas, it has a wide range and distribution of different types of environments and conditions which is very valuable for testing and developing solutions. Added to this, the presence of industry across a wide range of sectors can help to lever industry involvement in research and should help to align research with industry need. However, evidence suggests that research and education could be better aligned with industry and there is an important facilitation role required to enhance triple helix collaboration (industry, education, and the public sector). Provision of industry-aligned education and research strengthens skills and expertise across the workforce is an important component of the inward investment prospectus.

15.58 As well as research, the facilities and access to natural assets provide excellent learning and education opportunities for students and for industry. Employers can access learning to upskill and reskill staff, increasingly important given the pace of change for example through technological developments, automation, and climate emergency.

15.59 HIE recognises that a strong education and research base in the region helps to attract people, retain them, and offers local people learning opportunities across the skills and education system.[486] It is also an important part of the scaffolding that supports the development and competitiveness of the wider Blue Economy and joint venture innovation, and research and development projects lead to spin offs and catalyse new commercial enterprises. HIE works closely with UHI and other HE providers in the region for the strategic development of the knowledge sector and blue economy knowledge forms a substantial strand of this.

[486] https://www.hie.co.uk/latest-news/2021/january/27/milestone-for-region-s-own-university/

16 CONCLUSIONS AND PRIORITIES

INTRODUCTION

16.1 The aim of this study is to develop the strategic understanding of the blue economy in the Highlands and Islands and the sectors it comprises. Based on this, the work then focused on identifying the opportunities for growth and development that have the potential to be transformative for the region and Scotland, the priorities, and the role that HIE might play in catalysing and supporting this growth. This work has all been set within the broad policy context and drivers at regional, Scottish and UK levels as well as internationally.

16.2 This chapter draws together the evidence, provides high level conclusions and suggests priorities and steps for HIE and partners for the sustainable development of the Blue Economy in the Highlands and Islands. It is intended as a framework to inform the development of a Blue Economy regional delivery plan that targets resources where they can have the greatest impact. It recognises that in some sectors and activities, HIE is not best placed to take a lead role and its work may focus at a more locally place-based rather than regional level, for example through local area teams.

CONCLUSIONS

Defining the Blue Economy

16.3 The Blue Economy is a range of economic sectors and related policies that focus on the productive use of ocean resources, whilst at the same time pursuing sustainable environmental, social, and economic management. Within the Highlands and Islands context, the Blue Economy encompasses: Aquaculture; Fisheries; Seafood processing; Marine renewable energy; Oil and gas; Decommissioning; Seabed mining; Marine biotechnology and bioprocessing; Marine environmental services; Marine transport and shipbuilding; and Marine and coastal tourism.

16.4 Not all of these sectors are strategically important for the region. However, Blue Economy sectors in the Highlands and Islands are inextricably linked by overlapping spatial requirements – there is a degree of competition for the same marine space. Whilst there are commonalities and linkages between each of the sectors, they are not tightly integrated. In common with the rest of the UK, they are subject to very different regulatory requirements.

Policy environment

16.5 In the Highlands and Islands, in Scotland and in the UK, there is a supportive policy environment for the sustainable development of the blue economy and broadly, the sectors within it. Trends in Government and Enterprise Agency support at the UK and Scottish level (as well as other devolved administrations) has seen a shift in emphasis from a sectoral policy focus to one of opportunities. This recognises the important role and potential of the marine environment in tackling global issues such as food and energy security, human health and pharmaceuticals, and climate change. It also recognises the economic and social value of the world's seas and oceans.

16.6 In Scotland, there are a wide range of policies and strategies to manage, guide and support the sustainable development of the marine environment and Blue Economy Sectors. These are very much 'policy on' and active, for example Scotland's National Marine Plan and the supporting Regional Marine Plans for each of Scotland's eleven marine planning regions.

16.7 A point to be aware of is that the weighting of marine sector interests in devolved administrations are not necessary fully understood at UK level and reflected in UK policy, where these impact on, for example, Scotland. As an example, support mechanisms such as Contracts for

Difference (CfD) have arguably favoured offshore wind, having made no specific provision for wave and tidal energy putting these sources at a disadvantage and potentially inhibiting development. This has however been addressed to some extent by the announcement in late 2021 that the UK government will invest £20 million per year in Tidal Stream electricity as part of CfD auctions.[487]

16.8 Some sector-specific marine facilities have conditionality on their planning permission or operation, which prevents co-location of other marine uses, thereby limiting the degree of collaboration with other sectors. For example, at the European Marine Energy Centre (EMEC) in Orkney, only renewable energy activity is permitted. Some of the port infrastructure in Kirkwall is hypothecated to renewables and cannot be co-opted by other marine sectors, though in principle it still benefits them by creating more capacity overall.

16.9 There is scope for much more cross-sector engagement and collaboration in the Blue Economy in the Highlands and Islands which would help plan and balance the different uses and users, and ensure sustainability, managing environmental impacts. This will help to improve communication across industry stakeholders and strategic/public sector partners. It will enhance cross-sector knowledge and understanding and improve trust and cooperation between sectors and industry. It will enable a collaborative approach to identifying and addressing shared constraints and challenges and opportunities for synergies and clustering. HIE has a central role to play here, to help facilitate this collaborative activity and embed a whole-Blue Economy approach as opposed to sector-based.

Strengths and opportunities

16.10 There is no doubt that the Blue Economy sectors in the Highlands and Islands have strong growth potential. They are at different stages of maturity and development. Generally, they are competing in global marketplaces which are developing quickly. Scotland, and the Highlands and Islands are well positioned to capitalise on the market opportunities, but the lack of adequate infrastructure is a shared constraint to growth. Whilst ports and harbours may be the focus, the Blue Economy is underpinned by wider infrastructure needs such as transport and digital connectivity which are critical for productivity and access to markets.

16.11 Developing and trialling new devices and equipment for Blue Economy sectors is an important area, and the Highlands and Islands has a strong track record in Blue Economy science, innovation, and R&D. This is a key area for public sector intervention and essential if the region is to retain and build competitive advantage in Blue Economy sectors. Innovation aligned to industry need is key, and with a set of common challenges and constraints there can be common solutions, sharing the risk of investment in innovation and making manufacture more viable by stimulating larger scale more reliable demand.

16.12 At Scottish (and UK) level, government and public agencies including HIE should give greater consideration to the potential for co-location and clustering of different marine uses and achieving cross-sectoral synergies benefits in the region. There is an opportunity to benefit from overlapping spatial requirements, and optimise the interdependencies of different sectors, and the benefit that can be gained, e.g., marine energy and aquaculture, or using offshore wind farms to regenerate fisheries. There is also scope to consider how marine tourism can work with other sectors, for example tourism built appropriately around and integrated with fishing ports and harbours. There is increasing vertical integration in commercial capture fishing, aquaculture and seafood processing value chains and a high dependency of one stage on another. Fishing is likely to be increasingly integrated with seafood processing, as traceability and control over supply become prominent.

[487] https://www.gov.uk/government/news/uk-government-announces-biggest-investment-into-britains-tidal-power

16.13 Collaboration between industry, the public sector, education and communities (a quadruple helix approach) needs strengthened, and embedded at blue economy level, highlighting the cross-sectoral opportunities for sustainable growth, and understanding and addressing constraints.

PRIORITIES FOR THE DEVELOPMENT OF THE BLUE ECONOMY IN THE HIGHLANDS AND ISLANDS

16.14 The Blue Economy encompasses a wide range of sectors, industries and activities. The Highlands and Islands cannot be a global leader in all of these, and HIE cannot be the strategic leader – that would not be feasible (resource would be spread too thinly) nor appropriate (other organisations are better placed to fulfil that function).

16.15 Table 16.1 uses a RAG system to identify the strategic priorities for the sustainable development of the Blue Economy in the Highlands and Islands, and HIE's strategic role within that. It is based on the findings of the research including consultations and workshops. Where a sector is green, it is recommended that HIE takes a strategic role and approach to developing it. An assessment of amber indicates an important sector for the region and one that HIE should work in as a partner with other organisations, but not be the strategic lead. This does not of course preclude responses and activities on an 'as needed and appropriate basis', including that of local area teams. Red indicates where HIE should have a watching brief going forward but not a direct role in the sector. HIE may respond to the impacts of changes in the sector, for example oil and gas. In assessing and identifying the key priorities for HIE, it is important not to be over-ambitious and commit HIE to taking a strategic lead across too many sectors, spreading resource too thinly and diluting impact.

Table 16.1: Priorities and strategic development

Sector/enabler	Level of strategic priority and role for HIE	Rationale
Blue Economy sectors		
Aquaculture		• A key sector that has significant potential and policy support for growth. • Requires a strong strategic lead to capture the value and proactively drive the sector's development in the Highlands and Islands and Scotland.
Fisheries and commercial capture fishing		• An important sector in the Highlands and Islands facing challenges and opportunities. • Not a strategic priority for HIE intervention as this lies elsewhere in Scotland and the UK.
Seafood processing		• Within Food and drink in the region, there are important pockets of activity including in remote rural and island communities. • However, to achieve regional and transformational growth would require significant resource and input from a low base.
Marine energy and renewables (including green hydrogen)		• The Highlands and Islands has a competitive advantage in renewables covering wind, wave and tidal. • Transformational opportunity with HIE as a strategic leader, working with stakeholders across research, education and skills, industry and the supply chain.
Oil and Gas		• An important sector in the region and will continue to be so during energy transition. • HIE's role is likely to be in responding to impacts and implications of energy transition. • Strategic lead is embedded in UK Government policy and strategy.
Decommissioning		• A growth sector in the Highlands and Islands, and with the right support it has considerable long term growth potential in decommissioning of marine renewable energy structures. • The Highlands and Islands are critical to the UK's drive for decommissioning. • Opportunity to capture market share in energy decommissioning, given the assets at the region's disposal suited to decommissioning activity.
Seabed mining		• Extremely limited activity and potential at the current time.
Marine biotechnology and bioprocessing		• Strong growth potential with high value-added applications. Incudes seaweed cultivation (and harvesting). • Key will be to take strategic-level action to ensure that the high value activities take place in the region. This action is to be taken by a partnership of organisations including HIE, Scottish Government and others. • Decisions are required in the relatively short term as to the extent to which Scotland will seek to capitalise ono the opportunities and the commitment. Based on this, it might become 'green' in terms of level of strategic priority for HIE.
Marine environmental services		• Scotland has a strong digital tech sector including in innovation, research and development. • Marine environmental services are vital in terms of monitoring the marine environment in the Highlands and Islands, Scotland and internationally. This means there is a large, valuable, and developing market for technology, expertise, knowledge and systems. • This industry offers a transformational opportunity for the region, building on existing activities and the natural, science, tech and other assets.

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Sector/enabler	Level of strategic priority and role for HIE	Rationale
Marine transport and shipbuilding services		• Marine transport is vital in the Highlands and Islands, for example for logistics and distribution, travel, tourism, servicing key sectors, and in the delivery of essential services. HIE should therefore continue to seek to influence the provision of fit for purpose marine transport in the region. • There is a thriving industry in small boat building, and vessel repair and maintenance. • HIE's development role in these two strands will sit at local area office level rather than regional and strategic. • Where HIE has a strategic role (linked to renewables and blue knowledge) is in the development of clean and green marine transport.
Marine and coastal tourism		• Tourism is important in the region in terms of enterprise activity, employment and sustainability of thriving communities. • Opportunities tend to be local and place-based and so response is at local area level. • Strategic role lies with other organisations, in particular VisitScotland.
Cross-cutting enablers		
Ports and Harbours (and landside infrastructure)		• The Highlands and Islands' port infrastructure is critical to realising the ambition for, and potential of other sectors and supply chains. It is critical for the region and is strategically important for Scotland. • The required level of investment to upgrade ports to meet current and anticipated market demand is significant and cannot lie solely with HIE. It also includes private sector investment at substantial levels. • HIE's role is in supporting the co-ordination of the activities of strategic partners (potentially through a cluster approach) to ensure that investment is targeted, and capacity is developed where it is needed most and will have the greatest impact. This will be in response to market need, rather than spreading investment too thinly through a blanket, whole-region approach.
Blue Knowledge		• Blue knowledge, skills and education are a strength in the Highlands and Islands, through organisations such as SAMS UHI, Shetland UHI, other universities such as Heriot Watt, and organisations and initiatives such as EMEC, and Wave Energy Scotland. • Whilst Blue Knowledge and education are strategic and important to the Highlands and Islands, and HIE has a role and of course an interest in it as an enabler for other sectors and in talent attraction and retention, HIE is not positioned to be the strategic lead.

16.16 The table illustrates that the sectors that HIE should focus on in terms of taking a strategic role are: Aquaculture; Offshore renewables; and Marine Environmental Services. They are not simply the sectors with the biggest existing footprint, they reflect where the Highlands and Islands has a particular advantage that will lever significant opportunities. Some are established, with potential to grow, and some are more early stage. As noted in the table, Marine Biotechnology and Bioprocessing could be classed as a 'green' priority by HIE, but in recent years has remained on the cusp of being a sector with transformational potential. The opportunity is there but the level of policy and strategic level commitment is unclear. Similarly, Decommissioning is a sector that in future HIE could have more of a strategic role in, but this is considered to be longer term as Energy-related decommissioning activity increases – for operational Energy infrastructure, along with renewable energy installations currently in development – including those being planned and developed as part of ScotWind for example.

16.17 Sustainability must be at the heart of the development of Blue Economy sectors and the enabling infrastructure must support this, for example ports and harbours facilitating and supporting the greening of marine transport. It must also recognise that the Blue Economy is a Scotland-wide opportunity, and that there are not necessarily hard regional borders defining its operations.

KEY STEPS TO SUPPORT BLUE ECONOMY GROWTH

16.18 This section highlights the recommended steps for HIE and partners to plan and implement the strategic and sustainable development of the Blue Economy. It starts by setting out a number of principles that the research has identified and that should underpin the work going forward.

Principles for the sustainable development of the Blue Economy

- It will take an ecosystem approach to developing the Blue Economy as a whole and the sectors it comprises and that are a focus for growth.
- The economic and social development around the Blue Economy will be based on the premise of safeguarding physical and natural assets and minimising negative environmental impacts.
- It will add value to wider Blue Economy activities in Scotland and the UK – recognising that the marine assets in the Highlands and Islands can and do benefit the Scottish economy and deliver strategic added value (SAV).
- It will reflect the Place Principle and promote a shared understanding of place, and the need to take a collaborative approach to development and so achieve better outcomes for the region, its people, and its communities.[488]
- It will support and develop sectors in the Highlands and Islands that have a high potential for sustainable jobs and growth. This will include in the supply chain.
- It will contribute to shared prosperity through creation of high value jobs, local investment opportunities, and community wealth building.
- It will incorporate partnership working to understand and address skills challenges to ensure an available and skilled workforce, and that there is a fair distribution of the opportunities and benefits.
- It will catalyse and encourage cross-sectoral working and clustering of activity.

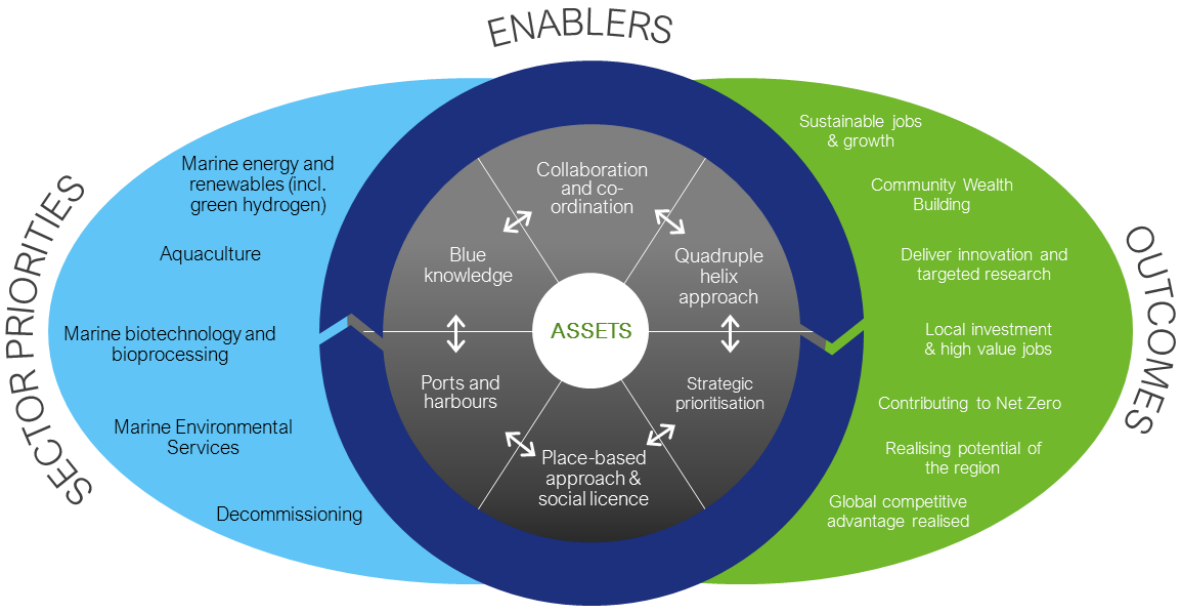
[488] https://www.gov.scot/publications/place-principle-introduction/

- It will be collaborative by adhering to a quadruple helix approach. It will include good practice in community participation as a means of establishing greater socio-economic resilience.
- Resources will be used in the most efficient way to maximise impact. Integral to this will be clear and agreed articulation of the roles and commitment of each stakeholder, including an identified strategic lead. In some cases this will be HIE, but not for all sectors.
- It will be ambitious, responsive and deliver innovation in industry and in response to industry need.
- Addressing market failures and constraints will be central to the Strategy.
- Its progress and achievements should be monitored on an on-going basis and the impacts evaluated regularly. This will be used to actively drive performance.

Next steps

16.19 The study has identified five Blue Economy sectors that should be the priority focus for HIE, along with sectors that HIE should continue to be involved in but not the strategic lead. By focusing resource and activity in these five sectors, HIE will be instrumental in capturing and growing their value to the Highlands and Islands and to Scotland. There are of course interdependencies and synergies to be achieved within these, and with the other sectors that comprise the Blue Economy. Blue Knowledge and Ports are two key cross-cutting enablers. Figure 16.1 illustrates the priorities, the enablers and the potential outcomes that will benefit the region socially, economically and environmentally.

Figure 16.1: HIE's Priorities for the Blue Economy, and the enablers and outcomes



16.20 This report provides an evidence base for HIE and partners to consider and use to agree priorities and plan next steps. Every stage will require cross-sector and multi-agency cooperation and collaboration. The ultimate aim is to develop a Blue Economy regional delivery plan for the Highlands and Islands that partners sign up to. The following steps are likely to be required.

16.21 The research has led to ekosgen recommending five sectors that HIE's Blue Economy regional delivery plan should focus on. However, as discussed, there are other sectors that have a significant presence in the region currently, are important economically and socially, and have growth potential. An initial point to consider is whether a regional delivery plan is developed that is solely about these five sectors and HIE's work, or if there is a broader regional action plan and the priority sectors for HIE are embedded within it, along with other sectors and strategic leads.

16.22 There is already substantial activity in the region across the Blue Economy sectors and within education, research, industry, and the public sector. There are also physical clusters, some that have been deliberately created such as in Oban, around the European Marine Science Park. Others have evolved naturally over time, often built around a natural asset, for example aquaculture and the supply chain in areas with sheltered inshore waters. Thematic clusters are also very valuable, for example the Scottish Blue Economy Cluster Builder. Linked to clustering of activities, there are synergies, and potential synergies that can be explored and exploited between Blue Economy sectors, and potentially sectors in the wider economy.

16.23 At an early stage, it will be useful to identify likely opportunities for synergies and clustering of activities and supply chains and consider the role of clusters and how these can be built on and developed. This should not seek to duplicate existing clustering but should add to it and consider how sector-level clustering could be layered to provide a Blue Economy super cluster.

16.24 The Blue Economy regional delivery plan, its objectives and the actions that will flow from it will be a valuable tool to stimulate investment and attract inward investment to the Highlands and Islands and Scotland. Understanding the current 'prospectus' under this theme will be an important basis to ensure that the strategic value is maximised.

16.25 Knowledge sharing will be essential at every stage of developing, planning, and implementing a regional delivery plan and this should be undertaken through a consortium approach, established at an early stage. The consortium and knowledge exchange will evolve over time, driven by the stage of development, implementation, and actions. Once the plan is implemented, on an on-going basis, knowledge accrual will involve collecting, analysing, managing, and sharing accurate and robust data. This will be used for a range of functions such as assessing and monitoring impact, fine-tuning the plan and the actions flowing from it, achieving efficiencies, and identifying and managing risks.

16.26 Coastal and marine environments are highly valued by local communities and by wider society in Scotland. There are a great many interested groups and stakeholders, reflecting the range of attitudes and views on how the marine environment should, and should not be used. This includes different uses and user groups, for example leisure and tourism, aquaculture, fisheries, and marine energy. There are often tensions between the uses, the users, and communities and these must be understood, balanced, and managed. There are opportunities for communities in the Highlands and Islands to benefit from a strategic approach to sustainable Blue Economy development, but the key is to ensure that there is responsible and evidence-based environmental stewardship and that this is demonstrated and communicated accurately. There are two points here. First, regional strategy development must ensure that there is social license in the Highlands and Islands, and this means involving communities in a quadruple helix from the start. This will help to addressing constraints and threats posed by a lack of social licence. The second strand links back to marine environmental services. Communities and stakeholders must have access to accurate and credible evidence about environmental impact and implications, and the benefits that sustainable development can deliver.

CONCLUDING REMARKS

16.27 There is no doubt that there is enormous potential to further develop the Blue Economy in a sustainable way in the Highlands and Islands, and for it to be transformational for the region and for Scotland. It is important that this potential is optimised and that the assets and competitive advantages in the Highlands and Islands are used to benefit the region and the people who live, work, learn, and do business within it.

16.28 It is a large and complex economy that cuts across and is part of wider economic, social, and environmental development considerations and themes such as climate change and net zero, the digital economy, and place-based development.

16.29 There are a number of areas for HIE to consider and reach decisions on, and then extend to wider stakeholders. This decision-making will sit within the wider context in which HIE operates, alongside its strategic objectives.[489]

[489] https://www.hie.co.uk/media/5006/strategyplusplanplus2019-2022-1.pdf

APPENDIX 1: DEFINING THE BLUE ECONOMY

This appendix provides a summary of definitions for the Blue Economy and arrives at a suitable definition for the Highlands and Islands context.

UN AND WORLD BANK DEFINITIONS

The United Nations has defined the Blue Economy[490] as:

> *…compris[ing] a range of economic sectors and related policies that together determine whether the use of ocean resources is sustainable. An important challenge of the blue economy is to understand and better manage the many aspects of oceanic sustainability, ranging from sustainable fisheries to ecosystem health to preventing pollution. Secondly, the blue economy challenges us to realise that the sustainable management of ocean resources will require collaboration across borders and sectors through a variety of partnerships, and on a scale that has not been previously achieved."*

The UN's Blue Economy concept seeks to promote economic growth, social inclusion and preservation or improvement of livelihoods while at the same time ensuring environmental sustainability. It is a key aspect of the UN's 2030 Sustainable Development Agenda.

Another definition, provided by OECD, characterises the blue economy as "*the sum of the economic activities of ocean-based industries, together with the assets, goods and services provided by marine ecosystems*".[491]

Similarly, the World Bank defines the Blue Economy[492] as sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health. According to this definition, activities in the following sectors and thematic areas are included:

- Fisheries;
- Maritime transport;
- Tourism;
- Renewable energy;
- Waste management; and
- Climate change.

Whilst these definitions of the Blue Economy are useful, they do not offer insight into specific industries or sectors that constitute the Blue Economy. Additionally, many of them are conceived with regard to more developing nations. With that in mind, we need to clearly define and delimit the Blue Economy for the Highlands and Islands.

DEFINING THE BLUE ECONOMY IN SCOTLAND

16.30 Previous research undertaken by ekosgen on the Marine Economy for Marine Scotland considered seven specific sectors:

[490] https://www.un.org/development/desa/en/news/sustainable/blue-economy.html
[491] http://www.oecd.org/innovation/inno/ocean-economy/
[492] https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy

- Commercial capture fishing (fisheries);
- Aquaculture;
- Seafood processing;
- Commercial seaweed cultivation and harvesting;
- Offshore renewable energy;
- Oil and gas decommissioning; and
- Marine tourism.

It is arguable that a definition for the Blue Economy should go wider than this. Work undertaken on behalf of Heriot-Watt University by ekosgen has also included a number of other marine-related sectors, including marine and maritime transport, marine biotechnology, and electricity distribution networks and operators.

Based on a review of existing Blue Economy definitions from a variety of sources (see Appendix 1), it was agreed with HIE that the following sectoral definition is adopted for the Blue Economy:

- Aquaculture (including seaweed cultivation and harvesting);
- Fisheries and commercial capture fishing;
- Seafood processing;
- Marine renewable energy (wave, wind, tidal and geothermal energy), incorporating distribution network operators (DNOs);
- Oil and gas;
- Decommissioning;
- Seabed mining;
- Marine biotechnology and bioprocessing;
- Marine environmental services;
- Marine transport (including trade, shipping, passenger transport) and shipbuilding; and
- Marine and coastal tourism.

Though some definitions include maritime security and surveillance, it was felt that as this typically falls within defence and related reserved matters at the UK level, it should not be included for the purposes of this study. Also, whilst there may be an argument for inclusion of supply chain activities related to the sectors and activities explicitly within scope, it was considered that this will result in too broad a definition. Some of the sources reviewed detail supporting indirect activities, such as blue carbon, financial mechanisms and ecosystem management. However, these activities are considered peripheral to the main Blue Economy sectors.

Also, facilities such as ports and offshore platforms can be classified more as infrastructure rather than as a discrete sector. Ports enable the activities of number of sectors, such as renewable energy, oil and gas, transport, and tourism. Consequently, ports harbours and related land-side infrastructure have been considered as a cross-cutting enabler, along with the Blue Knowledge Economy – the academic expertise that underpins R&D and innovation within the Blue Economy space.

SOURCES FOR BLUE ECONOMY DEFINITIONS

- http://documents.worldbank.org/curated/en/857451527590649905/pdf/126654-REPL-PUBLIC-WBG-Blue-Economy-Report-Bangladesh-Nov2018.pdf
- http://soclimpact.org/blue-economy-sector
- http://www.oecd.org/innovation/inno/ocean-economy/
- http://www.pemsea.org/our-work/blue-economy
- https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/swd-2017-128_en.pdf
- https://read.oecd-ilibrary.org/economics/the-ocean-economy-in-2030_9789264251724-en#page24
- https://sustainabledevelopment.un.org/content/documents/15434Blue_EconomyJun1.pdf
- https://www.dhakatribune.com/business/2019/03/02/potential-sectors-under-blue-economy-identified-but-remain-untapped
- https://www.iora.int/en/priorities-focus-areas/blue-economy
- https://www.oceancouncil.org/wp-content/uploads/2019/04/Social-License-to-Operate-and-the-Blue-Economy-1.pdf
- https://www.riverpublishers.com/pdf/ebook/RP9788793609259.pdf
- https://www.un.org/development/desa/en/news/sustainable/blue-economy.html
- https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy

APPENDIX 2: SUPPORTING SECTOR DATA TABLES

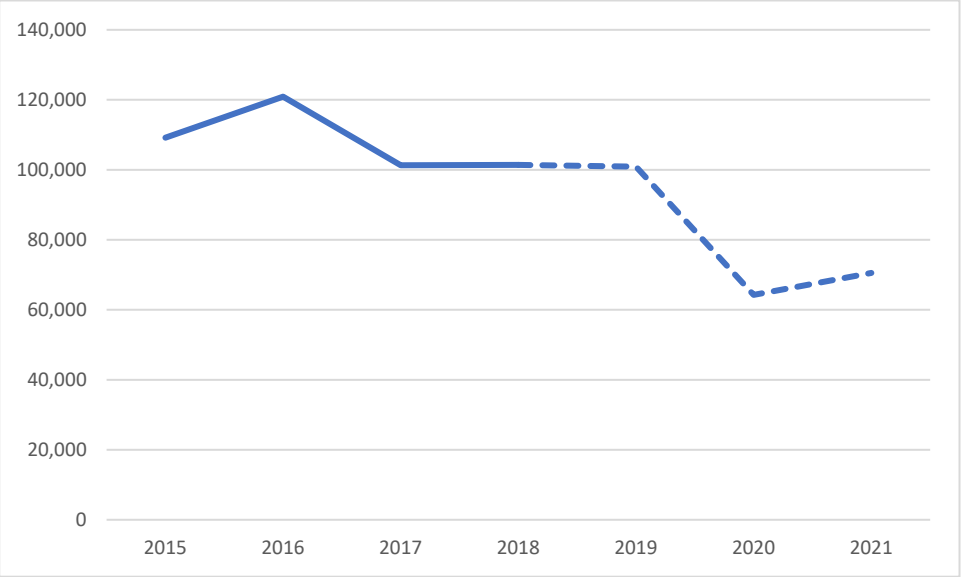
Oil and gas

Table A2.1: Employment in and supported by the Oil and Gas industry, UK

	2016	2017	2018	2019	2020 (Estimate)	2021 (Forecast)
Direct	35,600	31,400	30,400	30,400	25,700	26,900
Indirect	155,100	124,300	116,100	121,700	91,700	91,500
Induced	136,200	118,100	113,400	108,700	61,100	77,500
Total	**326,900**	**273,800**	**259,900**	**260,800**	**178,500**	**195,900**

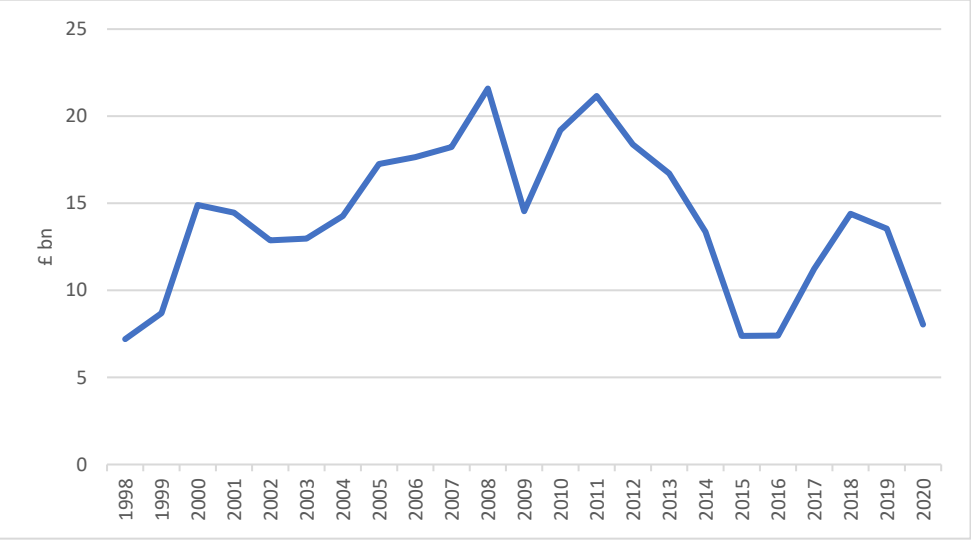
Source: OGUK, 2021

Figure A2.1: Estimated Scottish employment in the Oil and Gas industry, 2015-21



Source: OGUK, 2021; Scottish Energy Statistics, 2021

Figure A2.2: Oil and Gas GVA in Scotland (£ bn)



Source: Scottish Energy Statistics, 2021; Scottish Government Quarterly National Accounts Scotland, 2021

Decommissioning

Table A2.2: Business base, Support activities for petroleum and natural gas extraction by country

Date	UK	England	Scotland	Wales	Northern Ireland
2013	325	125	190	5	5
2014	230	95	130	0	5
2015	235	105	120	5	10
2016	245	110	130	5	5
2017	210	95	110	0	0
2018	210	100	105	0	0
2019	215	105	100	0	5
2020	220	105	110	0	5
2021	200	95	100	0	5
2022	180	90	85	0	5

Source: ONS, UK Business Counts: 2022

Note: All figures are rounded to avoid disclosure. Values may be rounded down to zero, so all zeros are not necessarily true zeros.

Marine transport and shipbuilding

Table A2.3: Annual shipbuilding contracting by builder country/region, 2016-20

	2016	2017	2018	2019	2020
EU	107	63	61	69	25
China	380	669	559	473	350
South Korea	76	207	285	229	185
Japan	178	282	395	340	86
Other Europe	28	49	41	25	23
Other Asia	180	245	129	93	43
Rest of World	68	112	15	13	4
Total	**1,017**	**1,627**	**1,485**	**1,242**	**716**

Source: Clarkson Research, cited by EMSA (2021)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